Analysing the drivers of irrigator drought strategies in the Southern Murray Darling Basin

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Abstract

During the 2000s there has been severe and ongoing drought in the southern Murray Darling Basin, with irrigators facing considerable cuts to their water allocations corresponding with a period of falling commodity prices. Ongoing work has suggested that strategies such as the buying and selling of allocation and entitlement water, the buying and selling of land, reducing the area under irrigation, changing crops and adopting more efficient irrigation infrastructure all have played differing roles in allowing farmers to cope with drought and manage farm viability. This study analyses the influences on irrigator strategy choice during this period of drought; in particular it seeks to answer why some irrigators choose to follow mainly intensive strategies (such as buying land/water, increasing irrigation area and adopting infrastructure), while others choose predominantly defensive strategies (selling land/water and decreasing irrigation area). Two key irrigation areas are studied, the Riverland in South Australian and the Goulburn Murray Irrigation District in Victoria, using 624 telephone surveys from 2008-09. The two irrigation areas are not homogenous, and there are different influences on irrigators' strategies. Irrigator characteristics, farm characteristics, attitudes and off-farm income all play important roles.
Keywords: drought strategies, water, Australia, irrigators, intensive, defensive.

1 Introduction

Water scarcity is intensifying in many irrigation regions in semiarid parts of the world. This increased scarcity is partly caused by an increase in and intensification of drought events but is also policy induced as governments have

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failed to react to increasing environmental consequences of over-extraction of water for consumptive use. Reduced availability of water can potentially have significant socioeconomic impacts on irrigation dependent regions.

The severity of this impact depends both on the policies that government introduce in response to the growing environmental problems and on the strategies that irrigators follow to deal with scarcity. Improving water use efficiency, changing water management strategies and increased productivity can help offset the impact of reduced access to irrigation water. It is therefore important to understand what influences irrigators' choice of drought strategy.

There has been a severe drought in South-eastern Australia since the early 2000s, ending only in 2010. This has emphasized the need to address growing concerns over the environmental impact of over extraction of water for consumptive uses and the need for policies to rectify this problem with minimum socioeconomic impact. Since irrigation is the major water user this will inevitably result in reduced allocation of water for irrigation. In the Murray Darling Basin (MDB) the combination of the drought and policy changes has substantially reduced seasonal allocations forcing irrigators to adopt strategies to deal with scarcity.

Irrigator behaviour and decision making within the MDB during this period therefore provides a unique opportunity to study irrigators' choice of drought management strategy and to identify the factors driving such choices. This paper is based on a survey of 624 irrigators within two key regions of the MDB: the Goulburn Murray Irrigation District in Victoria and the Riverland in South Australia. The next section will briefly discuss the water reform policy development in Australia leading up the drought. The following section outlines the irrigation drought management strategies available to irrigators that have been analysed in this paper. This is followed by a discussion on methodology and data. The last two sections provide a discussion of findings and some conclusions.

2 Some Australian water policy context

The severe drought during the first decade of this millennium has emphasized the need to deal with environmental problems in the major rivers and the need to facilitate structural change within the irrigation industry. These problems were particularly apparent within the MDB, Australia's largest and most important river system. However, environmental problems as a consequence of lack of environmental flows in the MDB has been apparent for a long time and has led to a plethora of government policy starting with a new water policy framework set out by the Council of Australian Governments (CoAG) in 1994. This framework made water markets mandatory in all Australian states, for the first time recognized the environment as a legitimate water user and required all states to define environmental needs in their catchments and to bring extraction back to sustainable levels.

Following concern over the consequences of continued increase in water extraction with the MDB a "Cap" on water use was introduced in 1995 to prevent further increases in surface water diversions and to work towards environmental sustainability. In 2004 the National Water Initiative (NWI) was introduced due to the slow pace of adjustment toward securing water for the environment and introducing efficiently working water markets. The NWI and an associated agreement on addressing over allocation with the River Murray sought to achieve environmentally sustainable social and economic outcomes through water sharing plans which defined the consumptive pool within all catchments, the adoption of feasible market-based mechanisms and efficiency investments to recover water for public benefit outcomes.

The major programs that the Federal Government is implementing with regard to the irrigation is the buying of water entitlements from irrigators to provide critical environmental flows (*Restoring the Balance* program) and the *Sustainable Rural Water Use and Infrastructure* (SRWUI) program in the MDB. These are part of the *Water for the Future* program introduced in 2008 (encompassed a $12.9 billion investment over 10 years, with $3.1 billion allocated to buy water entitlements from willing sellers to secure environmental water in the *Restoring the Balance* program and the remainder devoted to irrigation infrastructure upgrades). As part of the SRWUI program, up to 30 June 2009 irrigators on small blocks could apply for the *Small Block Irrigators Exit Grant Package* [1]. South Australian irrigators have been able to apply for this grant since November 2008; however Victorian irrigators could only apply from February 2009 [2].

2.1 The Riverland and the Goulburn Murray Irrigation District

Irrigators in the Riverland, South Australia (SA) and the Goulburn Murray Irrigation District (GMID) in Victoria (VIC), both part of the MDB, have faced considerable stress in dealing with reduced water allocations, higher temperatures, reduced rainfall and falling commodity prices. In 2008-09 all irrigators in the MDB had their allocations reduced, with Victorian irrigators in the Goulburn and Murray systems only receiving one-third of their water entitlements by the season's end and SA irrigators received less than one-fifth. Table 1 illustrates the historical profile of end of season water allocations in three regions across the MDB.

The Riverland and the GMID have had very different experiences with drought and have very different agricultural productions which call for different drought management strategies and capacities to deal with such strategies. Irrigators within the GMID have traditionally had very high and variable allocation levels; as is apparent from Table 1 the two Victorian systems originally had higher allocations i.e. 200%, and prior to the period covered in the table often had in excess of 200%. Annual production and a large dairy sector have traditionally been able to benefit from this fluctuation in seasonal allocations. It can also be seen that that Victorian irrigators experienced reductions much earlier than irrigators in SA. Prior to 2006/07 seasonal allocations basically not vary in SA. Historically, SA has tried to introduce above 100% seasonal allocations, but this had little uptake since the production in SA is dominated by horticulture and viticulture which cannot easily benefit from access to excess water during a single season. These industries need a consistent and dependable supply. Hence, when the drought started in earnest in 2006, SA irrigators had little experience in dealing with fluctuating supply and managing an industry which had little short-term adaptive capacity. On the other hand Victorian irrigators have had long standing experience with this and a production with a high level of seasonal adaptability.

Table 1: Final water allocations in three regions of the Murray Darling Basin.

	Goulburn System	**Victorian Murray System**	**SA Murray System***
1995/96	150	200	100
1996/97	200	200	100
1997/98	120	130	100
1998/99	100	200	100
1999/00	100	200	100
2000/01	100	200	100
2001/02	100	200	100
2002/03	57	129	100
2003/04	100	100	95
2004/05	100	100	95
2005/06	100	144	100
2006/07	29	95	60
2007/08	57	43	32
2008/09	33	35	18
2009/10	71	100	62

* Information provided by South Australia's Department of Water, Land and Biodiversity Conservation

3 Irrigation drought management strategies

There are a range of management strategies irrigators can adopt to allow them to manage reduced water allocations and drought conditions. One of the major strategies to manage seasonal risks and conditions includes trading in the allocation and entitlement water markets [3]. They may also implement other strategies to reduce their exposure to risk, such as adopting irrigation efficiency improvements and management practices, reducing production of high water use crops and switching to alternative land uses. Increasing output (through buying additional water or land) is another strategy irrigators may adopt to capture additional benefits from economies of scale. Other general drought management strategies include storing fodder, flexible (and conservative) stocking rates, off-farm income, minimising environmental risk, minimising financial debt and costs, crop insurance and various taxation schemes [4].

We classified irrigators' responses to reduced water allocations and water policy changes into David's [5] typologies of business strategies, namely: intensive and defensive. Intensive strategies often require offensive attacking behaviour to improve a businesses' competitive position by increasing their market share, expanding their market boundaries and improving/changing their present products or services. In the context of this paper, an intensive irrigator strategy can be either ‘attacking’ (purchasing land, increasing irrigation area, purchasing water entitlements) or ‘adopting’ (having adopted irrigation efficiency improvements over the past five years). Defensive business strategies generally refer to retrenchment, divestiture or liquidation [5]. In this paper, we refer to defensive strategies as selling land, reducing irrigation area or selling water entitlements. In other words, irrigators are deploying ‘defensive’ strategies. Irrigator objectives with defensive strategies are generally to try to find ways of staying on the farm and within the community until retirement, however they can be a viable drought strategy to deploy to minimise costs and debt. Hence, irrigators have three overall strategies they could deploy in absolute terms, or in combination with one another, in response to recent drought in South-eastern Australia: attack, defend or adopt.

Generally in business, intensive strategies in competitive markets tend to result in more efficient businesses that adapt to the changing external environment and, therefore, are able to remain in business. Defensive strategies may result in inefficient businesses, liquidation or even exit [5]. However, this may not be the case for irrigators. There is an extensive literature in agricultural economics on the best strategies for farmers to employ in terms of drought, albeit most of this work has been done for dryland farmers. At some times, defensive strategies are the most profitable for farmers to undertake, especially in times of drought. This paper seeks to understand what drives the deployment of intensive and defensive strategies by irrigators. The aim of this paper is to explore the motivation behind irrigators’ strategies. Do farmer characteristics or attitudes make a difference? Or, do the farm characteristics determine strategy choice?

4 Methodology and data description

4.1 Data collection

Mail-out surveys were posted in November 2008, followed by telephone surveys with additional attitudinal questions conducted with the respondents (plus additional irrigators) in the Riverland (n=324) and the GMID (n=300). The surveys collected information on: 1) personal characteristics; 2) farming operation; 3) management strategies; and 4) attitudes toward a range of issues such as tradition, community, profitability, lifestyle, environment, and technology.

4.2 Data analysis techniques

Factor analysis was used to identify the underlying value constructs from 56 attitudinal questions asked. Lane-Miller *et al.* [6] explains this in more detail. Five factors were identified: Succession, Commerce, Tradition, the Environment and Technology. The factor scores from the five constructs were used as attitudinal explanatory variables in our regression analysis.

Table 2: Variable definitions.

Variables	Definitions
Intensive	Intensive index (0=no strategy, 1=one strategy, 2=two or more strategies)
Defensive	Defensive index (0=no strategy, 1=one strategy, 2=two or more strategies)
Efficiency	1= efficiency improvement in irrigation in the last five years; 0 otherwise
age	Farmer's age
male	1=male; 0 otherwise
farmyears	Number of years spent in farming
liveyears	Number of years spent in living on a farm
yearsremain	Number of years remained in farming
farmfamily	1=if from a farming family; 0 otherwise
lowedu	1=if highest education is Year 10 or below; 0 otherwise
postg	1=if highest education is a postgraduate degree; 0 otherwise
successor	1=if expect a family member to take over the farm; 0 otherwise
wfp	1=if have a whole farm plan; 0 otherwise
farmsize	size of a farm five years ago, in thousand hectares
irrisize	size of irrigation area five years ago, in thousand hectares
tothwater	total water entitlement five years ago, in thousand MLs
pgrape	percentage of irrigation area in grape five years ago
pfrunut	percentage of irrigation area in fruit and nuts five years ago
pgrazing	percentage of irrigation area in pasture for grazing five years ago
pseed	percentage of irrigation area in pasture for seed, hay or silage five years ago
pcereal	percentage of irrigation area in cereal five years ago
landcare	1=if a member of Landcare; 0 otherwise
waterwatch	1=if a member of Waterwatch; 0 otherwise
ftcomfarm	1=if a full time commercial farm; 0 otherwise
offfarmincome	% of income from off-farm work (0%, 12.5%, 37.5% 63%, 88% and 100%)
contfarming	Likert scale on certainty of remaining farmer (1=uncertain, 5=certain)
info_gov	1=if information source is government; 0 otherwise
info_pri	1=if information source is private consultants; 0 otherwise
Drip	percentage of irrigation area with drip irrigation
reuse	percentage of irrigation area connected with a reuse system
offfdr	percentage of irrigation area with off-farm drainages
f1_tradition	Factor score of tradition
f2_sucession	Factor score of succession
f3_commercial	Factor score of commerce
f4_environ	Factor score of environment
f5_tech	Factor score of technology

Our first model of intensive strategy (attack) consisted of three potential strategies that farmers may have undertaken in the past five years: (1) purchase land; (2) buy water entitlements; and/or (3) increase irrigation area. Our first defensive strategy model (defend) also consisted of three potential strategies: (1) sell land; (2) sell water entitlements; and/or (3) decrease irrigation area. An index was constructed from 0 to 2 to indicate the extent to which intensive (or defensive) strategies were adopted. A value of 0 indicates no strategy was undertaken, a value of 1 indicates one strategy was undertaken; and an index of 2 indicates that at least two strategies were undertaken. The indexes of intensive and defensive strategies are ordinal outcomes and are appropriately estimated by an ordered probit model (see Greene [7] for more model details). We used a binary probit regression to model irrigators' adoption of irrigation efficiency improvements (adopt). The dependent variable is coded as 1 if more efficient irrigation infrastructure was adopted in the last five years and 0 otherwise (see Greene [7] for more model details).

The independent variables include a range of socioeconomic characteristics of farmers, farm characteristics and the five value constructs obtained from the factor analysis, with variable definitions in Table 2. In the efficiency improvement model, the irrigation infrastructure variables are not included as they are likely to be the result of improvements undertaken and not the causes of such improvements.

5 Results and discussions

Table 3 presents the results of ordered and binary probit regressions of the intensive and defensive strategies. The final models have reasonable fit, no problems with multicollinearity and are estimated with robust standard errors.

These results suggest some significant differences between irrigators in the Riverland and the GMID. This is probably a reflection of the different industry types within the two study regions and levels of water stress felt as outlined in section 2.1. The variables that explain the intensive, defensive and efficiency improvement strategies also differ considerably, implying that irrigators undertaking different strategies are influenced by different personal and property characteristics as well as different values and attitudes.

For Riverland irrigators, almost none of the farmer characteristics are significant explanatory variables for undertaking intensive or defensive strategies in the last five years. Farm characteristics, on the other hand, include a few significant variables that influence the extent of the intensive or defensive strategies. As Riverland irrigators are predominately grape growers, it is interesting to note that an increase in the percentage of the irrigated area planted in grapes is associated with a decrease in the extent of both intensive and defensive strategies. This implies that the higher the percentage of the irrigated land that is committed to wine grape production, the more likely it is that irrigators maintain constant strategies, which highlights the long-term nature of vines and the difficulty that grape growers experienced trying to stay alive during the drought.

Some positive results are that irrigators were able to undertake more intensive strategies if they have larger water entitlement and deploy more defensive strategies if they have a higher proportion of their household income from off-

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farm activities. Attitudes by Riverland irrigators to the environment are interesting: farmers who are looking to expand and are employing intensive strategies have positive attitudes to the environment and farmers' stewardship role; while those employing defensive strategies have less positive environmental attitudes. This could indicate that defensive irrigators are on their way out of farming and irrigation and feel under threat from environmental demand, while intensive irrigators intend to expand and remain in the industry in the long term and therefore may appreciate the need to resolve environmental issues in order for the industry to remain viable.

Table 3: South-eastern Australian Irrigator Strategies.

	Intensive		Defensive		Efficiency Imp.	
Variable	Riverland	GMID	Riverland	GMID	Riverland	GMID
Age	0.014	-0.043***	-0.0004	-0.015	-0.027	0.005
Male	-0.150	-0.043	0.309	-0.153	0.636**	-0.13
Farmyears	-0.017	-0.022**	0.011	-0.001	0.002	-0.015
Liveyears	0.008	0.014**	0.001	-0.002	-0.014*	0.005
Yearsremain	0.016	-0.004	0.001	-0.013	0.022	0.004
Farmfamily	0.252	-0.185	0.101	0.400	-0.473	-0.23
Lowedu	-0.168	0.172	-0.167	0.214	-0.279	0.23
Postg	-0.177	0.265	-0.186	-0.162	1.214**	-0.15
Successor	-0.020	0.360**	0.147	0.106	-0.011	-0.222
Wfp	0.155	0.554**	-0.227	0.100	0.992***	0.317
Farmsize	0.489	-0.239	-0.064	-0.194	0.725	-0.048
Irrisize	0.341	-0.748	-1.457	-0.320	37.537	1.745
Tothwater	0.564*	0.467*	0.327	0.265	2.461	-0.068
Pgrape	-0.010**	n.a.	-0.005**	n.a.	0.006	n.a.
Pfrunut	-0.008	-0.012	—	-0.014**	0.002	-0.003
Pgrazing	n.a.	-0.007	n.a.	-0.003	n.a.	-0.004
Pseed	n.a.	0.001	n.a.	-0.004	n.a.	0.005
Pcereal	n.a.	0.003	n.a.	-0.006	n.a.	0.033
Landcare	-0.518	0.286	-0.611**	0.158	-0.094	-0.05
waterwatch	0.405	0.419	-0.207	0.002	1.095**	0.16
ftcomfarm	0.099	0.738**	0.440**	-0.037	0.368	0.910**
offfarmincome	-0.002	0.001	0.006**	0.007**	-0.0002	-0.001
contfarming	0.045	0.225***	-0.032	-0.175***	0.186**	0.058
info_gov	0.393*	-0.149	0.071	-0.147	-0.12	-0.02
info_pri	0.050	-0.275	-0.030	0.121	0.155	-0.156
Drip	0.032	0.945	-0.128	-0.285	—	—
Reuse	0.002	0.001	0.003	0.005**	—	—
Offfdr	0.003	-0.0003	-0.003	-0.002	—	—
f1_tradition	-0.141	-0.031	-0.113	0.176**	0.009	-0.072
f2_succession	-0.067	-0.026	-0.102	-0.136	-0.345**	0.096
f3_commercial	0.029	-0.099	-0.085	0.150*	0.22	-0.178
f4_environ	0.217*	-0.090	-0.222**	0.037	-0.241*	0.143
f5_tech	0.156	-0.150	-0.076	0.037	0.236*	0.177
cut1/constant	1.689*	-0.353	0.666	-1.606*	0.62	0.646
cut2	2.630***	1.087	2.174***	-0.111	n.a.	n.a.
No. Of Obs.	259	262	259	262	260	268
Pseudo R2	0.14	0.20	0.14	0.11	0.38	0.27
Log likelihood	-117.29	-149.28	-204.31	-234.86	-60.04	-72.93

***, **, * signify significance level at 1%, 5% and 10% respectively.
n.a.: not applicable; —: variable dropped due to multicollinearity (pfrunut) or possible endogeneity.

Within the GMID, irrigators with future plans for their farm in terms of having a whole farm plan, having a successor in place, and expecting to continue farming for a long period of time were much more likely to have implemented intensive strategies in the past five years. The findings suggest that farmers deploying intensive strategies in GMID usually have large, well planned, commercially operated farms that would be passed on to the next generation. This result is quite different to the Riverland situation.

The issue of succession is difficult for many farmers, and Kuehne *et al.* [8] suggested that Riverland irrigators have not handled the issue well. This is illustrated by one irrigator's succession comments and their frustration over his parent's farm:

You start to get all those emotional things happening. … We look after that property for them, manage it and do all the work because they are eighty year olds… we're not about to say to them well we're sorry you're out on your ear, you can't do that; but [they are] a generation of people who didn't do forward planning they did not think of generational change and it's incredibly difficult to talk about. We've been trying, trying to talk it through for fifteen years and it's not talked about, and seen as their private business.

Such a situation makes succession planning difficult, and the results of the GMID models suggest that the farm families which have sat down and planned how the succession should take place were more likely to have undertaken intensive strategies.

In both states, an increase in off-farm income meant that irrigators were much more likely to undertake defensive strategies, signalling that off-farm income is associated with farms selling land or water or reducing irrigation area. They may either be looking to just keep the farm afloat while they maintain their lifestyle or they may be preparing for exit. GMID irrigators who undertook defensive strategies were more orientated toward tradition issues, their defensive strategies are directed toward maintaining the farm and their lifestyle until retirement, and, hence, also linked to the findings related to off-farm work. To stay on the farm they are cashing in on farm assets and replacing farm income with off-farm income. GMID irrigators were less likely to undertake defensive strategies if they had a higher percentage of irrigation area planted in fruit or nut trees while the percentage in pasture and cereal crops do not appear to influence either intensive or defensive strategies. Yet again it reflects the differences between farmers with permanent plantings and cereal or broadacre farmers.

In the Riverland, both farmer (male, liveyears, postg, wfp, waterwatch and contfarming) characteristics and farmer attitudes (succession, environ and tech) influence the probability of having undertaken irrigation efficiency improvements in the last five years. It appears that decisions to improve irrigation efficiency are driven by education, farm planning and conservation awareness. For Riverland farmers, holding strong value orientations towards succession and the environment is negatively related to the likelihood of having undertaken efficiency improvements while a favourable attitude towards technology is positively related to having undertaken efficiency improvements.

In the GMID, there was only one significant influence in the efficiency improvements model. Being a fulltime commercial farmer has a significantly positive influence on having undertaken efficiency improvements. Few significant explanatory variables in the GMID efficiency improvement model are in contrast to Liao and Martin's [9] study in 2006-08 on dairy farms that suggested farmer education, farm income and size were important determinants on farm innovation levels. However, this study was undertaken earlier than ours, and only utilized simple statistical analysis when making these suggestions. The severity of the continuing drought may have forced irrigators in GMID to make considerable more changes to their water practices. For example, Liao and Martin's [9] found that on average 42% of dairy farms had adopted new irrigation and water management practices, where we found that by early 2009, 88% of our GMID respondents had adopted some sort of irrigation efficiency in the past five years. This indicates that continued drought has forced a large number of irrigators to improve their irrigation efficiency.

6 Conclusions

This study has investigated what drives the strategic intensive and defensive drought management choices of irrigators. In particular, we studied attack, defend and adopt strategies in two key irrigation regions: the Riverland of South Australia and the GMID in Victoria. Our results show that the influences on the employment of intensive and defensive strategies by irrigators were very different within the two regions reflecting the differences in production and past experience in managing fluctuating supply. This indicates a disparity of influences on irrigator drought management strategies including both personal and property characteristics as well as values and attitudes. The type of production also plays an important role in influencing irrigators' intensive, defensive or adopting strategies. Farmers who seem to have a well planned and long term view of their farms, in terms of having a whole farm plan, having a succession strategy and planning to be continuing farming in the long-term, tend to be more responsive to the drought conditions by deploying more intensive strategies. On the other hand, there is some evidence that farmers with negative environmental attitudes and higher off-farm income are more likely to be deploying more defensive strategies.

Our paper provides some direction in understanding the main drivers of farmers' responses to difficult external environmental conditions and it offers useful policy implications for how to best assist farmers with structural adjustment. Nevertheless, this paper does not provide any indication on how different strategies in general influence farm viability. Future research investigating how these strategies influence farm viability would be beneficial.

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