The flexibility and adaptability of farm systems in the Mildura Old Irrigation Area

A report for *Rural and Resources Policy*

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Executive Summary

Introduction

In 2011 there had been a persistent decline in the profitability of some of the major primary horticultural industries in the Mildura Old Irrigation Area (the Area). There was a concern that a combination of low commodity prices, protracted drought, and floods in 2010-2011 was threatening the viability of existing farms in the Area. There was also concern that government policy decisions, such as the termination of the Exceptional Circumstances Relief Program and uncertainty over funding for a $103 million upgrade of the public irrigation infrastructure in the Area, could impact unfavourably on the capacity of farmers in the Area to make the changes necessary to maintain viable businesses, or to adjust out of agriculture.

In this research we used the farm flexibility framework (Kaine *et al.* 2010; Cowan *et al.* 2013) to characterise the tactical and strategic flexibility of farm production systems in the Area in relation to variability in critical inputs and variability in output prices. We also considered the role played by financial resources in constraining the exercise of this flexibility and the consequent implications for the viability of farm businesses.

Having characterised the flexibility of farm production systems in the Area, we identified options for adaptation and adjustment being considered by farmers in the Area. Knowledge of these options, when coupled with consideration of the constraining effect of financial resources on farm flexibility, revealed the limited capacity of farmers in the Area to adapt or adjust their farm businesses in response to changes in critical inputs and output prices. Given this, we identified implications for the region and provided insights and suggestions for improving the capacity of farm businesses in the Area to adapt and adjust.

Flexibility classification

The interviewees identified a number of different sources of variability. Three of these were identified as being critical and having an unfavourable impact on their business in recent times: irrigation water, extreme rain and associated flooding, and output prices. These three sources of variability were selected for analysis in this research.

All of the farmers we interviewed were classified as ‘rigid’ in relation to their ability to absorb each of the three sources of variability analysed in this research. This means that farmers have limited tactical and strategic flexibility to respond to unfavourable changes in farm input and output conditions.

Institutional factors

A number of interviewees identified constraints on their capacity to manage the impact of variability on their farm system, or to make changes to their farm, which they related to institutional factors (i.e. the unbundling of water from land, access fees for irrigation and changes in subdivision rules). These institutional factors, combined with the recent loss of Exceptional Circumstances funding and the then-rejection of the business case developed by Lower Murray Water seeking funding for the upgrading of the regional irrigation infrastructure, had depleted farmer confidence in government support for primary production in the region.

Adaptation and adjustment options

A key determinant of adaptation and adjustment options that interviewees were considering was their long-term business plan, which fell into either of three categories: building, maintaining or winding back.

Given recent bad years, farmers in a building phase could not afford, or were not confident, to expand as they would like. Some of these farmers shifted to a maintaining phase. Other interviewees in the building phase found that their financial reserves were so depleted that they could not afford to redevelop their farms, nor expand. Many of these farmers were running at a loss and could not move to a maintenance phase because of a high level of debt. Many of them were skirting the edge of a vortex leading to business failure while others were heavily subsidising the farm business; neither of which was sustainable.

In recent bad years, interviewees in a maintaining phase had either increased their level of debt or stagnated and many were holding off on redevelopment. Some farmers in a maintaining phase may shift to a winding back phase because recent problems had made it more difficult to maintain equity in the farm.

After recent bad years, interviewees who were winding back had few options available to them to achieve their plans regarding the farm business. Low rural land prices and new subdivision rules left some of these interviewees feeling that they were stuck with the farm. The water access fees constrained them even more, making the option of scaling back difficult.

Conclusions and recommendations

Overall, in the face of recent variability in the supply of irrigation water, extreme rain and low output prices, the rigid production systems of farms in the Mildura Old Irrigation Area resulted in steady reductions in financial reserves and a loss of confidence in the future profitability of farming. Changes in the institutional environment added to the erosion of financial reserves and confidence. These factors had a constraining effect on the plausible options available to farmers.

It seemed likely that variable irrigation allocations, extreme rainfall and low output prices would continue to bedevil grape farmers in the region. The implication of this was that, unless something changed, farms in the Area would continue to decline in profitability, entering a vortex that few may escape.

Through the farmer interviews, a number of key insights and suggestions were identified reflecting the experience of these farmers at the time of the interviews. These are presented using the farm flexibility framework as a lens.There are a number of options that government could consider for supporting viable primary industries in the Area. Importantly, this does not take into account other policy criteria and interventions that have not been included in this paper. Nor does it include any subsequent changes in the Area.

Actions that may increase tactical flexibility and therefore the capacity for production systems to absorb variability in irrigation water

- The replacement of old pumps to reduce the frequency of pump failure would be useful for growers when dealing with a low irrigation allocation, as pump failures (and perceptions of a high risk of pump failures) removed tactical options available to farmers.
- Investment in changing the regional irrigation infrastructure to a piped, pressurised system that delivers clean water on demand, all year round. This may increase tactical flexibility in two ways:
  - By providing improved access to irrigation water for farmers through a reduction in uniform demand for water from the irrigation system; and
  - By enabling farmers to consider changing their varietal mix based on having reliable and timely access to irrigation water at different times of the year.
- The provision of earlier, more accurate information about seasonal irrigation allocations would help maximise the tactical options available to farmers.

Actions that may increase tactical flexibility and therefore the capacity for production systems to absorb the effects of flooding

- Identification of areas where the impacts of flooding are the highest and consider possible structural changes such as improved drainage and pumping.

Actions that may increase tactical flexibility and therefore the capacity for production systems to absorb both extreme rainfall and low irrigation allocation

- Investing in research regarding the development of rain-tolerant, drought-tolerant root stocks may reduce the sensitivity of production systems to variable rainfall and irrigation water.
- The provision of financial support to enable conversion to more drought-tolerant and rain-tolerant root stock may reduce the burden for farmers, given the minimum of three years in lost production associated with changing root stock. Such support may also have a profound effect on farmer confidence of government support for primary production in the Area.
- Further research into the practice of grafting may lead to the development of relevant practices for farmers seeking to change varieties when adapting a farm production system. Such research could include consideration of the responses of different types of root stock to grafting, practices for reducing vulnerability to disease associated with grafting and ways to enable a faster return to production.

Actions that may enable the implementation of extension programs aimed at increasing the tactical flexibility of production systems

- Encourage the consideration of the relationships between tactics and farm flexibility by extension service providers in the support they offer to the farmers.
- Use the knowledge acquired by farmers through experience with low irrigation allocations, flooding and extreme rainfall to develop extension information for better managing these events in the future.

Actions that may increase strategic flexibility and therefore the capacity for production systems to absorb variability in irrigation water

- Investment in changes to the regional irrigation infrastructure to a piped, pressurised system that delivers clean water on demand, all year round. This would enable farmers in the region to contemplate producing a greater mix of outputs.

Actions that may increase the capacity of farmers to adapt and adjust their farm businesses, thereby supporting viable primary industries in the Area

- Consider options to minimise the impacts of barriers to land transactions, such as subdivision rules and amalgamation of titles.
- Removing or reducing the irrigation delivery share exit fees may increase the capacity of farmers to adapt or adjust by facilitating the transfer of irrigated land to dryland production and increasing the capacity of farmers who are 'stuck' in the winding back phase to adjust out of agriculture. However, consideration would have to be given to the potential of unintended consequences from the removal or reduction in exit fees (for example, the risk of a large number of farmers dewatering their properties, leaving the remainder to bear an unsustainable proportion of the costs of maintaining the irrigation network).
- Consider how government policy reduces the flexibility, financial reserves and confidence of farmers with the view to identifying options to reduce the regulatory burden and to minimise policy impact on flexibility and confidence (for example, limits on water trading and delivery share exit fees).
- Consider how government policy impedes farmers from exiting agriculture, such as asset levels allowed under the exit packages and subdivision rules.
- Consider how government policy can unexpectedly impede the transfer of irrigated agricultural land, such as assisted exit schemes that require the stripping of irrigation infrastructure and prohibit irrigating for several years.

Actions that may enable the implementation of extension programs aimed at increasing the capacity of farmers to adapt and adjust their farm businesses

- It may be useful to consider the development of extension advice on comprehensive financial analysis of the complete 'family business'.
- Advice, information and counselling support for exiting agriculture (for example, how to sell multiple properties with different titles) may help farmers considering adjusting out of agriculture in their decision making, which may increase the rate of exit.

If circumstances remained as they were in the Mildura Old Irrigation Area then, overall, farming would continue to lose viability. The only apparent alternative was to increase farm flexibility through adaptation or adjustment. Although, even if suitable adaptation and adjustment options were found, not all farmers were in a financial position to make the necessary changes. Nor did the institutional environment of the time instil confidence in farmers to finance such changes.

Introduction

In 2011 there had been a persistent decline in the profitability of some of the major primary horticultural industries in the Mildura Old Irrigation Area (the Area). There was a concern that a combination of low commodity prices, protracted drought and floods in 2010-2011 was threatening the viability of existing farms in the Area. There was also concern that government policy decisions such as the termination of the Exceptional Circumstances Relief Program and uncertainty over funding for the $103 million upgrade of the public irrigation infrastructure in the Area, could impact unfavourably on the capacity of farmers in the Area to make the changes necessary to maintain viable businesses, or to adjust out of agriculture. This had implications for the region.

A major determinant of farm viability is the capacity of a farm business to manage variability in the operating environment that impacts directly on the farm system. Fundamental determinants of this capacity are the tactics and strategies that are embedded in the farm production system. Consequently, understanding the capacity of farm production systems in the Area to absorb variability in critical inputs and output prices should offer useful insights into the state, and future, of primary production in the Area.

In this research we used the farm flexibility framework (Kaine *et al.* 2010; Cowan *et al.* 2013) to characterise the tactical and strategic flexibility of farm production systems in the Area in relation to variability in critical inputs, and variability in output prices. We also considered the role played by financial resources in constraining the exercise of this flexibility and the consequent implications for the viability of farm businesses.

Having characterised the flexibility of farm production systems in the Area, we identified options for adaptation and adjustment being considered by farmers in the Area. Knowledge of these options, when coupled with consideration of the constraining effect of financial resources on farm flexibility, revealed the limited capacity of farmers in the Area to adapt or adjust their farm businesses in response to changes in critical inputs and output prices. Given this, we identified implications for the region and provided insights and suggestions for improving the capacity of farm businesses in the Area to adapt and adjust.

How farmers manage variability

Variability in the physical production of farms is challenging as it affects profitability, potentially threatening the survival of the business. Variable farm performance reflects, in part, the variability of the operating environment (Dillon 1992). To seek a consistent business performance a farmer must manage this variability from the operating environment.

A farmer seeks to manage variability by organising the structure of the farm production system so that the range of behaviours of the farm matches, as much as is reasonably possible, the range of relevant variability in the operating environment (Ashby 1969). In other words, ideally, farmers make strategic decisions regarding what to produce and how to organise the farm production processes to produce it, so that they have enough options in their farm system to prevent variability in inputs, and in output prices, from unfavourably affecting the financial performance of the farm.

When the structure of a farm production system prevents variability in inputs and in output prices from generating variability in farm performance the farm system is absorbing the variability from the operating environment. Put another way, the capacity of a farm production system to absorb variability from the operating environment is the extent to which the system can continue to produce products that generate sufficient profit, without requiring change to system structure (Kaine and Cowan 2011).

When a farmer has to change the structure of the farm production system to return it to a state where it can absorb variability adequately, this is adaptation from a general systems perspective (Weinberg 2001). In this context adaptation can be described as a change in strategy: what is being produced and how the business is organised to produce it. This conceptualisation aligns with that used by the Intergovernmental Panel on Climate Change in which adaptation is described as ‘changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change’ (Smit *et al.* 2001, p. 881).

When changes in the state of the operating environment require a level of structural change to the farm production system such that the farm business strategy is no longer viable, then the farm system must transform into a new system or fail (Weinberg 2001). This aligns with common conceptualisations of adjustment in agriculture including farms exiting agriculture (Stayner 1997; Harris 2005; Malcolm et al. 2005; Godden 2006).

All change in structure comes at a cost, including once-off switching costs and constraints on future decisions (Crouch 1981; Holt and Schoorl 1985; Simon 1993; Leeuwis 2004).

Flexibility in farm systems

Flexibility in farm systems is used here to refer to the capacity of the farmer to offset the unfavourable impacts of unforeseen variations in the supply of critical farm inputs (or in output prices) by modifying the behaviour of the farm production system in a timely manner.

There are two fundamental ways that farmers absorb variability in critical inputs. One way is to alter the use of the critical input. The other is to change the output mix in order to reduce reliance on the critical input. In this section we describe a framework for conceptualising the relationship between these two ways of managing input variability that allows us to characterise different kinds of flexibility in farm production systems (Kaine *et al.* 2010; Cowan *et al.* 2013). The description of the framework here is based on Cowan *et al.* (2013).

The capacity to alter the use of critical inputs in farm production systems and change the output mix of these systems is constrained in three ways (Wright 1985; Murray-Prior 1994). First, the long production cycles characteristic of agriculture limit the opportunities available for farmers to make investment and management decisions. Consequently, opportunities to alter the use of inputs or change outputs are necessarily limited in themselves. This also implies that the timeliness of relevant information may be important. Second, asset fixity can cause considerable costs to arise when switching between investment paths (Leeuwis 2004). Third, technical constraints imposed by technology and the characteristics of location will constrain opportunities for altering the use of inputs, or changing output mix.

Given these constraints we can now consider how the use of tactics enables the farmer to alter the use of inputs and how strategy enables the farmer to alter the output mix.

Using tactics to alter the use of critical inputs

One way that farmers can manage variability in critical inputs is by using tactics to alter the use of the input. Tactics are pre-programmed actions available to the farmer that do not involve having to make changes to the structure of the farm system. Timely activation is crucial for a tactic to be effective; therefore tactics tend to be more tightly coupled within the farm system to enable a quick response (Glassman 1973).

A farmer can alter the use of a variable input in three ways: by altering the timing of the use (within the day or throughout the season); substituting another input for the variable input; and by modifying the amount of the input used.

Tactical flexibility refers to the portfolio, or repertoire, of pre-programmed actions, at a point in time, available for the farmer to activate as needed in response to a change in a critical input. The tactical flexibility of a farm production system depends on the average capacity of tactics to match the variability of an input, and the number of tactics available. Hence, the larger the portfolio of tactics available for an input, and the greater the average capacity of a tactic to match the variability in that input, the greater is the tactical flexibility of the farm system.

Logically, a farmer can increase the farm's tactical flexibility by expanding the portfolio of tactics to match the variability of an input. This would require some change in the technologies or practices used in the farm system. Given the more tightly-coupled relationships of tactics to other components of the system, expanding the portfolio of tactics would entail changing the structure of the farm system.

Put another way, when a farmer uses the existing portfolio of tactics to respond to a change in a critical input, this is absorbing the change in the supply of the critical input. When a farmer modifies the portfolio of tactics to better absorb a change in a critical input this is adapting the farm system because this is changing the structure of the farm production system.

Tactics are input-specific responses built into the farm production processes. This means that an individual farm production system may have little tactical flexibility in relation to one input but have considerable tactical flexibility in relation to another. Given many critical inputs are variable, a farmer will need to include a portfolio of tactics into the farm system for each input. For example, a grape grower may use a farm dam as a tactic to manage a variable surface water allocation and use overhead sprays as a tactic to manage days of extreme temperature.

Some tactics may be used for managing variability in a variety of inputs. For example, a dairy farmer may use a silage pit to store feed as a tactic for managing either variability in feed production resulting from variability in water supply, or variability in the supply of purchased feed. This may bring benefits by spreading the costs associated with adopting, integrating and managing a new tactic within the system (Villano et al. 2010). This may also increase the risk to the system if the tactic fails.

Summary Box 1: Tactics and tactical flexibility

- Tactics can be used to alter use of an input.
- Tactics are pre-programmed actions available to the farmer without changing farm structure.
- The use of an input can be altered in three ways:
  - altering the timing of the use,
  - substituting another input for the variable input, and
  - by reducing the use of the input.
- Tactical flexibility refers to the portfolio of tactics available for the farmer to use in response to a change in a critical input.
- Tactical flexibility is determined by the number of tactics available and the capacity of each tactic to match the variability in an input.

Using strategy to reduce reliance on critical inputs

In addition to using tactics to alter the way an input is used, farmers can manage variability in inputs by changing their output mix to reduce reliance on the critical input. Given that strategy has been described as decisions about what is going to be produced and how the business is going to be organised to produce it, this means choices about the mix of outputs to be produced from a farm system are strategic choices.

In this context, the capacity of a farmer to deliberately vary the composition of their output mix in response to extant or imminent variation of an input, without changing strategy, is a measure of the farm's strategic flexibility. The greater the capacity to alter the mix of outputs of the farm system without changing strategy, the greater the strategic flexibility of the system. Strategic flexibility is inherent in the repertoire of outputs that can be produced with the current strategy.

Put another way, some farmers develop a farm business strategy that deliberately allows for some variation in output mix. Such a strategy requires loose coupling among the components of the farm system.

To increase their strategic flexibility a farmer must change their farm business strategy, the set of outputs that may be produced. Fundamentally, this would require the addition of a novel output to the feasible output mix. Such a change would entail a change in farm system structure and is, therefore, adaptation.

Finally, although tactics are subordinate to strategy, investments to expand tactical flexibility can have strategic implications. This is because changing the portfolio of tactics may change how the output will be produced, which is a change in strategy.

Summary Box 2: Strategies and strategic flexibility

- Strategy can be used to reduce reliance on a variable input.
- Strategies are decisions about what is going to be produced and how it will be produced in the farm system.
- This means that strategy determines the farm output mix.
- Strategic flexibility is the capacity of the farmer to change the output mix in order to reduce reliance on a variable input, without changing strategy.
- The greater the capacity to deliberately alter the mix of outputs of the farm system the greater the strategic flexibility of the system.

Flexibility and variability in output prices

There are few ways, usually, that farmers can address variability in output prices. Farmers can set up their farm businesses to:

- Use forward or future contracts to change the relative impacts of production risk and price risk,
- Target niche markets where price variability is expected to be smaller than in pure commodity markets,
- Diversify output to hedge price risk,
- Alter output mix in response to relative price expectations, or
- Create the capability to modify timing of supply.

Only the last two of these options may offer some flexibility to the farm business.

Altering the output mix in response to relative price expectations may increase strategic flexibility to output price variability. Such strategic flexibility relies on reliable and timely information about price expectations. Price information quality tends to be better the shorter the production cycle of the enterprise that is involved. Therefore, the longer the production cycle is the poorer the quality of necessary information is and the less effective this strategy is in offsetting the impacts of output price variability.

Creating the capacity to modify the timing of supply may be a way of increasing tactical flexibility to manage variable output prices. The effectiveness of a farmer controlling the timing of supply depends, in part, on the continuity of supply in the market. For example, there will be less capacity to match supply to price movements for a product that can only be sold on a limited number of occasions than for a product that can be sold more continuously throughout the year.

It's all a matter of time

The tactical and strategic flexibility that can actually be exercised depends on the timeliness of information (signals) from the operating environment. When information that is necessary to make a choice between alternative responses arrives too late for an alternative to be implemented, then that alternative is effectively removed from consideration (Ashby 1969). Thus, untimely information reduces farm flexibility.

This is particularly salient with respect to output prices as, typically, predicting changes in output prices is problematic. This places farmers in a position where they cannot reliably anticipate changes in output prices, they can only respond after price changes have occurred.

A classification of farm flexibility

In this section we classify farms into four types that characterise the different mix of tactical and strategic flexibility that might occur in relation to a variable critical input or output price (see Figure 1) (Kaine *et al.* 2010; Cowan *et al.* 2013). While we present four different ideal types of flexibility mixes, they should be considered as resting on two continuums.

Rigid farm systems

Farm systems that have low tactical flexibility and low strategic flexibility can be described as rigid systems. Rigid systems can essentially only maintain system viability by using tactics to absorb variability in inputs (Feibleman and Friend 1969). Even so, the portfolio of tactics available to rigid systems tends to be relatively small. Put another way, farms that are rigid systems have a limited capacity to alter the use of inputs. If the portfolio of tactics is not sufficient then the farmer needs to make an adaptation to the production system to expand the portfolio of tactics, to increase tactical flexibility.

The low strategic flexibility of rigid systems indicates that there are very limited options available to these farmers to alter the output mix without changing the farm's business strategy. The impacts on financial performance of input variability are expected to be greatest for rigid systems.

Examples of rigid systems could include specialist wheat or wool enterprises, specialist fruit or grape enterprises, and pasture-based dairy systems.

Robust farm systems

Farm systems that have high tactical flexibility and low strategic flexibility can be described as robust. A robust farm system attempts to maintain the current strategy by using a relatively broad portfolio of tactics to absorb variability. This type of farm system has a greater capacity to alter the use of variable inputs than does the rigid type. Hence, robust

systems have more tactical flexibility than rigid systems. As a result, the greater tactical flexibility implies that the financial consequences of a given level of input variability are expected to be smaller for robust systems than they are for rigid systems.

An example of robust systems could be cut-and-carry dairy systems.

Elastic farm systems

Farm systems that have high strategic flexibility but low tactical flexibility can be described as elastic (Feibleman and Friend 1969). Elastic systems have some capacity to change output mix to manage variability, while maintaining the farm production strategy. Farmers with this type of system will tend to change the mix of outputs so that they are less affected by inputs whose variability has increased.

The ability of the elastic type to switch between outputs requires that these systems have infrastructure that is less enterprise-specific overall, as infrastructure that is enterprise-specific impedes the ability to easily move between outputs. This feature of a farm's infrastructure is a function of both the demands of the specific outputs produced and the farmer's willingness to trade operating efficiency for flexibility. This also means that elastic systems have a low level of tactical flexibility, as tactical flexibility relies on investment in enterprise-specific infrastructure to obtain an increased portfolio of tactics. Such investment will be constrained, of course, by the variety of outputs produced on the farm.

Examples of elastic systems could include mixed livestock and cropping enterprises, and mixed vegetable enterprises.

Plastic farm systems

Farm systems that have high strategic flexibility and high tactical flexibility would be described as plastic. A plastic farm system has a broad portfolio of tactics to enable the system to alter the use of variable inputs. Additionally, plastic farm systems would have a strategy that enables them to vary output mix without having to change the farm production strategy. Given the practical constraints on farming that we discussed earlier such as asset fixity, long production cycles and technical constraints, plastic systems are not likely to exist in farming. Including this category in the conceptual model and application of the model to farms enables testing of this expectation.

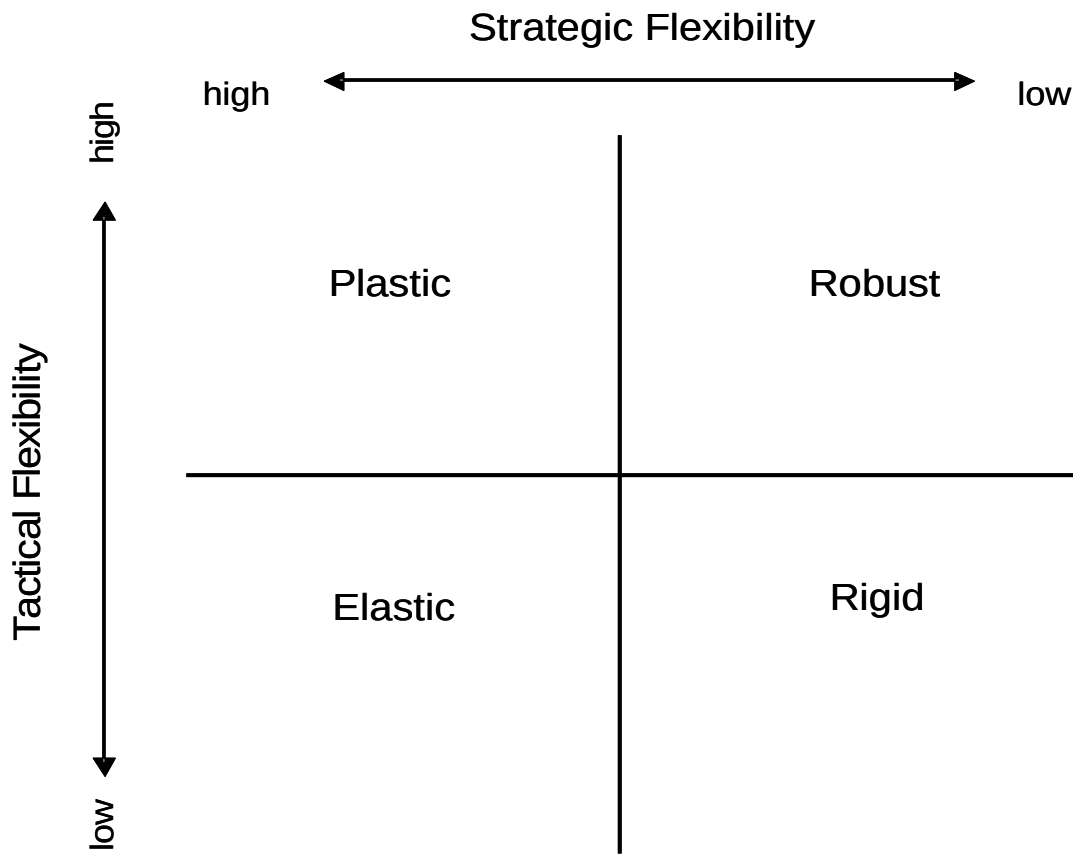

Figure 1: Characterising the flexibility mix in farm systems, from Cowan *et al.* 2013

Other determinants of farm business viability

The tactical and strategic flexibility of a farm production system is a critical determinant of the sensitivity of an individual farm to changes in inputs and prices for outputs. However, this is not the only determinant of whether or not a farm business survives.

Another important determinant of farm business survival is the compounding effect of multiple sources of variability interacting over time. For example, the compound effect of a combination of flood and low commodity prices, following back-to-back years of drought. In the case of water, particularly, reductions in availability often occur in a series over consecutive years (Productivity Commission 2009). The cumulative impact on the farm business can be severe and enduring. This impact is financial, physical (loss of land, loss of labour) and psychological (lessening of sense of self-efficacy, of control, and lowering of aspirations).

Consideration of the cumulative effect of variability was relevant to this research given the combination of numerous years of low water allocation due to drought, extreme heat events, as well as extreme rainfall and flooding in Sunraysia (Argus 2011; SunRISE 21 2010; Webb *et al.* 2009; Welsh *et al.* 2011). Consequently, the most important observable measure of the impact of input variability on farms was the cumulative effect variability had on profit and net equity; that is, more pragmatically, financial reserves.

The state of financial reserves is, then, another determinant of the sensitivity of an individual farm to changes in inputs and prices for outputs. Financial reserves can interact in two ways with tactical and strategic flexibility. First, the capacity to offset variability with strategy or tactics modifies net equity and thus the state of financial reserves. Second, the exercise of some strategic and tactical responses will require the use of some reserves. If reserves diminish, one effect can be the loss of access to some tactical or strategic responses. This reduces flexibility and increases the downside risks associated with future relevant variability. It can create a vortex.

An implication of this is that flexibility assessed at a point in time may be conditioned by the state of financial reserves. The use of temporary water is an example of the importance of considering flexibility in light of the cumulative effects of variability and financial reserves. Farmers may purchase temporary water as a tactic for managing a low irrigation allocation. They may need to purchase temporary water for a number of seasons, given the likelihood of back-to-back low allocation years. For some farmers, the purchase of temporary water at extremely high prices may deplete their financial reserves, removing the possibility for a time that they can purchase temporary water in the future.

The state of farm and family finances is central, then, to considering the decision-making by farmers regarding the future adaptation and adjustment options for their farms. This means that understanding the flexibility of the farm systems in the Area, and how this interacts with cumulative variability in critical inputs and prices for outputs, and financial reserves, is fundamental to considering the future of the Mildura Old Irrigation Area.

Research methods

To ascertain the flexibility of individual farm systems in the Mildura Old Irrigation Area we conducted 23 semi-structured interviews in which primary producers were questioned about the general characteristics of their farms, what they considered to be the key sources of variability, how they managed these key sources of variability and options they were considering for the future of their farms and families. Interviewees were also asked to describe, in general terms, how they had been faring financially in recent times, in a comparative sense rather than in real terms. This was to get an idea of the financial stress these interviewees were experiencing without encroaching on their privacy (see Appendix A).

We used a purposive sampling approach, focusing on identifying potential interviewees within the three main commodity types within the Area (Argus 2011): wine grapes, table grapes, and dried vine fruit. Department staff provided us with contacts for initial interviews in the Merbein, Mildura and Red Cliffs areas. From these first interviewees we used a snowball sampling approach, in which we asked interviewees to recommend other growers for us to speak with who may have had similar or different experiences. We sought growers from different farm contexts in relation to off-farm income, levels of financial pressure due to recent bad experiences and farm size. The final sample is characterised in Table 1.

All interviews were conducted with two researchers present to enable cross-checking of data and interpretation. Interviews were recorded and transcribed with the relevant data used to develop and analyse each case. The data from each case was analysed using the farm flexibility framework (Kaine *et al.* 2010; Cowan *et al.* 2013). Researchers also used a cross-case analysis approach to identify any themes that emerged from the experiences of all the interviewees.

Farms ranged in size from 6 hectares to 120 hectares. The median farm size was 21 hectares.

Table 1: Distribution of interviews

	Dried Vine Fruit	Wine Grape	Table Grape	Total # interviewed
Merbein District	8	4	4	9
Mildura District	2	1	3	6
Red Cliffs District	5	4	0	8
Total	**15**	**9**	**7**	**23***

* Totals of individual enterprise types do not equal total number interviewed because eight of the farmers interviewed produced more than one enterprise type.

Results

Sources of variability identified by interviewees in the MOIA

The interviewees identified a number of different sources of variability in inputs and prices for outputs. Three of these were identified as being critical and having an unfavourable impact on their business in recent times:

- Irrigation water
- Extreme rain and associated flooding
- Output prices

Given the time and resource constraints on this research, these three sources of variability were selected for analysis and the results are described in the next section. The other sources of variability identified by farmers are reported in Table 2 with some brief comments.

Table 2: Additional sources of variability described by interviewees

Source	Comments
Extreme heat	Extreme heat events occured at different times throughout the growing season, leading to detrimental effects on crops through heat stress and sunburn. The tactics that interviewees described for managing extreme heat were: canopy management, the use of sprayers to cool the vines / fruit and timing irrigation to ensure a good level of soil moisture coincided with such events. Practices varied among farms, depending on farm context. **Heat stress was closely linked to vines stressed by lack of water and therefore intersected with variability in irrigation water.**
Frost	Management practice for frost prevention focused on maintaining soil moisture (through mulching and reduced tillage practices) and purchase of insurance. **Maintaining soil moisture for frost prevention intersected with variability in irrigation water.**
Hail	Hail damage was very localised and unpredictable. Limited options for managing hail included having farm blocks relatively spread out spatially to spread the risk and purchasing hail insurance.
Nutrient levels in soil	Interviewees identified maintaining good soil nutrition for vine health and productivity as important and managed this through the input of fertiliser and winter cover crops. Fertiliser itself was not identified as a variable input. **The use of winter cover crops to increase organic matter and nutrients (e.g. nitrogen) intersected with variability in irrigation water.**
Pest and disease	Interviewees described pest and disease management as crucial to their farm businesses. They were confident with their general pest and disease management programs in general. **Pest and disease intersected with variability in rainfall and flooding.**
Power (i.e. fuel, electricity)	Interviewees described power as important and a major cost to their businesses. **Variability in power intersected with irrigation water and rainfall.**

Irrigation water

Variability

Some interviewees had flood irrigation but most had pressure irrigation systems. Although most interviewees believed they irrigated efficiently and that any reductions in water use would reduce the volume and quality of output, a couple of interviewees had discovered they could reduce water use by 50 per cent without any noticeable impact.

None of the interviewees had dams, although one interviewee was contemplating installing a dam. Most interviewees believed that their properties were too small for dams to be feasible. None of the interviewees used groundwater as it was too saline.

Some interviewees had a water entitlement that exceeded their routine use and sold water temporarily when possible. No research participants mentioned the possibility of purchasing more water entitlement.

After a decade of drought and two years of particularly low water allocations, variability in the supply of irrigation water was a critically important problem for the interviewees (Welsh *et al.* 2011). The interviewees distinguished three components in the variability in the supply of irrigation water: allocations supplied; the timing of delivery; and the timing of information about these.

Sensitivity to the timing of delivery was important at different points in the year for different crops. For example, currants, and Sun Muscat dried vine fruit were sensitive to under-watering early in the season, table grapes were sensitive throughout the growing season, while some varieties of wine grapes benefited from water stress late in the season. As well, water requirements varied with soil type, root stock, crop variety and stage of growth.

The absence of information early in the season about the overall irrigation allocation for the season, and piecemeal announcement of allocations throughout the season, added to the uncertainty within which the interviewees had to make tactical decisions.

More mundane problems in regard to the supply of irrigation water were: crowding of users, especially (but not only) on weekends, which impeded access; and pump breakdowns and power supply problems assumed greater importance when supply was less plentiful and timely.

Variability in irrigation water hindered the capacity of interviewees to manage three other sources of variability: heat stress, frost and soil nutrients (see Table 2).

Tactics

The interviewees described a number of tactics that they used to cope with low, and untimely, allocations. These were:

- Buying temporary water: stocking up if allocations were likely to be low; buying one month ahead; buying as needed;
- Mulching and keeping vegetation on mounds when dry;
- Watering everything less;
- Selectively watering based on important flowering and fruiting times; ensuring more sensitive varieties (currant, Sun Muscat) had sufficient water early in the season;
- Sacrificing a block;
- Bringing forward development plans for retraining, regrafting or replanting vines as these needed less water;
- Using carryover water to ensure water was available early in the season when allocation was expected to be low.

Interviewees did not rely on a single tactic but used a combination of these tactics. How these tactics were implemented, and the combinations employed, had changed as the interviewees had become more experienced in managing years of low allocations.

The interviewees described two adaptations to variability in irrigation water. These were to adopt drip irrigation and purchase permanent water.

Classification

All the interviewees grew perennial tree crops. Consequently, they were unable to change their agricultural output in the short or medium-term to reduce their reliance on irrigation water. While there was some variation among interviewees in the mix of tactics they were able to implement, none had the capacity to use other inputs to substantially reduce their reliance on irrigation water. Consequently, all interviewees were classified into the rigid quadrant of the farm flexibility framework with respect to irrigation water.

Interviewee reliance on having entitlement in excess of usual requirements, and temporarily purchasing water to supplement entitlement in years of low allocation, is consistent with a rigid classification (Kaine et al. 2010).

Being based on rigid farm production systems, the capacity of these farm businesses to implement tactics to cope with seasons of low water allocation and remain viable depended on their having access to ample financial reserves to implement their tactics and to absorb fluctuations in farm revenue.

Rain and flooding

Variability

Interviewees had experienced problems with excessive rain and flooding. The region had received three times the average rainfall during the 2010-2011 growing season, much of which fell late in the season (Argus 2011). The resultant flooding had a substantial direct effect on many growers in the Area while many more experienced indirect effects, primarily from an increased incidence of diseases and reduced fruit quality.

The impact of flooding varied considerably. The determinants of the impacts of flooding included: topography of the farm; soil drainage characteristics; drainage system and pump adequacy; the age of vines (young vines drowned while old vines suffered from excess vigour); and the extent to which access to crops to deal with diseases was restricted.

The main disease problems were Downy Mildew, due to high humidity, and Botrytis, due to splitting fruit. Fruit quality was affected by restricted ripening from rain, from abnormal cloud cover and associated cooler temperatures. As noted, excessive rain had second round impacts by restricting spraying for disease control.

The impact of diseases also varies across farms. The severity of these impacts depended, particularly, on the severity of damage to fruit quality. This was greatest for those interviewees with dried vine fruits that attracted quality premiums and for those interviewees with table grapes.

Tactics

There were no tactics to cope with the direct effects of flooding. All farms were impacted according to the vulnerability of their particular farm to the intensity of flooding they experienced.

The interviewees described a number of tactics that they used to cope with excessive rain. These were:

- Removal of mulch and vegetation from the mounds;
- Reduction of disease with preventative and eradicant chemical sprays;
- Dried vine fruit farmers harvested early to prevent the spread of disease from splitting fruit;
- Table grape farmers covered fruit with plastic sheeting early in the season. However, this raised the risk of higher humidity and susceptibility to diseases;

There were other, related factors that influenced the capacity of interviewees to manage diseases. Some interviewees found their regular preventative spraying program was not sufficient to effectively manage the conditions. As well, most interviewees had never encountered Botrytis and did not include Botrytis control in their preventative spray programs. Some interviewees stated that, since Botrytis could not be controlled once it appeared, they were going to preventatively spray for Botrytis in the future even though this would increase average costs.

Interviewees had found that deciding what type and quantity of spray chemicals to store had become more difficult having experienced conditions of extreme rainfall. Preventative spray programs had proved inadequate in such conditions and the supply of some chemical sprays had been quite limited. The inability to predict the reoccurrence of similar conditions, together with the limited shelf life of chemicals and the risk of suppliers running out of stock, made decisions about the purchase and storage of some chemicals problematic.

The interviewees described three adaptations they have made to better cope with excessive rain. These were changing to early ripening varieties to avoiding late season rain, changing to varieties that were less prone to splitting, and diversifying outputs to spread their risk.

Classification

All the interviewees grew perennial tree crops. Consequently, they were unable to change their agricultural output in the short or medium-term to reduce their reliance on irrigation water. While there was some variation among interviewees in the mix of tactics they were able to implement, none had the capacity to use other inputs to completely offset the more severe impacts of excessive rain. Consequently, all interviewees were classified into the rigid quadrant of the farm flexibility framework with respect to excessive rain. The marked variation in the scale of impacts on different farms of excessive rain and flooding has to be borne in mind, however.

Being based on rigid farm production systems, the capacity of these farm businesses to implement tactics to cope with seasons of excessive rain and flooding, and remain viable, depended on their having access to ample financial reserves to implement their tactics and to absorb fluctuations in farm revenue.

Output Prices

Variability

Output prices were consistently described by interviewees as beyond their control. Several said that they were 'price takers, not price makers'.

There was considerable variety in the markets that the interviewees were targeting, with the most consistency being among dried vine fruit farmers. The determinants of output prices ranged from quality characteristics in apparent niche market strategies to quantity in high volume wine grape contexts. Consequently, price variability was diverse.

The common export orientation of the table grape farmers we interviewed meant the substantial appreciation of the Australian dollar was a depressing factor on returns. The wine grape farmers we interviewed were experiencing depressed prices as a result of the over-supply of wine grapes in Australia and increased competition from overseas. The dried vine fruit farmers we interviewed believed they were benefiting from firm demand for dried fruit and the emergence of three, competing processors. There was concern from these farmers that the quantity being produced in the region may be insufficient to sustain these three processors in the long-term and that prices may eventually decline.

Farmer responses

The lack of control over output price had prompted a variety of responses among the interviewees. All involved attempts to identify markets offering best value, given the characteristics of their output, and trade-offs between price variability and certainty of sale.

Interviewees described a number of ways they had adapted their farm businesses to enable them to cope with variations in output prices. These were:

- Targeting multiple markets (domestic and export, local 'farmers markets');
- Spreading production throughout the season to spread supply;
- Contracting with guaranteed minimum prices;
- Integrating forward into processing;
- Investing in on-farm storage to control supply.

Classification

All the interviewees grew perennial tree crops. Consequently, they were unable to change their agricultural output in the short or medium-term in response to variability in output prices. With the exception of one interviewee with a cold-store, none of the interviewees had any tactics they could use to modify the impact of price movements. For the interviewee with storage, the financial risks and costs of holding product off the market for an extended period of time meant they were classified, with the other interviewees, as rigid categorisation with respect to price variability.

Being based on rigid farm production systems, the capacity of these farm businesses to cope with variations in output prices, and remain viable, depends on their having access to ample financial reserves to implement strategic responses such as diversifying and to absorb fluctuations in farm revenue.

Institutional factors

A number of interviewees identified constraints on their capacity to manage variability with their farm system, or to make changes to their farm, which they related to institutional factors. These factors were generally described as:

- The unbundling of water from land;
- Access fees for irrigation; and
- Changes in subdivision rules.

Many interviewees thought that unbundling had undermined, if not reduced, their tactical options for coping with low allocations. Some interviewees believed that the unbundling of water from the land had lowered the value of their land; this in turn, had reduced their borrowing capacity. Some interviewees believed that the changes to the water market (with unbundling) during a period of low allocations had inflated the price of water. This had reduced the tactical flexibility of some interviewees by pricing them out of the temporary water market.

A few interviewees had seriously depleted their financial reserves when they 'panic bought' water at a very high prices. Several interviewees referred to the years of low allocations as a 'political' or 'government' drought.

A number of interviewees described how carryover water had become a very useful tactic for ensuring they had some irrigation water early in the season. Hence, this new rule had increased the tactical flexibility for some interviewees.

Many interviewees described how the access fees attached to their irrigation entitlements had hampered their adaptation or adjustment decisions. The two options for removing this access fee were to sell the land (at a very low value) or pay the water authority the equivalent of 10 years of water access fees. Interviewees were aware that selling permanent water did not remove the water access fee. Some interviewees, who were running their farm at a loss, would incur even greater losses if they halted production, partly because of the access fees.

In principle, the water access fees also contributed to a decrease in financial reserves, thereby potentially reducing tactical options for interviewees.

Some interviewees had considered subdividing a portion of their land for various reasons: as a part of superannuation, to reduce debt or to enable them to sell the farm but keep living in the house after retirement. These interviewees felt that a state government decision to change planning rules had eliminated this option thereby reducing the adaptation and adjustment options available to them.

These institutional factors may have meant that some interviewees were unable to change the structure of their farm businesses because the cost of change was too high. This could have extremely serious consequences. For example, a couple of interviewees commented that the value of the farm had to be quite low to be eligible for exit assistance. This meant that those who had some equity in their farm, and therefore were not eligible for assistance, could eventually be forced by circumstances into a foreclosure or bankruptcy.

The recent loss of Exceptional Circumstances funding, and the rejection of the business case developed by Lower Murray Water seeking funding for the upgrading of the regional irrigation infrastructure, added to frustrations felt by interviewees. For many, these, coupled with the other institutional changes, indicated a lack of government support for primary industries in the Area.

It was apparent that, for many of the interviewees, the institutional environment was depleting their confidence in government support for primary production in the region. A number of interviewees said that they were hesitant to make any further long-term investments in grape production until they got some signal of a brighter future, such as public investment in upgrading the regional irrigation infrastructure.

Discussion

In the discussion we will consider what the results regarding farm flexibility in the Mildura Old Irrigation Area mean for the future of grape enterprises in the Area, including the options interviewees were considering for adaptation and adjustment. Given we are considering the viability of these farms into the future, we will focus on the role of off-farm income in the survival of these farm business.

Role of financial reserves and off-farm income

Low irrigation allocations, extreme rain events with flooding, and low output prices in recent seasons played a major part in the accumulated poor financial performance common among the interviewees. Notwithstanding the extent of cross-subsidisation of farm activity by off-farm employment, many families had seen their financial reserves, and the value of their farms, decline. It appears that their reserves were likely to be insufficient to sustain the declining trend in financial performance should the trend continue. Some were faring better, were in profit, albeit less than before, and were looking to expand.

Earning off-farm income was common among the interviewees. This ranged from full-time employment of the farm owner elsewhere, through part-time employment of the farm owner in roles related or unrelated to farming, to part-time or full-time employment of the interviewee's partner.

The close personal identification of farm-owning families with their farm businesses seems usually to lead to the effective classification of all continuous sources of family income into a single pool. In financially challenging farming periods, non-farm revenues will be used to support farm expenditure; in stronger farming periods, 'surplus' farm profit will be used for family expenditure. Anecdotal evidence indicates that this is commonplace across many micro-businesses in Australia.

A formalised financial analysis of such situations would indicate that this may be a financially risky way for farm families to proceed. The risk arises from one of the central benefits of the approach: a greater financial capacity to tolerate fluctuations in farm profitability.

The notional pooling of revenues is essentially a corporate approach where a number of enterprises (farm business, off-farm work and investments in this case) comprise a single financial entity with diversified revenue sources. Prudent

management of such corporations normally involves regular tracking of total net worth and analysis of the contributions of component enterprises to it. The objective is to optimise the mix of enterprises given the resources of the corporation and the risk:return characteristics of the enterprises.

This is not the objective of farm families and consolidated financial management is far from what usually happens with most micro-businesses, including farm families. Specific, continuous financial management usually only relates to the farm business. Typically, this is driven by (farm) bank expectations and taxation requirements, neither of which treats off-farm income as an element of the farm business.

Consolidated family accounts are not likely to be drawn up. The item of most continuing interest, cash balance, is readily apparent and constructing such accounts would be demanding. Hence, the benefit of such accounts and data for family decision making is not obvious. A family is very likely aware of the direction of cross-subsidisation among enterprises, but may be less aware of the magnitudes involved and the net cumulative effects.

There are exceptions and one was in our sample: one interviewee was quite alert to the overall tax effects associated with farm profitability, signalling a corporate perspective.

The variability, and temporal lumpiness, of much farm revenue leads to high financial risk compared to many other micro-businesses: the danger of not being able to service fixed financial commitments is relatively high for farm businesses. If there is a negative correlation between farm and off-farm revenue sources, aggregate revenue flows will be smoothed as well as increased at the family business level. Unfortunately, typically the major types of revenue flows to a farm family will not be negatively correlated. In fact, some off-farm employment such as contract harvesting can be positively correlated with the farm's income, amplifying variability in revenue.

Whatever the effect on smoothing, off-farm income does increase revenue and provide 'deeper pockets' for the family to meet the fixed financial obligations of the farm business and, thus, reduce its financial risk as a business. Another effect of off-farm income, in aggregate terms, is to reduce income inequality among farm families (Boisvert and Ranney 1990).

When the main components of variability in farm revenue (farm output quality and quantity, and output prices) are enjoying stable distributions of possible values, the absence of negative correlations among farm and off-farm revenue can be ignored, assuming the farm is viable: the deeper the pockets, the greater the ease of bearing volatile farm income. If, as can never be really known at the time, these distributions change to the disadvantage of farm profitability, or with the effect of amplifying its variability, the risk to corporate performance increases.

This means specifically that significant erosion can occur in the net equity of the family business with little or no meaningful warning: financial resources can suddenly be depleted as never before as the family business moves into negative income despite its off-farm income. The usual variability in farm business performance masks a qualitative shift in the long term viability of the farm business and, therefore, the family business.

It is apparent from the interviews that the flooding experienced in 2010-11 in the Area may be a good example of this problem. So too, has been policy variability in the form of the introduction of a new policy to unbundle water and land property rights.

In summary, it is commonplace for farms to rely from time to time on off-farm income to weather rough financial patches of the kind most of the interviewees had experienced recently. Undetectable, secular changes in the potential profitability of farms in a region can result in unwarranted optimism about 'things coming good'. This can lead to substantial losses in family wealth because the reliance on off-farm income means family wealth continues to be unjustifiably sunk into the farm business.

The strategy of meeting 'pot-holes' in the cash flow of the farm business with off-farm income depends for success on the absence of enduring, unfavourable changes in the operating environment. Secular change in input variability, output prices or policy can vitiate the strategy.

Regional considerations

An emergent property of the set of farms within a region is the degree to which they are tightly coupled: the extent to which actions on one farm impact on the options facing other farms. Coupling is difficult to consider across the dimensions of a farm system. It is most clear when evaluated with respect to particular dimensions of the operating environments. Tight coupling on a specific dimension may, of course, imply tight coupling overall since it seems unlikely that there could be offsetting factors.

Coupling is tight when an input is in relatively fixed supply, or an output is in relatively fixed demand, at the regional level. If market price can vary, a farmer's purchasing or selling decisions will impact on the prices other farmers encounter for inputs or outputs, respectively. If price cannot vary, other forms of rationing of the item will have to occur, which are unlikely to accurately reflect the strength of demand of each buyer. If the input is in relatively fixed supply then the regional impacts of variations in the input turn on the relevant homogeneity of those using the input.

A good example is irrigation water for farms following identical strategies: that is, producing the same crop using the same production methods. With fixed water availability, with or without price-based rationing, the impact of low allocation would be broadly similar across all farms. Hence, tight coupling means that, when one farm is under stress, all are under stress, with consequent, depressing implications for the regional economy.

The more diverse the needs for an input, by time, quantity or importance, the easier will it be for the region's farmers, as a group, to cope with input variability. This means that the Area is favoured to some degree, in this regard, by having a diversity of vine fruit crops, and a variety of strategies, across farms. While all grape growing systems are rigid with respect to water inputs, there is some variety in the rigidity. Moves to greater regional homogeneity in outputs and farm production systems would not be helpful, following this reasoning.

The Area may be less favoured by government policies that have modified institutional settings, such as subdivision rules and fees for irrigated water access, that have locked farmers into situations they would rather leave, arguably putting downward pressure on regional productivity.

Adaptation and adjustment options

A key determinant of adaptation and adjustment options interviewees were considering was their long-term business plan. Long-term farm business plans tended to fall into three categories among the interviewees, namely: building, maintaining and winding back. These categories were not specific to the age of the farmers.

Building

Those interviewees who were in a building phase were actively seeking to position themselves financially for expansion and redevelopment. These interviewees described block size and proximity to the existing farm as key characteristics they were considered when assessing opportunities to acquire land to expanding the farm. Redevelopment of new blocks, including trellis and irrigation system upgrades, was commonly described by these interviewees as a part of their immediate plans for the farm.

Interviewees in the building category differed from interviewees in the other categories in the levels of debt that they were comfortable with. These interviewees were more willing to carry some debt compared to those farmers in a maintaining or winding back phase.

Interviewees in the building phase could not afford, or were not confident, to expand as they would like. Some had decided to focus on redeveloping their farm in order to increase profitability and build up enough equity to be able to continue building at some time in the future. Some of these interviewees had expressed doubts about continuing to grow their businesses and had essentially moved to a maintaining phase. They were depending on increasing the productive capacity of the farm, and the hope of a run of some profitable years, to be able to return to a building phase.

Other interviewees in the building phase found that their financial reserves were so depleted that they could not afford to redevelop their farms, let alone expand as they would like. Many of these interviewees were running at a loss. They were actively looking for other sources of income but felt their options were constrained by low land values and institutional factors such as subdivision rules. There was no possibility to move to a maintenance phase for these interviewees because of their high level of debt. Many of them were skirting the edge of the vortex while others were heavily subsidising the farm business; neither of which was sustainable.

Maintaining

Interviewees in a maintaining phase generally felt that their farm size was satisfactory. These farmers were focused on reducing debt and increasing equity in their farm business. They spoke about having redeveloped their blocks to increase their productive capacity and operating efficiency.

Many of the interviewees in a maintaining phase had either increased their level of debt or stagnated, meaning they hadn’t increased their net equity. While many of these interviewees identified blocks that needed to be redeveloped and other investments that would increase their productive capacity, they were not making these investments. They were waiting until they were more confident that they would not be ‘throwing good money after bad’ before investing further in their farms. Some interviewees in a maintaining phase may have been about to shift to a winding back phase because recent problems with variability in inputs and prices for outputs had made it more difficult to maintain equity in the farm.

Winding back

Interviewees who were winding back tended to be those who were actively setting themselves up to retire from the farm. These interviewees were looking at options to sell the farm, subdivide or scale-back production. The decision as to how to wind back influenced investment decisions on the farm. An interviewee that planned to scale-back production made very different decisions, for example, compared to one that planned to sell the farm as a highly productive business. Even so, these farmers tended not to be investing in redevelopment, especially redevelopment that would increase debt.

Interviewees who were in a winding back phase had few options available to them to achieve their plans regarding the farm business. Low rural land prices and new subdivision rules left some of these interviewees feeling they were stuck with the farm. The water access fees constrained them even more, making the option of scaling back difficult.

Conclusions and recommendations

Overall, in the face of recent variability in the supply of irrigation water, extreme rain and low output prices, the rigid production systems of farms in the Mildura Old Irrigation Area resulted in steady reductions in financial reserves and a loss of confidence in the future profitability of farming. Changes in the institutional environment added to the erosion of financial reserves and confidence. These factors had a constraining effect on the plausible options available to farmers.

The reality is that variable irrigation allocations, extreme rainfall[1] and low output prices are likely to continue to bedevil grape farmers in the region. The implication of this was that, unless something changed, farmers in the Area would continue to decline in profitability, entering a vortex that few may escape.

Recommendations

Through the farmer interviews, a number of key insights and suggestions were identified reflecting the experience of these farmers at the time of the interviews. These are presented using the farm flexibility framework as a lens.There are a number of options that government could consider for supporting viable primary industries in the Area. Importantly, this does not take into account other policy criteria and interventions that have not been included in this paper. Nor does it include any subsequent changes in the Area.

Actions that may increase tactical flexibility and therefore the capacity for production systems to absorb variability in irrigation water

- The replacement of old pumps to reduce the frequency of pump failure would be useful for growers when dealing with a low irrigation allocation, as pump failures (and perceptions of a high risk of pump failures) removed tactical options available to farmers.
- Investment in changing the regional irrigation infrastructure to a piped, pressurised system that delivers clean water on demand, all year round. This may increase tactical flexibility in two ways:
  - By providing improved access to irrigation water for farmers through a reduction in uniform demand for water from the irrigation system; and
  - By enabling farmers to consider changing their varietal mix based on having reliable and timely access to irrigation water at different times of the year.
- The provision of earlier, more accurate information about seasonal irrigation allocations would help maximise the tactical options available to farmers.

Actions that may increase tactical flexibility and therefore the capacity for production systems to absorb the effects of flooding

- Identification of areas where the impacts of flooding are the highest and consider possible structural changes such as improved drainage and pumping.

Actions that may increase tactical flexibility and therefore the capacity for production systems to absorb both extreme rainfall and low irrigation allocation

- Investing in research regarding the development of rain tolerant, drought tolerant root stocks may reduce the sensitivity of production systems to variable rainfall and irrigation water.
- The provision of financial support to enable conversion to more drought tolerant and rain tolerant root stock may reduce the burden for farmers, given the minimum of three years in lost production associated with changing root stock. Such support may also have a profound effect on farmer confidence of government support for primary production in the Area.
- Further research on the practice of grafting may lead to the development of relevant practices for farmers seeking to change varieties when adapting a farm production system. Such research could include consideration of the responses of different types of root stock to grafting, practices for reducing vulnerability to disease associated with grafting and ways to enable a faster return to production.

[1] Since this research was conducted stormwater runoff infrastructure has been installed to increase the capacity of the community drainage system to better manage flooding associated with extreme rainfall. The degree to which these changes will mitigate the threat to businesses associated with extreme rainfall is unknown.

Actions that may enable the implementation of extension programs aimed at increasing the tactical flexibility of production systems

- Encourage the consideration of the relationships between tactics and farm flexibility by extension service providers in the support they offer to the farmers.
- Use the knowledge acquired by farmers through experience with low irrigation allocations, flooding and extreme rainfall to develop extension information for better managing these events in the future.

Actions that may increase strategic flexibility and therefore the capacity for production systems to absorb variability in irrigation water

- Investment in changes to the regional irrigation infrastructure to a piped, pressurised system that delivers clean water on demand, all year round. This would enable farmers in the region to contemplate producing a greater mix of outputs.

Actions that may increase the capacity of farmers to adapt and adjust their farm businesses, thereby supporting viable primary industries in the Area

- Consider options to minimise the impacts of barriers to land transactions, such as subdivision rules and amalgamation of titles.
- Removing or reducing the irrigation delivery share exit fees may increase the capacity of farmers to adapt or adjust by facilitating the transfer of irrigated land to dryland production and increasing the capacity of farmers who are ‘stuck’ in the winding back phase to adjust out of agriculture. However, consideration would have to be given to the potential of unintended consequences from the removal or reduction in exit fees (for example, the risk of a large number of farmers dewatering their properties, leaving the remainder to bear an unsustainable proportion of the costs of maintaining the irrigation network).
- Consider how government policy reduces the flexibility, financial reserves and confidence of farmers with the view to identifying options to reduce the regulatory burden and to minimise policy impact on flexibility and confidence (for example, limits on water trading and delivery share exit fees).
- Consideration of how government policy impedes farmers from exiting agriculture, such as asset levels allowed under the exit packages and subdivision rules.
- Consider how government policy can unexpectedly impede the transfer of irrigated agricultural land, such as assisted exit schemes that require the stripping of irrigation infrastructure and prohibit irrigating for several years.

Actions that may enable the implementation of extension programs aimed at increasing the capacity of farmers to adapt and adjust their farm businesses

- It may be useful to consider the development of extension advice on comprehensive financial analysis of the complete 'family business'.
- Advice, information and counselling support for exiting agriculture (for example, how to sell multiple properties with different titles) may help farmers considering adjusting out of agriculture in their decision making, which may increase the rate of exit.

If circumstances remained as they were in the Mildura Old Irrigation Area then, overall, farming would continue to lose viability. The only apparent alternative was to increase farm flexibility through adaptation or adjustment. Although, even if suitable adaptation and adjustment options were found, not all farmers were in a financial position to make the necessary changes. Nor did the institutional environment of the time instil confidence in farmers to finance such changes.

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Appendix A: Mildura Interview guide

Introduction
Purpose of the research
Interview process (recording)
Privacy act / confidentiality
Don't have to answer questions

Farm context:
Can you tell me about the farm?
Biophysical context

Do you or a family member have other employment to support the family/farm?
Importance of farm business to family income?

How have things been going for you?
(Change in proportion of debt?)

Managing variability (absorbing):

What are your biggest worries regarding your farm business?
For each thing:

- Why?
- What do you do to manage it?
- Do you do anything else to manage it?
- What other things have you thought about doing to manage it, why haven't you done that?

What about . . . (water, labour, output prices, seasonal conditions, pests and diseases)? – if not said to be biggest worries

Changes to the farm (adaptation/adjustment):

What changes have you made to your production system over the past 5 years? Why? What other options did you consider?

What changes have you made as a family over the past 5 years to accommodate changes in water availability, input and output prices, seasonal conditions? Why?
What other options did you consider? (Why didn't you choose these options?)

Are there any changes that you are currently considering for your production system or family? What kind of changes, why?

Recommendations of who else to talk to?
Different or similar experience

Can I ring you if I have any follow up questions?

Appendix B: Sample of case summaries

This appendix consists of case summaries based on interviews conducted in September/October 2011 as a part of research to characterise the tactical and strategic flexibility of farm production systems in the Mildura Old Irrigation Area in relation to variability in critical inputs, and variability in output prices.

Due to its size (~75 pages), the full collection of case summaries have been packaged as a supplement to the final report. A copy of this supplementary report is available through the corresponding author, Lisa Cowan at: lisa.cowan@depi.vic.gov.au.

These case summaries describe the individual experiences of six out of 23 individual farmers who were interviewed as a part of this research. Following each summary is a description of farm flexibility and options for the future for each case.

Some elements of the case summaries such as names, genders and the nature of relationships between individuals in the case summaries (eg. mother/daughter, brothers etc.) have been changed or removed to protect the anonymity of individuals. Additionally, the level of detail in the information provided by each farmer may differ based on their comfort level with sharing personal and business information.

Bernie

Bernie is a WG farmer on a 50 acre property with 180 ML water entitlement. He currently has 46 acres in production. The property was converted to WG from DVF in 1993. Things were going badly for the DVF industry at the time and WG were looking profitable. Bernie and his wife run the farm themselves because employing people, other than for picking, 'takes away any profit'. Bernie said that the wineries are telling him he needs 100 acres; but, if he goes to 100 acres, he will have to hire an additional permanent person to help.

Bernie has an even mix of chardonnay, shiraz and merlot. He had some good years with WG up until 2006, when his winery contract was cancelled, and thinks he has fared better than those who got into WG later. He has always made a profit out of his farm except for two years. ‘The good years’ enabled him to pay off debt and establish his family’s current lifestyle.

Bernie is not making enough profit, however, out of the farm alone. Bernie uses his farm machinery to do contract work for other farmers in the area. Some years they are 'living off the contract work, not the grapes'. Last year all of Bernie’s profit came from this off-farm income.

Bernie converted the irrigation system from furrow to drip in 1992, so he didn’t really have any problems in the early years of the drought. Though he was not getting a full allocation, he was getting enough with the drippers. As the drought continued Bernie grew a cover crop over the winter that he could use as mulch on the banks during the next summer. He bought temporary water at $1000/ML, which meant he had higher-than-normal costs. He also watered less. Bernie’s farm had some vine deaths and generally the vines suffered so the crops weren’t great. This indicates that the tactics Bernie used to manage a reduced water allocation were not sufficient to prevent damage to his crops.

Bernie’s low profitability during the drought was compounded by last year’s extreme rains. Half of his crop rotted on the vine and the price that he got for what was left was so low that he didn’t make back his costs: production costs for him were $300/tonne and sales revenue was $250/tonne.

The major problem Bernie had with last year’s wet weather was increased disease pressure which required chemical spray control. He couldn’t get some of the chemicals he needed and other chemicals were really expensive. There was a chemical that he knew would work, but it was not allowed because it prolongs the processing time for the winery.

Bernie thinks it will be wet again this coming season and has prepared for it. He has started clearing the banks to reduce moisture retention and allow the ground to warm up in direct sunlight. He has also stocked up on some of the chemicals that were unavailable last year.

The low prices for WG that Bernie has been getting over the last few years, and last season’s poor crop, have left him feeling ‘stuck’. He has used up all of his reserves and currently has no savings. However, Bernie has to keep going even though he is running at a loss. He cannot afford to stop because water access fees have to be paid whether he uses water or not. He cannot afford to make output changes to his farm as that would mean three years out of production on top of the cost to convert. As well, Bernie doesn’t have the confidence to change to another enterprise as every industry is going through the same thing.

Other than farming, Bernie said that he is not qualified to do anything else. He could do more contracting to other farmers, but then he would have to change everything else, including farming. Bernie and his family have talked about

the possibility of getting out of farming but they cannot subdivide, which means they would have to leave their house if they don't grow grapes. Leaving would mean losing a $600,000–$1,000,000 investment.

Bernie: Description of farm flexibility and options for the future

Bernie has a rigid system overall. There is no flexibility to change output mix within his current business strategy, and hence no strategic flexibility. He has few tactical options available for managing much of the variability affecting his farm.

Bernie described his business's highly profitable years as ending when his contract was cancelled. He still does not have a contract. The low prices he has been getting for his fruit have been detrimental for his business. Bernie is rigid in relation to output prices.

The tactics he used to manage low water allocations during the drought were inadequate and costly to him, in loss of vines, productivity and reduced financial reserves. Coming out of the drought, the rain events that led to rotting of half of his crop have embedded him in his current circumstances. Overarching all of this, the major source of variability with which Bernie has had to cope since 2006 is a decline in the price he gets for his WG.

Bernie's long-term business plan can be described broadly as *maintaining*. He does not want to increase the size of his farm business, as this would require hiring additional labour. Unfortunately, Bernie does not see a way out of his current circumstances, in which the business is in a decline. What he is doing is hoping for some profitability to come out of good yields at a better price. In his current frame of mind, however, if this happens he is likely to put that money away as reserves for his family rather than investing it in redevelopment of the farm, given that he cannot identify a profitable way forward for his farm beyond his hope for better prices.

Gary

Gary runs a 55 acre fully-mechanised DVF business, of which 25 acres are currently in production with sultanas, Sun Muscat and currants. Gary's plan has always been to farm full-time. The reality is that the household is supported by off-farm income. Gary's wife works off-farm and Gary works as a contractor for other farmers (though getting payment from struggling farmers has been an issue). Generally, the farm has just been paying for itself. Gary bought the last 16 acres two years ago to increase the farm's output. He wants to get to a point where he can hire a full-time manager and start stepping back a bit in a few years when he is getting closer to retirement.

The 30 acres currently not in production includes the 16 acres he bought two years ago as well as some patches of unproductive vines he has been redeveloping. He is redeveloping these acres over to Sun Muscat because they are highly productive and don't damage easily in the rain. He has chosen varieties based on what is most productive and rain tolerant; 'everything harvests in the same two months anyway'.

All of Gary's productive vines were converted to swing-arm trellis so that he could mechanically harvest. In doing so he had to purchase a dryer, wetter and harvester. Once he converted to mechanical harvesting labour costs dropped from $20,000/year to $1,000/year. The savings were used to pay for the machinery. Now he only uses extra labour with his redevelopment work.

Prices for DVF were fairly low for a long time but Gary had a contract with a guaranteed minimum price of $1,500/tonne. Generally, he actually received about $1,700/tonne. And when the spot price went down to $1,200/tonne he was doing relatively well compared to those with no contract. He currently has a ten-year contract; it has worked for him because if the price goes up his price goes up as well, but his price only goes down to the guaranteed minimum level.

Gary has a 200 ML water entitlement and feels he has plenty of water. He converted the farm over to drip irrigation a while ago (pre-drought) to ensure he can utilise the water that is available. He thinks he needs at least 70% of his allocation in a season so that, when water is a bit more scarce, he can manage. During the drought, however, when allocations went well below this 70%, he bought some temporary water.

When there was a zero allocation at the beginning of the season he decided to buy water over time, as he needed it. This meant that he didn't end up spending much money on water as an allocation was announced and this allocation increased throughout the season. He also used a lot less water through the drought, but thinks he didn't get the crops that he should have because he was under-watering. His soil moisture monitors were a huge help during the drought, as he discovered that certain rootstock needed a lot more water than others.

Towards the end of the drought the lack of water started to take its toll on productivity, however, and his yields were down by 50%. This was followed by last season's flooding due to which productivity was down by 75%.

The extreme rain events made disease control very challenging. Gary ended up harvesting early. Disease got to some of his vines so quickly that he ended up taking a chainsaw to the vines to harvest the fruit as quickly as possible. Though he saved the fruit, those vines will be out of production for a year while he re-trellises these existing vines.

Gary said that, while the disease problems he had last year were caused by the rain, he thought it was exacerbated by lack of management on adjoining properties. Many properties have been abandoned and were not being managed, which increased the incidence of disease around his property that spread to his vines.

The flooding that was associated with the rain also affected Gary, but not directly on his property. He had new stock he was preparing to plant this year as a part of redevelopment; this was flooded and killed in the nursery. This means that he will have to start again, putting him a year behind and out of pocket for all of the investment he put into the original young vines.

Gary said that he has a 'fair-sized debt' from land acquisitions, redevelopment and running costs. With these last couple of bad years he was, unfortunately, only able to pay for the interest on his loan. While the prices for DVF have actually improved, the poor crops have put a big dent in cash flow. This is one of his major worries, as he needs enough cash to allow him to do the redevelopment necessary to get productivity up.

The plan was for Gary to pay someone to help him with redevelopment this year, but he couldn't afford to do this. Instead, Gary planted 2½ acres of capsicum on the land that needed to be redeveloped. He hopes that the capsicum crop will give him the ready cash he needs. He doesn't want to keep doing these kinds of crops because it is very labour intensive and takes him even further away from the redevelopment he needs to do.

Since Gary is trying to get bigger he will have to get a new harvester. He will start looking at purchasing one when he gets about 30 acres under production. Also, Gary did consider buying another piece of land this last year and selling some permanent water to pay for it, but changed his mind. For him, 'it is all about having the right size property to be able to sit back a bit more'.

Gary: Description of farm flexibility and options for the future

Gary has a rigid system overall. There is no flexibility to change the output mix within his current business strategy, and hence no strategic flexibility.

Gary's business is rigid in relation to output prices. He has a ten-year contract with a processor with a guaranteed minimum of $1,500/tonne. This places a floor to the price he receives but gives him no flexibility to respond to changes in price through time, in any given year.

With regards to his irrigation allocations, Gary does have some capacity to manage a somewhat reduced allocation with the use of his drip irrigation system. In reality, below a 70% allocation, Gary's system began to struggle. He was able to purchase temporary water and water less. However, using these tactics led to decreased yields and a gradual loss of output and therefore profit. This loss in profit, combined with the increased cost of buying temporary water, further decreased his capacity to manage variation in irrigation allocations. Gary is rigid in relation to irrigation allocations.

Though Gary sprayed to manage increased disease pressure during last season's extreme rain, he still suffered a 75% drop in typical production, which indicates this tactic was not sufficient. As well, any exacerbation of the problem due to abandoned adjoining properties is outside his control. Gary is rigid in relation to rainfall.

For routine production, flooding is not a threat to Gary 's farm. Apart from the exposure of vine nurseries, experienced floods are not a source of relevant variability for him.

The compounding effects of variability that Gary cannot absorb into his system continue to reduce his flexibility, putting his business at increasing risk. Less than half of Gary's farm is productive at the moment, and while Gary knows that he needs to redevelop to improve the situation he does not have the ready cash and labour needed to enable this. Gary desperately needs a good year so that he can begin to redevelop and, hopefully, build up some financial reserves, thereby making some tactics more readily available.

Gary's long-term business plan can be described broadly as *building*. He has been actively seeking to increase the size of his farm business so that he can afford to hire a full-time manager and retire. Unfortunately, his recent purchase of 16 acres as a part of this strategy has increased the risk to his business by increasing debt.

Mark

Mark has a 40 acre property on which he produces WG and a small amount of DVF. He took over his family's farm in the mid 1970s, redeveloping and adding new blocks over the years as he could afford to do so. The farm was DVF until the market for DVF went down and he converted over to WG.

Mark is full-time on the farm and his wife works off-farm part-time. Mark is able to run the farm on his own. He thinks he could probably get bigger, up to 100 acres, and run it on his own. He has got all of the big equipment required and gets 'mates rates' from a contract harvester.

Mark has a 120 ML water entitlement and he needs 75% of it in a typical year. When he originally redeveloped the property he had put in overhead sprays. Mark was fortunate in the first year of low water allocation because, when they unbundled water from the land, they also introduced carryover. Mark happened to have some carryover water that year. This helped him get by. As well, he started the season with his subsoil wet, and it was a lot easier to maintain that than to let it get dried out and 'have to play catch-up'. In that first drought year Mark did purchase some temporary water, though not a huge amount of it, and he managed to hold off and buy it at $300-$400/ML rather than $1200/ML. Additionally, because the allocation was being announced piecemeal throughout the season, this meant he actually ended up having 20 to 30 ML left over as carryover from that year as well. Mark ended the first year of drought with a 10% drop in yield.

After that first low allocation year, he converted to drippers with the help of a $20,000 water grant. The cost of the conversion was well above this and he ended up having to borrow $60,000 to go towards it. In some way he feels that the grant was a burden rather than a help because the conversion cost so much more.

Generally, Mark was able to manage the extreme rain last year. He did have to manage disease a bit more but was able to do so. The quality of his fruit was good as well. He was even able to pick his grapes before the late-season disease hit the region. The problem he had with his crop was the low price he got for his fruit.

Other than this, he did lose some young DVF vines last year that ended up sitting under floodwaters. He has some interest from a processor, though, and will replant some sultanas there for DVF. It looks like last year he made $15,000, which sounds like a trivial return but, compared to others, he thinks he faired pretty well.

Five years ago Mark was debt free, now he is back to $100,000 in debt because of the upgraded irrigation system, temporary water that he had to buy and the drop in market prices. He thinks his business is viable 'in a sense'. But he doesn't feel like it is viable at times, because he is 'going backwards'.

He has a block of land that he has a building permit for, as a subdivision. He got it approved just before they changed the subdivision rules. He has left all of the abandoned vines on it on purpose: if he takes them off, the land value would increase and his rates would go up. He hopes to build on it before the permit runs out, but that takes money and he is not sure he wants to increase his debt level even more.

Mark is not encouraging his children to come back to the farm at this point. While it is 'every father's dream to pass the family farm on to one of the kids, it is really another form of child abuse, giving the farm to the kids'. They are not interested in coming back anyway.

Mark: Description of farm flexibility and options for the future

Mark has a rigid system over all. There is no flexibility to change the output mix within his current business strategy, and hence no strategic flexibility.

Mark had some capacity to manage a reduced water allocation through the use of carryover water, the purchase of temporary water and starting the year with wet subsoil. In the first year of a reduced allocation Mark had bought a little water and also had a drop in yield by 10%. This demonstrates that Mark was rigid in relation to his irrigation allocation, though not as rigid as some of the other interviewees.

Mark's upgraded irrigation system may increase his tactical flexibility in relation to his irrigation allocation. However, how it interacts with his tactic of starting the season with a moist subsurface is unknown. If he cannot get the moisture levels required to maintain this tactic, the new irrigation system removes a tactical option available to him.

In relation to extreme rainfall and its associated flooding, Mark's spray program seemed to manage sufficiently the increased disease pressure. As well, his grapes were able to be harvested before the late-season disease problems. However, this was related to the timing of when the late-season rain occurred rather than his tactical flexibility. His likely vulnerability to different rainfall distributions which increase disease pressure (for example the typical late-season rains beginning earlier) indicates that he is rigid to rainfall variation.

While Mark's farm generally coped well with the flooding, the capacity of his young vines to cope with flooding is decidedly rigid.

Mark, overall, can cope with some variability in rainfall and his irrigation allocation. The biggest issue for Mark is the price he is getting for his grapes. He believes he is viable, but is worried about his future options, as the price he is getting keeps dropping. Mark is rigid in relation to output prices.

Mark's current long-term business plan can be described broadly as *maintaining*. His predominant interest is in continuing to run a profitable business with little debt.

Oliver

Oliver is a full-time farmer with a 200 acre DVF and WG business, though the blocks are not all connected. He has built the business up over the years from an original 20 acres that he bought decades ago. He believes that, for a farm to be profitable, it needs to be big enough to achieve critical mass. As he bought blocks of land, he redeveloped them and planted crops that appeared profitable. When he purchased blocks they were all sultana DVF. Currently, he has 20% Sun Muscat and Carina Currant DVF, with the rest in WG.

Oliver has re-trellised, planted new vines, put new irrigation systems in and made the blocks far more productive and a lot easier to manage and run. There are a couple of small blocks where he has not upgraded the irrigation systems because he couldn't justify the cost of doing so. Overall, Oliver's farm is 'pretty efficient'.

In general, Oliver is willing to put extra water on his vines for more output; this is because he has big vines with big trellises which can take the vigour. He doesn't believe there is a quality difference to keeping output up. It is easier for him to 'manage vigour down than to manage vigour up'. Some of his biggest losses are to hail and sunburn; 'if you start off with only half as much you end up with a quarter. So you've got to give yourself a reasonable opportunity'.

Oliver converted 150 acres of the farm over to drippers 12 years ago, for labour savings. Given he is basically a one-person operation, he does whatever he can to save time. This ended up being really important to him in the drought, as he wouldn't have made it through without the drippers.

Oliver got some advice with regard to the drought to 'not run on one strategy, but run on a number of strategies; so while no one strategy will be right, none will be dead wrong'. He bought some temporary water, bought 64 ML of permanent water (by purchasing a 7 hectare property) and watered everything less than usual. He ended up not putting enough on and paid the price in lost output. When this still was not enough, Oliver decided to sacrifice some of his sultanas. By the end of the drought he had 25 acres that weren't in production, which he had left unwatered.

With the extra costs associated with managing the drought, Oliver decided that the first thing to go was his integrated pest management consultant. It was 'an easy way to save $12,000'.

Since the drought has broken, Oliver has been investing in changing over the sacrificed sultanas to Carina Currants, utilising the existing swing arm trellis. He chose Carinas because they fit his program better. They are more productive than sultanas, but at a different time of year, when Oliver is not so busy with WG.

Last year, with all the rain, and its associated disease, Oliver only harvested half of his crop. He was able to harvest the DVF, but the yield was 'pathetic'. What he was able to pick of the WG achieved a really poor price because it was all basically reject or salvage quality. For most of the fruit that should have been $400 or $500/tonne, he was getting $110/tonne. He figures he lost about $400,000 last year.

Managing disease was a huge cost to Oliver. He spent 10 times what he normally would on sprays. While he had a full typical year's worth of chemicals in the shed, this was not enough. He had to go out and buy three times this, and at a higher price. He also had a problem with Botrytis, which was unusual.

Twelve years ago Oliver was planning for his retirement. He decided then to buy a 70 acre block and redevelop it over time. The thought was that, with his combined property size, he should be able to retire now, twelve years later, debt free. This has not eventuated. He now has 200 acres and a huge debt.

For several years during the drought he was not able to pay any principal off his loan. He feels like the debt is getting out of control. Last year's $400,000 loss and the low price he is getting for his WG have added to this. Additionally, Oliver is owed money for grapes in 2009 which he will never be paid because the winery that purchased them went bankrupt. He has had to sell some permanent water, just to cover some of his debt.

Oliver used to have six casual staff working for him; he now only has one person part-time. With the low prices he is getting and the problems in the last few years, he has had to drop this back. The award also changed, so any staff that work for him get paid more. He 'has never worked as hard' as he has in the last couple of years.

Oliver thinks that retirement looks pretty good, but he really has no prospect of that at the moment. Nobody wants to buy his place, so he is 'chained to the place and the bank' at the moment. The idea of selling gets very complicated anyway. It was easy for him to buy individual blocks of land, but now he has 15 titles and is overwhelmed with the idea of working out how to sell all of these.

When he realised things were going backwards during the drought he changed his strategy to try and get through with everything intact. His thinking was that, if he could keep the farm intact and productive, it would be easier to sell as a productive block. He thinks it would be easy for a TG farmer, for example, to graft the rootstock and convert his WG to TG.

Oliver thinks the worst is over. He ended up replanting 25 acres towards the end of the drought, which was expensive. But these are starting to come into production. In some way, Oliver wishes he were younger, as now would be the time to expand, when land prices are so low.

Oliver: Description of farm flexibility and options for the future

Oliver has a rigid system overall. There is no flexibility to change the output mix within his current business strategy, and hence no strategic flexibility.

Oliver has been planting varieties that he sees are more likely to get a good price. He also has a contract for a majority of his fruit, though he says this is 'for the bank', not for an increased price. Oliver is rigid in relation to output prices.

Oliver's tactics for managing the low allocation associated with the drought were to buy temporary water and water everything a bit less. When this was not working he decided to sacrifice 25 acres of sultanas. Oliver is rigid in relation to his irrigation allocation.

Knowing that these tactics were not going to be enough, Oliver also purchased 64 ML of extra permanent water, adapting his system to increase his entitlement. Unfortunately, Oliver's tactical options and the adaptation to his farm came at a cost. His debt was increasing and he had 25 acres that he had to redevelop, with loss of production for 2-3 years and the resources required to replant vines. He has also had to sell some of his permanent water. This means that his tactical flexibility to manage future reduced allocations has decreased.

The pressure on the farm business was exacerbated by last season's extreme rains. He could only spray to keep disease at bay and harvest his DVF early. Unfortunately, these were not enough and he ended up with losses of $400,000. Oliver is rigid in relation to extreme rainfall.

While Oliver has been redeveloping 25 acres over the last couple of years, putting in Carina Currants, he did not suffer any flooding that resulted in the loss of his new young vines; hence, his small glimmer of optimism regarding the future.

Oliver's current long-term business plan can be described broadly as *winding back*. His fundamental aim is to ensure the farm business is 'intact and productive' in the hope of selling it to another farmer. Over all, Oliver is not where he wants to be financially and can see no realistic options for changing his situation. His reserves have been significantly depleted and his debt increased. The price he is getting for his WG, which is 80% of his property, is so low that his debt is not likely to decrease quickly.

Oliver obviously sees some prospects in the DVF industry, as is evident in his recent redevelopment. However, the capacity for him to redevelop further is very constrained. As well, his capacity to absorb any further major shocks is very limited.

Quinn

Quinn has a 300 acre TG enterprise in which he produces Crimson Seedless, Menindee Seedless and Red Globe grapes. He sells 80% of his grapes to the export market and 20% domestically. The focus for Quinn is on achieving premium quality, essential to be able to sell his product.

TG production is labour intensive. Quinn employs five people full-time and has another 10 casual staff who work for him for 10 months of the year. He has as highly technically-efficient a business as he can; he doesn't believe he can be any more efficient.

Quinn converted his farm from overhead sprayers to drip irrigation in 1997-8. He maintained his overhead sprayers to cool the vines in extreme heat. Originally, Quinn had over 1000 ML of water on his farm and he had purchased 400 ML of water for another property. He sold half of this water permanently to the government so, leading up to the years of low irrigation allocation, Quinn had a 700 ML water entitlement. He needs 1000 ML to adequately water his vines.

In the first low allocation year, Quinn had a hard time working out what to do, because the allocation decisions were coming so slowly. He ended up having a 45% allocation in March, which was no use at all because he needed the water back in November/December.

Given that he needs 1000 ML, Quinn had no choice but to buy water. Given the investment he has put into the business and the type of enterprise it was, he faced a choice to either 'put 100% on or nothing at all'. So he bought temporary water. At one stage he bought 160 ML of water for $170,000.

Even with the temporary water Quinn did not have enough to manage his property. He made the decision then to cut back 40% of the blocks that were less profitable. He top-worked (grafted) to new varieties what he took out of production. That knocked production back for two to three years but it meant that they only needed 2 ML/ha rather than 9 ML/ha.

During the first year of low allocations Quinn noticed that there was a huge difference in allocations between states. At the end of that season he decided to sell his permanent water entitlement in Victoria and buy a property with a 500 ML water entitlement in another state. This enabled him to transfer water back to his Victorian property.

Quinn sees a lot of the problems with water, including the 'panic buying' that increased the price of water, as coming out of government policies such as unbundling of water from the land. Therefore, he sees the blame for the increased risk to his farm arising from low allocation as sitting squarely with government policy.

Quinn used to have issues getting water to irrigate, as he was competing with others on the system for the time he needed. This was especially important when it was very hot, as extreme heat can affect fruit quantity and quality. Farms have started to 'go under' over the last 5 years, which means that he no longer has issues getting water because there is no one left on the irrigation system to fight over water with anymore.

During a heatwave in 2010 Quinn lost 70% of his crop, which was flowering at the time. While other farmers in the region lost a bit as well, it especially affected Quinn because his varieties flower earlier. He had losses of $700,000 to $800,000 from that crop.

After two years of poor productivity due to low allocations, and a 70% loss due to extreme heat, Quinn then had to try and manage extreme rain and subsequent flooding. Any money he may have saved on not having to buy water he spent last season on chemicals. Quinn had pre-purchased some of his chemicals, so he didn't have a hard time getting what he needed; it was just costly.

That rainy season was a 'salvage job.' Quinn spent the whole time trying to keep on top of disease (downy and powdery mildew). He sprays for Botrytis every year as a matter of course, having had the disease before, so he did not have a problem with it. Quinn covers his grape vines with plastic to keep the rain off, but could not alleviate the humid environment under the plastic. Managing the increased disease pressure was made harder by the fact that 15 % of his property was sitting under water, so the tractor would get bogged and it took a lot longer to spray. Even so, he was at least able to get his machinery through the floodwaters and he did not lose any vines.

In the end Quinn ended up bringing in 95% of his crop and it was all good quality. The one problem with last year's crop was that the quality of his Crimson Seedless got downgraded because it didn't 'eat properly' (they were not sweet enough). This meant the price he got fell by over 20% for those grapes.

After the years of low allocation Quinn kept trying to expand his productive capacity by redeveloping/reworking the unproductive vines. In 2009 he was in a good position financially. He had 70% equity in the farm and only 30% debt. Now, after two 'disastrous seasons' he is sitting at 70% debt and 30% equity. The bank is getting nervous, especially since land values have dropped, not just about his farm but about the whole industry. With Quinn's 80% export orientation, the high Australian dollar is not helping.

Quinn believes the problems he is having on his farm are putting his family finances at risk. For the first time in the 40 years or more he has been on the farm, Quinn is thinking about getting out, trying to work out how he can minimise the financial damage for his family.

Quinn thinks 'things will get very interesting' if he doesn't get a good year very soon. He's had an early bud burst this year because it was the hottest August ever. This was followed by the coldest September/October ever. The region has had every extreme of weather in the last few years. What can he do?

Quinn: Description of farm flexibility and options for the future

Quinn has a rigid system overall. There is no flexibility to change the output mix within his current business strategy, and hence no strategic flexibility.

Quinn's farm business is rigid in relation to output prices. He produces 80% of his fruit for the export market, which achieves a higher price for high quality fruit. The high Australian dollar, however, is reducing the price he gets for his fruit.

Quinn's capacity to manage a low water allocation is extremely limited. He currently only has a 500 ML water entitlement, which means in a year of 100% allocation he still needs to buy 500 ML to water his vines fully. His system is very sensitive to any drop in quantity of water application because of the focus on quality TG for the export market. Other than buying water, all that Quinn is able to do is sacrifice blocks of vines so he can divert water to those that are more productive. Quinn's decisions to sell permanent water have actually decreased his system's capacity to manage a reduced allocation. Quinn is rigid in relation to a low water allocation.

Quinn's use of plastic covers each year to keep rain off the fruit was a useful tactic, though it could not protect against the humidity, which increased the disease pressure he faced. Though Quinn found managing the extreme rain and

flooding time consuming and expensive, he was able to keep disease at bay. His previous experience with Botrytis has led him to include Botrytis control as a regular part of his spray program. While others experienced huge losses to this disease, he did not. However, Quinn did experience a lowering of quality in his Crimson Seedless grapes due to a low sugar content, which may have resulted from less sun exposure. Quinn is rigid in relation to extreme rain.

As well, Quinn has relatively early varieties of TG. This may have mitigated the effects of extreme rain later in the season on his crops, if his earlier harvesting occurred before the disease became prevalent in the region. This means earlier varieties may help with managing late season rain.

Conversely, having earlier varieties actually increased the impact of early season extreme heat on Quinn's farm. Though he could turn on overhead sprayers to cool the vines, these were obviously not enough in the 2010 early season heatwave which cost Quinn 70% of his fruit production. Quinn is rigid in relation to extreme heat.

Overall, Quinn is 'walking a knife's edge'. The flipping of his profit to debt ratio is an indicator of his current position. Quinn's decisions regarding his permanent water may have been sound when he had relatively deep pockets. Unfortunately, his circumstances have changed, which means he has reduced the capacity of his business to cope with low water allocations in the future. This means that any reduced allocation is likely to actually affect his business, and possibly more than the 4% loss of production he faced last time.

Quinn's current long-term business plan can be described broadly as *maintaining.* He is actively trying to sustain a viable TG business, even though he is now considering 'getting out'. This consideration of leaving is due to his current dire financial conditions rather than a long-term business plan.

Tony

Tony has a 125 acre farm that is 75% TG and 25%DVF. The farm has been in the family since the mid 1950s and started as a DVF enterprise. Tony and other family members have been adding blocks over time.

Running the farm is very labour intensive. The TG are all done by hand and the DVF require a lot of work as well. Overall, there are three family members who work full-time on the farm and also 20 casual staff over a 12-month period.

In around 1998, when the DVF market was really depressed, Tony started converting the entirely DVF business to add TG. He converted to spread the price risk: 'when the price for one is down the price of the other may be up'. As well, he has a variety of each TG (Crimson, Thompson and Menindee Seedless) and DVF (sultana, Sun Muscat and currants) to spread the risk of variable growth performance across the season.

Most of the farm was flood irrigated until 2006 when Tony converted it to automated drippers. He got a $20,000 government grant that covered 10% of the cost. This was the year before the low allocations due to drought, but Tony could see the low allocations coming and thought 'we've got to get more efficient with what we're doing'. So, while he wasn't really financially ready, he borrowed money to do the conversion. It is now a great management tool as well as water saver, as he can water the whole farm in 24 hours (when it used to take eight to ten days).

When the low allocations did come he found it difficult to decide what to do. It was a gamble - buy temporary water now, hope the market softens later or allocations go up later. He kept close track week-to-week and ended up buying temporary water two to three times each season to make sure he had enough. He spent about $500,000 on water over three years. That money was all of Tony's superannuation; the money went 'into thin air' but he 'had to do it'.

Tony ended up stretching out the time between watering and, coupled with the drippers and temporary water, he was able to keep 100% of the farm alive. Keeping it all alive was important for Tony, as crop yields are determined, in part, by the management practices from the previous year. So, if he didn't water enough one year, the negative effects would last for two. He ended up having a good, high quality yield throughout the drought.

Trying to keep the rain off the TG is important to Tony. He uses rolls of plastic to do this, but there are costs. The plastic costs $1200 an acre just for the material, then it requires time to put it on and take it off.

Last year's extreme rainfall made managing the effects of rain challenging. All Tony and his family could do was spray two to three times the amount of fungicide they would normally to hold off the downy mildew and powdery mildew. Whenever he could, Tony was out on his tractor spraying.

The flooding did stop Tony for a week or two at a time but, fortunately, one of the advantages he has with his drip irrigation is that the centre of his rows are kept a bit drier, which helped him to get on quicker. There were also some low-lying parts that had water on them for months, but Tony just pumped the water out.

The quality in the DVF was one of the worst in 10 years, just in terms of grade quality. But he didn't lose as much in quantity as he could have: only 50% of his latest variety (Sun Muscat). The biggest issue was low quality, which was true of the whole district. Quality is one of the things that determine the price Tony gets for his DVF and quality is based on colour, which is affected by rain. There was nothing he could do about that.

The TG yield was better than expected, given the conditions. The main issue was the increased labour requirements at harvest. The yield was down 25% but the quality was good. Tony is not really sure if he ended up going backwards or breaking even last year, given the increased costs in chemicals.

Tony has been actively redeveloping and expanding the farm. He is trying to get the yield of the existing farm up to 100% of its capacity. Tony thinks it is only at 70-75% currently. Some more redevelopment will be necessary for this, though some of it is just ‘a waiting game’ while the young vines get bigger and start producing more.

Once Tony gets more output from the farm then he will look at getting another adjoining block. He wants all of the blocks to be connected. If one of his neighbours’ blocks came up for sale, he might have to take a bit more debt than he is comfortable with because 'you have to take the opportunities as they come'.

Debt is a factor for Tony. He doesn’t want to get over 50 % debt; otherwise ‘you dig a hole that you can't climb back out of’. Having to put the $500,000 into temporary water has slowed down redevelopment. He thinks that, with everything that has happened, they haven’t gone backwards, but they have stagnated. He thinks they are probably not going to expand for another three to five years now.

In thinking about the future options of his farm Tony is concerned about the ‘two to four year blocks of decisions’ being made by government. This worries him because, with his permanent plantings, he has to make decisions over much longer timeframes. He needs some certainty about long-term water security for the region. At the moment he is worried that he may be ‘creating a white elephant’ and that he will turn around and his asset will be worth nothing.

Tony: Description of farm flexibility and options for the future

Tony has a rigid system overall. There is no flexibility to change the output mix within his current business strategy, and hence no strategic flexibility.

Tony produces both DVF and TG to spread the price risk for his business, but this does not indicate significant control over his output price. Overall, Tony is rigid in relation to output prices.

Tony’s capacity to manage a low water allocation is limited but was greatly improved by the timely adaptation to drip irrigation. He went into years of low allocation with more tactical flexibility than he would have had with flood irrigation. As it was, with the increased efficiency of drip irrigation and stretching out the time between watering Tony still ended up needing to purchase $500,000 worth of temporary water. Tony is rigid in relation to his irrigation allocation.

Tony is also rigid in relation to rainfall. While he could cover his TG and spray to manage the increased disease pressure, these were not sufficient to stop the impacts from translating into a drop in output quantity and quality.

Tony’s long-term business plan can be described broadly as *building.* They have long-term plans for their future on the property. While redevelopment and expansion has been slowed for Tony, it has not been stopped. However, increased variability of critical inputs that impact the farm output are likely to, over time, have a negative impact on this long-term plan.

An impediment to Tony’s plan is his concern over the state of the region. He is acutely aware that government policy affects the economics of the region and his business.

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