DEPARTMENT OF
PRIMARY INDUSTRIES

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Irrigation system modernisation

and the demand for agricultural inputs

A report for

Regional Development Victoria and the Water Technology Cluster

Victoria
The Place To Be

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1 Summary

Regional Development Victoria and the Water Technology Cluster were interested in understanding the potential for the modernisation of irrigation infrastructure to trigger demand among primary producers for agricultural technologies and services. To the degree modernisation would alter the delivery of water to farm systems, then modernisation would change the farm context for technologies in use on some, perhaps many, farms. This would trigger a need for producers to restructure their farm systems. This could take the form of reconfiguring farm systems to re-establish farm context, or adopting new technologies that fit better with their new farm context, or both. The demand among primary producers for agricultural technologies and services as a consequence of modernisation will depend on which of these occurs.

In this report the key factors that determined when modernisation was likely to require the redevelopment of irrigation properties and stimulate interest in the adoption of different agricultural technologies were identified. These key factors were changes in the number and location of connections to the public delivery system, and changes in the rate of flow at connections, respectively.

A sample of 23 irrigators was interviewed and classified into six segments based on the combination of key factors that were present when their connections to the public delivery system were modernised. Most interviewees had made changes to their farm systems thereby creating a demand for a range of agricultural input products and services. The agricultural technologies and services required by the interviewees in each segment as a consequence of modernisation were identified.

The increase in demand for products and services caused by modernisation tended to be greatest where it resulted in a need to construct an alternative connection to the public delivery system, and farms needed to be reconfigured because connections were substantially reduced in number or relocated. However, changes in flow rates at connections alone, by creating opportunities to change irrigation systems, triggered demand for a variety of products and services. Often, the potential to change irrigation systems, which depend on flow rates, were a direct outcome of choices made in regard to connecting to the public delivery system.

The results presented in this report provide a basis for obtaining numerical estimates of the size of the market for different products or services created by modernisation. A description as to how this might be done was provided in the report.

There appeared to be a potential demand for products and services that can support irrigators to make and implement choices in response to modernisation, such as; project and site management services specialising in modernisation projects; brokerage services specialising in sourcing and coordinating products and services; and extending product and service supplier listings.

Research should be considered into the products and services that may be required to convert to dryland farming as this is a response that is expected to appear more frequently as modernisation progresses.

2 Introduction

In this paper we report on a study in which we identified the markets for agricultural inputs, technologies and services, created by modernisation. The market for an agricultural technology or practice consists of those producers who are potential adopters of that technology and practice. In other words, the population of *potential adopters* of an agricultural technology or service is the market for that technology or service. The proportion of this population that then acquires the technology or service, the *actual buyers*, depends on many factors (Rogers 1995).

We have developed a method to identify the market for an agricultural technology or service which combines consumer behaviour theory and farming systems theory (Kaine 2009). The method is based on two assumptions. First, that the adoption of agricultural technologies and practices is a highly involving decision for producers. Second, that the benefits to be had from a technology or practice are influenced by particular elements in a farming system that are specific to that technology or practice. These elements are termed the *farm context* for the technology.

The method allows the market to be classified into segments on the basis that producers with different farm contexts obtain different benefits from a particular technology or practice. The method, which provides a basis for forecasting producer demand for products and services triggered by modernisation, and is described in the next section.[1]

Our use of this method is based on the assumption that the modernisation will trigger changes in farm systems which would prompt producers to reconfigure their farm systems and consider adopting technologies and practices. Some producers may consider adopting a technology or practice because modernisation improves the fit of the technology or practice with their farm system. Other producers may consider investing in technologies and practices in order to reconfigure or redevelop their farm system following modernisation to maintain the performance of their farms.

After describing the method we present the results of its application to data gathered from interviews with 24 producers sourced across the Shepparton Irrigation Region.

[1] See Kaine (2010) for a detailed description.

The results include a description of the factors that influence producers' responses to modernisation and, as a consequence, which agricultural technologies and services they are likely to seek. These factors are reported as a series of steps in a decision tree. This tree, coupled with knowledge of the distribution of modernisation options across the irrigation delivery system, provides a basis for quantifying the potential markets for agricultural products and services created by modernisation.

3 The market for an agricultural technology

The population of potential adopters of a technology can be defined as the set of producers who would perceive a technology as offering them a net benefit, given sufficient knowledge of the consequences of adopting the technology (Rogers 1995).[2] This population represents the market for that technology, that is, the potential buyers of the technology. This means decisions to adopt new technologies are purchase decisions.

3.1 Purchase behaviour

The literature on consumer purchasing is founded on social psychology which recognises that different decision processes are invoked in different circumstances (Krugman 1965; Sherif et al. 1965; Petty et al. 1983; Derbaix and Vanden Abeele 1985; Olson and Zanna 1993; Levy 2005). This is important as the adoption of a novel agricultural technology is different in nature from the purchase of routine, familiar, unexceptional agricultural inputs (Derbaix and Vanden Abeele 1985).

Central to explaining and predicting the different types of processes followed by consumers when making purchase decisions, is the concept of involvement. Involvement is a motivational state that results from the consumer's perceptions that a product or activity can contribute to satisfying their goals (Mittal and Lee 1989). Involvement is intensified by perceived risk (Dholakia 2001; Conchar et al. 2004; O'Cass 2000).Consumer involvement has been shown to influence purchase behaviours such as extensiveness of decision-making, interest in advertising, brand

[2] The arguments advanced here apply equally to agricultural practices. We have expressed the arguments only in terms of technology for convenience.

commitment, frequency of product use, shopping enjoyment and social observations of product use and brand use (Mittal and Lee 1989).

The decision to adopt an agricultural technology is a high involvement purchase decision for producers because the adoption of technologies has the potential to strongly influence the achievement of their business, social and lifestyle goals. To the extent that the adoption of an agricultural technology is perceived by producers to carry risks in regard to undesirable psychological, social and functional outcomes, their degree of involvement will be intensified.

High involvement purchases are characterised by effortful search for information about, and extensive consideration of, the attributes of the product and how these relate to the source of involvement. Assael (1998), Klonglan and Coward (1970), Rogers (1995), Parthasarathy et al. (1995) and others have proposed a variety of models that describe purchase decisions when involvement is high. The central theme in these models is that the process of making a purchase decision requires the development of purchase criteria which are based on the consumer's motivation for involvement. These criteria are used to evaluate the alternative products or brands on offer (Howard and Sheth 1969; Percy and Rossiter 1992; Engel et al. 1995; Assael 1998).

The purchase criteria used by the consumer to evaluate products or brands represent the key benefits sought by the consumer (Assael 1998). For example, economy, dependability and safety may be key purchase criteria for many consumers with families buying motor vehicles to be used to transport family members, especially children, on a daily basis. Having settled on a set of criteria for deciding between products, the consumer then evaluates various makes and models against the criteria and makes a decision to purchase.

Consumers can be grouped into market segments on the basis of similarities and differences in the purchase criteria that they use to evaluate a product. Each segment will value products differently and/or on the basis of varying product attributes. Knowledge of the criteria that will be used by consumers in a segment can be employed to tailor products to meet the specific needs of consumers in that segment and promote products accordingly (Kotler 2003).

Given that primary producers find the adoption of agricultural technologies highly involving they can be expected to develop purchase criteria for evaluating technologies. Such criteria will represent the key benefits producers are seeking in adopting the technology. Further, the decision to adopt a technology will depend on their evaluation of the characteristics of the technology based on their purchase criteria.

Producers' purchase criteria – the key benefits they seek from a technology – should reflect their consumption situation. The consumption situation for primary producers is defined by the characteristics of their farming system that influence the benefits to be had from adopting an agricultural technology. We term these characteristics the *farm context* for the technology.

3.2 The farm context for a technology

As described earlier farms are production systems made up of components such as resources (including people), exogenous environmental, social and economic constraints (such as access to markets), agricultural technology and management practices, and strategies for managing risks and pursuing objectives. These components and the relationships between them are used by the producer to generate agricultural outputs and realise family and business objectives (Norman 1980).

The relationships between the components of a farm system restrict the way in which components can be configured to achieve the objectives of the primary producer. Consequently, the benefits to be had from introducing a technology into a farm system will depend on how the technology changes fits with other components of the farm system to change the way the system can be managed to achieve the objectives of the producer. Hence, the consumption situation for an agricultural technology is defined by the way in which the technology would change the practical constraints on the way a farm system can be managed (Haines 1982; Cary et al. 2001; Collinson 2001; Cramb 2005; Crouch 1981; Curruthers 2007).

These considerations suggest, as argued earlier, that a correct description of the consumption situation for an agricultural technology requires the identification of those components and relationships within a farm system that influence the benefits

to be had from a technology. It is these components and relationships that we call the 'farm context' for a technology.

To the degree modernisation will alter the delivery of water to farm systems, then modernisation will change the farm context for technologies in use on some, perhaps many, farms. This will trigger a need for producers to reconfigure their farm systems. This could take the form of redeveloping farm systems to re-establish farm context, or adopting new technologies to that fit better with their new farm context, or both.

4 The method for identifying the market

In this section we propose a method for identifying and quantifying the market of potential adopters for an agricultural technology. Broadly speaking, the method involves two stages. The objective in the first stage is to qualitatively identify the elements in farm systems that influence the benefits, and associated costs, to be had from adopting a particular technology and which thereby form the salient farm contexts for the technology. The objective in the second stage is to quantify the proportion of producers in the population possessing the salient farm contexts for the technology. This proportion is an estimate of the population of potential adopters of the technology.

4.1 Qualitative stage

The first stage method is based on three propositions that follow from the theoretical framework described earlier. The first proposition is that the benefits to be had from adopting agricultural technologies depend on farm context. This means that knowledge of a producer's farm context is the basis for predicting whether a producer is a potential adopter of a technology and why.

The second proposition is, given the adoption of technologies is a high involvement decision for producers, that their reasons for adopting technologies – their purchase criteria - will mirror their farm context. It follows from this proposition that producers with similar farm contexts will advance similar reasons for adopting a technology. It also follows that producers from different farm contexts that adopt a technology will offer different reasons for their behaviour.

The third proposition is that producers are the most authoritative source of knowledge about their farm contexts. This proposition means that, among all observers, producers have the richest understanding of their farm systems and the likely consequences of changing that system. Hence, producers will be the best source of information about the likely consequences of introducing a technology into their farm systems and the factors that shape those consequences.

Together these three propositions lead to the conclusion that the set of farm contexts for an agricultural technology can be discovered by using an interview process to elicit information from primary producers about their reasons for adopting the technology. Given that similarities and differences in the reasoning supplied by producers ought to reflect similarities and differences in their farm contexts, then a dialectical approach to interviewing should be followed (Dick 1999).

Given that the elements in a farm system that constitute the farm context for a technology are to be discovered through the elicitation process, the process cannot be structured a priori in terms of content or sample design. Consequently, a process is required that allows the elements that constitute farm context to emerge through disclosure, testing and confirmation. The process should also allow the sampling strategy to be refined as the elements that constitute farm context emerge.
These considerations suggest that, among the dialectical approaches to elicitation, convergent interviewing (Dick 1999) would be the most appropriate technique for identifying farm contexts. Convergent interviewing essentially involves a sequence of interviews with the information in each interview analysed and interpreted for consistency with previous interviews.

4.2 Quantitative stage

In the second stage of the method the proportion of producers in a region with farm systems that are consistent with the farm context for the technology is quantified.[3] This proportion is an estimate of the population of potential adopters of the technology.

[3] Since this stage was not included in this project only a brief description is provided here.

Through the interview process in the first stage the various elements of the farm system that are thought to form the set of farm contexts for a technology are identified. The benefits the technology is thought to generate in each farm context are also identified. Hence, the interview process yields a set of hypothesised associations between the various elements of the farm system that constitute the set of farm contexts for a technology, the adoption of the technology and the benefits and costs of the technology.

In principle then, these hypothesised associations may be tested statistically by gathering quantitative data on the elements that form the farm contexts and data on the adoption of the technology. Such data could be gathered, for instance, by distributing a mail questionnaire to a random sample of producers based on the findings from the interviews subject to appropriate design and piloting (Converse and Presser 1986; Frazer and Lawley 2000).

The responses to such questionnaires could be used to classify producers into segments representing the set of farm contexts for a technology and estimates could then be made of the number of potential adopters in each segment and the potential population of adopters of the technology as whole given the sample is statistically representative of the population of producers.

This approach has been successfully used to identify market segments for technologies such as irrigation systems in the horticultural, viticultural, vegetable and dairy industries in Australia, breeding practices and animal health practices in sheep and cattle in Australia and New Zealand, and pest and disease management practises in horticulture and viticulture in Australia and New Zealand among others (see Kaine and Bewsell (2002a); Bewsell and Kaine (2002); Kaine and Bewsell (2000); Kaine and Niall (2001); Kaine, Tarbotton and Bewsell (2003); Kaine and Bewsell (2003) and Bewsell and Kaine (2003) respectively).

In most of these studies the purchase criteria that were identified as constituting the farm context relevant to a particular technology were concrete biophysical elements of the farm system that are often used to classify enterprises into farming systems – topography, soil type, climate, type of enterprise, scarcity of natural resources such as water. Where this is the case spatial mapping may be used to quantify market size and market segments if appropriate databases are available.

However, in most studies at least some of the purchase criteria were more socio-economic in nature. Such criteria included the length of time needed to irrigate a property, the period of time taken to spray an orchard, the availability of labour, and the layout of channels on a property. For some technologies producers' perceptions of risk and the strategies used to ameliorate risk were key purchase criteria. For example, perceptions of risk in regard to the performance of rams in different environments, and the strategies for avoiding this risk, were the key factors influencing the way wool producers choose studs to purchase rams from and use performance data to select rams (Kaine and Niall 2001).

Often there were relatively subtle interactions between a technology and the criteria. For example, the impact of property layout can have a critical impact on the benefits of automatic irrigation (Kaine and Bewsell 2000), or the choice of spray irrigation technology (Kaine and Bewsell 2002b). Property layout, as well as topography, also influences the effectiveness of pheromone mating disruption in controlling orchard pests (Kaine and Bewsell 2005).

These studies highlight the point that different mixes of farm practices, technologies, resources, risks and values influence the benefits and costs of adopting different technologies. These studies confirm that purchase criteria are frequently technology specific and often cannot be generalised across technologies.

5 Responses to modernisation

Prior to interviewing the main sample of 24 producers a series of scoping interviews were conducted with ten key informants from the Department of Primary Industries, Northern Victorian Irrigation Renewal Project, Goulburn-Broken CMA and Goulburn-Murray Water. The purpose of the interviews was to obtain information which could be used to develop a schedule to guide interviews with producers. Consequently, in the scoping interviews we sought to:

- Identify precisely what changes modernisation might introduce into a farm system
- Identify the various actions producers might consider in response to those changes

- Identify the kinds of technologies and services that producers would require to implement those actions

5.1 Scoping interviews

The scoping interviews with the ten key informants suggested that, by changing the way in which irrigation water is delivered, modernisation may alter the interface between the public delivery system and farm systems in four fundamental ways. These were:

- disconnection from the delivery system
- changing the location of the connection between the farm and the delivery system;
- changing the number of connections between the farm and the delivery system;
- and changing the rate at which water could be delivered through the connection between the farm and the delivery system by, for instance, changing the type or size of connection, or raising or lowering the reliable running level of a channel

These changes in the interface between farm systems and the public delivery system could:

1. Stimulate interest in the adoption of different agricultural technologies
   For example, micro-irrigation, fast flow irrigation, pipes and risers, centre pivots or fixed sprinkler systems, sub-surface tape irrigation, automatic irrigation and the use of soil moisture or irrigation monitoring.
2. Require the reconfiguration of irrigation properties
   For example, laser grading, upgrading leaky channels, increasing channel capacity for fast flow irrigation, increasing water head on farm.
3. Trigger a change in enterprise or enterprise mix
   For example, decommissioning channels, annual cropping, fence removal, enterprise selection aids, fodder equipment.

Adopting technologies, redeveloping properties and changing enterprise mix requires purchasing a variety of products and services from agribusiness including services in relation to financial and business planning, strategic planning, project management, and legal planning.

The results of the scoping interviews were used to construct a Farm Modernisation Response Tree. The tree provides a convenient, logical summary of the relationship between:

- the way in which modernisation changes the interface between farm systems and the public delivery system (i.e. farm context); and
- the actions producers might take in response to the change in the interface between farm systems and the public delivery system

The Tree provided a basis for the design of the schedule for the producer interviews.

5.2 Farm modernisation response tree

The Farm Modernisation Response Tree is presented in Figure 1. The tree consists of a series of branches where each branch is created by considering, sequentially, the possible changes in the interface between farm systems and the public delivery system. At the terminus of each branch the kinds of actions producers might take in response to the changes are summarised. These terminations represent response segments in that the range of products and services that producers may need can be predicted based on the actions they can take.

The first change in the interface to consider is if modernisation entails disconnection from the public delivery system. If this is the case, and the producer is unable or chooses not to connect to the public delivery system, then the producer must consider changing agricultural enterprises and decommissioning their irrigation infrastructure. That is, unless they can gain access to other supplies of irrigation water. If they are able to source a new supply, then the producer may need to reconfigure their properties and modify their irrigation infrastructure to accommodate that new supply. They may also need to change their irrigation system. Otherwise, a range of decisions will need to be taken which may require a specific range of products and services to implement, for instance establishing a new stock and domestic water system

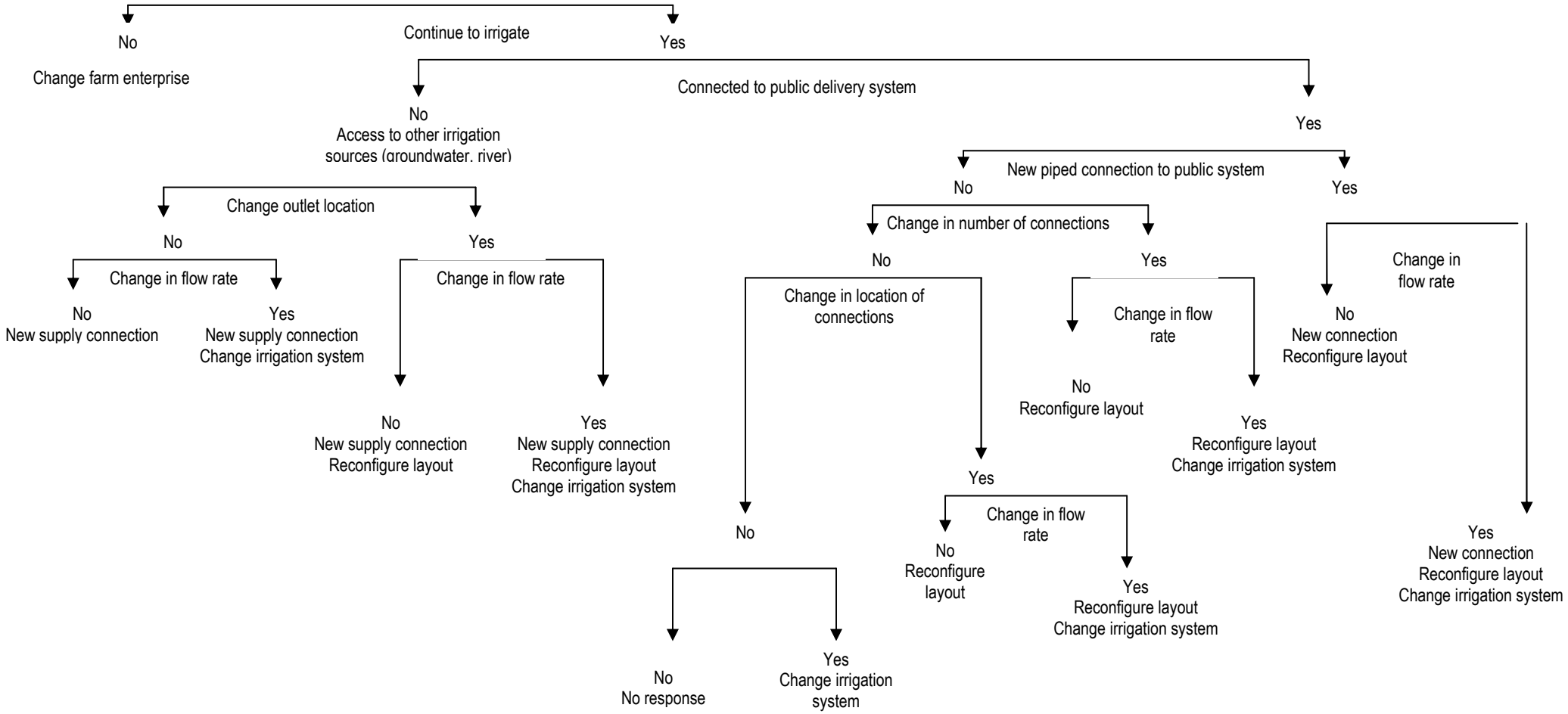
Where modernisation involves changing the connection between the farm system and the delivery system then the first consideration is whether modernisation entails changing the nature and number of connections between the farm system and the delivery system. If this is the case then the producer may need to consider

reconfiguring their properties and modifying their irrigation infrastructure to accommodate the change in the number, and associated location, of connections.

The next consideration is whether modernisation, by changing the type of connection, changes the rate at which water could be delivered through the connection between the farm and the delivery system. If this is the case then the potential arises to change the irrigation system. For example, installing micro-irrigation or fast flow irrigation, pipes and risers or automatic irrigation might become feasible.

Where modernisation does not involve changing the number of connections between the farm system and the delivery system then producers need not consider reconfiguring their properties. The main consideration for these producers is whether modernisation, by changing the type of connection, changes the rate at which water could be delivered through the connection between the farm and the delivery system. If this is the case then the potential arises for them to change their irrigation system.

Figure 1 Farm Modernisation Response Tree



6 Results of producer interviews

We interviewed 23 producers from the Shepparton, Murray Valley, Central Goulburn, Campaspe, Rochester, Pyramid Hill and Torrumbarry Irrigation Areas. The contact details for interviewees were obtained from NVIRP. Interviewees were questioned on:

- The nature and characteristics of their farming business and irrigation system
- Modernisation and any changes in their connection to the public delivery system
- The actions they had taken to change their farm systems in response to changes in their connections
- The products and services they had purchased, and activities undertaken, to implement their actions
- Issues they had encountered in responding to modernisation

The interviewees produced a range of agricultural commodities including milk, beef, sheep-meat, pome fruit, stone fruit, fodder, tomatoes and cereal grains on properties ranging from 50 to 1000 hectares in size.

Many properties owned or managed by interviewees were made up of separate parcels of land. Often these parcels were not contiguous and were serviced by different irrigation delivery systems. Commonly, these separate parcels were at different stages in the modernisation process. A range of different types of irrigation systems were used by the interviewees including border-check flood, sub-surface, spray, drip and micro-irrigation.

Water for irrigation was sourced from open channels via a meter, stream diversions, groundwater, and direct suction from an open channel and/or a privately owned pipeline. Some interviewees had made major investments in farm infrastructure over the past five years. For example, some interviewees had installed micro-irrigation in orchards and rotary milking systems in dairying.

All of the interviewees were located on, or adjacent to, sections of the irrigation delivery system that was to remain part of the public delivery system and had been modernised - the ‘backbone’. They had chosen to continue to operate irrigated

enterprises and connect to the backbone. Consequently, our sample of interviewees was representative of producers on the right hand side of the Farm Modernisation Response Tree.[4] While all interviewees reported they would rely mostly, if not entirely on surface water entitlement, some did state they intended to supplement their entitlement with groundwater in the future.

For most interviewees modernisation had involved a change in the number and location of connections to the public delivery system and changes in flow rates at connection points. The types of connections described by interviewees were varied. For instance, temporary community pumping arrangements in Rochester were going to be converted to permanent installations as part of modernisation. Some interviewees had been located on spur channels and had to either privatise the spur, or decommission it and install a large diameter pipeline to connect to the backbone. Interviewees located adjacent to the backbone commonly had had delivery points on the backbone, but they also had had delivery points on spur channels that were decommissioned as part of the modernisation process. Generally, the decommissioning of spur channels involved the construction of an alternative system for delivering irrigation water to farms.

The amount of effort required to connect a property to the backbone varied. Where interviewees were adjacent to backbone, connections mainly involved changes in metering. However proximity to the backbone also in several cases was reported to have enabled a higher level of service and flow rate due to higher and more reliable water levels in the public channel. In contrast other interviewees had to either construct pipelines to the backbone, or use old spur channels to connect. Where interviewees had to construct a connection to the backbone some installed large diameter piping. The resulting higher and more reliable flow rates which could be achieved by these new systems created benefits both for pressurised irrigation systems and gravity irrigation systems. These benefits, and the products and services involved in connecting to the backbone, are listed in Table 1.

[4] Modernisation of the public delivery system has not yet proceeded to the point where some producers are electing to permanently convert their properties to dryland agriculture.

Table 1: Benefits, products and services associated with large diameter piped connections

Benefits	Associated products and services
• Saves time by not have to wait for supply channels to fill, reports were between half and one day of time savings. • An opportunity to pressurise farm delivery system • An opportunity to install a backbone connection that is compatible with new on farm delivery systems, in particular pipes and risers or high flow. • Facilitates the installation of new on farm delivery systems, in particular pipes and risers or high flow, and enables the on farm benefits of these new systems to be realised. • When crossing neighbours land piped connections reduce disruption to neighbours land use.	• Planning and design • Planning approvals • Project management • Pipes • Trench digging and restoration • Pipe laying • Pipe welding • Pumps • Pump installation • Pump maintenance • Three phase power • Fencing

The few instances where modernisation had not changed the number of connections to properties occurred where interviewees were located within the Future Flow Project Area, or had only one or two connections prior to modernisation.[5] Modernisation appeared less likely to have changed the number or location of connections for horticulturalists. This was because horticulturalists were more likely to already have only one or two connections, and to have a direct suction connection and a pressurised farm irrigation system.

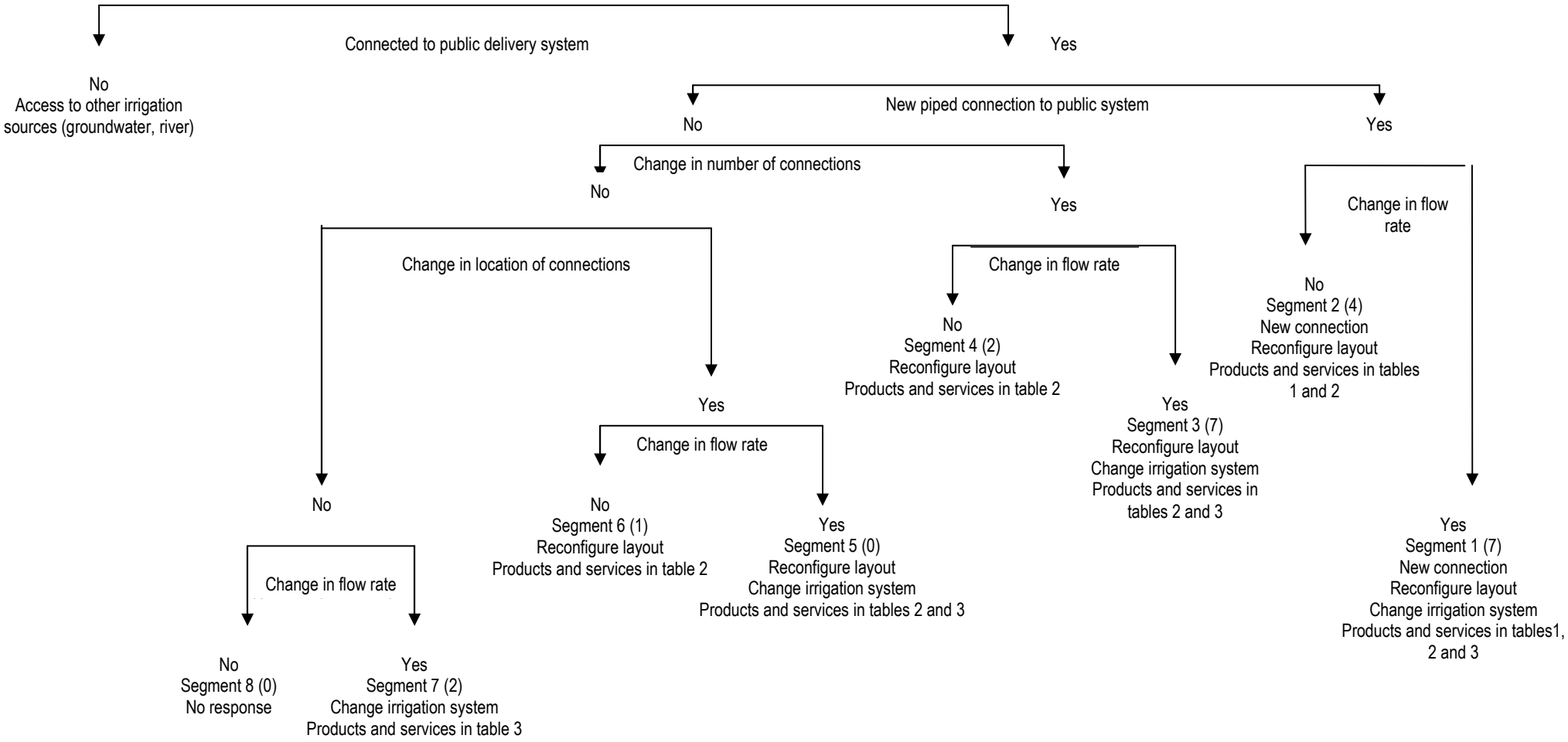
The interviewees identified a number of benefits arising from increases in flow rates. Many of the interviewees planned to realise these benefits by adopting new technologies or changing management practices. Some interviewees, however, had not experienced changes in flow rate as a result of modernisation; this was because modernisation had involved replacing a dethridge wheel with new meter of comparable flow, or they were already using direct suction connections and pressurised irrigation systems. Consequently, for these interviewees, modernisation did not change their farm context sufficiently to warrant changing their irrigation systems. Some of these interviewees did observe that modernisation had improved the security of supply and, by maintaining flow rates, had ensured that a range of technology and management options would remain open to them. Modernisation appeared less likely to have changed the flow rate for horticulturalists. This was because horticulturalists were more likely to employ direct suction connections and a pressurised farm irrigation system.

The number of interviewees experiencing changes in the number of connections, location of connections, flow rates, or some combination of these, is reported in Figure 2.[6] The products and services that interviewees purchased in response to modernisation are also summarised in the figure.

In the following sections the changes modernisation has brought about for interviewees are summarised and their responses to modernisation, and consequent purchasing of products and services, are summarised.

[5] The Future Flow Project involved the replacement of connections with a similar number of new meters that provided similar flow rates ("like for like").
[6] The value in parentheses for each segment in Figure 2 is the number of interviewees for that segment.

Figure 2 Sampling and Farm Modernisation Response Tree



6.1 Segment one

For the 7 interviewees in this segment modernisation has meant that they have installed a new large diameter piped connection to the public delivery system and the flow rate at the connections has changed. The number of connections may also have changed. As a consequence of the change in the number of connections these interviewees have had to reconfigure their farms in order to continue irrigating. Generally, changes in the number of connections occurred as a result of the decommissioning of spur channels and involved the construction of an alternative connection for delivering irrigation water to the farm. In most cases this involved changing farm channels and storages, or the installation of large diameter pipe. The use of large diameter pipes and the resulting change in flow rates created a number of benefits for these interviewees including the potential to change the irrigation systems on their farms by for example, installing pipes and risers, high flow stops, or system automation (see Table 1).

In responding to modernisation the interviewees in this segment may require products and services in regard to installation of a new connection, and to reconfigure their irrigation layout to accommodate the change on number or location of connections, and the change in flow rates. These are listed in Tables 1, 2 and 3 for the new large diameter pipe connection, and changes to the number and location of connections, and flow rates, respectively. An example of interviewees in this segment is reported in Text Box one.

Table 2: Products and services associated with reconfiguring farm in response to changes in number and location of connections

Products and services

• Legal services
• Financial planning
• Planning and design
• Planning approvals
• Project management
• Meters
• Earthworks
  ○ Laser grading and channel works
  ○ Outlets
• Installation of micro-irrigation systems
• Fence removal and fencing
• Electrical supply and electrical services
• Pumps

Table 3: Products and services associated with increases in flow rates

Products and services

• Legal services
• Financial planning
• Planning and design
• Planning approvals
• Project management
• Meters
• Earthworks
  ○ Laser grading and channel works
  ○ Outlets
 	
• Installation of pipes and risers:
  ○ Pipes
  ○ Trench digging
  ○ Pipe laying
  ○ Pipe welding
  ○ Pumps
  ○ Pump installation
  ○ Pump maintenance
 	
• Installation of automated systems:
  ○ Planning and design
  ○ Automation technology
  ○ servicing automated systems
 	
• Installation of high flow irrigation
  ○ High flow stops
  ○ Earthmoving
 	
• Installation of micro-irrigation systems
 	
• Seed and sowing contractors

Segment One - Text box

Farm Description
The farm business is a dairy farm milking 250 cows located on one property. The farm business also produces annual pasture and cereal crops to minimise the need to buy in feed.

Modernisation
The irrigator now pumps directly from a channel through a pipeline onto their property. Water flow of the new pump and pipeline is twice that of the old gravity system. The new connection enabled the installation of a pipe and riser irrigation system which has resulted in time and labour savings, increased management flexibility and the ability to easily command sections of property which had been difficult to irrigate.

Response
Services used: liaison and planning services with modernisation staff, irrigation design services for pressurised pipes and riser system, advice related to planning approvals, three phase power connection, trenching, pipe welding, pipe laying, project management, sourcing materials and services, project management.
Products used: Meter, pump, three phase power infrastructure, three phase power, large diameter polyethylene pipe, pipes and risers.

Issues affecting responses
A range of issues arose that affected the decision making of the interviewee. These were (i) the time taken to get planning approvals for trenching through a G-MW drain and installing a direct suction connection; (ii) the availability of reliable and accurate meters; (iii) Installing a temporary G-MW pump so that the farm could receive supply to avoid crop failure. The compensation package offered by NVIRP was mentioned by the interviewee as important since it allowed them to implement works immediately as it covered most of the cost associated with connection and the first stage of pipe and riser installation.

Future plans
The interviewee intended to complete the installation of pipes and risers on their farm in two stages with the first stage to be completed 12 months after the connection to the backbone.

6.2 Segment two

For the four interviewees in this segment modernisation has meant that they have installed a new large diameter piped connection to the public delivery system but this has not changed the flow rate at the connection. These interviewees may have had to reconfigure their farms in order to continue irrigating. In responding to modernisation the interviewees in this segment may require products and services listed in Tables 1 and 2. An example of an interviewee in this segment is reported in Text Box two.

Segment Two - Text Box

Farm Description
The farm business is a 600ha mixed irrigated cropping property near Rochester. The business grows "whatever is profitable at the time" with cropping rotations varying between cereals, pulses and processing tomatoes. Because of low allocations on the Campaspe system the property had been connected to a main channel via a community pumping scheme prior to modernisation.

Modernisation
New pumping stations, pumps and pipes will replace the temporary pipelines and pumping stations that formed the community pumping scheme. The new pumps and pipelines will provide a similar level of service to the old community scheme and flow rates will remain unchanged. Ongoing maintenance costs will be minimised by the permanent installation of the new pumping stations and pipelines.

Response
As part of the reconfiguration package offered to Campaspe irrigators this farm business will convert temporary installations of sub-surface irrigation technology to permanent installations.

Issues affecting responses
There were two issues that affected the response of the interviewee to modernisation:
i. The permanency of new pumping stations and pipelines gave the irrigator confidence that they would have access to water in the future.
ii. Federal grants covered the extra cost of installing permanent sub surface technology and provided the opportunity to use permanent installations for crops other than tomatoes.

Future plans
The interviewee intended to invest in permanent installations of sub-surface technology over time.

6.3 Segment three

For the seven interviewees in this segment modernisation has meant that the number of connections, and the flow rate at them, has changed. Consequently, these interviewees may have had to reconfigure their farms in order to continue irrigating. The change in flow rates has created the potential for these interviewees to change the irrigation systems on their farms. In responding to modernisation the interviewees in this segment may require products and services listed in Tables 2 and 3. An example of an interviewee in this segment is reported in Text Box three.

Segment Three - Text Box 3

Farm Description
The farm business is a 600ha irrigated cropping property specialising in cereal grain and hay production. While the whole property had been laser graded the property has been run as a dryland farm in years of low water allocation.

Modernisation
By privatising a spur channel two connections were rationalised to a single flume gate on the backbone. Two other flume gates replaced existing wheels on the backbone. A direct suction connection remained unchanged. Replacing dethridge wheels with flume gates increased flow rates.
The interviewee had already lasered 120 ha of land in the three year period to modernisation in anticipation of the higher flow rates that would be possible.

Response
Services used: liaison and planning services with the modernisation staff; whole farm planning, legal services.
Products used: Flume gates, laser grading

Issues affecting responses
The key issue mentioned by the interviewee was the difficulty associated with delays and coordination of flume gate installation because there was no continuity of project management between the installation of one flume gate and the next.

Future plans
The interviewee planned to install an automated irrigation system on 200 ha and implement an upgraded delivery infrastructure and laser grading on 50 ha to suit high flow rates.

6.4 Segment four

For the two interviewees in this segment modernisation has meant that the number of connections has changed but the flow rate at them has not. These interviewees may have to reconfigure their farms in order to continue irrigating. In responding to modernisation the interviewees in this segment may require products and services listed in Table 2. An example of an interviewee in this segment is reported in Text Box four.

Segment Four - Text Box

Farm Description
The farm business is made up of several separate blocks in Shepparton East and involves growing and packing apples and pears. Most of the available land is planted, or in the process of being replanted, to apples and pears. The trees are irrigated using automated micro-irrigation systems.

Modernisation
Direct suction connections were already in operation before modernisation and have remained in place. Unused dethridge wheels have been removed. Modernisation led directly to improved levels of service and reliable web ordering so that some connections have immediate access to water. Service to some blocks is still constrained by public irrigation infrastructure but should get a much better level of service when the Shepparton East pipeline is constructed.

Response
Services used: liaison and planning services with the modernisation staff; legal advice regarding access to property and compensation for decommissioned wheels, online water ordering service for immediate ordering.
Products used: No new products mentioned.

Issues affecting responses
The principal issue for the interviewee was the financial disadvantage associated with G-MW access to their property and compensation for decommissioned wheels.

Future plans
The interviewee was considering converting one of their groundwater pumps to solar power.

6.5 Segment five

In principle, for producers in this segment modernisation would mean a change in the location, but not number, of connections and a change in flow rates. The change in location and in flow rates would create the potential need to reconfigure the farm to continue irrigating and to change irrigation systems. In responding to modernisation the producers in this segment may require products and services listed in Tables 2 and 3. We did not interview any producers in this segment.

6.6 Segment six

For the producers in this segment modernisation has changed the location of connections but not the number or the flow rate at their connections. Consequently, modernisation may trigger demand for products and services associated with reconfiguring the farm to continue irrigating. In responding to modernisation the producers in this segment may require products and services listed in Table 2. An example of an interviewee in this segment is reported in Text Box six.

6.7 Segment Seven

For the producers in this segment modernisation has not changed the number or location of connections, only the flow rate at their connections. Consequently, modernisation is expected to create the possibility for producers in this segment of changing irrigation systems. In responding to modernisation the producers in this segment may require products and services listed in Table 3. An example of an interviewee in this segment is reported in Text Box seven.

6.8 Segment Eight

For the producers in this segment modernisation has not changed the number or location of connections, or the flow rate at their connections. Consequently, modernisation is not expected to require a response from the producers in this segment. We did not interview any producers in this segment.

Segment Six - Text Box

Farm Description
The farm business consists of a property North of Shepparton and a larger property outside the region. Both properties are irrigated and involve finishing beef cattle and commercial hay production. The properties are flood irrigated, laser graded and sown to lucerne.

Modernisation
Connection to the public distribution system had always been through pumping and piping water onto the farm. Modernisation has led to a change in pump and meter location. Modernisation has not led to changes in flow, level of service, watering time or ordering time for supply.

Response
Services used: liaison and planning services with the modernisation staff; supply and installation of a new meter, installation of pump at new site, supply and installation of large diameter pipe.
Products used: pumps, meters, large diameter pipe.

Issues affecting responses
The interviewee did not identify issues that affected their response to the process of modernisation.

Future plans
The interviewee had no intention to change how the property was already managed since it had already been appropriately set up to take advantage of the flow rates and service offered by modernisation.

Segment Seven - Text Box

Farm Description
The farm is a medium-sized dairy run by a couple. The property is made up of three non-contiguous blocks. One block is on the backbone and involved in stage 1 of modernisation, while the other two are on spurs and will be involved in stage 2 of modernisation. This interviewee has "already spent funds lasering and increasing capacity."

Modernisation
The block adjacent to the backbone has had dethridge wheels replaced with magnetic flow meters. The increased flow associated with these meters has led to channel remodelling and replacement of outlets.

Response
Planning, financial, legal, design, site/project management, laser grading, excavation, Channel remodelling etc.

Products used: The types of products used include: magnetic flow meters, new channel outlets, fencing, crossings, plastic pipe.

Issues affecting responses
The farmer expressed that everybody "has their specific problems and concerns" which have an impact on decision making. Concern was expressed about the other blocks as access to irrigation water in the future remains uncertain. This has affected the confidence in decisions made.

Future plans
The farmer was concerned about the other two blocks, as both are integral to the operation of the business. He noted that "If there is 100% allocation for the next five years that would turn things around" enabling people like him to embrace changes in irrigation efficiency.

6.9 Factors influencing the scale and rate of response to modernisation

The factors influencing irrigators' responses to modernisation can be classified into two types: scale, and rate of response. Scale refers to factors that influence the nature, breadth, or scope of response to modernisation. Rate refers to factors that influence the timing and speed of response to modernisation.

Scale of response

The interviewees identified a number of factors that influenced the nature of their responses to modernisation. As expected interviewees identified the following as influential:

- To keep farming or to maintain a similar enterprise mix they needed to connect to maintain access to irrigation water.
- By increasing flow rates modernisation offered the opportunity to invest in technologies and services that would improve efficiencies, for instance reduce the time taken to irrigate their properties. These changes also offered benefits in terms of lower maintenance costs and greater control over irrigation timing and the volume of water applied.
- By increasing flow rates modernisation offered the opportunity to invest in technologies and services that would reduce the amount of labour they needed to expend to irrigate their properties.
- If flow rate and metering were largely unchanged there was unlikely to be any need to change farm systems, including irrigation systems, in response to modernisation.

In addition, interviewees also indicated:

- Modernisation offered the opportunity to realise cost savings associated with reducing the amount of water lost in irrigation delivery systems and the amount of water used to grow crops and pastures.
- Technologies associated with the high flow rates enabled by modernisation gave irrigators greater flexibility in how they managed their farming system.
- Pre-existing channel infrastructure was sometimes reported to disrupt land-use by preventing the construction of appropriately sized bays for flood irrigation. Installing underground pipes to connect to the backbone removed this constraint (on their own farm and on neighbouring farms).

- In all cases works were able to complement the farming system. For example, complementing farm irrigation infrastructure, existing bay sizes and gradients and enterprise mix.

Rate of response

The interviewees identified a number of criteria that influenced how quickly they have implemented their response to modernisation; whether they would respond immediately or defer action. The criteria included:

- Immediate desire to realise benefits of high flow rates
- Desire to secure water supply for coming irrigation season
- Opportunities to reduce their workload immediately
- Immediate action would facilitate remodelling and upgrade of farm irrigation systems while delay might mean missing out
- Cost of works
- Size of NVIRP cost share for works associated with rationalisation of spur channels and other infrastructure
- Access to capital
- Successful bids for federal funding to undertake on farm water saving activities
- Avoiding anticipated increases in the cost of pumps, contractors, pipes and structures
- Commitment to remaining in agriculture, plans for succession and stage of life

The interviewees identified a number of factors that had delayed how quickly they could implement their response to modernisation. These included:

- Access to appropriate planning and design services
- Planning approval delays regarding direct pumping and crossing of public infrastructure such as drains and channels.
- Replacement of faulty technology such as magnetic flow meters and direct suction meters.
- Manufacturing shortages of large diameter black polyethylene pipe.
- Significant differences amongst suppliers in the cost of materials leading individuals to devote substantial time and effort in identifying lowest cost materials.

- Time required for project management, coordination and sourcing materials and contractors. Project management was regarded as important enough by some interviewees to undertake personally to avoid problems with installation.
- Negotiation process with NVIRP, water authorities and municipalities.

7 Discussion

Modernisation has changed the farm context of the producers we interviewed. Modernisation has changed either their number of connections to the public delivery system, the location of connections, or the rate of flow at connections, or some combination of these. Most interviewees had made changes to their farm systems in response to modernisation thereby creating demand for a range of agricultural input products and services.

The increase in demand for products and services brought about by modernisation tended to be greatest where it resulted in a need to construct an alternative connection to the public delivery system, and farms needed to be reconfigured because connections were substantially reduced in number or relocated. However, changes in flow rates at connections alone, by creating opportunities to change irrigation systems, triggered demand for a variety of products and services. Often, the potential to change irrigation systems, which depend on flow rates, were a direct outcome of choices made in regard to connecting to the public delivery system.

Making choices about connections to the public delivery system and any consequent changes in farm irrigation layout and systems, and implementing those choices, can be time-consuming, requiring a substantial investment of effort, resources and money. Given the scale of modernisation there may be a substantial demand for products and services that can support producers in making their choices and implementing them, such as project and site management services specialising in modernisation projects, brokerage services specialising in sourcing and coordinating products and services, and improved product and service supplier listings.

To date modernisation has not progressed to the point where substantial numbers of producers are choosing not to be connected to the public delivery system or are

unable to connect to the public delivery system because of system rationalisation. As a consequence, our sampling was limited in regard to these producers and the products and services they may require to convert to dryland farming. This is an area which could merit further research.

The results of our interviews suggest that modernisation is triggering demand for a range of products and services that are agricultural inputs. The size of the market for each of these products and services depends on the way in which modernisation changes the farm context for producers. Consequently, the demand for products and services at any point in time will depend on the pace with which modernisation proceeds and the rate at which producers can, or must, respond to changes in farm context.

Estimates of the size of the market for the different products or services could be made by combining the methods we have used here with spatial mapping techniques as follows. Data on the backbone planned or likely changes in the number and location of connections, and data on the potential for changing flow rates when installing meters, could be used to classify properties into each of the response segments we have identified. The number and location of properties in each segment could then be determined using spatial mapping techniques, as has been done with regard to trading segments in the water market (Kaine et al. 2009). The resulting estimates would provide an indication of the market for, that is, the number of potential buyers of, products and services as a consequence of the modernisation of the irrigation delivery system.

8 Recommendations

Recommendation 1: Regional Development Victoria in conjunction with the Water Technology Cluster consider commissioning projects to quantify the response segments identified in this report and obtain estimates of the size of the market for the different products or services.

Recommendation 2: Regional Development Victoria in conjunction with the Water Technology Cluster consider research into the products and services that may be required to convert to dryland farming, as this is a response that is expected to appear as modernisation progresses.

Recommendation 3: Regional Development Victoria in conjunction with the Water Technology Cluster investigates the potential for supplying a service that specialises in project and site management in regard to farm responses to modernisation.

Recommendation 4: Regional Development Victoria in conjunction with the Water Technology Cluster investigates the potential for supplying a brokerage service that specialises in sourcing and coordinating products and services in regard to farm responses to modernisation.

Recommendation 5; Regional Development Victoria in conjunction with the Water Technology Cluster expands and refines their listings of suppliers and consider providing listings and comparisons of products and services[7].

9 Conclusion

Regional Development Victoria through its funding of this Water Technology Cluster project is interested in understanding the potential for the modernisation of irrigation infrastructure to trigger demand among primary producers for agricultural technologies and services. An analysis of relevant literature, complemented by interviews with key informants, indicated that modernisation was likely to trigger profound changes in the farm systems of many producers. Depending on their nature these changes were likely to require the redevelopment of irrigation properties, or stimulate interest in the adoption of a variety of agricultural technologies, or both.

In this report the key factors that determined when modernisation was likely to require the redevelopment of irrigation properties and stimulate interest in the adoption of different agricultural technologies were identified. These key factors were changes in the number and location of connections to the public delivery system, and changes in the rate of flow at connections, respectively.

The increase in demand for products and services caused by modernisation tended to be greatest where it resulted in a need to construct an alternative connection to the public delivery system, and farms needed to be reconfigured because

[7] Such as Cumming (2009)

connections were substantially reduced in number or relocated. However, changes in flow rates at connections alone, by creating opportunities to change irrigation systems, triggered demand for a variety of products and services. Often, the potential to change irrigation systems, which depend on flow rates, were a direct outcome of choices made in regard to connecting to the public delivery system.

The results presented in this report provide a basis for obtaining numerical estimates of the size of the market for different products or services created by modernisation,

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Appendix One

Technology and management practices and corresponding benefits

Technology / Practice	**Benefits**
Pipes and risers	• Save water by not having to fill farm channels, amount saved was reported to be between 5% and 10%. • Save time by not have to fill farm channels, reported time savings were between half and one day. • Immediate response, open valve and have water. • Change irrigation scheduling from system based on farm channels to one based on the needs of pasture/crop. • If pressurised can generate hydraulic head and easily water land that had been hard to command. • Reduce amount of earthmoving when laser grading. • Can be easily automated. • Easily integrated with other water sources such as groundwater and reuse.
Automation	• Saves time and water when regularly irrigating and soil water profile is predictable. • Particularly useful when growing summer crops. • Potential benefits greater when combined with pressurised farm delivery system and reduced waiting times of modernised channel system.
Laser grading	• Laser grading bays to the appropriate fall to facilitate the movement of high volumes of water quickly can save water. • Laser grading for high flows is of benefit when on farm delivery system, and connection to backbone can deliver appropriate volumes of water.
High flow bay outlets	• High flow bay outlets allow high volumes of water to flow down irrigation bays. • Are of benefit when delivery system and fall of irrigation bays leads to water savings.
Channel remodelling	• Remodelling channels to take high volumes of water can lead to water savings if combined with appropriate structures and earthworks such as high flow stops and laser grading.
Micro irrigation systems	• Conversion from flood irrigated horticulture to pressurised systems using micro sprays allowed water and labour savings to be realised.
Irrigation scheduling	• Irrigation scheduling was improved because greater flow rates allowed more crop to be irrigated from a single connection during a twelve hour period. • Irrigation scheduling improved for since the effective waiting time between ordering and receiving water was reduced from four days to 24 hours.
Crops and pastures	• Lucerne was identified as a pasture species particular suited to high flow rates across bays. • Water savings were associated with use of lucerne. • Pressurised irrigation allowed paddocks or bays that had been difficult to irrigate to be sown to crop or pasture.

Appendix Two

Products and services related to technology and management practices.

Technology/management Practice	Associated services
Pipes and Risers	• Planning and design • Planning approvals • Pipe sourcing • Trench digging • Pipe laying • Pipe welding • Pump sourcing • Pump installation • Pump maintenance • Project management • Fencing
Automation	• Planning and design • Automation technology • Servicing automation technology
Laser grading	• Planning and design • Planning approvals • Earthmoving
High flow stops	• Planning and design • Sourcing structures
Channel remodelling	• Planning and design • Sourcing structures • Fencing
Micro irrigation systems	• Planning and design • Sourcing
Irrigation scheduling	• Goods and services associated with automation
Crops and pastures	None specifically mentioned

Appendix Three

Summary of products and services

	DECISION SUPPORT & PLANNING SERVICES	PROJECT SERVICES	PRODUCTS
WATER DELIVERY	Whole Farm Planning Survey & design services Meter replacement services Channel design Pressurized delivery design Agric. /tech Advisory services Information services Alternative water sourcing services Water trading services	Project site management & coordination Lasering/ remodeling for surface flow irrigation Excavation/ compaction/ drain/ channel/ storage construction Channel re-modeling/ sealing & repair services Construction/ assembly of components Groundwater system services Alternative surface water sourcing Plumbing and ancillary services Electrical services Trenching & pipe-laying services	LOW PRESSURE Meters/ Flumes/ direct suction at GMW channel Channel items: eg. outlets, crossings Large pipe-main items: eg pipe, joiners Gates, controllers Liner/ beaching, fill, clay, gravel, rock HIGH PRESSURE Pipes, valves, fittings Pumps, filters, manifolds etc Horticulture micro irrigation Broad-acre sub surface Mobile spray irrigation systems Fixed sprinklers Groundwater harvesting systems
WATER MANAGEMENT	Technology design services Weather forecasting/ monitoring services Soil moisture/ scheduling services	Installation Repairs and maintenance	Moisture and water demand monitoring systems: soil, leaf, sap-flow etc Automation systems Remote control systems Telemetry and communications equipment. Electronic hardware Weather stations Water depth, quality, flow etc measuremen
NON-IRRGATION SPECIFIC	Legal advisory services Business / financial planning support services Statutory authority / municipal planning services	Site preparation, clearance, renovation etc following removal of irrigation Infrastructure installation/ construction: eg feedpads, roads, fences Installation of stock and domestic supplies following removal of irrigation Rationalization of electricity supplies	Stock and domestic water supply systems Non-water products necessary following enterprise change eg. machinery, infrastructure Electrical supply and equipment following irrigation removal Public electricity supply line extension, improvement or rationalization