Managing irrigation and fertiliser in dairy farming

Interim report

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Executive Summary

The efficiency of water and fertiliser use on irrigated dairy farms has become an issue for farmers and the community in the Macalister Irrigation District in Gippsland, Victoria for a number of reasons. A number of best management practices are being identified to improve the efficiency of water and fertiliser use on dairy farms in the District. These practices include Whole Farm Plans, water reuse systems and spray irrigation systems as well as some specific fertiliser practices. Our objective in this study is to understand the adoption of these practices.

Personal interviews were conducted with a number of extension staff and fifteen dairy farmers in the Macalister Irrigation District. Telephone interviews about fertiliser management were also conducted with ten dryland dairy farmers in the Lake Wellington catchment.

We found farmers originally adopted laser grading to save themselves time irrigating. Farmers used spray irrigation in the past on land that was not suited to flood irrigation. In recent times farmers have been motivated to adopt spray irrigation or laser grading by declining water allocations.

The type of irrigation system chosen by farmers depends on the soils and topography of their property, financial constraints, and farm layout. Time and labour constraints were also identified as key factors in the choice of an irrigation system.

The benefit of installing reuse dams was found to be heavily dependent on the soil type, topography and type of irrigation system used on the farm. Management of groundwater and of effluent also influenced the need for, and management of, reuse systems.

We found most farmers view Whole Farm Plans as a method for planning the staged redevelopment of the farm when implementing a laser grading program. Consequently, Whole Farm Plans are seen to be largely irrelevant to the installation of spray irrigation systems.

We found that similar factors governed fertiliser management on irrigation and dryland dairy farm. Differences among farmers in fertiliser management were mainly attributable to differences in soil types and pasture composition, beliefs about the value of nitrogen, and beliefs about the need to ‘wash in’ fertiliser after spreading.

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We are indebted to the dairy farmers who participated in the study by being kind enough to grant us interviews.

All errors and omissions remain the responsibility of the authors.

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Introduction

The efficiency of water and fertiliser use on irrigated dairy farms has become an issue for farmers and the community in the Macalister Irrigation District in Gippsland, Victoria for a number of reasons. For example, the demand for irrigation water in the district has been increasing as the area under irrigation in the district has been expanding over time. This has resulted in a long-term decline in water allocations, which has been exacerbated by a series of unusually dry seasons. In addition, water and nutrient losses from dairy farms in the Lake Wellington catchment are believed to be contributing to algal blooms in the Gippsland Lakes and to the salinisation of agricultural land in the district.

To improve the efficiency of water and fertiliser use on dairy farms a suite of best management practices are being identified (see for example, Slee and Ewert 1998 and DNRE 2000). These practices are to be promoted through initiatives such as the Lake Wellington Salinity Management Plan and the Macalister Irrigation District Nutrient Reduction Plan. The nutrient reduction plan contains a number of financial incentives to promote the adoption of Whole Farm Plans (WFPs), water recycling or reuse systems and the installation of spray irrigation systems. The salinity management plan has an irrigation extension component aimed at improving irrigation management on dairy farms.

Our objective in this study is to understand the adoption of Whole Farm Plans, water reuse systems and spray irrigation systems on dairy farms, and to identify and understand the factors that influence fertiliser management. This knowledge will be used to develop extension strategies to promote more widespread adoption of these systems and practices.

The study involves three stages. In the first stage we identify the technologies, practices and resources at the farm level that influence the benefits and costs of adopting different types of irrigation systems and fertiliser management practices. This involves interviews with farmers, extension staff and other relevant experts or specialists.

In the second stage, we use data collected through a mail survey to classify dairy farmers into adoption segments based on key differences in their endowment of relevant irrigation technologies, and fertiliser practices.

In the third stage extension and research strategies and priorities are determined. This involves detailed analysis and interpretation of the study results by the project team in collaboration with research and extension personnel. For a more detailed description and justification of the methods used in the study see Kaine and Niall (1999), Kaine and Bewsell (2000), and Kaine and Niall (2001).

In this report we describe the findings from the first stage of this study. The results reported here are based on interviews with around 15 irrigated dairy farmers in the Macalister Irrigation District and 10 dryland dairy farmers in the Lake Wellington catchment. The results are also based on information provided by Department staff at Ellinbank and Maffra.

Irrigation on dairy farms in the Macalister

Discussions with dairy farmers revealed that a range of irrigation systems are used in the Macalister Irrigation District and that number of factors determine the type of irrigation system adopted by farmers. The types of systems used in the District include:

- Wild flood irrigation. This is basically uncontrolled flooding of ungraded land.
- Graded flood irrigation. This is controlled flooding of land that has been graded into short, narrow bays that follow the contours of the land by tractor or some other means without the assistance of laser levelling. Some of this land may have been graded more than three decades ago.
- Laser graded flood irrigation. This is controlled flooding of land that has been graded into long, wide bays by earthmoving equipment with the assistance of laser levelling.
- Spray irrigation. The most common types of spray irrigation are lateral move sprays (ie hand or bike shift, van den Bosch). Linear move and centre pivot spray systems are less demanding of labour but are more expensive to install. Fixed sprinkler spray irrigation requires perhaps the least labour but is probably the most expensive spray irrigation system to install.
- Travelling gun irrigation.

Generally speaking, farmers who were irrigating land that had been laser graded had originally been motivated to adopt laser grading by a need to save time irrigating. The original method of land grading resulted in many small, narrow bays. This meant that a considerable amount of time needed to be devoted to irrigation. When holdings were amalgamated as herd sizes increased they became impractical to irrigate. Consequently, laser grading was used to amalgamate numerous small bays into a few long, wide bays thereby reducing the time that needed to be spent irrigating.

More recently, farmers have been motivated to adopt laser grading in an effort to save irrigation water. By using high flow rates to rapidly irrigate long, wide bays the infiltration of water into the soil can be considerably reduced. In addition, surface

run-off can be collected in a reuse dam for subsequent use in another irrigation. Consequently, some farmers have been motivated to adopt laser grading, and to install a reuse dam, in order to save water by reducing water use per hectare per irrigation.

Although an attractive option for some, laser grading can be impractical for a number of reasons. For example, laser grading is more suited to impermeable soils and a relatively flat topography. Much of the Macalister consists of highly permeable soils and hilly or broken topography. Also, there must be sufficient capacity in the irrigation delivery system to permit laser-graded bays to be irrigated at high flow rates if savings in water use are to be achieved.

Consequently, many farmers in the Macalister use spray irrigations systems. In the past spray systems have been installed to irrigate land that is unsuited to flood irrigation. More recently, farmers have been motivated to install spray irrigation in an effort to save irrigation water. Although a variety of spray systems are available most farmers that use spray irrigation have installed a lateral move spray system. This is the least expensive system to install but is labour intensive as sprays must be shifted individually using a tractor or bike every few hours. In the interviews with farmers it became clear the type of spray irrigation system adopted by a farmer depends on a number of factors. These include:

- The time and labour constraints the farmer faces. For example, lateral moves will be unattractive to farmers with a restricted amount of time to devote to irrigation.
- Financial constraints. Labour saving systems such as linear moves and centre pivots are considerably more expensive to install than a lateral move system.
- The layout of the farm. Centre pivots and linear moves are not suited to paddocks of an irregular shape. Also, the installation of centre pivots and linear moves may require changing location of channels and fences, and the clearing of obstacles such as trees and hedges. Fixed sprinklers can be installed in oddly shaped paddocks but are relatively expensive.
- Whether the property has been laser graded. Farmers may have laser graded at considerable expense in order to reduce the amount of time they need to spend irrigating. Farmers in this situation are reluctant to install a lateral move system,

as this would increase the time they spend irrigating. On the other hand, the cost of installing centre pivots or linear moves could be prohibitive, especially if changes are required to the farm layout.

Note, however, that the entire property may not have to be converted from flood to spray irrigation. Placing a proportion of the property under spray irrigation may be sufficient to give the water savings that are needed. For example:

> *George owns and runs a 300 cow dairy farm in Tinamba. His property covers 100 hectares of light soils. His current irrigation system is very labour intensive and he is looking at installing spray irrigation to reduce his labour input and to reduce his water use from over 1 ML/hectare to 0.5 ML/hectare. George has worked out that if he converts 40 hectares of his property to spray he will reduce his water use to the desired level. He is comparing different spray systems at the moment to make sure that they won't take up a lot of time to maintain and run.*

The reliability of water delivery is may be a factor influencing the installation of spray irrigation. Most of the farmers we interviewed with spray irrigation either ran their sprays from groundwater or are in a district with a pressurised pipe delivery system. Some farmers, with bores producing relatively low flows, stored groundwater in a reuse dam (often a natural depression). The risk of pasture and production losses may be a barrier to the adoption of spray systems in areas where water delivery through the district channel system is unreliable. Ordering water in advance and storing it in a reuse dam ready for use could reduce this risk.

Irrigation segments in dairy farming

On the basis of our interviews with dairy farmers we believe dairy farmers in the Macalister can be tentatively classified into five segments. These segments are illustrated in the following figure.

Farmers in the first segment, 'dryland developers', are expanding the area they have under irrigation by converting dryland. Given the limited availability of water right, most farmers in this situation rely on groundwater to irrigate the extra land. Usually, farmers install centre pivot spray irrigation as the shape of paddocks is not an issue and there is a need to minimise the extra demand labour needed to irrigate the additional area.

> *Anthony runs a 450 cow dairy farm and has just bought a new property on the river. This new land has no water right so he now has more land than water. As he wants to milk 100 extra cows with no extra labour, he is going to install a centre pivot irrigation system. He can pump directly out of the river for the pivot, which is an advantage compared to having to use channel water. Channel flows can be variable, particularly at the end of a system, and this will affect the performance of the pivot. Anthony says you can run a pivot off the channel, but it would depend where you were on the channel. He prefers to work on night rate power, it's cheaper and it reduces evaporation.*
>
> *Anthony does not have ready access to groundwater. There may be some deep groundwater but it is uneconomic as it would cost him between $300 and $800 a megalitre to develop.*

Farmers in the second segment, which we have termed 'selective developers', have already undertaken an extensive program of laser grading on their properties. These farmers have either completed or are near to completing their development program. These farmers commenced their program of laser grading to save time irrigating. An example is:

> *Wally and his wife Jenny run 160 cows on a 56 hectare property in Tinamba. They began a development program for the farm in the early 80's. They began lasering to save time irrigating, and water as well. Wally estimates he decreased the amount of water he used by as much as 50 per cent by lasering the farm. He also spends a lot less time irrigating. It used to take him five days to irrigate the property, now it only takes two.*

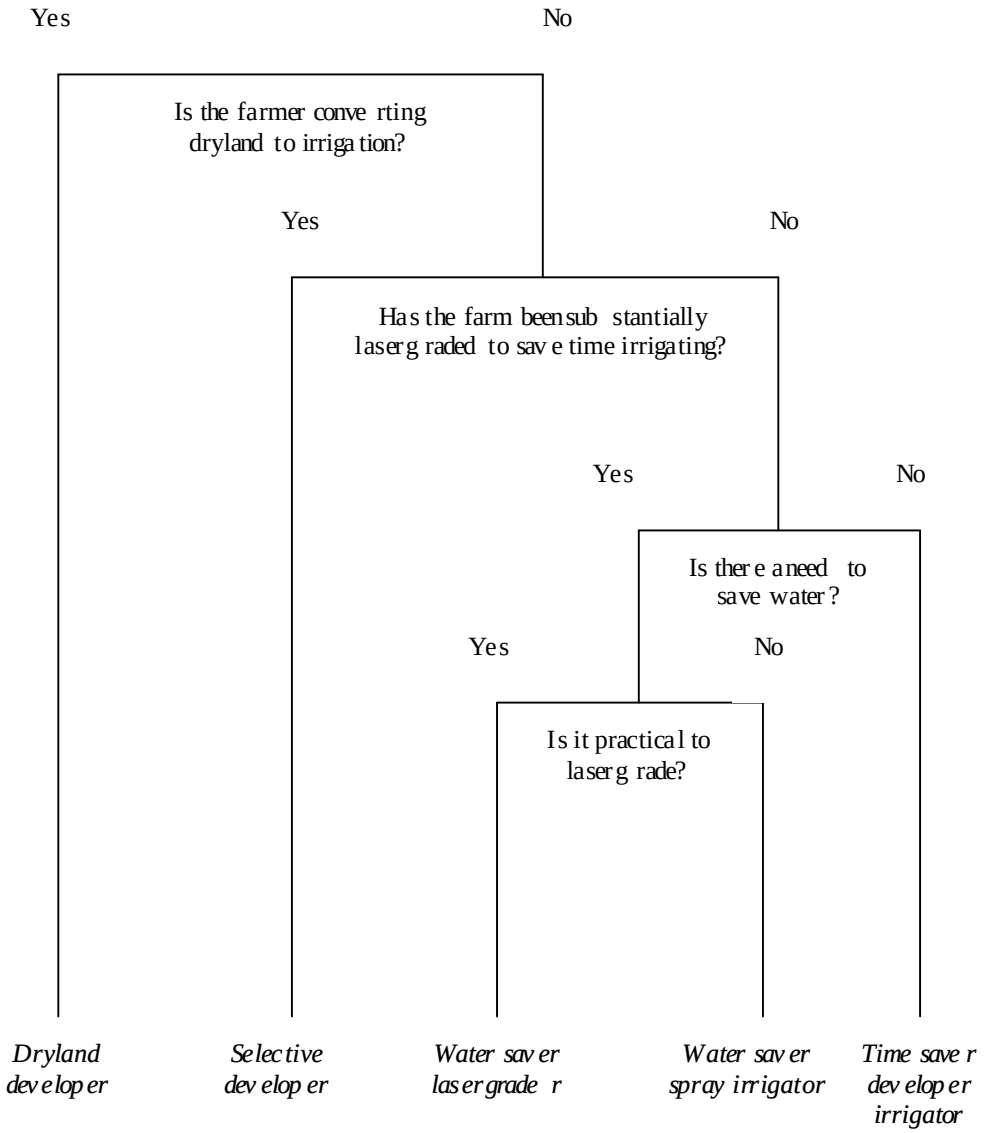

Figure 1: Irrigation system segments for dairy farming in the MID

The farmers in this segment have two options if they wish to reduce water use further. Some may be able to upgrade their internal channel system to allow them to irrigate at higher flow rates. The other option is to convert some or all of the property to spray irrigation. For some farmers it may be sufficient to install lateral moves on the areas of the property that use the most water. Others may need to consider installing a linear move. For example:

> *Tim works in a partnership with his brother in Tinamba. They irrigate 140 hectares and all but 8 hectares of this has been graded over the last 20 years. Tim has a groundwater pump and irrigates 30 hectares solely from this. Another 40 hectares can be watered with groundwater if needed. Prior to putting down the pump Tim regularly used 200% of his water right. He had thought about installing lateral move spray irrigation but apart from problems with wind they are very time consuming to shift. They are better for more porous soil. Tim weighed this up and came to the conclusion that as long as you can get a fair flow of water and can get it down the bay quickly, flood is preferable.*

> *Matt runs 450 cows on a farm near Boisdale. He began laser grading the property 15 years ago. He did not go to longer bays because of the light soils – with longer bays the water soaks in halfway down the bay. He found that the changes meant he was saving time but not saving water. Recently, Matt has been running out of water and so has installed spray irrigation on 75 per cent of the property. Matt found the spray irrigation generally successful, with some limitations. The lateral move sprays are quite time consuming.*

We termed the farmers in the third segment 'water saver laser graders'. As water has become increasingly scarce these farmers have responded by redeveloping their properties through laser grading rather than shifting to spray irrigation.

> *David milks 200 cows on two blocks making up 90 hectares. The entire property is under flood irrigation and there is 10 per cent of the farm left to laser grade. He lasered to save water and to cover the property more effectively. The farm is in a high water use area and they need to get water across the bays quickly. David has a reuse dam on one block, and the other block drains to a Southern Rural Water drain. Although he's still got some water problems he believes the biggest gains to be had are to improve the channels, install larger bay outlets, put in automatic irrigation and catch run-off in a sump.*

> *With the property lasered David is able to do all the irrigating himself. He uses a water baby but with flows split several ways you get to know how long*

the watering will take and visit the bay appropriately. He is on the top of a main channel so water flows generally don't vary much.

Farmers in the fourth segment, the 'water saving spray irrigator', have properties with highly permeable soils or undulating country that is unsuitable for laser grading. These irrigators have installed spray irrigation primarily to save water. The type of system they chose will depend on the characteristics of their properties and the district delivery system.

Russell has owns 170 hectares of land in Clydebank. He has had a sharefarmer running the property for two years. Russell says this has worked out well. At present he has 20 hectares under lateral sprays, and 70 hectares laser graded. Russell plans to develop another 50 hectares in the future. This area is not suitable for lasering however and to give him some extra water he will be installing more laterals.

All the lasered ground drains into a billabong. The quality of this water is generally OK, although it can have high levels of fertiliser sometimes. Russell will pump out of this to run the new sprays as it gives him a high and constant flow rate. He weighed up the alternatives – a centre pivot or linear move is impractical because of the shape of the block. Lateral sprays would cover the entire area, and although labour was a bit of a concern, the figures worked out OK.

Farmers in the final segment, 'time saving developers', are not under pressure to save water. However, they do need to reduce the amount of time and labour they spend irrigating. Depending on the topography and soils on the property they may chose to laser grade or to install spray irrigation. Farmers in this segment may be in the process of expanding their farming operation by acquiring additional land.

Rob and Kerry run 500 cows on 130 hectares at Bushy Park. They have a mix of spray irrigation systems. They began with lateral move spray irrigation, and have since put in travelling irrigators and rain guns. They've found laterals and travelling irrigators are a "labour nightmare". Employees don't like moving laterals particularly. Now they have two centre pivots. They are finding they grow more feed, have a much more even water distribution and much less time is involved.

Reuse dams

In interviews with farmers we found reuse dams were being managed in a variety of ways. Note that, sometimes, a natural depression may be used quite effectively as a reuse dam. The decision to install a reuse system is influenced by a number of factors. Factors that promote the installation of a reuse dam are:

- A need to store groundwater. Farmers with bores that yield relatively low flow rates may pump groundwater into a reuse dam prior to spray irrigating.
- A need to conserve irrigation water. Farmers that have laser graded may use a reuse dam to catch irrigation run-off and as a means of avoiding the risk of severe water losses from lasered bays that run too long.
- Whether the reuse system can be used in part to manage effluent. This depends on the layout and topography of the farm.

Factors that might prevent the installation of a reuse dam are:

- The topography and soils of the property. Often, on very undulating properties, the property is broken up into a number of sub-catchments. This means reuse dams are too expensive to install as a number will be needed to catch all the run-off from the property.
- The use of spray irrigation. Most farmers regard reuse dams as unnecessary with spray irrigation as there is little or no run-off with this type of irrigation.

Whole Farm Planning

We found during interviews with farmers that they see Whole Farm Plans mainly as a method for planning the staged redevelopment of the farm layout when laser grading. Consequently, Whole Farm Plans are seen to be largely irrelevant to the installation of spray irrigation systems. As one farmer expressed the point:

> *"You only need a Whole Farm Plan if you need to move dirt."*

Not surprisingly, many farmers expressed some concern about the need to obtain a Whole Farm Plan from a consultant in order to qualify for the incentives offered under the Macalister Nutrient Reduction Program.

Fertiliser management in dryland dairy farming

In our interviews with dryland dairy farmers we found all were applying phosphorus, generally with potassium and sulphur, although this depended a lot on their soil type and the time of year. Nitrogen was also applied, though not by all farmers. Lime and poultry manure were other inputs into fertiliser programs. Farmers stated they tried to manage dairy effluent to ensure there was little, if any, run-off into creeks or waterways.

We found some dryland farmers only applied phosphorus once a year. In contrast, other dryland farmers were applying phosphorus up to five or six times in a year. The differences in the frequency of application of phosphorus appeared to be related to plant requirements, the location of the farm, farm topography and the use of nitrogen. The location of the farm influences the types of plant species in pasture species, the timing of pasture growth and the risk of storms.

Nitrogen was generally applied four or five times a year on dryland farms. Farmers applying nitrogen would usually apply some phosphorus at the same time thereby spreading the risk of phosphorus losses due to unexpected rain events.

Several farmers did not apply any nitrogen fertiliser, as they believed it was detrimental to overall pasture health. For example:

> *Dennis is running 130 cows on 60 hectares. His cow numbers have dropped back a bit because of the drier weather over the last few years. He says "I'm a little bit organic really," as he doesn't believe in using nitrogen fertilisers. He tried nitrogen a few years ago and found that you got good growth after you apply it, but then the growth dies back and you have to keep applying it to get continued growth.*

All the farmers we spoke to applied phosphorus, either as straight super or as blend.

> *Ken runs a 250-300 cow dairy farm on 120 hectares. About 60 hectares is river flat country, the remainder being hill country. He applies phosphorus twice a year. He applies straight super in spring and 2 in 1 in autumn.*

Most farmers employed contractors to spread fertiliser and perceived them to be quite cost effective. Few farmers indicated they had experienced problems organising contractors when needed. An exception was one farmer on very hilly country.

> *Rob and Laura run a 120 hectare dairy farm and are milking 240 cows. Their property is very hilly and they have had to invest in their own fertiliser spreader as the contractors with trucks aren't able to spread on the hills. Rob says he made the decision to get their own spreader so that he could do what he wanted done and so he didn't have to go to the trouble of getting a contractor with a tractor – something he says is very hard.*

Some farmers believe fertiliser should be 'washed in' after it is applied. Other farmers believe 'washing in' is unnecessary as the fertiliser will be absorbed in the soil provided there is some moisture on the ground and in the air (on dewy nights for example). These beliefs influence how and when farmers apply their fertiliser. For example:

> *Mike and Sue run 160 cows on a 62 hectare dairy farm. They have a turnout block of 45 hectares that they use for young stock and dry cows. They apply phosphorus twice a year, after the autumn break and in late October as soon as the ground has dried out. Bruce doesn't believe that you need to wash in fertiliser – the moisture in the soil will do that so he tries to avoid rain events as much as he is able to.*

This contrasts with the following:

> *Peter runs a 85 hectare farm and milks 140 cows. He applies fertiliser once a year with an extra application for paddocks being cut for hay. He uses 2 in 1 with trace elements and some nitrogen, but never nitrogen on it's own as he believes it knocks the pasture around. Peter likes to wash in the fertiliser so he tries to put it out before rain.*

Fertiliser management in irrigated dairy farming

We found that irrigation and dryland dairy farmers were similar in that differences among farmers in fertiliser management were mainly attributable to differences in soil types and pasture composition, beliefs about the value of nitrogen, and beliefs about the need to 'wash in' fertiliser after spreading. The most crucial difference in fertiliser management between dryland and irrigated dairy farmers is the capacity of farmers with irrigation to integrate irrigation and fertiliser management.

> *Graeme has 60 hectares of flood irrigated land, running 200 cows. He applies nitrogen and phosphorus three times a year to match grass requirements. He believes it's important to wash fertiliser in and will try to use rain outside the irrigation season to do this if possible. Otherwise, he irrigates after fertilising, as he does not believe the fertiliser moves down the bay.*

This contrasts with:

> *Shane and Kim share-farm on 60 hectares and run 200 cows at the seasonal peak. The property is flood irrigated. They apply fertiliser two to three times a year depending on their budget and what the owner believes is necessary. They apply the fertiliser when the soil is damp, usually as soon as possible after an irrigation or some rain.*

The irrigated dairy farmers we interviewed employed contractors to spread fertiliser and perceived them to be quite cost effective. Farmers indicated they had not experienced any problems organising contractors when needed.

Farmers expressed some concern about the idea of not spreading fertiliser at the end of irrigation bays. They believed they would suffer significant pasture and production losses if they were to follow this recommendation. They also believed that even if they wished to follow the recommendation they would have to rely on the contractor to operate their machinery appropriately. Farmers believed that contractors did a reasonable job of avoiding unproductive areas on the farm such channels, drains, and streambeds when spreading.

Note that the fertiliser budget represents a significant proportion of farm costs. Consequently, farmers were concerned to ensure that they received a satisfactory return on their fertiliser expenditure. This means most farmers wish to be as effective as possible in using fertiliser and to keep expenditure on fertiliser within reasonable limits. This means most farmers will be receptive to information that will assist them with fertiliser management. However, given the importance of fertiliser as an input to pasture growth and milk production, most farmers are unlikely to change fertiliser management until they are convinced the change will be beneficial.

Conclusion

In interviews with farmers we have identified the factors that influencing the adoption of laser grading, spray irrigation systems, reuse dams and whole farm planning. We have also identified the factors that influence fertiliser management.

We found farmers originally adopted laser grading to save themselves time irrigating. Farmers used spray irrigation in the past on land that was not suited to flood irrigation. In recent times farmers have been motivated to adopt spray irrigation or laser grading by declining water allocations.

The type of irrigation system chosen by farmers depends on the soils and topography of their property, financial constraints, and farm layout. Time and labour constraints were also identified as key factors in the choice of an irrigation system.

The benefit of installing reuse dams was found to be heavily dependent on the soil type, topography and type of irrigation system used on the farm. Management of groundwater and of effluent also influenced the need for, and management of, reuse systems.

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