Goulburn Broken CMA

Farm Water Round 2 Case Studies

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Table of Contents

Summary

In 2014 ten irrigators were interviewed on the costs and benefits of changes made to their farming systems as a result of irrigation modernisation in the Goulburn Murray Irrigation District under the Farm Water Program Round 2. This report shows the changes for those ten farms.

This analysis includes the farm benefits as a result of modernisation, including both the change in farm infrastructure and the benefit from the off-farm GMW modernisation (all farms had a backbone connection and benefits from the farm and off-farm upgrades cannot be separated). The benefits are compared with farm costs only. If the GMW modernisation costs were to be included in the analysis the costs would change[1].

It is important to note that this is not a program evaluation of the Farm Water Program, it does not consider program administration costs or whether the upgrades would have occurred in the absence of Farm Water; or the timing, cost and scale of future upgrades in the absence of Farm Water. It also does not include any non-farm environmental benefits (such as downstream salinity or nutrient benefits) that can be associated with improved irrigation efficiency.

Instead its purpose is to identify and estimate the relative scale of benefits and costs of on-farm irrigation modernisation as they have occurred in the case studies.

Identifying and measuring specific numbers for the water saved, time saved and production gained for the upgrade area was difficult. Therefore, estimates of costs and benefits were made and tested with the landholders based on their experience with the old system prior to modernisation, and the new system following off-farm and on-farm modernisation. The uncertainty in determining benefits is further increased when the new system also results in a change in enterprise mix (eg. change from annual crops to summer /perennial crops).

The analysis was done assuming current crop type comparing the performance of the old irrigation system with the new irrigation system. The analysis was then repeated accounting for the change in crop type as well as the change in system. Based on the information collected the findings determined for the **same** crop type/mix:

- Water use savings (reductions for same crop) varied from 1.0 to 5.0 ML/ha/y, which compared with the water savings calculator value of 1.9 to 4.2 ML/ha/y.
- NPV[2] of the projects from +$987 to $+8,179/ha with a benefit/cost ratio ranging from 1.1 to 3.2.
- There is a wide variation in the changes achieved between farms, but the overall results are consistent with the results from round 1 case studies[3].

Changes in crop type were significant for four farms out of the ten interviewed. When these crop type changes are accounted for, as per round 1 case studies, the average water savings were negative, but the farm productivity gross margin gains were increased. This is because farmers with the new more efficient irrigation systems then adopted higher water use crops with a higher gross margin. When compared with the analysis for the same crop type the NPV for changed crop type (all ten farms but with changes to four farms) the result was a lower NPV, (it varied from -$3,757 to +$4,731). This is different to the round 1 sample where the NPV for changed crop type and same crop type were similar.

[1] The cost of GMW modernisation would need to be offset by its other benefits and its own water savings and a value put on this saved water.
[2] at 7% over 30 years for surface irrigation and for 20 years for centre pivots
[3] Results for Round 1 case studies are shown in the Appendices of this report

However, it should be noted that the results were for a very small sample and are sensitive to the water value assumed.

It is important to recognise that while the economic analysis is positive for most case studies, the benefits assumed will only be achieved if the current irrigated land use continues and has a positive gross margin. For example, if there is a future drought sequence and irrigation does no occur for some seasons, then the benefits would be over estimated. Also, unlike business growth through land or water entitlement purchases, few of the case study farmers believed that their property value would have increased to the same extent as the investment made in infrastructure.

The Farm Water Program by providing infrastructure payments in return for a share of the water savings changes the balance of farm investment in favour of irrigation upgrades, rather than say land or water asset investment; and this provides wider environmental benefits and regional productivity gains that are associated with improved irrigation performance.

1 Purpose

The purpose of this report is to undertake an analysis of the costs and benefits of farm irrigation system modernisation.

The report aims to provide an estimate of the economic value of modernisation by comparing current practices with the practices that would have occurred without modernisation.

It is important to note that these case studies have been connected to the modernised backbone, which is a criteria for participating in the Farm Water Program. A rationale for backbone modernisation is that it can facilitate on-farm modernisation and lead to higher farm productivity. This study explores the validity of that premise by estimating the costs and benefits of on-farm modernisation in areas that have benefitted from both on-farm and off-farm backbone modernisation.

This analysis has been undertaken by comparing farms “with the new technology” versus those “without the new technology” using examples of upgraded irrigation properties implemented as part of Round 2 of Farm Water. This includes farms funded by the Commonwealth’s On-Farm Irrigation Efficiency Program (OFIEP), the Victorian On farm State Priority Project (VOSP) and the contributions made by the farmers themselves.

It is important to note that this is not a program evaluation, as it does not consider program administration costs or whether the upgrade have occurred anyway, and if so within what time period or cost.

Instead its purpose is to identify and determine the relative costs and benefits of farm modernisation as they have occurred in the case studies.

2 Method

Case studies

The case studies were selected in conjunction with Farm Water staff to be:

- Representative of the types of farm in Round 2. (Whilst the sample was selected to be representative, a statistical analysis has not been completed to confirm if this is the case)
- Able to provide a meaningful comparison of the new system versus the old system
- Examples where works have been completed and some experience with the new system had occurred

Farmers were given the opportunity to review early drafts of their individual write-ups to provide feedback and ensure accuracy.

Economic analysis

A partial discounted cash flow analysis was undertaken to determine the cost-benefit of the upgrade. All costs and benefits associated with the change in system were considered.

It is important to realise that if the upgrade demonstrates a large net benefit or cost, this is not a measure of the performance of the whole farm business either before or after the upgrade. The approach has been to: -

1. Examine costs and benefits of the 'modernised' system.
2. Examine costs and benefits of the same land if not modernised.
3. Net out costs without modernisation and with modernisation, net out benefits with and without.
4. Determine a NPV over 30 years, at 7% discount rate. Thirty years was selected to be the effective life of the system with nil residual value and 7% discount rate was selected to reflect the risks of commercial farming. Capital costs are assumed to occur in year zero, whilst benefits and water savings are assumed to occur from year 1 to 30. In the case of pressurised sprinkler systems such as centre pivots costs and benefits were determined over twenty years as the life expectancy of these systems is expected to be shorter.
5. Production benefits have been estimated by determining changes in stocking rates or yields with typical industry benchmarks for gross margins.

Water savings need to consider:

a) The crop mix in the water savings calculator at project acceptance
b) The calculator estimate for the current crop mix
c) The estimated actual change in water use with the current crop mix as a result of the upgrade (this was used to assess the benefit of change in water use)
d) Estimated actual water saving allowing for changes in crop yield. This is because higher crop yields impact on a higher water requirement.[4]. However, this was not used to assess the benefits of water savings, as it would be double counting with the productivity gain.

The estimated actual change in water use ((c) above) was valued at $1,500/ML saved[5]. This reflected the market value of Victorian High Reliability Water Shares at the time works were completed. It should be noted that this value fluctuates over time. This value was applied to all water savings regardless of the % transferred to the Commonwealth and the % retained on farm.

The benefit of farm labour savings have been estimated using a standard $25/hour rate[6] with the farmers experience to date on time savings with the new system compared to the old system. In reality this saving may not be cash saving, if the time saving does not reduce labour expenses, but it is a real benefit in terms of lifestyle and/or ability to expand the operation.

This analysis takes the viewpoint of change in costs and benefits at the farm level. It does not discriminate if capital costs have been subsidised by any grants the farmers obtained through the Farm Water Program. Therefore, the grant payments towards capital costs have not been

[4] See FAO Irrigation & Drainage Paper 66 Crop Yield Response to Water, 2012 for more information on this topic.

[5] The market price of high reliability water shares in Northern Victoria was lower in 2012/13 than in 2011/12, with a median of $1,500/ML versus $1,800/ML. Reference http://waterregister.vic.gov.au/images/documents/Water%20Trading%20Annual%20Report_2012-13%20version2.pdf accessed 23/2/14

[6] This is slightly above farm labour award rates. A high rate has been adopted to reflect the time saved for the business owner doing most of this work. Note FLH 8 as of 14/2/13 was $19.97/hour on https://extranet.deewr.gov.au/ccmsv8/CiLiteKnowledgeDetailsFrameset.htm?KNOWLEDGE_REF=216329&TYPE=X&ID=3487003589121842088889912894&DOCUMENT_REF=375115&DOCUMENT_TITLE=Pastoral%20Award%202010&DOCUMENT_CODE=MA000035

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included as a benefit in the analysis, as they are included in the total costs of the farm investment. This is because we are interested in the benefit/cost of the investment as a whole, regardless of whether it has received a grant payment. The analysis does not include other costs beyond the farm gate that are associated with the administration of the Farm Water Program.

The analysis was completed considering extra costs, revenue forgone, cost savings and farm productivity gains as a result of the upgrade using partial budgets. A whole farm analysis was not completed.

Identifying costs and benefits

A key uncertainty in the base case for a program evaluation, is whether the upgrade would have occurred anyway, and within what time period and cost. This question is not evaluated in this study. Instead its purpose is to identify and determine the relative scale of benefits of farm modernisation as they have occurred in the case studies.

Determining the production, water use and labour requirement for the project area without the upgrade is a major challenge in this type of analysis. The case studies focussed on the change to these values as a result of modernisation. It was assumed that the relative gain as a result of modernisation continues over 30 years and that any other technological changes that may have occurred in the absence of the project that improves production/labour/water use would equally apply to both cases (with and without), such that the scale of the benefits remains the same. In reality, adoption of new practices is more likely on upgraded areas, as these areas are less limited by low irrigation efficiency and more likely to be intensively used. i.e. production benefits may be underestimated.

A comparison of “with modernised irrigation system” versus “without irrigation system” is not as simple as it first appears. Many changes occur on a farm from one season to the next season and other significant changes to the farm system are made. For example, farms change size, change crop mix, upgrade dairies, experience different seasonal conditions, change personnel, all of which impacts on costs and income. Often these changes are inter-related.

Irrigation farms in northern Victoria experienced very low water availability during the drought and are now experiencing much higher water availability. This has had a significant impact on the farm system. In particular, people have moved back into perennial pastures and summer crops, while during the drought they focussed their limited water on annual pastures and winter cereals.

This had made it impossible to do a simple “before upgrade” versus “after upgrade” comparison as there are large changes to the farm irrigation mix and scale that are beyond the impact of the irrigation system but need to be considered.

It was also difficult to assess actual productivity benefits as experience with the new system is limited and there is little data on the benefits that are only now being realised. This report should be considered as representing preliminary findings, which require confirmation over time.

The data collected in our interviews was used to untangle the impacts and list the additional benefits and costs that can be allocated to the upgrade using partial budgeting.

Benefits have been calculated according to the specific changes made on farm. In some cases this has been through increased cow numbers and a margin per cow has been used to determine the benefit. In other cases it is through less bought in feed or increased yield of crops. In these cases the value of the additional feed or crop has been used to assess the benefits (less any additional costs associated with the increased production). The specifics are documented in each of the individual case studies.

In order to address these information gaps the approach has been to interview the farmers, use their data where it is available and fill gaps by developing costs and benefits based on their experience to date supplemented with industry generic data.

Identifying and measuring specific numbers for the water saved, time saved and production gained for the upgrade area is difficult. Therefore, estimates of costs and benefits were made and tested with the landholders based on their experience with the old system and the new system. The uncertainty in benefits is further increased when the new system results in a change in enterprise mix (eg. change from annual crops to summer /perennial crops).

The analysis of benefits also does not account for the fact that farms are dynamic and will change crop mix from year to year according to market demands, water prices and individual circumstances. It assumes that the experience of the first year is representative for the next thirty. This may overstate benefits, if there are droughts or flooding events or other serious crop losses. On the other hand, it also does not account for future productivity gains that may occur as the irrigator improves their system or “bumper” years when prices or yields are well above the experience from the first year.

Two types of analysis have been carried out

In last years analysis two types of analysis were undertaken to compare “with” versus “without” upgrade scenarios.

The first analysis involved comparing the two scenarios with a standard crop mix that reflected the current mix (method 1).

However, it should be recognised that in some cases irrigating the current crop mix with the previous irrigation system would not be practical. Irrigating current crops with higher water requirements with the old system would mean very high water use, high labour requirement and lower production and because of this may have been uneconomic. That is often why the old systems were mainly used for low water use crops such as annual pastures and annual crops.

In these cases an important benefit of the new system is to enable more flexibility in choosing the crop type. It allows the farmer to move to higher water use crops such as perennials and summer crops, whereas previously this would not have been a practical option.

Therefore, a second analysis (method 2) was undertaken to estimate the cost-benefit with a different crop mix of the old system versus the new system. This recognises that modernisation has enabled the adoption of more intensively irrigated crops such as perennial pastures, lucerne and summer crops on areas that with the old system would only have been used for annual crops.

In these cases upgraded systems have enabled people to move to a higher proportion of perennials and summer cropping (which have a higher water requirement) from land that would only ever be used for annual pastures/crops. When compared to the previous analysis this:

- Reduces the change in water use (due to higher water use crops now being selected the change in water use can be negative),
- Increases the productivity gain (more yield t/ha from the new higher water use crops) and
- Reduces the labour savings (more work per ha with the new crop versus the old crop).

Goulburn-Murray Water modernisation

The purpose of this analysis has been to evaluate the cost/benefit of farm modernisation, which is a different question to the cost/benefit of total system modernisation.

This analysis includes the farm benefits as a result of modernisation, which includes the both the change in farm infrastructure and the benefit from the off farm GMW modernisation. This is because all farms had to have a backbone connection and the benefits from the two upgrades cannot be separated.

The benefits are compared with farm costs only. If the GMW modernisation costs were to be included in the analysis the costs would change[7].

The data collected in this report would be useful to inform an evaluation of the benefits of overall modernisation, although caution is needed to draw broad regional conclusions given the small sample size, the preliminary nature of the experience to date and the uncertainty in estimates.

[7] The cost of GMW modernisation would need to be offset by its other benefits and its own water savings and a value put on this saved water.

3 Summary of Results

3.1 Estimating costs and benefits assuming current crop mix (method 1)

Results of the analysis are presented in Table 3-1. To enable an easy comparison between annual and capital costs all capital items have been converted to an equivalent annual cost per ha at 7% over 30 years (or 20 years for centre pivots).

The table lists lowest, average, highest and median values for:-

- additional capital costs associated with the upgrade,
- additional annual costs associated with the upgrade
- estimated change in water use ML/ha/y,
  - using the calculator at the time of project proposal,
  - using the calculator with current crop mix
  - water savings assuming no change in yield with current crop mix
  - water savings based on experience to date with current crop mix and allowing for change in yield (this value is used to calculate the economic benefit of water saved).
  - value of saved water (benefit).
- additional annual benefits
  - saved channel operation and maintenance costs, - chemicals, - labour, -wear and tear on equipment and - contractors
  - other saved labour (mostly in irrigation operations)
  - increased value of production
  - benefits sensitivity tested at -25% and +25% of above estimated benefits including water value.
- Benefits-Cost equivalent annual value/ha, Net Present Value/ha and Benefit/Cost ratio with sensitivity testing at -25% and +25% of the benefits.

The results show that assuming the same crop mix, the three biggest benefits are the value of saved water, the value of saved labour and the increased productivity.

There is a wide range in results. The individual case study chapters provide more detail for the specific farms and Appendix 1 aggregates the information from the individual farms to allow observation of the ranges.

It is important to recognise that while the economic analysis is positive for most case studies, the benefits assumed will only be achieved if the current irrigated land use continues and has a positive gross margin. For example, if there is a future drought sequence and irrigation does no occur for some seasons, then the benefits would be over estimated.

Table 3-1 Method 1 - Change in costs and benefits with current crops as a result of the upgrade for ten round 2 case studies using 1 years of experience

Change in costs and benefits		*lowest*	*average*	*highest*	*median*
	Area upgraded ha	*28*	*66*	*140*	*57*
Additional Costs					
Capital		*per ha*	*per ha*	*per ha*	*per ha*
	Total estimated cost irrigation works	*$ 2,986*	*$ 5,108*	*$ 8,452*	*$ 4,688*
	other costs fencing stock water etc	*$ -*	*$ 256*	*$ 1,071*	*$ -*
	lost production during upgrades	*$ -*	*$ 313*	*$ 714*	*$ 225*
	Other non irrigation capital required as a result of upgrade eg. new dairy	*$ -*	*$ -*	*$ -*	*$ -*
	total capital cost of works	***$ 2,986***	***$ 5,677***	***$ 9,039***	***$ 5,513***
	equivalent annual cost of capital 7%, 30 years or 20 yrs pivot, nil residual value	*$ 241*	*$ 478*	*$ 798*	*$ 458*
Annual					
	additional power costs $/y	*$ -*	*$ 90*	*$ 288*	*$ 55*
	additional repairs and maintenance $/y	*$ -*	*$ 56*	*$ 323*	*$ -*
	Total additional costs/y	***$ 241***	***$ 624***	***$ 1,354***	***$ 506***
Additional Benefits					
Capital					
ML/ha/y	Water savings calculator estimated prior to works	*1.0*	*2.5*	*4.2*	*2.4*
ML/ha/y	Water saving calculator with current crop mix	*1.9*	*2.7*	*4.2*	*2.3*
ML/ha/y	water saving adopted for assessment of water value excludes saving used for additional yield	*1.0*	*2.6*	*5.0*	*2.3*
	market value of water saved $1,500/ML annualised value $/y	*$ 121*	*$ 324*	*$ 639*	*$ 286*
	saved channel structure replacement costs - not costed	*$ -*	*$ -*	*$ -*	*$ -*
Annual					
	saved channel costs	*-$ 29*	*$ 31*	*$ 78*	*$ 27*
	saved labour $/y	*$ 59*	*$ 188*	*$ 479*	*$ 145*
	saved vehicle use and saved other costs $/y	*$ 1*	*$ 8*	*$ 28*	*$ 5*
	- saved pumping costs on water saved $/y	*$ -*	*$ 1*	*$ 8*	*$ -*
	- saved variable water charges at $7.11/ML/y	*$ 7*	*$ 18*	*$ 36*	*$ 16*
	increased production $/y	*$ -*	*$ 346*	*$ 720*	*$ 353*
	Other savings due to non irrigation capital eg. new dairy $/y	*$ -*	*$ -*	*$ -*	*$ -*
		$ -			
	Total additional benefits/y	***$ 321***	***$ 915***	***$ 1,517***	***$ 841***
	sensitivity test -25% benefits	*$ 241*	*$ 686*	*$ 1,138*	*$ 630*
	sensitivity test +25% benefits	*$ 401*	*$ 1,144*	*$ 1,896*	*$ 1,051*
	Benefits-cost/y	***$ 80***	***$ 292***	***$ 659***	***$ 157***
	NPV	*$ 987*	*$ 3,509*	*$ 8,179*	*$ 2,915*
	B/C ratio	*1.1*	*1.6*	*3.2*	*1.3*
Sensitivity testing					
-25% benefits	***Benefits-cost/y***	*-$ 217*	*$ 63*	*$ 418*	*-4*
-25% benefits	*NPV*	*-$ 2,294*	*$ 800*	*$ 5,191*	*-52*
-25% benefits	*B/C ratio*	*0.84*	*1.19*	*2.38*	*0.99*
+25% benefits	***Benefits-cost/y***	*$ 161*	*$ 472*	*$ 900*	*317*
+25% benefits	*NPV*	*$ 1,996*	*$ 6,218*	*$ 11,825*	*4841*
+25% benefits	*B/C ratio*	*1.40*	*1.98*	*3.96*	*1.65*

The sensitivity to plus or minus 25% of the total benefits is indicated by the change in NPV and benefit cost ratios. This shows that as would be expected, the results are sensitive to the benefits assumed.

The variability across the case studies for a range of parameters is shown in the graphs below (Figures 3-1 to 3-3).

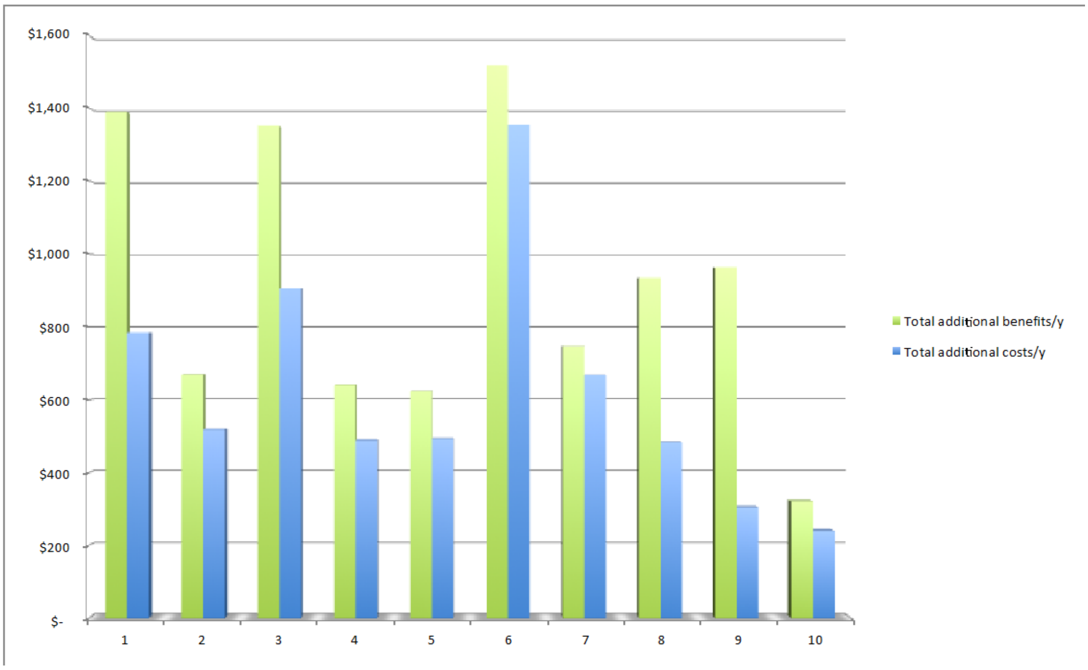


Figure 3-1 Total additional costs/ha/y and total additional benefits/ha/y for the 10 case studies interviewed (method 1)

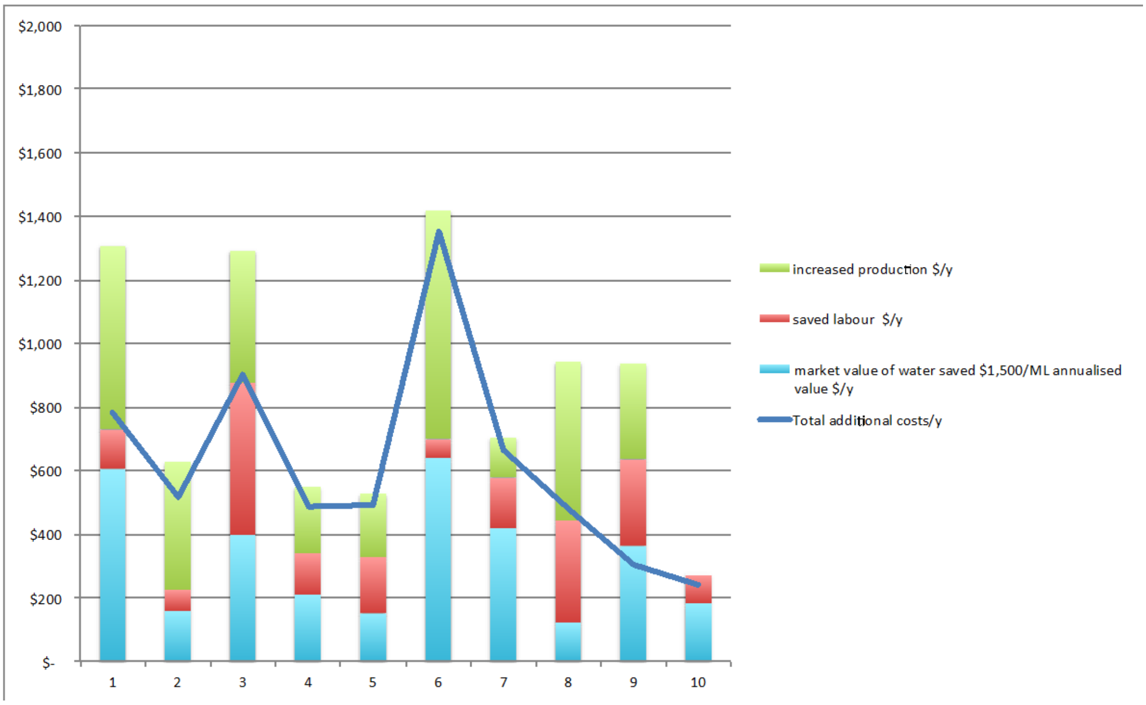


Figure 3-2 Total additional costs and split of additional benefits (into labour savings, water savings and increase in gross margin production gains) for the 10 case studies (method 1)

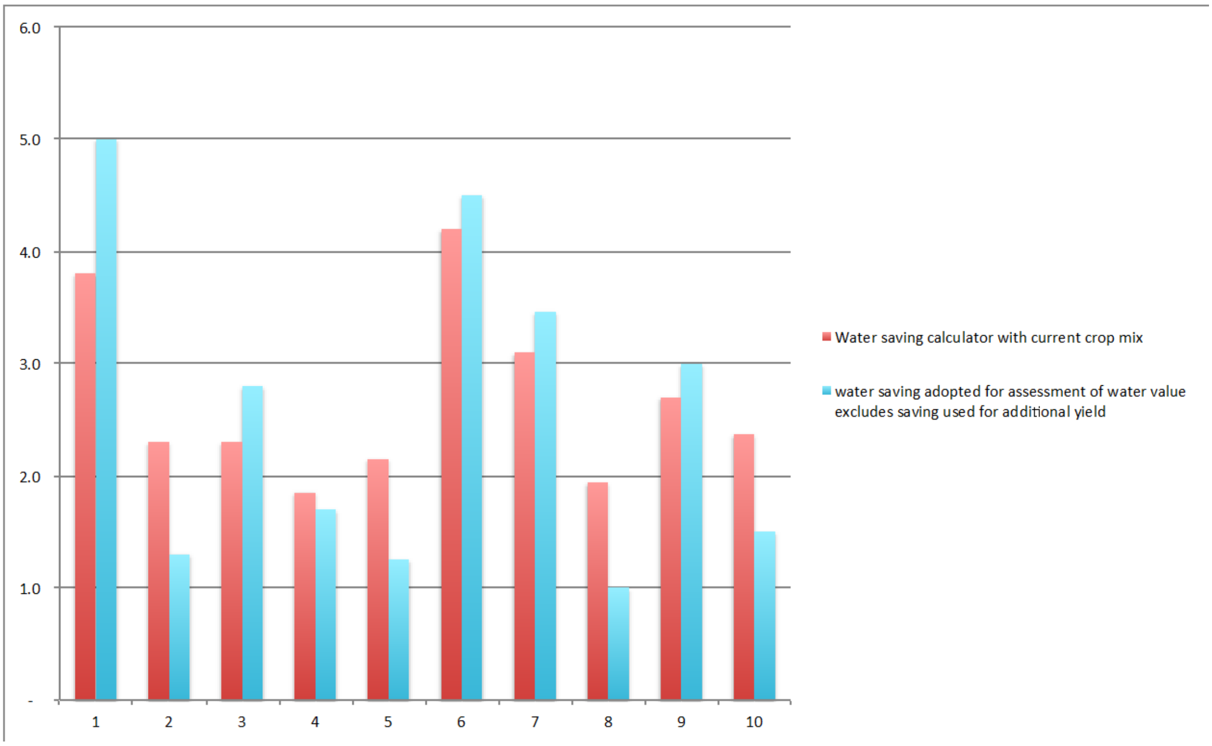


Figure 3-3 Estimated water savings for the 10 case studies (method 1).

3.2 Estimating costs and benefits with changed crop mix (method 2)

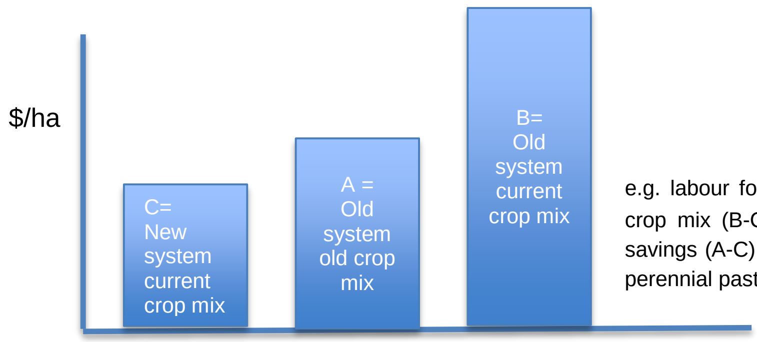
The previous analysis (method 1) did not account for the fact that the modernisation on some farms has enabled the adoption of more intensively irrigated crops such as perennial pastures, lucerne and summer crops on areas that with the old system would only have been used for annual crops.

Estimating the crop mix with the old system depends very much on the state of the old system. In some instances the upgrade was from unlasered or old style irrigation areas that were too labour intensive to irrigate perennials or summer crops. In these cases the crop mix with the old system would be predominantly annual pastures, which have a lower irrigation requirement than the summer irrigated crops now adopted (perennial pastures and summer cropping).

In general, where re-lasering was not required, no change in crop mix is likely. This is because these areas were already at a modern standard and a change in crop mix would be less likely to be facilitated by the upgrade. The changes to the analysis changes when allowing for the benefit of changed crop type are described in Table 3-2 and Figure 3-4.

Table 3-2 Change in costs and benefits allowing for more perennial pastures/summer crops as a result of the upgrade

Attribute	Change in analysis with for different crop mix (more perennial pasture/summer crop with upgraded system compared to non-upgraded)	Impact on analysis compared to same crop mix
Capital costs of upgrade	Same	No change
Water saved	Need to allow for less summer irrigation (higher water requirement) with previous system	Lower water use reductions (is negative when the additional crop irrigation requirement exceeds estimated savings). This impacts on the market value of saved water. Pumping cost savings, and water charge savings.
Channel maintenance costs	Less maintenance required with less summer irrigation on previous system	Theoretical decrease in maintenance savings. But this is a very minor component of the overall cost/benefit and has been left unchanged.
Saved labour and vehicle savings	Less labour required with less summer irrigation on previous system	Decrease labour /vehicle savings. Due to the individual farm differences this has been estimated on a case-by-case basis.
Farm productivity	Higher productivity gain as more production from summer irrigated area	Increase farm production gains. Due to the individual farm differences this has been estimated on a case-by-case basis. From previous stocking rates and pasture mixes. And change in annual/summer crop mixes.



e.g. labour for irrigating[8]. Big savings for current crop mix (B-C) both perennial pastures, smaller savings (A-C) allowing for move to from annual to perennial pastures.

Figure 3-4 Changes in parameters as a result of crop type changes and irrigation system changes

From the graph above the previous analysis (section 3-1) compared the difference between B and C. This analysis compares A and C.

They show that for the same costs per ha, total benefits are lower and the mix of benefits changes:

- On average water savings are negative
- labour savings are smaller
- The reduction in labour and water saving benefits is offset to some extent by the corresponding increase in production gain (gross margin) from the crops with a higher water requirement.
- The difference between the two approaches is sensitive to water value. For example, using a lower water value than $1,500/ML[9] saved would improve the benefit-cost ratio for the method 2 analysis and worsen it for the method 1 analysis.

[8] The relative differences will vary with the parameter and farm. For water use typically B>C>A and dry matter yield C>B>A if there has been a major change in crop type.

[9] ($1,500/ML at 7% over 30 years is equivalent to an annual value of $121/ML/y)

Table 3-3 Method 2- Change in costs and benefits with changed crops as a result of the upgrade for ten round 2 case studies using 1 years of experience ***(sample of ten with 4 farms having changed crop type)***

Change in costs and benefits		*lowest*	*average*	*highest*	*median*
	Area upgraded ha	*28*	*66*	*140*	*57*
Additional Costs					
Capital		*per ha*	*per ha*	*per ha*	*per ha*
	Total estimated cost irrigation works	$ 2,986	$ 5,108	$ 8,452	$ 4,688
	lost production during upgrades	$ –	$ 313	$ 714	$ 225
	other costs fencing stock water etc	$ –	$ 256	$ 1,071	$ –
	Other non irrigation capital required as a result of upgrade eg. new dairy	$ –	$ –	$ –	$ –
	total capital cost of works	**$ 2,986**	**$ 5,677**	**$ 9,039**	**$ 5,513**
	equivalent annual cost of capital 7%, 30 years, nil residual value	$ 241	$ 478	$ 798	$ 458
Annual					
	additional power costs $/y	$ –	$ 90	$ 288	$ 55
	additional repairs and maintenance $/y	$ –	$ –	$ –	$ –
	Total additional costs/y	**$ 241**	**$ 624**	**$ 1,354**	**$ 506**
Additional Benefits					
Capital					
ML/ha/y	Change in water use	– 6.8	– 0.6	4.5	1.3
Annual	market value of water saved $1,500/ML annualised value $/y	– 822.0	– 54.5	639.4	154.5
	saved channel costs	-$ 29	$ 31	$ 78	$ 27
	saved labour $/y	-$ 18	$ 135	$ 479	$ 110
	saved vehicle use $/y	$ 1	$ 7	$ 28	$ 5
	- saved pumping costs on water saved $/y	$ –	$ 1	$ 8	$ –
	- saved variable water charges at $7.11/ML/y	-$ 48	-$ 4	$ 32	$ 9
	increased production $/y	$ –	$ 608	$ 1,426	$ 458
		$ –			
	Total additional benefits/y	**$ 256**	**$ 729**	**$ 1,517**	**$ 654**
	Benefits-cost/y	**-$ 303**	**$ 106**	**$ 447**	**$ 139**
	NPV	-$ 3,757	$ 1,148	$ 4,731	$ 1,148
	B/C ratio	0.61	1.17	1.49	1.28

In summary, this analysis (method 2) results in a lower NPV and lower benefit/cost ratio than assuming the same crop type (method 1). This is different to the round 1 survey, which had similar results between method 1 and 2 (See Appendix 1 and Appendix 2).

These results are sensitive to the water value assumed and show lower than actual benefits when the actual water market price is lower than the assumed value, which was the case in the season surveyed.

This highlights another complexity in this type of analysis, as the crop mix will change according to water market price from season to season, and as a result it is difficult to define the water saving, productivity and other benefits in such a dynamic system.

Also, only four farms identified significant crop type changes and so the sample is very small and these results should be treated with caution.

Unlike business growth through land or water entitlement purchases, few of the case study farmers believed that their property value would have increased to the same extent as the investment made in infrastructure. This illustrates that a less risky investment to expand, is to invest in additional land and/or water entitlement assets that may appreciate and if necessary be sold; rather than purchase new irrigation systems, which depreciate and cannot be easily sold. However, the case studies show that upgraded irrigation systems provide labour efficiency, more flexibility (quality of life or able to do other jobs around the farm) which is difficult to fully quantify. A couple of the early case studies saw farmers get a new lease of life with the change, as they were not constantly chasing water all summer long. Business expansion via investment in additional land assets, water assets or irrigation upgrades will depend upon the individual circumstances, level of profit and appetite for risk.

Appendix 1 - Case study details Method 1

Table 12-4 Round 2 – Year 1 Change in costs and benefits for the 10 case studies interviewed assuming current crop mix comparing with versus without the new irrigation technology.

Change in costs and benefits		1	2	3	4	5	6	7	8	9	10	lowest	average	highest	median
	Area upgraded ha	28	36	96	48	32	31	116	70	66	140	28	66	140	57
Additional Costs															
Capital		per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha
	Total estimated cost irrigation works	$ 7,761	$ 4,250	$ 4,250	$ 5,125	$ 5,188	$ 8,452	$ 5,888	$ 4,171	$ 3,008	$ 2,986	$ 2,986	$ 5,108	$ 8,452	$ 4,688
	other costs fencing stock water etc	$ 1,071	$ 167	$ -	$ -	$ 469	$ -	$ -	$ 857	$ -	$ -	$ -	$ 256	$ 1,071	$ -
	lost production during upgrades	$ 207	$ -	$ 625	$ 244	$ -	$ -	$ 690	$ 714	$ 652	$ -	$ -	$ 313	$ 714	$ 225
	Other non irrigation capital required as a result of upgrade eg. new dairy	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	total capital cost of works	$ 9,039	$ 4,417	$ 4,875	$ 5,369	$ 5,656	$ 8,452	$ 6,578	$ 5,743	$ 3,659	$ 2,986	$ 2,986	$ 5,677	$ 9,039	$ 5,513
	equivalent annual cost of capital 7%, 30 years or 20 yrs pivot, nil residual value	$ 728	$ 356	$ 460	$ 433	$ 456	$ 798	$ 548	$ 463	$ 295	$ 241	$ 241	$ 478	$ 798	$ 458
Annual															
	additional power costs $/y	$ 55	$ 162	$ 288	$ 56	$ 38	$ 234	$ 58	$ -	$ 9	$ -	$ -	$ 90	$ 288	$ 55
	additional repairs and maintenance $/y	$ -	$ -	$ 156	$ -	$ -	$ 323	$ 60	$ 20	$ -	$ -	$ -	$ 56	$ 323	$ -
	Total additional costs/y	$ 783	$ 518	$ 904	$ 489	$ 493	$ 1,354	$ 667	$ 483	$ 304	$ 241	$ 241	$ 624	$ 1,354	$ 506
Additional Benefits															
Capital															
ML/ha/y	Water savings calculator estimated prior to works	3.8	2.3	2.1	3.1	2.4	4.2	2.6	1.9	1.4	1.0	1.0	2.5	4.2	2.4
ML/ha/y	Water saving calculator with current crop mix	3.8	2.3	2.3	1.9	2.2	4.2	3.1	1.9	2.7	2.4	1.9	2.7	4.2	2.3
ML/ha/y	water saving adopted for assessment of water value excludes saving used for additional yield	5.0	1.3	2.8	1.7	1.3	4.5	3.5	1.0	3.0	1.5	1.0	2.6	5.0	2.3
	market value of water saved $1,500/ML annualised value $/y	$ 604	$ 158	$ 397	$ 209	$ 151	$ 639	$ 419	$ 121	$ 363	$ 181	$ 121	$ 324	$ 639	$ 286
	saved channel structure replacement costs - not costed	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual															
	saved channel costs	$ 18	$ 28	$ 26	$ 73	$ 78	$ 65	$ 17	-$ 29	$ -	$ 32	-$ 29	$ 31	$ 78	$ 27
	saved labour $/y	$ 125	$ 67	$ 479	$ 131	$ 176	$ 59	$ 159	$ 321	$ 273	$ 89	$ 59	$ 188	$ 479	$ 145
	saved vehicle use and saved other costs $/y	$ 28	$ 4	$ 13	$ 7	$ 8	$ 2	$ 1	$ 14	$ 3	$ 1	$ 1	$ 8	$ 28	$ 5
	- saved pumping costs on water saved $/y	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8	$ -	$ 1	$ 8	$ -
	- saved variable water charges at $7.11/ML/y	$ 36	$ 9	$ 20	$ 12	$ 9	$ 32	$ 25	$ 7	$ 21	$ 11	$ 7	$ 18	$ 36	$ 16
	increased production $/y	$ 579	$ 403	$ 417	$ 208	$ 200	$ 720	$ 126	$ 500	$ 303	$ -	$ -	$ 346	$ 720	$ 353
	Other savings due to non irrigation capital eg. new dairy $/y	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
												$ -			
	Total additional benefits/y	$ 1,389	$ 668	$ 1,351	$ 640	$ 622	$ 1,517	$ 746	$ 935	$ 963	$ 321	$ 321	$ 915	$ 1,517	$ 841
	sensitivity test -25% benefits	$ 1,042	$ 501	$ 1,013	$ 480	$ 466	$ 1,138	$ 560	$ 701	$ 722	$ 241	$ 241	$ 686	$ 1,138	$ 630
	sensitivity test +25% benefits	$ 1,736	$ 835	$ 1,689	$ 800	$ 777	$ 1,896	$ 933	$ 1,169	$ 1,204	$ 401	$ 401	$ 1,144	$ 1,896	$ 1,051
	Benefits-cost/y	$ 606	$ 150	$ 447	$ 151	$ 128	$ 163	$ 80	$ 452	$ 659	$ 81	$ 80	$ 292	$ 659	$ 157
	NPV	$ 7,516	$ 1,865	$ 4,731	$ 1,879	$ 1,593	$ 1,724	$ 987	$ 5,613	$ 8,179	$ 1,000	$ 987	$ 3,509	$ 8,179	$ 2,915
	B/C ratio	1.8	1.3	1.5	1.3	1.3	1.1	1.1	1.9	3.2	1.3	1.1	1.6	3.2	1.3
Sensitivity testing															
-25% benefits	***Benefits-cost/y***	$ 259	-$ 17	$ 109	-$ 9	-$ 27	-$ 217	-$ 107	$ 219	$ 418	$ 0	-$ 217	$ 63	$ 418	-4
-25% benefits	*NPV*	$ 3,208	-$ 208	$ 1,153	-$ 107	-$ 336	-$ 2,294	-$ 1,327	$ 2,712	$ 5,191	$ 3	-$ 2,294	$ 800	$ 5,191	-52
-25% benefits	*B/C ratio*	1.33	0.97	1.12	0.98	0.95	0.84	0.84	1.45	2.38	1.00	0.84	1.19	2.38	0.99
+25% benefits	***Benefits-cost/y***	`	$ 317	$ 784	$ 312	$ 284	$ 542	$ 266	$ 686	$ 900	$ 161	$ 161	$ 472	$ 900	317
+25% benefits	*NPV*	$ 11,825	$ 3,939	$ 8,310	$ 3,866	$ 3,522	$ 5,743	$ 3,302	$ 8,514	$ 11,166	$ 1,996	$ 1,996	$ 6,218	$ 11,825	4841
+25% benefits	*B/C ratio*	2.22	1.61	1.87	1.64	1.58	1.40	1.40	2.42	3.96	1.67	1.40	1.98	3.96	1.65
	old system yield t DM/ha/y	11.00	17.00	13.00	7.90		12.00		15.00	7.00		7.00	11.84	17.00	12.00
	new system yield t DM/ha/y	15.00	19.00	15.00	8.60		16.00		20.00	10.00		8.60	14.80	20.00	15.00
	production gain per ha t DM/ha/y	4.00	2.00	2.00	0.70	1.00	4.00		5.00	3.00		0.70	2.71	5.00	2.35
	old system water use efficiency t DM/ML/y	0.61	1.12	1.12	0.80		0.73		1.10	0.60		0.60	0.87	1.12	0.80
	new system water use efficiency t DM/ML	1.15	1.37	1.70	1.00		1.33		1.50	1.10		1.00	1.31	1.70	1.33
	production gain per ML t DM/ML	0.54	0.25	0.58	0.20		0.60		0.40	0.50		0.20	0.44	0.60	0.50

Note: some case studies had inadequate production data to estimate water use efficiency t/ DM/ha or t dry matter/ML.

The following tables are from the Round 1 case studies and have been included for information.

Table 13-5 Round 1 – Year 1 Change in costs and benefits for the 12 case studies plus 7 Vic Dairy Australia assuming current crop mix comparing with versus without the new irrigation technology.

Change in costs and benefits- case study number		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	10	lowest	average	highest	median
	Area upgraded ha	120	115	126	120	35	160	53	144	33	68	77	58	101	31	43	140	10	250	17	10	90	250	77
Additional Costs																								
Capital		per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha
	Total estimated cost irrigation works	$ 5,659	$ 3,261	$ 2,619	$ 4,167	$ 4,800	$ 1,563	$ 4,868	$ 3,465	$ 6,435	$ 4,044	$ 5,390	$ 3,190	$ 5,452	$ 6,581	$ 7,223	$ 6,429	$ 7,100	$ 3,833	$ 8,529	$ 1,563	$ 4,979	$ 8,529	$ 4,868
	lost production during upgrades	$ 1,250	$ -	$ 198	$ -	$ 1,327	$ 350	$ 377	$ -	$ 1,212	$ -	$ 519	$ 200	$ 228	$ -	$ -	$ -	$ -	$ 360	$ -	$ -	$ 317	$ 1,327	$ 198
	other costs fencing stock water etc	$ 417	$ 435	$ 437	$ 833	$ 1,229	$ 500	$ 943	$ -	$ -	$ -	$ 117	$ -	$ 983	$ 1,095	$ 465	$ 714	$ -	$ 160	$ -	$ -	$ 438	$ 1,229	$ 435
	Other non irrigation capital required as a result of upgrade eg. new dairy	$ -	$ -	$ 3,968	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -	$ -	$ -	$ -	$ -	$ 220	$ 3,968	$ -
	total capital cost of works	$ 7,326	$ 3,696	$ 7,705	$ 5,000	$ 7,356	$ 2,413	$ 6,189	$ 3,465	$ 7,648	$ 4,044	$ 6,026	$ 3,390	$ 6,663	$ 7,675	$ 7,756	$ 7,143	$ 7,100	$ 4,353	$ 8,706	$ 2,413	$ 5,982	$ 8,706	$ 6,663
	equivalent annual cost of capital 7%, 30 years, nil residual value	$ 590	$ 298	$ 582	$ 403	$ 593	$ 194	$ 499	$ 279	$ 616	$ 326	$ 486	$ 273	$ 537	$ 619	$ 625	$ 576	$ 572	$ 351	$ 702	$ 194	$ 400	$ 702	$ 537
Annual																								
	additional power costs $/y	$ 20	$ 18	$ 39	$ 30	$ 12	$ 9	$ 8	$ 5	$ -	$ 2	$ -	$ 16	$ 52	$ 408	$ 5	$ 7	$ 24	$ 29	$ 87	$ -	$ 41	$ 408	$ 16
	additional repairs and maintenance $/y	$ -	$ -	$ -	$ -	$ -	$ 9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4	$ 29	$ -	$ 2	$ 29	$ -
	Total additional costs/y	$ 610	$ 316	$ 621	$ 433	$ 605	$ 212	$ 506	$ 284	$ 616	$ 328	$ 486	$ 290	$ 589	$ 1,027	$ 625	$ 583	$ 597	$ 384	$ 818	$ 212	$ 523	$ 1,027	$ 583
														$7,307	$12,739	$7,756	$7,231	$7,403	$4,764	$10,150				
Additional Benefits														$ 6,643	$ 10,616	$ 4,562	$ 8,035	$ 6,580	$ 4,537	$ 5,639				
Capital																								
ML/ha/y	Water savings calculator estimated prior to works (50% of this was transferred)	2.8	2.8	1.8	2.2	2.1	2.4	2.5	0.9	1.4	2.3	1.1	1.1		3.7	3.3	2.3	2.8	2.8	3.8	0.9	2.3	3.8	2.4
ML/ha/y	Water saving calculator with current crop mix	3.2	2.5	1.8	1.8	1.7	1.5	2.5	1.6	1.3	1.2	2.0	1.9		2.2	2.3	2.3	2.8	1.9	3.8	1.2	2.1	3.8	2.0
ML/ha/y	water saving estimated adjusted for additional yield	3.9	1.7	4.8	3.1	3.9	4.0	5.9	2.3	5.3	3.9	2.9	1.2		3.8	4.7	1.8	2.3	5.1	6.7	1.2	3.7	6.7	3.6
ML/ha/y	water saving adopted for assessment of water value excludes saving used for additional yield	1.7	0.9	0.8	1.7	2.5	2.5	3.0	0.5	2.0	1.2	1.7	1.2	2.2	2.4	3.4	1.8	2.3	2.1	3.6	0.5	2.0	3.6	2.0
	market value of water saved $1,800/ML annualised value $/y	$ 242	$ 126	$ 115	$ 242	$ 365	$ 363	$ 435	$ 73	$ 286	$ 171	$ 245	$ 175	$ 319	$ 351	$ 493	$ 259	$ 326	$ 310	$ 520	$ 73	$ 285	$ 520	$ 286
	saved channel structure replacement costs - not costed	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Annual																								
	saved channel costs																							
	-labour $/y	$ 20	$ -	$ 20	$ 30	$ 6	$ 6	$ 31	$ 7	$ 21	$ -	$ -	$ -	$ 12	$ 6	$ 9	$ 7	$ 15	$ 8	$ -	$ -	$ 10	$ 31	$ 7
	-chemicals $/y	$ 2	$ 17	$ 4	$ 17	$ 3	$ -	$ 7	$ 7	$ 3	$ -	$ -	$ -	$ 3	$ 6	$ 2	$ 2	$ -	$ 2	$ -	$ -	$ 4	$ 17	$ 2
	-wear and tear on equipment $/y	$ 8	$ 9	$ 8	$ 8	$ 3	$ -	$ 7	$ 7	$ 3	$ -	$ -	$ -	$ 4	$ 6	$ 7	$ 2	$ -	$ 6	$ -	$ -	$ 4	$ 9	$ 4
	-contractors $/y	$ 28	$ -	$ 32	$ -	$ 3	$ -	$ 7	$ -	$ -	$ -	$ -	$ -	$ 44	$ 6	$ 47	$ 4	$ -	$ 8	$ 59	$ -	$ 12	$ 59	$ 3
	other saved labour $/y	$ 400	$ 209	$ 95	$ 42	$ 254	$ 123	$ 142	$ 111	$ 606	$ 21	$ -	$ -	$ 114	$ 129	$ 26	$ 321	$ 28	$ 17	$ -	$ -	$ 139	$ 606	$ 111
	saved vehicle use $/y	$ -	$ 4	$ 4	$ -	$ 9	$ 7	$ 1	$ 6	$ 11	$ 1	$ -	$ -	$ 10	$ 61	$ -	$ -	$ -	$ -	$ -	$ -	$ 6	$ 61	$ 1
																							$ -	
	- saved pumping costs on water saved $/y	$ 4	$ 5	$ -	$ -	$ -	$ 6	$ -	$ -	$ -	$ -	$ -	$ -	$ 3	$ -	$ -	$ -	$ -	$ 5	$ -	$ -	$ 1	$ 6	$ -
	- saved variable water charges at $7.11/ML/y	$ 12	$ 6	$ 6	$ 12	$ 18	$ 18	$ 21	$ -	$ 14	$ 8	$ 12	$ 9	$ 16	$ -	$ 24	$ 13	$ 16	$ 15	$ 26	$ -	$ 13	$ 26	$ 13
	increased production $/y	$ 417	$ 217	$ 238	$ 117	$ 614	$ 200	$ 377	$ 200	$ 1,061	$ 500	$ 643	$ -	$ 396	$ 466	$ 372	$ 357	$ -	$ 330	$ 750	$ -	$ 382	$ 1,061	$ 372
	Other savings due to non irrigation capital eg. new dairy $/y	$ -	$ -	$ 381	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ -	$ 21	$ 381	$ -
																					$ -			
	Total additional benefits/y	$ 1,135	$ 595	$ 903	$ 469	$ 1,276	$ 724	$ 1,030	$ 412	$ 2,007	$ 701	$ 901	$ 185	$ 923	$ 1,035	$ 979	$ 966	$ 387	$ 704	$ 1,358	$ 185	$ 879	$ 2,007	$ 903
	Benefits-cost/y	$ 524	$ 279	$ 282	$ 36	$ 671	$ 512	$ 524	$ 128	$ 1,390	$ 374	$ 416	-$ 105	$ 334	$ 9	$ 358	$ 384	-$ 209	$ 321	$ 540	-$ 209	$ 356	$ 1,390	$ 358
	NPV	$ 6,504	$ 3,463	$ 3,504	$ 442	$ 8,324	$ 6,355	$ 6,502	$ 1,591	$ 17,252	$ 4,638	$ 5,160	-$ 1,299	$ 4,144	$ 110	$ 4,440	$ 4,760	-$ 2,599	$ 3,977	$ 6,707	-$ 2,599	$ 4,420	$ 17,252	$ 3,965
	B/C ratio	1.86	1.88	1.45	1.08	2.11	3.41	2.03	1.45	3.26	2.14	1.86	0.64	1.57	1.01	1.57	1.66	0.65	1.83	1.66	0.64	1.74	3.41	1.66
	old system yield t DM/ha/y	8.30	10.78	6.30	8.70	14.30		8.20		9.10	5.00	10.70	13.00	8.04	8.00	11.50	10.80	10.30	7.12	14.00	5.00	9.66	14.30	9.10
	new system yield t DM/ha/y	10.00	11.70	11.10	10.00	15.50		10.60		12.70	10.00	11.90	13.00	10.00	10.00	12.25	10.80	10.30	9.80	21.00	9.80	11.80	21.00	10.80
	production gain per ha t DM/ha/y	1.70	0.92	4.80	1.30	1.20		2.40		3.60	5.00	1.20	0.00	1.96	2.00	0.75	0.00	0.00	2.68	7.00	0.00	2.15	7.00	2.05
	old system water use efficiency t DM/ML/y	0.65	1.09	0.70	0.69	0.82		0.50		0.60	0.70	0.80	1.30	0.75	1.00	0.85	0.91	0.95	0.65	0.80	0.50	0.81	1.30	0.80
	new system water use efficiency t DM/ML	1.00	1.29	1.30	0.92	1.04		0.80		1.10	1.80	1.00	1.50	1.20	1.40	1.20	1.10	1.01	1.10	1.60	0.80	1.20	1.80	1.10
	production gain per ML t DM/ML	0.35	0.20	0.60	0.23	0.22		0.30		0.50	1.10	0.20	0.20	0.45	0.40	0.35	0.19	0.06	0.45	0.80	0.06	0.39	1.10	0.35

Note case studies 6 and 8 were cropping farms and water use efficiency t dry matter/ML have not been calculated. All other farms were irrigated pastures.

Table 13-6 Round 1 – Year 2. Change in costs and benefits for the 10 case studies reinterviewed in second year assuming current crop mix comparing with versus without the new irrigation technology

Change in costs and benefits		1	2	3	4	5	7	8	10	11	12	*lowest*	*average*	*highest*	*median*
	Area upgraded ha	120	115	126	120	35	53	144	68	77	58	*35*	*92*	*144*	*96*
Additional Costs															
Capital		per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	*per ha*	*per ha*	*per ha*	*per ha*
	Total estimated cost irrigation works	$ 6,101	$ 3,261	$ 2,619	$ 4,167	$ 4,800	$ 4,868	$ 3,465	$ 4,044	$ 5,390	$ 3,190	*$ 2,619*	*$ 4,190*	*$ 6,101*	*$ 4,105*
	lost production during upgrades	$ 1,250	$ -	$ 198	$ -	$ 1,327	$ 377	$ -	$ -	$ 519	$ 200	*$ -*	*$ 387*	*$ 1,327*	*$ 199*
	other costs fencing stock water etc	$ 417	$ 435	$ 437	$ 833	$ 1,229	$ 943	$ -	$ -	$ 117	$ -	*$ -*	*$ 441*	*$ 1,229*	*$ 426*
	Other non irrigation capital required as a result of upgrade eg. new dairy	$ -	$ -	$ 3,968	$ -	$ -	$ -	$ -	$ -	$ -	$ -	*$ -*	*$ 397*	*$ 3,968*	*$ -*
	total capital cost of works	**$ 7,768**	**$ 3,696**	**$ 8,533**	**$ 5,000**	**$ 7,356**	**$ 6,189**	**$ 3,465**	**$ 4,044**	**$ 6,130**	**$ 3,390**	***$ 3,390***	***$ 5,557***	***$ 8,533***	***$ 5,565***
	equivalent annual cost of capital 7%, 30 years, nil residual value	$ 626	$ 298	$ 649	$ 403	$ 593	$ 499	$ 279	$ 326	$ 494	$ 273	*$ 273*	*$ 444*	*$ 649*	*$ 448*
Annual															
	additional power costs $/y	$ 24	$ 18	$ 39	$ 26	$ 12	$ 8	$ 5	$ 2	$ -	$ 16	*$ -*	*$ 15*	*$ 39*	*$ 14*
	additional repairs and maintenance $/y	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	*$ -*	*$ -*	*$ -*	*$ -*
	Total additional costs/y	**$ 650**	**$ 316**	**$ 688**	**$ 429**	**$ 605**	**$ 506**	**$ 284**	**$ 328**	**$ 494**	**$ 290**	***$ 284***	***$ 459***	***$ 688***	***$ 461***
Additional Benefits															
Capital															
ML/ha/y	Water savings calculator estimated prior to works (50% of this was transferred)	2.8	2.8	1.8	2.2	2.1	2.5	0.9	2.3	1.1	1.1	*0.9*	*2.0*	*2.8*	*2.2*
ML/ha/y	Water saving calculator with current crop mix	3.2	2.5	1.8	1.8	1.7	2.5	1.6	1.2	2.0	1.9	*1.2*	*2.0*	*3.2*	*1.9*
ML/ha/y	water saving estimated adjusted for additional yield	3.9	1.7	4.8	3.1	3.9	5.9	2.3	3.9	2.9	1.2	*1.2*	*3.3*	*5.9*	*3.1*
ML/ha/y	water saving adopted for assessment of water value excludes saving used for additional yield	1.7	0.9	0.8	1.7	2.5	3.0	0.5	1.2	1.7	1.2	*0.5*	*1.5*	*3.0*	*1.5*
	market value of water saved $1,800/ML annualised value $/y	$ 242	$ 126	$ 115	$ 242	$ 365	$ 435	$ 73	$ 171	$ 245	$ 175	*$ 73*	*$ 219*	*$ 435*	*$ 208*
	saved channel structure replacement costs - not costed	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	*$ -*	*$ -*	*$ -*	*$ -*
Annual															
	saved channel costs														
	-labour $/y	$ 20	$ -	$ 20	$ 30	$ 6	$ 31	$ 7	$ -	$ -	$ -	*$ -*	*$ 11*	*$ 31*	*$ 6*
	-chemicals $/y	$ 2	$ 17	$ 4	$ 17	$ 3	$ 7	$ 7	$ -	$ -	$ -	*$ -*	*$ 6*	*$ 17*	*$ 3*
	-wear and tear on equipment $/y	$ 8	$ 9	$ 8	$ 8	$ 3	$ 7	$ 7	$ -	$ -	$ -	*$ -*	*$ 5*	*$ 9*	*$ 7*
	-contractors $/y	$ 28	$ -	$ 32	$ 50	$ 3	$ 7	$ -	$ -	$ -	$ -	*$ -*	*$ 12*	*$ 50*	*$ 1*
	other saved labour $/y	$ 400	$ 209	$ 95	$ 42	$ 254	$ 142	$ 111	$ 21	$ 39	$ -	*$ -*	*$ 131*	*$ 400*	*$ 103*
	saved vehicle use $/y	$ -	$ 4	$ 4	$ -	$ 9	$ 1	$ 6	$ 1	$ -	$ -	*$ -*	*$ 2*	*$ 9*	*$ 1*
														$ -	
	- saved pumping costs on water saved $/y	$ 4	$ 5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	*$ -*	*$ 1*	*$ 5*	*$ -*
	- saved variable water charges at $7.11/ML/y	$ 12	$ 6	$ 6	$ 12	$ 18	$ 21	$ -	$ 8	$ 12	$ 9	*$ -*	*$ 10*	*$ 21*	*$ 10*
	increased production $/y	$ 148	$ 217	$ 317	$ 267	$ 614	$ 377	$ 200	$ 500	$ 277	$ -	*$ -*	*$ 292*	*$ 614*	*$ 272*
	Other savings due to non irrigation capital eg. new dairy $/y	$ -	$ -	$ 381	$ -	$ -	$ -	$ -	$ -	$ -	$ -	*$ -*	*$ 38*	*$ 381*	*$ -*
												$ -			
	Total additional benefits/y	**$ 866**	**$ 595**	**$ 982**	**$ 669**	**$ 1,276**	**$ 1,030**	**$ 412**	**$ 701**	**$ 575**	**$ 185**	***$ 185***	***$ 729***	***$ 1,276***	***$ 685***
	Benefits-cost/y	**$ 216**	**$ 279**	**$ 295**	**$ 240**	**$ 671**	**$ 524**	**$ 128**	**$ 374**	**$ 81**	**-$ 105**	***-$ 105***	***$ 270***	***$ 671***	***$ 260***
	NPV	$ 2,680	$ 3,463	$ 3,661	$ 2,979	$ 8,324	$ 6,502	$ 1,591	$ 4,638	$ 1,004	-$ 1,299	*-$ 1,299*	*$ 3,354*	*$ 8,324*	*$ 2,993*
	B/C ratio	1.33	1.88	1.43	1.56	2.11	2.03	1.45	2.14	1.16	0.64	*0.64*	*1.57*	*2.14*	*1.51*

Appendix 2 - Case study details Method 2

Table 12-7 Change in costs and benefits for the Round 2 -10 case studies assuming different crop mix with versus without the new technology.

Change in costs and benefits		1	2	3	4	5	6	7	8	9	10	lowest	average	highest	median
	Area upgraded ha	28	36	96	48	32	31	116	70	66	140	28	66	140	57
Additional Costs															
Capital		per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha
	Total estimated cost irrigation works	$ 7,761	$ 4,250	$ 4,250	$ 5,125	$ 5,188	$ 8,452	$ 5,888	$ 4,171	$ 3,008	$ 2,986	$ 2,986	$ 5,108	$ 8,452	$ 4,688
	lost production during upgrades	$ 207	$ -	$ 625	$ 244	$ -	$ -	$ 690	$ 714	$ 652	$ -	$ -	$ 313	$ 714	$ 225
	other costs fencing stock water etc	$ 1,071	$ 167	$ -	$ -	$ 469	$ -	$ -	$ 857	$ -	$ -	$ -	$ 256	$ 1,071	$ -
	Other non irrigation capital required as a result of upgrade eg. new dairy	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	total capital cost of works	$ 9,039	$ 4,417	$ 4,875	$ 5,369	$ 5,656	$ 8,452	$ 6,578	$ 5,743	$ 3,659	$ 2,986	$ 2,986	$ 5,677	$ 9,039	$ 5,513
	equivalent annual cost of capital 7%, 30 years, nil residual value	$ 728	$ 356	$ 460	$ 433	$ 456	$ 798	$ 548	$ 463	$ 295	$ 241	$ 241	$ 478	$ 798	$ 458
Annual		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -				
	additional power costs $/y	$ 55	$ 162	$ 288	$ 56	$ 38	$ 234	$ 58	$ -	$ 9	$ -	$ -	$ 90	$ 288	$ 55
	additional repairs and maintenance $/y	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Total additional costs/y	$ 783	$ 518	$ 904	$ 489	$ 493	$ 1,354	$ 667	$ 483	$ 304	$ 241	$ 241	$ 624	$ 1,354	$ 506
Additional Benefits															
Capital															
ML/ha/y	Change in water use	- 5.0	1.3	2.8	1.7	1.3	4.5	- 4.1	- 6.8	- 3.0	1.5	- 6.8	- 0.6	4.5	1.3
Annual	market value of water saved $1,500/ML annualised value $/y	- 604	$ 158	$ 397	$ 209	$ 151	$ 639	- 492	-$ 822	-$ 363	$ 181	- 822.0	- 54.5	639.4	154.5
	saved channel costs	$ 18	$ 28	$ 26	$ 73	$ 78	$ 65	$ 17	-$ 29	$ -	$ 32	-$ 29	$ 31	$ 78	$ 27
	saved labour $/y	-$ 18	$ 67	$ 479	$ 131	$ 176	$ 59	$ 78	$ 157	$ 136	$ 89	-$ 18	$ 135	$ 479	$ 110
	saved vehicle use $/y	$ 28	$ 4	$ 13	$ 7	$ 8	$ 2	$ 1	$ 7	$ 3	$ 1	$ 1	$ 7	$ 28	$ 5
	- saved pumping costs on water saved $/y	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 8	$ -	$ 1	$ 8	$ -
	- saved variable water charges at $7.11/ML/y	-$ 36	$ 9	$ 20	$ 12	$ 9	$ 32	-$ 29	-$ 48	-$ 21	$ 11	-$ 48	-$ 4	$ 32	$ 9
	increased production $/y	$ 1,093	$ 403	$ 417	$ 208	$ 200	$ 720	$ 1,114	$ 1,426	$ 500	$ -	$ -	$ 608	$ 1,426	$ 458
												$ -			
	Total additional benefits/y	$ 480	$ 668	$ 1,351	$ 640	$ 622	$ 1,517	$ 689	$ 748	$ 256	$ 321	$ 256	$ 729	$ 1,517	$ 654
	Benefits-cost/y	-$ 303	$ 150	$ 447	$ 151	$ 128	$ 163	$ 22	$ 265	-$ 48	$ 81	-$ 303	$ 106	$ 447	$ 139
	NPV	-$ 3,757	$ 1,865	$ 4,731	$ 1,879	$ 1,593	$ 1,724	$ 277	$ 2,762	-$ 599	$ 1,000	-$ 3,757	$ 1,148	$ 4,731	$ 1,148
	B/C ratio	0.6	1.3	1.5	1.3	1.3	1.1	1.0	1.4	0.8	1.3	0.61	1.17	1.49	1.28

note: yellow cells highlighted indicate changed crop type and changed values.

The following table from the Round 1 case studies and have been included for information

Table 13-8 Round 1 – Year 1. Change in costs and benefits for the 19 case studies including the change in crop mix with versus without the new technology.

Change in costs and benefits- case study number		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	10	*lowest*	*average*	*highest*	*median*
	Area upgraded ha	120	115	126	120	35	160	53	144	33	68	77	58	101	31	43	140	10	250	17	*10*	*90*	*250*	*77*
Additional Costs																								
Capital		per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	per ha	*per ha*	*per ha*	*per ha*	*per ha*
	Total estimated cost irrigation works	$ 5,659	$ 3,261	$ 2,619	$ 4,167	$ 4,800	$ 1,563	$ 4,868	$ 3,465	$ 6,435	$ 4,044	$ 5,390	$ 3,190	$ 5,452	$ 6,581	$ 7,223	$ 6,429	$ 7,100	$ 3,833	$ 8,529	*$ 1,563*	*$ 4,979*	*$ 8,529*	*$ 4,868*
	lost production during upgrades	$ 1,250	$ -	$ 198	$ -	$ 1,327	$ 350	$ 377	$ -	$ 1,212	$ -	$ 519	$ 200	$ 228	$ -	$ -	$ -	$ -	$ 360	$ -	*$ -*	*$ 317*	*$ 1,327*	*$ 198*
	other costs fencing stock water etc	$ 417	$ 435	$ 437	$ 833	$ 1,229	$ 500	$ 943	$ -	$ -	$ -	$ 117	$ -	$ 983	$ 1,095	$ 465	$ 714	$ -	$ 160	$ -	*$ -*	*$ 438*	*$ 1,229*	*$ 435*
	Other non irrigation capital required as a result of upgrade eg. new dairy	$ -	$ -	$ 3,968	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	-	$ -	$ -	$ -	$ -	*$ -*	*$ 220*	*$ 3,968*	*$ -*
	total capital cost of works	**$ 7,326**	**$ 3,696**	**$ 7,705**	**$ 5,000**	**$ 7,356**	**$ 2,413**	**$ 6,189**	**$ 3,465**	**$ 7,648**	**$ 4,044**	**$ 6,026**	**$ 3,390**	**$ 6,663**	**$ 7,675**	**$ 7,756**	**$ 7,143**	**$ 7,100**	**$ 4,353**	**$ 8,706**	***$ 2,413***	***$ 5,982***	***$ 8,706***	***$ 6,663***
	equivalent annual cost of capital 7%, 30 years, nil residual value	$ 590	$ 298	$ 582	$ 403	$ 593	$ 194	$ 499	$ 279	$ 616	$ 326	$ 486	$ 273	$ 537	$ 619	$ 625	$ 576	$ 572	$ 351	$ 702	*$ 194*	*$ 400*	*$ 702*	*$ 537*
Annual																								
	additional power costs $/y	$ 20	$ 18	$ 39	$ 30	$ 12	$ 9	$ 8	$ 5	$ -	$ 2	$ -	$ 16	$ 52	$ 408	$ 5	$ 7	$ 24	$ 29	$ 87	*$ -*	*$ 41*	*$ 408*	*$ 16*
	additional repairs and maintenance $/y	$ -	$ -	$ -	$ -	$ -	$ 9	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4	$ 29	*$ -*	*$ 2*	*$ 29*	*$ -*
	Total additional costs/y	**$ 610**	**$ 316**	**$ 621**	**$ 433**	**$ 605**	**$ 212**	**$ 506**	**$ 284**	**$ 616**	**$ 328**	**$ 486**	**$ 290**	**$ 589**	**$ 1,027**	**$ 630**	**$ 583**	**$ 597**	**$ 384**	**$ 818**	***$ 212***	***$ 523***	***$ 1,027***	***$ 583***
Additional Benefits																								
Capital																								
ML/ha/	water saving adopted for assessment of water value excludes saving used for additional yield	- 0.6	0.9	- 0.7	1.7	- 0.7	0.1	- 7.0	- 2.8	- 1.0	1.2	1.7	1.2	2.2	- 5.2	3.4	1.8	2.3	- 0.4	- 7.8	*- 7.8*	*- 0.5*	*3.4*	*0.1*
	market value of water saved $1,800/ML annualised value $/y	-$ 92	$ 126	-$ 107	$ 242	-$ 99	$ 19	-$ 1,015	-$ 399	-$ 147	$ 171	$ 245	$ 175	$ 319	-$ 818	$ 698	$ 259	$ 326	-$ 55	-$ 1,130	*-$ 1,130*	*-$ 68*	*$ 698*	*$ 19*
	saved channel structure replacement costs - not costed	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	*$ -*	*$ -*	*$ -*	*$ -*
	saved channel costs																							
	-labour $/y	$ 20	$ -	$ 20	$ 30	$ 6	$ 6	$ 31	$ 7	$ 21	$ -	$ -	$ -	$ 12	$ 6	$ 9	$ 7	$ 15	$ 8	$ -	*$ -*	*$ 10*	*$ 31*	*$ 7*
	-chemicals $/y	$ 2	$ 17	$ 4	$ 17	$ 3	$ -	$ 7	$ 7	$ 3	$ -	$ -	$ -	$ 3	$ 6	$ 2	$ 2	$ -	$ 2	$ -	*$ -*	*$ 4*	*$ 17*	*$ 2*
	-wear and tear on equipment $/y	$ 8	$ 9	$ 8	$ 8	$ 3	$ -	$ 7	$ 7	$ 3	$ -	$ -	$ -	$ 4	$ 6	$ 7	$ 2	$ -	$ 6	$ -	*$ -*	*$ 4*	*$ 9*	*$ 4*
	-contractors $/y	$ 28	$ -	$ 32	$ -	$ 3	$ -	$ 7	$ -	$ -	$ -	$ -	$ -	$ 44	$ 6	$ 47	$ 4	$ -	$ 8	$ 59	*$ -*	*$ 12*	*$ 59*	*$ 3*
	other saved labour $/y	$ 200	$ 209	$ 95	$ 42	$ 254	$ -	$ -	$ -	$ 303	$ 21	$ -	$ -	$ 114	$ -	$ 26	$ 321	$ 28	$ -	$ -	*$ -*	*$ 85*	*$ 321*	*$ 26*
	saved vehicle use $/y	$ -	$ 4	$ 4	$ -	$ 9	$ 7	$ 1	$ 6	$ 11	$ 1	$ -	$ -	$ 10	$ 61	$ -	$ -	$ -	$ -	$ -	*$ -*	*$ 6*	*$ 61*	*$ 1*
																							$ -	
	- saved pumping costs on water saved $/y	-$ 2	$ 5	$ -	$ -	$ -	$ 0	$ -	$ -	$ -	$ -	$ -	$ -	$ 3	$ -	$ -	$ -	$ -	-$ 1	$ -	*-$ 2*	*$ 0*	*$ 5*	*$ -*
	- saved variable water charges at $7.11/ML/y	-$ 4	$ 6	-$ 5	$ 12	-$ 5	$ 1	-$ 50	$ -	-$ 7	$ 8	$ 12	$ 9	$ 16	$ -	$ 24	$ 13	$ 16	-$ 3	-$ 55	*-$ 55*	*-$ 1*	*$ 24*	*$ 1*
	increased production $/y	$ 838	$ 217	$ 603	$ 117	$ 1,616	$ 422	$ 1,777	$ 1,120	$ 1,957	$ 500	$ 643	$ -	$ 396	$ 1,799	$ 373	$ 357	$ -	$ 524	$ 2,100	*$ -*	*$ 808*	*$ 2,100*	*$ 524*
	Other savings due to non irrigation capital eg. new dairy $/y	$ -	$ -	$ 381	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	*$ -*	*$ 20*	*$ 381*	*$ -*
																					$ -			
	Total additional benefits/y	**$ 998**	**$ 595**	**$ 1,034**	**$ 469**	**$ 1,789**	**$ 455**	**$ 764**	**$ 747**	**$ 2,144**	**$ 701**	**$ 901**	**$ 185**	**$ 923**	**$ 1,068**	**$ 979**	**$ 966**	**$ 387**	**$ 489**	**$ 974**	***$ 185***	***$ 872***	***$ 2,144***	***$ 901***
			$ -		$ -						$ -	$ -	$ -											
	Benefits-cost/y	**$ 388**	**$ 279**	**$ 413**	**$ 36**	**$ 1,184**	**$ 243**	**$ 258**	**$ 463**	**$ 1,528**	**$ 374**	**$ 416**	**-$ 105**	**$ 334**	**$ 41**	**$ 358**	**$ 384**	**-$ 209**	**$ 105**	**$ 156**	***-$ 209***	***$ 350***	***$ 1,528***	***$ 334***
	NPV	$ 4,810	$ 3,463	$ 5,126	$ 442	$ 14,689	$ 3,017	$ 3,199	$ 5,750	$ 18,958	$ 4,638	$ 5,160	-$ 1,299	$ 4,144	$ 512	$ 4,440	$ 4,760	-$ 2,599	$ 1,302	$ 1,932	*-$ 2,599*	*$ 4,339*	*$ 18,958*	*$ 4,144*
	B/C ratio	1.64	1.88	1.67	1.08	2.96	2.15	1.51	2.63	3.48	2.14	1.86	0.64	1.57	$ 1.04	1.57	1.66	0.65	1.27	1.19	*0.64*	*1.71*	*3.48*	*1.64*

Note nine properties (2, 4, 10, 11, 12) and (Dairy Australia 1, 3, 4, 5) are not expected to have changed crop mix significantly as a result of the upgrade and their results have not been modified.

Note: Method 2 for the round 1 - ten case studies that were re-interviewed in year 2, has not been conducted.