Goulburn Broken CMA

Farm Water Round 3 Case Studies

Summary

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Summary

In 2015 nine irrigators were interviewed on the costs and benefits of changes made to their farming systems as a result of irrigation modernisation of their on-farm irrigation systems in the Goulburn Murray Irrigation District under the Farm Water Program Round 3[1].

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[2].

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).

Where there were significant changes to costs and benefits from the original interviews then the original economic analysis was redone with the new data. This was done assuming no change in crop mix.

When comparing the **same** crop mix for the new system versus the old system:

- Estimates of water use savings varied from 0.6 to 2.8 ML/ha/y (average of 1.7), which compared with the water savings calculator value of 0.6 to 3.3 ML/ha/y (average of 1.8). However, few farms had good data that could confirm savings given the enormous variability in seasonal conditions, crop types, areas and change in metering and location of meter outlets.
- NPV of the projects varied from $-10,941(this case study had a crop failure not related to irrigation upgrade) to +$2,771/ha using a 7% discount rate over 30 years. Benefit/cost ratios varied between 0 to 1.9. Three projects had a benefit-cost ratio less than one (costs of the change exceeded the benefits produced). The three negative results were associated with
    1. crop failure due to late sowing that was not related to the irrigation upgrade,
    2. nil yield production increase from the crops although there was a small production gain associated with channel removals and the farmer did comment that this was the first year and future years may have yield increases,

[1] Farm Water refers to a program to modernise farm irrigation in return for a share of the water savings being transferred to the Commonwealth Environmental Water Holder and is managed by a Consortium led by the Goulburn Broken CMA with funding from the Australian Government's On Farm Irrigation Efficiency Program (Rounds 1 and 2) and through Victorian On Farm Irrigation State Priority Project and the Victorian Farm Modernisation Program..

[2] 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. no production gains from a system that had construction problems.

- Sensitivity testing of total benefits by minus 25% showed that the benefit cost ratios ranged from 0 to 1.4. When benefits were plus 25% they were from 0 to 2.3.

It is important to note the mix of benefits changes when allowing for the **change** in crop mix that is facilitated by some projects. Water savings are reduced to negative levels as irrigators move to more water intensive summer crops and perennial crops, which in some cases were impractical to grow with the old irrigation system; and the productivity gains are increased.

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 not occur for some seasons, then the benefits would be over estimated.

The benefits are also sensitive to the water value, the volume of water savings, value of saved labour and the ability to convert production gains into income, either through additional milk, reduced feed purchases or sales of feed/crop. There is considerable uncertainty around these values and how these change relative to the base case of no upgrade.

Despite these uncertainties, the case studies do provide a useful picture of the types of change and the relative values of the different benefits that are possible with irrigation upgrades.

Unlike land or water entitlement purchases that a farmer can make, few of the case study farmers believed that their property value would be increased by the size of the investment made in infrastructure. This illustrates that a more risk averse investment in expansion of a profitable farm business can be to invest in additional land and/or water entitlement assets. This is because over the long term these assets tend to appreciate and if necessary can be sold. Rather than purchase new irrigation systems, which depreciate and cannot be easily sold.

Expansion via investment in additional land assets, water assets or irrigation upgrades will depend upon the individual circumstances and their own appetite for risk. The Farm Water Program by providing infrastructure grants in return for a share of the water savings changes the balance in favour of irrigation upgrades with the objective of also providing wider environmental benefits and regional productivity gains that are associated with improved irrigation performance.

The table below compares Round 3 case studies results with that from previous years.

Table 1-1 Comparison of results for different rounds (assuming same crop as current system for both old and new system)- unweighted average values attributes calculated independently

Attribute	**Round 1 values corrected with up to 3 years experience (up to 3 updates)**			**Round 2 Values (1 year of experience)**	**Round 3 values (1 year of experience)**	**Suggested typical values across three rounds (note variation is very large)**
Sample size	19	10	8	10	9	Not applicable (NA)
Water value assumed on savings $/ML at time of transfer	1,800	1,800	1,800	1,500	1,450	NA depends on market price at time of transfer
Capital cost $/ha	5,982	5,557	5,067	5,677	4,951	5,500 (2,000 to 10,000)
Total additional annualised cost per ha of upgrade	523	459	421	624	434	500 (200 to 1,000)
Total additional annualised benefit per ha of upgrade	879	729	635	915	417	700 (200 to 2,000)
NPV per ha	4,420	3,354	2,653	3,509	-217 (increases to >1,000 if 10 ha crop failure ignored	3,000 (-2,000 to +18,000)
BCR	1.7	1.6	1.5	2.0	1.1	1.5 (0.6 to 3.5)
Detail on benefits						
Water saving ML per ha	2.0	1.5	1.4	2.6	1.8	1.8 (0.5 to 3.6)
Change in t dry matter/ha	2.1	Not calc	Not calc	2.7	2.3	2.3 (0 to 7)
Change in t DM/ML	0.4	Not calc	Not calc	0.4	0.4	0.4 (0 to 1.1)
Change in gross margin $/ha	382	292	273	346	274	300 (0 to 600)
Labour savings $ per ha (at $25/hr)	143	137	140	188	69	140 (0 to 400)

Table 1-2 Comparison of results for different rounds (including changed crop with new system)

Attribute	Round 1 values	Round 2 Values	Round 3 values	Suggested typical long term values
Total additional annualised cost per ha of upgrade	523	624	434	500 (200 to 1,000)
Total additional annualised benefit per ha of upgrade	872	729	448	700 (200 to 2,000)
NPV per ha	4,339	1,148	169	2,000 (-2,600 to +19,000)
BCR	1.7	1.2	1.2	1.3 (0.6 to 3.5)
Detail on benefits				
Water saving ML per ha	-0.5	-0.6	0.9	-0.5 (-8 to +3.4)
Change in gross margin $/ha	808	608	274	600 (0 to +2,100)
Labour savings $ per ha (at $25/hr)	95	135	51	90 (0 to 300)

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 on the case study farms.

It is important to note that these case studies have been connected to the modernised backbone, which is a requirement 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 3 of Farm Water. This includes farms funded by NVIRP (now GMW Connections Program) and farms funded by the Commonwealth's On-Farm Irrigation Efficiency Program plus the contributions made by the farmers themselves.

This report captures data after one season of experience with the new system.

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 funded in Round 3 of the Farm Water Program. (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 economic 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 a 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. Water is valued at 7% of $1,450/ML based on water market price at the time of transfer. Note since this time water prices for Victorian HRWS have increased to around $2,400/ML.
5. Production benefits have been estimated by determining changes in stocking rates or yields with typical industry benchmarks for gross margins.

Water savings have been listed as per:

a) The crop mix in the water savings calculator, which was used by Farm Water to estimate the water savings based on technology type, crop type and soil type 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 was calculated as increased crop growth and yield can result in water use increases as there is less waterlogging and less water stress[3]. However, this estimation 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 $1,450/ML saved. 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, but by adopting $1,450/ML at 7% this has an equivalent annual value of $101.50/ML, which is similar to annual water market prices that were experienced in this season. 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 has been estimated using a standard $25/hour rate[4] with the farmers experience to date on time savings with the new system compared to the old

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

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.

Primarily 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 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.

However, to illustrate the impact to the farmer, the annual net benefit (benefit-costs) per year and the NPV have been derived by treating the grant for works as additional income and the value of water transferred as an additional cost. This has been termed the farmer's net benefit per year and farmer's NPV.

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 versus the base case

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 then experienced higher water availability. This has had a significant impact on

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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).

Where there were significant changes to costs and benefits from the original interviews then the original economic analysis was redone with the new data.

Two types of analysis have been carried out

In the first 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.

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 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 estimated water use savings (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[5].

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.

[5] 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

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.

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 also 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. While there is a large variation, the analysis indicates that there is a positive benefit-cost analysis for six farms and negative for three. The three negative results were associated with

1. crop failure due to late sowing that was not related to the irrigation upgrade,
2. nil yield production increase from the crops although there was a small production gain associated with channel removals and the farmer did comment that this was the first year and future years may have yield increases,

3. no production gains from a system that had construction problems.

Table 3-1 Change in costs and benefits with current crops as a result of the upgrade for nine case studies using 1 year of experience at 7% discount rate over 30 years

Change in costs and benefits		*lowest*	*average*	*highest*	*median*
	Area upgraded ha	10	107	280	89
Additional Costs					
Capital		*per ha*	*per ha*	*per ha*	*per ha*
	Total estimated cost irrigation works	$ 2,225	$ 4,632	$ 9,700	$ 3,600
	lost production during upgrades	$ -	$ 204	$ 719	$ -
	other costs fencing stock water etc	$ -	$ 111	$ 1,000	$ -
	Other non irrigation capital required as a result of upgrade eg. new dairy	$ -	$ -	$ -	$ -
	total capital cost of works	**$ 2,464**	**$ 4,951**	**$ 9,700**	**$ 5,050**
	equivalent annual cost of capital 7%, 30 years, nil residual value	$ 199	$ 399	$ 782	$ 407
Annual					
	additional power costs $/y	$ -	$ 35	$ 100	$ 12
	additional repairs and maintenance $/y	$ -	$ -	$ -	$ -
	Total additional costs/y	**$ 199**	**$ 434**	**$ 882**	**$ 453**
Additional Benefits					
Capital					
ML/ha/y	Water savings calculator estimated prior to works (59% of this was transferred)	0.8	2.0	4.5	1.8
ML/ha/y	Water saving calculator with current crop mix	0.6	1.8	3.3	1.7
ML/ha/y	water saving adopted for assessment of water value excludes saving used for additional yield	0.6	1.7	2.8	1.8
	market value of water saved $1,450/ML annualised value $/y	$ -	$ 156	$ 284	$ 202
	saved channel structure replacement costs - not costed	$ -	$ -	$ -	$ -
Annual					
	saved channel costs				
	-labour $/y	$ -	$ 6	$ 15	$ 5
	-chemicals $/y	$ -	$ 3	$ 11	$ 3
	-wear and tear on equipment $/y	$ -	$ 3	$ 11	$ 3
	-contractors $/y	$ -	$ 5	$ 22	$ 4
	other saved labour $/y	$ -	$ 63	$ 197	$ 44
	saved vehicle use $/y	$ -	$ 10	$ 80	$ -
				$ -	
	- saved pumping costs on water saved $/y	$ -	$ -	$ -	$ -
	- saved variable water charges at $7.11/ML/y	$ -	$ 11	$ 20	$ 14
	increased production $/y	$ -	$ 160	$ 333	$ 168
	Other savings due to non irrigation capital eg. new dairy $/y	$ -	$ -	$ -	$ -
		$ -			
	Total additional benefits/y	**$ -**	**$ 417**	**$ 705**	**$ 492**
	sensitivity test -25% benefits	$ -	$ 313	$ 529	$ 369
	sensitivity test +25% benefits	$ -	$ 521	$ 881	$ 615
	Benefits-cost/y	**-$ 882**	**-$ 18**	**$ 223**	**$ 101**
	NPV	*-$ 10,941*	*-$ 217*	*$ 2,771*	*$ 1,254*
	B/C ratio	*0.00*	*1.14*	*1.87*	*1.17*
Sensitivity testing					
-25% benefits	***Benefits-cost/y***	*-882*	*-122*	*93*	*-75*
-25% benefits	***NPV***	*-10941*	*-1511*	*1158*	*-933*
-25% benefits	*B/C ratio*	*0.00*	*0.86*	*1.40*	*0.88*
+25% benefits	***Benefits-cost/y***	*-882*	*87*	*353*	*266*
+25% benefits	***NPV***	*-10941*	*1076*	*4384*	*3299*
+25% benefits	*B/C ratio*	*0.00*	*1.43*	*2.34*	*1.46*
	Farmers net benefit/y (grant treated as income, and water transferred treated as a cost)	-$ 535	$ 165	$ 575	$ 240
	Farmers NPV (grant treated as income, and water transferred treated as a cost)	-$ 7,141	$ 1,442	$ 4,501	$ 2,774

With this round a famer's NPV and net benefit per year was calculated. This calculation involved treating only the retained water savings as a benefit (after 59% transfer of the water savings calculator value to the Government) and including the grant payment received as income.

As would be expected the farmer's net benefit/year and NPV is higher. This is because the value of the grant received at $2,881 per ML transferred[6] exceeds the value of the water transferred when valued at $1,450 per ML.

It is important to recognise that:

[6] $1,700 per ML saved with 59% transfer = $2,881/ML transferred

- while the economic analysis for average NPV is negative at -$217/ha it is positive for most case studies, this is because a large negative value for a small area (10 ha) on one case study that had a crop failure does bring down the average NPV from a positive $1,123/ha (excluding this case study) to -$217/ha (including the case study.

- 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 may be over estimated.

- the increased flexibility and resilience of a modernised system also provides significant mitigation against drought and low allocations.

- unlike 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 more risk averse investment in expansion, for profitable farming systems, is to invest in additional land and/or water entitlement assets that can appreciate and if necessary be sold. Rather than purchase new irrigation systems, which depreciate and cannot be easily sold. Expansion via investment in additional land assets, water assets or irrigation upgrades will depend upon the individual circumstances and their own appetite for risk.

- The Farm Water Program by providing infrastructure grants in return for a share of the water savings changes the balance in favour of irrigation upgrades with the objective of also wider environmental benefits and regional productivity gains that are associated with improved irrigation performance.

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

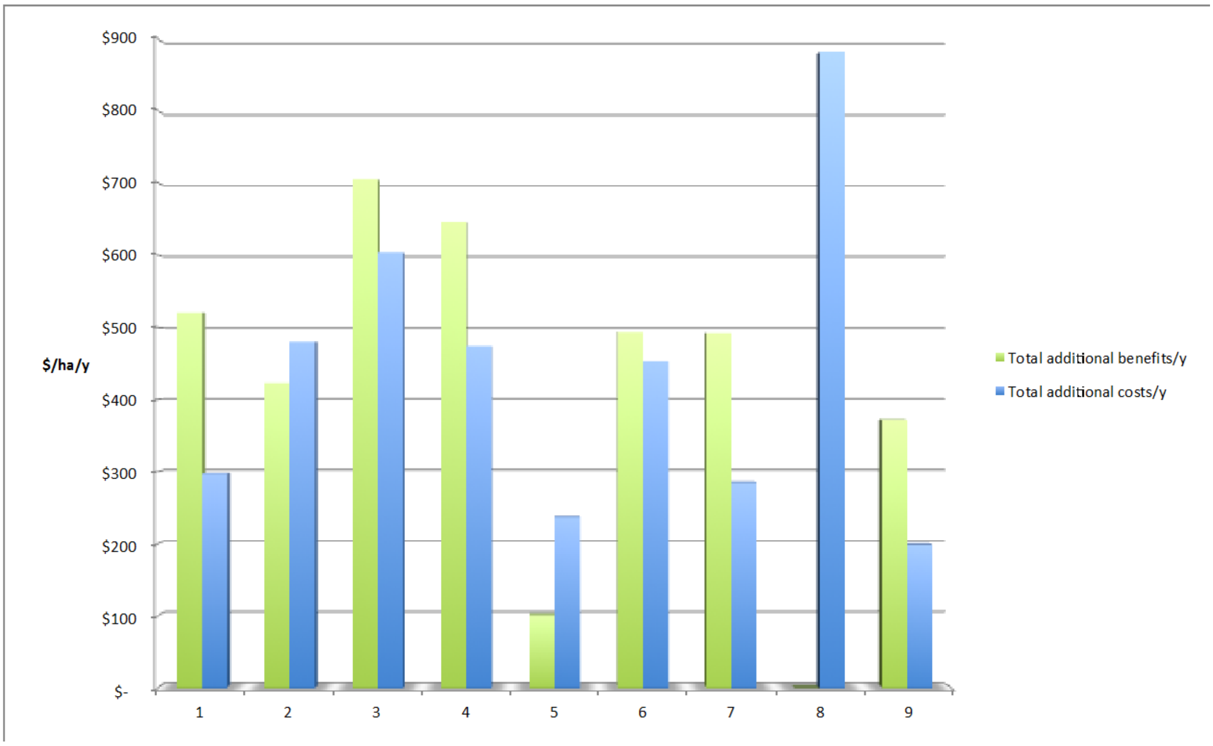


Figure 3-1 Total additional costs/ha/y and total additional benefits/ha/y for the 9 case studies interviewed for current crop mix

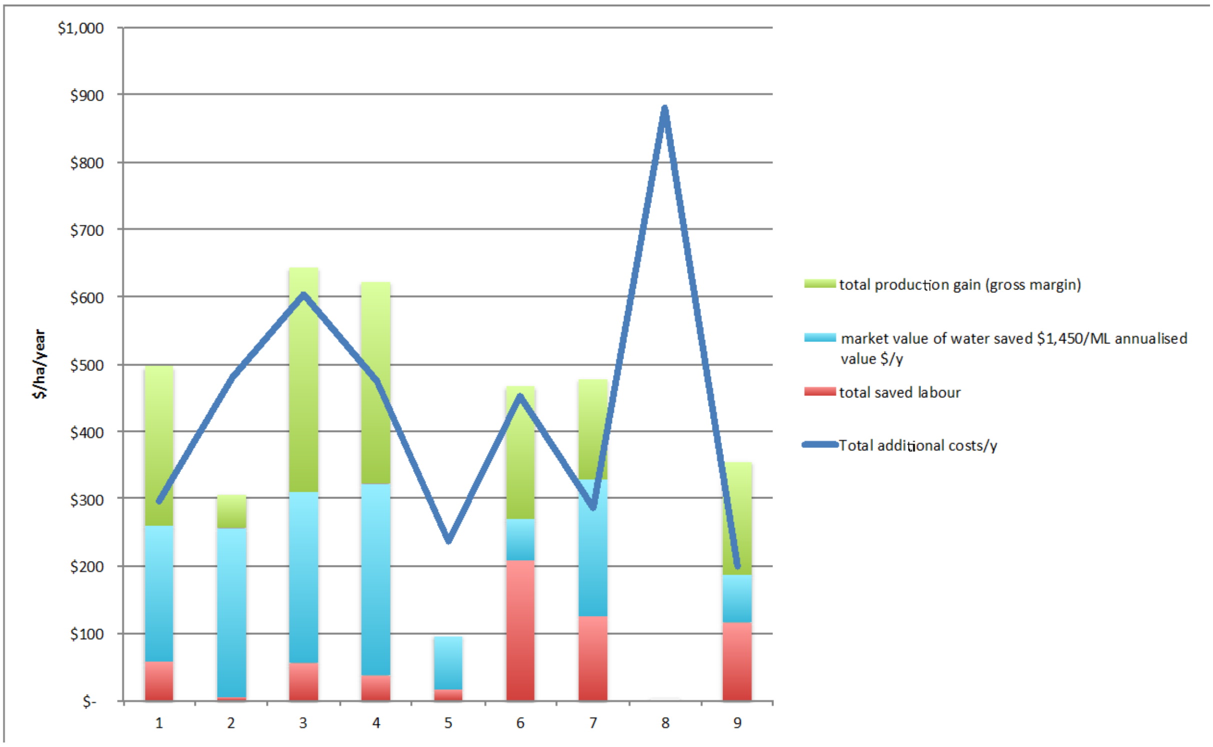


Figure 3-2 Total additional costs and split of additional benefits (into labour savings, water savings and production gains) for the 9 case studies

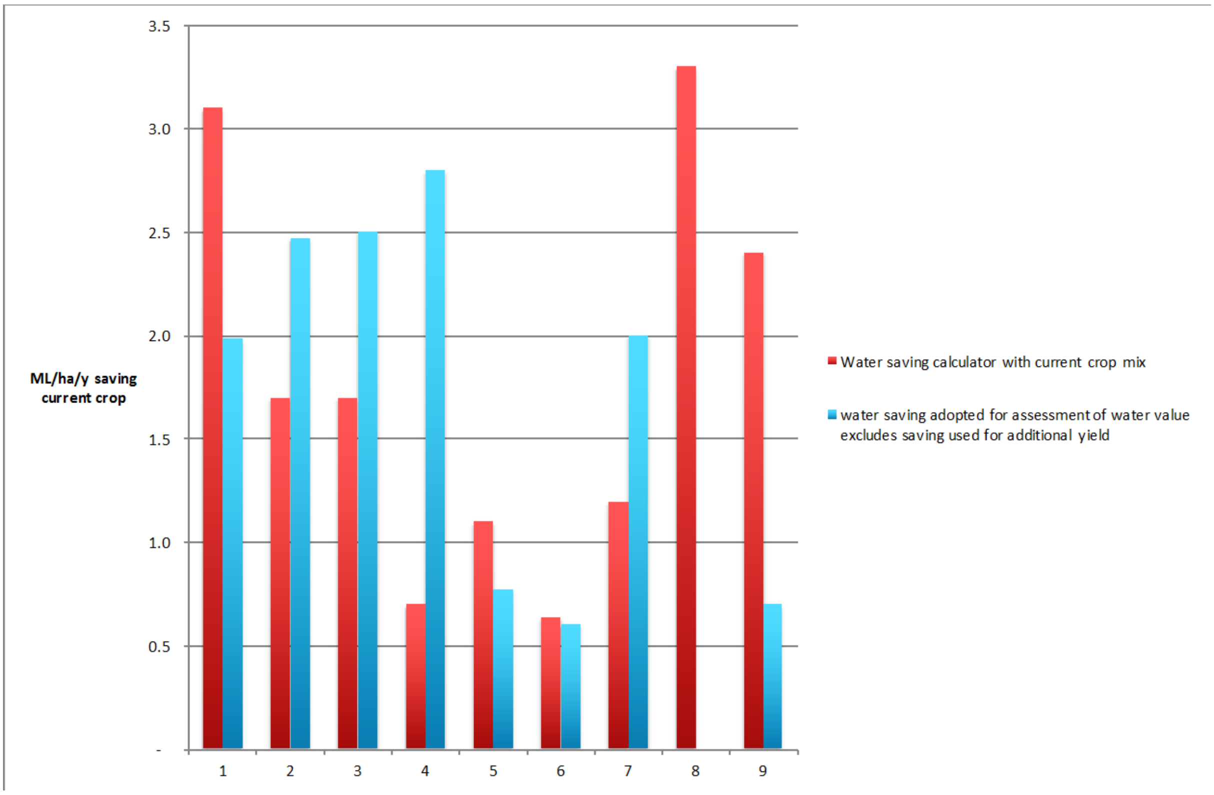


Figure 3-3 Estimated water savings for the 9 case studies for current crop mix.

3.2 Estimating costs and benefits allowing for changed crop mix

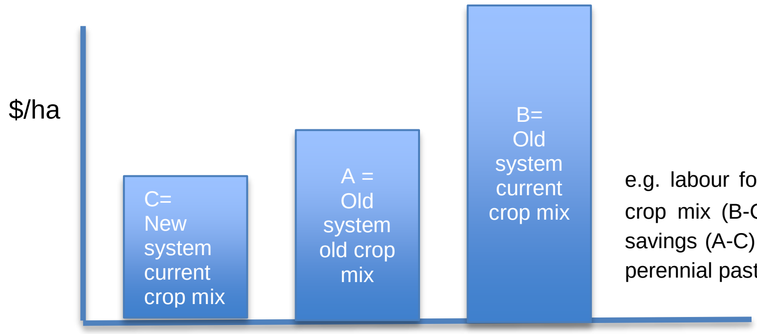
The previous analysis did not account for the fact that the modernisation has enabled the adoption of more intensively irrigated crops such as perennial pastures, lucerne and summer crops on areas that with the old system would only have been used for annual crops.

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 have been predominantly annual pastures, which have a lower irrigation requirement than the summer irrigated crops now adopted (perennial pastures and summer cropping).

In cases where re-lasering was not required, no change in crop mix was assumed. This is because these areas were already at a modern standard and no change in crop mix would be likely. 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 3-3-2 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[7]. 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 type of analysis compares A and C.

Only three properties changed crops and these are shown in Appendix 1 Table 12-7.

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

- Average water savings are negative
- Average labour savings are smaller
- The reduction in labour and water saving benefits is offset by the corresponding increase in average production gain from the crops with a higher water requirement.
- The difference between the two approaches is sensitive to water value. For example, using a higher water value than $1,450/ML[8] saved would worsen the benefit-cost ratio for the analysis above and improve it for the previous analysis.

[7] 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.
[8] At the time of writing water prices for some Victorian HRWS had increased to $2,400/ML. But $1,450/ML has been used to reflect water market at time of transfers.

Table 3-3 Change in costs and benefits allowing for a changed crop mix (where relevant) as a result of the upgrade for nine case studies using 1 year of experience at 7% discount rate over 30 years

Changed crop mix					
Change in costs and benefits		*lowest*	*average*	*highest*	*median*
	Area upgraded ha	10	107	280	89
Additional Costs					
Capital		*per ha*	*per ha*	*per ha*	*per ha*
	Total estimated cost irrigation works	$ 2,225	$ 4,632	$ 9,700	$ 3,600
	lost production during upgrades	$ -	$ 204	$ 719	$ -
	other costs fencing stock water etc	$ -	$ 111	$ 1,000	$ -
	Other non irrigation capital required as a result of upgrade eg. new dairy	$ -	$ -	$ -	$ -
	total capital cost of works	**$ 2,464**	**$ 4,951**	**$ 9,700**	**$ 5,050**
	equivalent annual cost of capital 7%, 30 years, nil residual value	$ 199	$ 399	$ 782	$ 407
Annual					
	additional power costs $/y	$ -	$ 35	$ 100	$ 12
	additional repairs and maintenance $/y	$ -	$ -	$ -	$ -
	Total additional costs/y	**$ 199**	**$ 434**	**$ 882**	**$ 453**
Additional Benefits					
	market value of water saved $1,450/ML annualised value $/y	-$ 568	$ 91	$ 426	$ 83
Annual					
	saved channel costs				
	-labour $/y	$ -	$ 6	$ 15	$ 5
	-chemicals $/y	$ -	$ 3	$ 11	$ 3
	-wear and tear on equipment $/y	$ -	$ 3	$ 11	$ 3
	-contractors $/y	$ -	$ 5	$ 22	$ 4
	other saved labour $/y	$ -	$ 45	$ 197	$ 17
	saved vehicle use $/y	$ -	$ 10	$ 80	$ -
	- saved pumping costs on water saved $/y	$ -	$ -	$ -	$ -
	- saved variable water charges at $7.11/ML/y	$ -	$ 11	$ 30	$ 6
	increased production $/y	$ -	$ 274	$ 910	$ 198
	Other savings due to non irrigation capital eg. new dairy $/y	$ -	$ -	$ -	$ -
		$ -			
	Total additional benefits/y	**$ -**	**$ 448**	**$ 889**	**$ 492**
	sensitivity test -25% benefits	$ -	$ 336	$ 667	$ 369
	sensitivity test +25% benefits	$ -	$ 560	$ 1,112	$ 615
	Benefits-cost/y	**-$ 882**	**$ 14**	**$ 333**	**$ 158**
	NPV	-$ 10,941	$ 169	$ 4,135	$ 1,965
	B/C ratio	0.00	1.21	2.12	1.36
Sensitivity testing					
-25% benefits	***Benefits-cost/y***	-$ 882	-$ 98	$ 176	$ 11
-25% benefits	*NPV*	-$ 10,941	-$ 1,221	$ 2,181	$ 132
-25% benefits	*B/C ratio*	0.00	0.91	1.59	1.02
+25% benefits	***Benefits-cost/y***	-$ 882	$ 126	$ 508	$ 248
+25% benefits	*NPV*	-$ 10,941	$ 1,558	$ 6,305	$ 3,072
+25% benefits	*B/C ratio*	0.00	1.51	2.65	1.70
	Farmers net benefit/y (grant treated as income, and water transferred treated as a cost)	-$ 535	$ 165	$ 472	$ 243
	Farmers NPV (grant treated as income, and water transferred treated as a cost)	-$ 7,141	$ 1,828	$ 5,655	$ 2,894

In summary, though the average for current/same crop type was negative and the average for changed crop type was positive for most irrigators the upgrades were generally economically attractive, whichever of the two analyses is performed.

Comparison with previous round case studies

The table below compares Round 3 case studies results with that from previous years.

Table 3-4 Comparison of results for different rounds (assuming same crop as current system for both old and new system)- unweighted average values attributes calculated independently

Attribute	**Round 1 values corrected with up to 3 years experience (up to 3 updates)**			**Round 2 Values (1 year of experience)**	**Round 3 values (1 year of experience)**	**Suggested typical values across three rounds (note indicative variation is very large)**
Sample size	19	10	8	10	9	Not applicable (NA)
Water value assumed on savings $/ML at time of transfer	1,800	1,800	1,800	1,500	1,450	NA depends on market price at time of transfer
Capital cost $/ha	5,982	5,557	5,067	5,677	4,951	5,500 (2,000 to 10,000)
Total additional annualised cost per ha of upgrade	523	459	421	624	434	500 (200 to 1,000)
Total additional annualised benefit per ha of upgrade	879	729	635	915	417	700 (200 to 2,000)
NPV per ha	4,420	3,354	2,653	3,509	-217 (increases to >1,000 if 10 ha crop failure ignored	3,000 (-2,000 to +18,000)
BCR	1.7	1.6	1.5	2.0	1.1	1.5 (0.6 to 3.5)
Detail on benefits						
Water saving ML per ha	2.0	1.5	1.4	2.6	1.8	1.8 (0.5 to 3.6)
Change in t dry matter/ha	2.1	Not calc	Not calc	2.7	2.3	2.3 (0 to 7)
Change in t DM/ML	0.4	Not calc	Not calc	0.4	0.4	0.4 (0 to 1.1)
Change in gross margin $/ha	382	292	273	346	274	300 (0 to 600)
Labour savings $ per ha (at $25/hr)	143	137	140	188	69	140 (0 to 400)

Table 3-5 Comparison of results for different rounds (including changed crop with new system)

Attribute	Round 1 values	Round 2 Values	Round 3 values	Suggested typical long term values
Total additional annualised cost per ha of upgrade	523	624	434	500 (200 to 1,000)
Total additional annualised benefit per ha of upgrade	872	729	448	700 (200 to 2,000)
NPV per ha	4,339	1,148	169	2,000 (-2,600 to +19,000)
BCR	1.7	1.2	1.2	1.3 (0.6 to 3.5)
Detail on benefits				
Water saving ML per ha	-0.5	-0.6	0.9	-0.5 (-8 to +3.4)
Change in gross margin $/ha	808	608	274	600 (0 to +2,100)
Labour savings $ per ha (at $25/hr)	95	135	51	90 (0 to 300)