Irrigator's considerations for change and investment in farm irrigation systems using economic criteria

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Abstract. Irrigators across northern Victoria have an opportunity to participate in the Commonwealth Government initiated On-Farm Irrigation Efficiency Program. The program provides investment opportunities to upgrade and convert farm irrigation systems to generate water savings shared between the Government and irrigators. Benefits reported are reduction in watering times, water use and water logging and improved pasture and crop production. However, the actual impact on farm profitability is less understood. Qualitative as well as quantitative data were collected from one commercial farm to assess costs and benefits. A partial discounted cash flow approach was used. If water and labour savings and productivity gains are realised, participating provides an attractive return on investment. Economic success was particularly sensitive to the productivity increase generated. This highlights the need for irrigators to understand potential productivity gains that could be made under their own circumstances before considering farm irrigation investments.

Key words: partial budget analysis, productivity increase, return on investment

Introduction

Irrigators across northern Victoria have an opportunity to participate in the Commonwealth Government initiated On-Farm Irrigation Efficiency Program, also called the Farm Water Program. The program began in the Goulburn-Murray water services area in Victoria in 2010-11, initially through Commonwealth funding and later with support through the Northern Victoria Irrigation Renewal Project and the Victorian Department of Sustainability and Environment.

The program provides co-investment opportunities to irrigators to achieve farm water savings by modernising irrigation infrastructure on-farm. Irrigator's co-investment with the Government in upgrading irrigation infrastructure occurs in return for water savings shared between the irrigator and the Government. The program operates like an indirect buyback program, whereby at least 50% of the water savings generated by funded projects are permanently transferred to the Government.

There are four main infrastructure technologies adopted by landowners in northern Victoria. These are pipes and risers systems, improved border check irrigation systems, improved channel systems with automation and irrigation scheduling systems, and pressurised systems.

There will be at least four rounds, of the program of which the first and the second rounds have already commenced or completed. An announcement was made at the end of 2012 about the third round. The program has been popular among irrigators, with approximately 400 projects funded to date. Some of the potential benefits to farmers to modernise their irrigation systems are: on-farm productivity gains, labour savings, water savings, consolidation of channels and laneways, and larger flow rates.

This study was undertaken to understand the reasons for irrigator's participation in the program and to assess the impacts of irrigation infrastructure investment from farmer's perspective using a benefit-cost analysis of an on-farm investment under the program and to:

- Identify the reasons for irrigators participating in the Farm Water Program.
- Establish what level of productivity benefits is required for investments to be financially viable.
- Determine the benefits and costs in relation to on-farm works.

Method

Case study approach

A case study farm approach was chosen to examine the economic viability of an improved border check irrigation system adopted through the Farm Water program. This approach was considered appropriate given the complexity behind the farm business management decision-making process.

The following case study is from a landowner's perspective and considers the adoption of an improved border check irrigation system on an existing dairy farm approximately 15 km north of Shepparton. The farm consists of four separate allotments or part allotments, which were originally soldier settlement blocks. All four allotments have one water supply outlet and an internal laneway system which links each allotment to allow stock movement.

Formation of steering committee

A collaborative work program was proposed with the Department of Environment and Primary Industries Dairy Directions Team. A steering committee was formed to oversee the study which ensured that the analyses were conducted in a rigorous manner and a broad range of perspectives were considered. All the assumptions made in the study were tested with the committee.

Data collection

Both qualitative and quantitative data were collected during a structured interview. An audio tape was used to record the discussion. The irrigator was made aware of the use of the audio tape. Immediately after the interview, the main points were recorded. The qualitative data was analysed using the transcript from the interview. This provided the background for conducting the partial budget analysis. Irrigators were also asked to provide the detailed costs and benefits of their investments.

Partial budget analysis

A partial financial discounted cash flow analysis was applied to determine the financial worth to a farmer of investing in irrigation infrastructure through the Farm Water Program. The analysis is only partial because it does not undertake a whole farm budget in its evaluation. It is a form of marginal analysis designed to show, not profit or loss for the farm as a whole, but the net increase or decrease in income resulting from the proposed changes (Brown 1979).

The analysis looked into the 'With Project' and 'Without Project' situation. The 'Without project' in this case study was the situation which showed what the irrigators would earn if the project was not implemented. The 'With the project' situation is what the irrigators have earned after implementing their irrigation investments.

A 5% discount rate was used based on maintaining the existing return on capital from the investment.

Three key economic criteria were used for the analysis:

1. Net Present Value (NPV): is the present worth of the benefits and costs of a project at a given discount rate. The higher the NPV the more economically viable the project since the project is earning at a given rate plus some more. If the NPV is negative, the project is not economically viable.
2. Benefit-Cost Ratio (BCR): is the ratio of the present value of project benefits to the present value of project costs. The higher the BCR, the more economically viable the project becomes because it is earning more than the required rate of return.
3. Internal Rate of Return (IRR): is the discount rate at which the present value of the benefits from a project equals the present value of the costs of the project. The higher the IRR, the more economically attractive the project is.

In addition to the above criteria, a sensitivity analysis was conducted to study the effect of key variables like water savings and variation in pasture production. A separate analysis showing the single parameter benefits (considering one parameter at a time) that need to be generated in order to make the project viable at a 5% discount rate was also undertaken. The analysis period was 20 years, which is the estimated productive life of the irrigation investment. This approach is similar to the analysis conducted by Armstrong et al. (2011) and Maskey (2003).

Case study description

The owner operates a 107.9 ha dairy farm in the Shepparton Irrigation Region of northern Victoria. The property was an amalgamation of four smaller soldier settlement properties. Of the total farm, 89 ha is the total effective area, of which 52 ha is under perennial pasture and 37 ha is under annual pasture. At present, the landowner milks 200 cows; however, during the drought he was milking 160 cows. The farmer operates a 22 a-side herringbone milking system.

The landowner has been operating the farm since 1988. He reported that he is at the consolidation stage of the business and has no interest in getting bigger. He is working towards building equity so that when the next generation come in, they can have options to expand. Recently he sold 200 ML of permanent water to pay out the loans and build equity. At present he has 90% equity on his farm. He is currently considering succession issues since his son has expressed an interest in managing the property in future. Thus the decision regarding the investment in irrigation infrastructure is pertinent.

Soil type: The property has predominantly Katamatite loam with some Congupna clay loam and Congupna clay.

Water: The property has 392 ML of High Reliability Water Share and 280 ML of Low Reliability Water Share. The property is served by four 450 mm Magflow meters, each of which can provide 20 ML/day.

Project detail: Out of 89 effective hectares, the project area consists of 24.13 ha, which was the only section that had not been developed for efficient border check irrigation. This area was irrigated using ten 90 cm doors and thirty-five, six inch clay pipes. Irrigation was done by opening half a dozen clay pipes at a time. It used to take 36-44 hours to complete irrigation in this area.

The project included construction of farm channels, installation of 9 bay outlets and laser grading 24.13 ha serving these bays. It also included installation of one channel check, one two-way diverter and one crossing. After the completion of this stage of the project, the landowner was able to complete the irrigation within 14 hours. He is also thinking of participating in the second round of the Farm Water program to install automation on his property.

Farm Water Program from landowner's perspective

The program is about achieving farm water savings through improved farm irrigation systems, where the water savings are shared between farmers and the environment, with at least half the water savings being transferred to the Government.

The program uses a Water Savings Calculator to determine the water saved from irrigation investments. The water savings is based on 3 major factors: soil type, types of crop grown; and technology to be adopted. The program calculated the water savings of 26 ML to implement the above mentioned activities. As part of participating in the program, the landowner provided 13 ML of water savings to the Government and received a total of A$57,452 for completing the project. He received half of the above amount (A$28,726) immediately after he transferred 13 ML of water to the Government and received another half after completing the project. He used the initial amount as seed money to start the project. This, he thought, was a key benefit for him to participate in the program. Getting money immediately after transferring 13 ML provided him with cash to implement the project. 'The Farm Water Program helped me to tap into cash to do the work' he said. He was positive with how the water savings were calculated and was happy to transfer 13 ML to participate in the program.

For the landowner, the benefits from faster flow irrigation with laser grading included a reduction in watering times, water use, waterlogging, time spent irrigating and groundwater accessions. The lifestyle benefits, including being able to be away from the property and spending more time with family, were also important. The farmer is considering automating the project area in the next round of the Farm Water Program. Although the 'lifestyle' benefit was the key driver for participating in the program, he thinks that he would have easily saved 26 ML by investing in irrigation infrastructure as he did.

Project benefits and costs

A range of different benefits and costs are identified as a result of the irrigation infrastructure investments.

Project costs

Investment cost: This cost consists of decommissioning old outlets, laser grading 9 bays, construction of farm channels, installation of bay outlets and structures along the channels. The capital cost involved for these activities was A$71,854.

In-kind labour cost: A full time person was involved in decommissioning and project managing for the duration of the project, from September to May.

Production foregone: During the 9 months from September 2010 to May 2011, the landowner bought 150 tonnes of hay because of the disruption on bays due to laser grading. The cost of a tonne of hay was A$200/tonne of dry matter. There was no production in this entire 24 ha during the construction period. The production foregone amounts to A$30,000.

Due to the disruption caused by decommissioning old infrastructures, laser grading and installation of outlets in the entire 24 ha, water was not applied in the project area during the construction stage. This saved 297.6 ML of water for the construction period.

Pasture re-establishment cost: A perennial pasture re-establishment cost of A$6,000 (A$250/ha) was required after the construction phase.

Operation and maintenance cost: The landowner uses an existing pump to irrigate the project area. He uses 600 litres of diesel per year to operate the pump. However, he observed that there was no difference in the pump use before and after the project.

A maintenance cost of 2% of the capital cost was used for the analysis since the landowner suggested that there will be some minor regular maintenance required with the new installations, which he didn't have to spend for his previous system.

The project costs are presented in Table 1.

Table 1. Additional project costs

Items		Cost (A$)
Capital Costs	*Investment cost* - Installation of 9 bay outlets and structures serving these bays covering 24.13 ha - Laser grading and associated earthworks on 9 bays(24.13 ha)	71,854
	Labour cost - Decommissioning and project management	25,000
	Production foregone - To replace production from 24.13 ha, 150t of DM was bought in at $200/t DM	30,000
	Pasture re-establishment - Pasture re-sowing in lasered area at $250/ha	6,000
Annual costs	*Maintenance cost* - 2% of the capital cost for the life of the project	1,438

Project benefits

Incentives: The incentive from the Government is based on a calculation of the amount of water saved through improved farm irrigation investment. Of the total water savings, only half is transferred to the government with irrigators receiving the remaining amount saved.

In this case study, this landowner saves a total of 26 ML with his irrigation investment. He transferred 13 ML to the Government even before starting the project and received $28,726 for the water transferred. The rest of the amount for the other half of the water savings was transferred at the completion of the project. From the landowner's perspective, the real incentive is half the amount received from the Government. For him, the other half of the total amount received is just a transaction for transferring (selling) water to the Government.

Water savings: Water savings have been a major benefit of the project. The area, before the project, was supplied by ten 90 cm doors and thirty-five, six inch clay pipes. Before the project, the landowner used to open half a dozen six inch clay pipes each time to irrigate the property, taking between 36-44 hours to complete irrigation. Now irrigation occurs with nine outlets using 20 ML flow per day and is completed in 14 hours.

With the information provided by the landowner, the calculation of the volume of water applied per irrigation before the project ranges from 0.62 to 0.75 ML/ha/year. With the irrigation investment, he applies 0.50ML/ha/year. With 20 irrigations per irrigation season, the irrigator previously applied 12.4 to 15.0 ML/ha compared to 10 ML/ha with the new investment. Water savings of 2.4 ML/ha/year have been used for the analysis. The price of water is $60/ML. This figure represents the temporary market price of water at the time of conducting this study.

Production benefits: The farm is now growing perennial pasture in the project area. Before the project was implemented, the landowner was growing annual pasture during the drought season which resulted in the production of four tonne of dry matter per hectare. Before the drought, the landowner used to grow perennial pasture. He used to obtain 12 tonne dry matter per hectare. These production figures were calculated during the time when the landowner used to participate in the Dairy discussion group run by the Department of Primary Industries. The landowner suggested that the production after the project is about 14-15 tonne dry matter per hectare. The perennial pasture production increase of 2 t DM/ha/year was used for the analysis.

During the time of preparing the case study, the landowner was milking 160 cows but suggests that he will be able to add in another 0.6 cows/ha in the project area. This provides him with the potential of adding another 12- 15 cows to the herd in the project area.

Time saved chasing water: Labour saving is considered as a key benefit by the landowner and this was one of the key drivers for him to participate in the program. However, the exact labour savings are difficult to estimate. Obviously after the implementation of the project, the time taken to irrigate has reduced from 36-44 hours to 14 hours. This reduction of 22 to 30 hours of irrigation chasing water cannot be considered as a total labour savings, as the landowner occupies his time completing other activities during irrigation.

The landowner suggested four hours of effective labour being saved just chasing water after the implementation of the project. A labour cost of A$25/hour was assumed. Costing of labour savings was a topic that attracted considerable discussion during the preparation of this paper. It was argued that some farmers would value their labour much higher than others. The argument adopted was that you can purchase a labour unit to irrigate the farm at a cost of $25/hour.

Vehicle saving: There is no significant change in vehicle use.

Salvage value: Salvage value normally represents the residual market value or scrap value of assets used in the project. For the purpose of this analysis, a salvage value of 30% of the capital cost was used at the end of year 20.

The project benefits are shown in Table 2 below.

Table 2. Additional project benefits

Items		(A$)
Capital benefits	*Water saving during construction stage* Water savings of 297.6ML during construction stage	17,856
	Salvage value 30% of the capital cost at the end of 20th year	21,556
	Incentive from the Farm Water Program Half of the total funding from the program is considered as the incentives	28,726
Annual benefits	*Water saving* Water saving of 2.4 ML/ha	3,456/year
	Production increase Increase of 2t DM/ha	9,600/year
	Time saving 4 hours of effective time saved per irrigation	2,000/year

Results and discussion

The investment in improved border check irrigation infrastructure on a part of a dairy farm in this case study was analysed to see whether the project was economically viable. The key parameters used to assess the economic viability are water savings, increased production and labour savings. The incentive from the Farm Water Program was also considered in the analysis.

The analysis shown below was undertaken to identify whether or not the investment in irrigation infrastructure through the Farm Water program is economically viable from an irrigators' perspective. Table 3 below shows that his project was viable 'with' and 'without' the government incentives considering all three economic criteria. Obviously, with the incentive, the investments appeared more attractive.

Table 3. Economic indicators for improved border check irrigation investments

Indicators	With incentive	Without incentive
Net Present Value @ 5% discount rate	A$ 90,206	A$ 62,848
Benefit-Cost Ratio @ 5% discount rate	1.60	1.42
Internal Rate of Return (%)	14.35%	10.50%
Years to break-even	8 years	12 years

The Net Present Value (NPV) is the difference between the present value of benefits and the present value of costs. A positive NPV provides a net gain and so is desirable. The Net Present Value with the incentive was A$90,206 and without the incentive was A$62,848.

The Benefit-Cost Ratio (BCR) is the ratio of the present value of benefits to the present value of costs. The ratio is greater than 1 when discounted benefits exceed discounted costs. The BCR with the incentive was 1.60 and without the incentive was 1.42.

The Internal Rate of Return (IRR) is the discount rate at which the present value of benefits equals the present value of costs, i.e. the rate at which the NPV is zero. If the IRR is greater than a defined 'desirable' discount rate then the project is desirable. The IRR with the incentive was 14.35% and without the incentive was 10.50%.

The 'years to break even' is a measure of the time taken for the returns from an investment to pay for the investment's purchase. This occurs when the cumulative net cash become positive. It is not a measure of economic or financial benefit, simply the time taken to remove the debt and regain positive cash flow. It varies from 8-12 years to break even depending on whether the calculation was done with or without the incentives.

Sensitivity analysis

Sensitivity analysis can be performed for a range of parameters to assess their importance for the success of the project. It is conducted to clarify the impact of uncertainty in benefits, costs and discount rate values. In this report, sensitivity analysis was conducted to assess the impact on the economic success of the project of gains in productivity and water savings.

Sensitivity to pasture production

In this case study with the irrigation investments, the pasture production was reported to grow an additional 2 t DM/ha/yr compared to the old system. Sensitivity analysis was conducted to see the viability of the project if the production was 1 t DM/ha/yr instead of 2 t DM/ha/yr (Table 4).

Table 4. Pasture production sensitivity analysis (reduced pasture production increase of 1t DM/ha/year)

Indicators	With incentive	Without incentive
Net Present Value @ 5% discount rate	A$ 30,388	A$3,029
Benefit-Cost Ratio @ 5% discount rate	1.20	1.02
Internal Rate of Return (%)	8.38%	5.28%

The project was still viable with and without the incentives. Without the incentive, the project is found to be just viable indicating that the viability of the project could be considered sensitive to the size of the productivity increase.

The case study landowner suggested obtaining an additional 2 t DM/ha/yr with his investment. Landowners in a similar situation should consider that production could vary greatly from farm to farm, from year to year on any given farm (Lawson et al 2002) and within a given area on farm. The sensitivity of economic desirability to productivity increase highlights the importance of farmers being able to accurately assess the expected productivity increase prior to investment in similar projects.

Sensitivity to water savings

The water savings of 2.4 ML/ha/year was calculated for this case study with information provided by the landowner. The level of water savings in the case study site depended on several factors: good irrigation system design, effective management and soil hydraulic properties of the farm.

It is likely that other landowners in a similar situation could have water savings that vary greatly. The sensitivity of economic desirability was tested with the water savings of 1.2 ML/ha/year, which is half the water savings reported by the irrigator. A perennial pasture production advantage of 2 t DM/ha/yr was maintained. This reduction in the volume of water saved would still make the project viable both with incentives and without incentives scenarios (Table 5).

Table 5. Water savings sensitivity analysis (project with reduced water savings of 1.2 ML/ha/year)

Indicators	With incentive	Without incentive
Net Present Value @ 5% discount rate	A$68,671	A$41,313
Benefit-Cost Ratio @ 5% discount rate	1.46	1.27
Internal Rate of Return (%)	12.28%	8.70%

Productivity improvements required

All the above analyses were conducted based on the productivity information provided by the landowner. In the absence of experimental data, it is difficult to quantify the actual benefits to assume in the partial budget. In such a situation, one of the ways of analysing would be to determine the level of productivity improvement, reduced water usage or labour savings required for the investment to be profitable.

Table 6 shows the single parameter benefits (considering one parameter at a time) that need to be generated in order to make the project viable at a 5% discount rate.

Table 6: Single parameter benefits required to be no worse off

	Pasture improvement (t/DM/ha)	**Labour savings** (hrs/irrigation)	**Water savings**	
			Retain water savings ongoing* (ML)	Water savings to be sold** (ML)
With incentive	2.3	20	165	74
Without incentive	2.9	25	208	93

* using temporary water (allocation) price of A$60/ML
** using permanent water (High Reliability Water Share) price of A$1,800/ML

For example, considering only productivity benefits, landowners should be able to generate an additional 2.3 t DM/ha/year (with incentive) and 2.9 t DM/ha/year (without incentive) to make the project viable.

The farmer's estimates of productivity gain and water savings are below the estimates of the single parameters in Table 6, illustrating that each of these benefits by itself would not have been sufficient to make the investment worthwhile. However, when considering the farmer estimates as a whole (as was shown earlier), the project becomes profitable. This highlights the importance of considering a range of benefits rather than simply the water savings, the labour savings, or the productivity improvements.

Conclusion

When all economic criteria are considered together the project is found to be economically desirable. Thus, from an economic perspective and given the data and assumptions used in the analysis, irrigation investment is a viable option 'with' or 'without' the incentives. However, if the project is to be implemented without the incentives, it will require substantial upfront cost and will take 12 years just to break even.

The analysis has shown that:

- The improved border check irrigation investments can be profitable especially with the help from a program like the Farm Water program.
- The magnitude of the economic benefit is particularly sensitive to the productivity increase from the investment. This highlights the need for landowners to consider their own circumstances and to assess the productivity gains to be made before considering irrigation investments.
- Prior to making an investment decision, landowners who want to venture into similar projects should assess their own situation and make sure that they can generate water savings and productivity increases to make their projects economically desirable.

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