CENTRE PIVOTS AND LATERAL MOVES: PROFITABLE OR NOT?

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ABSTRACT

There is considerable interest in converting furrow irrigation areas to overhead sprinkler systems (centre pivots and lateral moves) within the Cotton Industry. This has been driven in part by the apparent water use efficiency benefits of these machines over traditional furrow systems. In 2005 the Cotton Catchment Communities CRC funded a project to assess the profitability and risk associated with converting existing furrow irrigation systems to centre pivots and lateral moves (CPLMs). The aim was to assist irrigators in making this investment decision in their existing cotton-grain farming systems.

A profitability assessment approach at the whole farm scale was tested with cotton-grain irrigators currently using CPLMs in five different cotton districts – Emerald, Darling Downs, Macintyre, Macquarie and Lower Lachlan. For each farm a current farming system economic and financial model (the "without" scenario) was developed based on the crops, yields and water use information provided. Each irrigator was asked to consider how they would go about introducing CPLM cropping activities within their farming system. A whole farm financial and economic model was developed for each "new" farming system (the "with" scenario) and compared to the existing farming system (the "without" scenario).

This paper examines each aspect of this "with" and "without" scenario analysis for each of the case study farms. It shows it is a robust method to assess the economic and financial performance of converting from furrow irrigation to CPLMs.

INTRODUCTION

There is considerable interest in the installation of centre pivot and lateral move (CPLM) irrigation systems within the Cotton Industry in recent years. This has been driven in part by the apparent water use efficiency benefits of these machines over traditional furrow irrigation systems. In 2005 the Cotton Catchment Communities CRC funded a project to assess the profitability and risk associated with converting existing furrow irrigation systems to CPLMs. The aim was to assist irrigators in making this investment decision in their existing cotton-grain farming systems.

Irrigators considering such an investment should:

1. prepare a **steady state profit analysis** at the whole farm scale for the current farming system (the "without" scenario) and the one with the CPLM investment (the "with" scenario).
2. undertake a **financial analysis** over the life of the investment for the "without" and "with" scenarios
3. complete an **economic analysis** to calculate and compare the Internal Rate of Return and the Net Present Values for the "without" and "with" scenarios.
4. perform a **marginal analysis** to calculate the marginal return and payback period for the CPLM investment

This approach will not only identify the viability of the CPLM investment but also the gaps in information that may exist and their importance.

This approach was tested with five cotton-grain irrigators with CPLMs in five different cotton districts – Emerald, Darling Downs, Macintyre, Macquarie and Lower Lachlan. For each farm a current farming system economic and financial model (the "without" scenario) was developed based on the crops, yields and water use information provided. Each irrigator was asked to consider how they would go about introducing CPLM cropping activities within their farming

system. A whole farm financial and economic model was developed for each "new" farming system as well (the "with" scenario).

STEADY STATE PROFIT ANALYSIS

A steady state profit analysis was conducted on each farm to determine the annual operating profit for the "without" and "with" scenarios. The return on assets for each was then calculated using the annual operating profit and the value of assets for each farm (the land, improvements and machinery). Table 1 summarises the size of each farm and the cropping system "without" the CPLM irrigation system and "with" the CPLM irrigation system installed.

Table 1 The characteristics of each case study farm "without" and "with" investment in the CPLM systems

		Farm A		Farm B		Farm C		Farm D		Farm E	
		Without	With	Without	With	Without	With	Without	With	Without	With
Farm Size	(ha)	450	650	800	800	2000	2000	1000	1000	1000	1000
Surface irrigation	(ha)	400		525	525	720	720	105	105	200	200
Centre pivots	(Number)		5						4		
Centre pivots	(ha)		475						144		
Lateral moves	(Number)				1		1				1
Lateral moves	(ha)				100		78				200
Raingrown area	(ha)			240	135	1200	1120	720	580		
Water Supply	(ML)	3500	3500	1200	1200	4500	4500	1500	1500	2352	2352
Crop Area (ha)											
CPLM Canola									40		
CPLM Cotton			380		66		52				66
CPLM Lucerne									32		
CPLM Maize					33						66
CPLM Seed Corn									40		
CPLM Sorghum							26				
CPLM Wheat			380						72		132
Furrow cotton		380		210	210	480	480	70	70	100	100
Furrow pigeon pea		20	25								
Furrow sorghum				105	105	240	240				
Furrow wheat				105	105			35	35	100	100
Long Fallow				105	105						
Raingrown canola								180	145		
Raingrown fallow				80	45						
Raingrown lupins								180	145		
Raingrown sorghum				80	45	300	280				
Raingrown wheat				80	45	900	840	360	290		

Investment in CPLMs increased the number of crops grown on all farms. Each co-operator was asked to provide a range of expected yields for each of the crops they currently grow and would grow following investment in a CPLM system. They were asked for the lowest and highest possible yields, and three yields representing what they considered to be poor, the most likely and good yields for their surface irrigated and raingrown crops. Yield estimated were also obtained for CPLM irrigated crops. They were also asked to provide an estimate of the probability of obtaining their three yield estimates for each crop. The yields and probabilities were combined to produce the expected yield estimates presented in Table 2.

Each co-operator was also asked to provide estimates for crop prices and their probability of occurring – the worst, poor, most likely, good and the highest possible estimates were combined with the probabilities to produce the expected price estimates presented in table 3.

Table 2 Expected irrigated crop yields (t/ha) for each case study farm "without" and "with" investment in the CPLM systems

	Farm A		Farm B		Farm C		Farm D		Farm E	
	Furrow	CPLM	Furrow	CPLM	Furrow	CPLM	Furrow	CPLM	Furrow	CPLM
Canola								3.0		
Cotton	8.0	7.0	8.5	8.5	8.0	7.2	9.0		8.5	8.5
Lucerne								600		
Maize				10.0						7.0
Pigeon Pea	0.0	0.0								
Seed Maize								2.5		
Sorghum			8.0		3.0	3.0				
Wheat		6.0					6.0		4.5	6.0
Raingrown canola							2.5	2.5		
Raingrown lupins							2.0	2.0		
Raingrown sorghum			5.0	5.0	1.9	1.9				
Raingrown wheat			3.0	3.0	2.5	2.5	3.0	3.0		

* Cotton and lucerne yields in bales/ha

Table 3 Expected crop prices ($/t) for each case study farm "without" and "with" investment in the centre pivot or lateral move irrigation systems

	Farm A	Farm B	Farm C	Farm D	Farm E
Canola				$350	
Cotton	$450	$453	$459	$450	$450
Lucerne				$6	
Lupins				$400	
Maize		$190			
Seed Corn					$400
Sorghum		$156	$158		
Wheat	$150	$181	$156	$170	$170

* prices for cotton and lucerne in $/bale

The co-operators were asked to specify irrigation water use for the crops and irrigation systems based on their experience. Table 4 summarises the crop irrigation water use for the "without" and "with" scenarios. All co-operators who grew cotton with sprinkler irrigation suggested a reduction in irrigated water use over surface irrigation – the reductions ranged from 26 to 59%. On Farm C the reduction in irrigation water use with the lateral move irrigated sorghum was 40% over furrow irrigated sorghum. The reduction in irrigation water use by sprinkler irrigated wheat compared to furrow irrigated wheat ranged from 0 to 33%.

In all case studies the co-operators indicated that investment in the CPLMs resulted in a more complete use of their available water resource (see decrease in "unused" water between the "without" and "with" scenarios for each farm in Table 4).

A gross margin for each crop option was drawn up using the machinery and operational information provided by each co-operator, together with the expected yield, price and irrigation water use from Tables 2, 3 and 4.

The results of the steady state economic analysis of each case study farm "without" and "with" investment in the CPLM systems is summarised in Table 5.

Table 4 Expected crop irrigation water use for each case study farm "without" and "with" investment in the centre pivot or lateral move irrigation systems

	Farm A		Farm B		Farm C		Farm D		Farm E	
	Without	With	Without	With	Without	With	Without	With	Without	With
CPLM Canola								2.0		
CPLM Cotton		6.0		3.3		3.1				7.0
CPLM Lucerne								6.0		
CPLM Maize				3.1						7.0
CPLM Seed Corn								7.0		
CPLM Sorghum						1.5				
CPLM Wheat		3.0						2.0		2.0
Furrow Cotton	9.0		4.5	4.5	7.5	7.5	10.0	10.0	9.5	9.5
Furrow Pigeon Pea	3.0	3.0								
Furrow Sorghum			3.5	3.5	2.5	2.5				
Furrow Wheat			2.0	2.0			3.0	3.0	2.0	2.0
Total Water Use (ML)	**3480**	**3495**	**1,523**	**1,843**	**4,200**	**4,400**	**805**	**1501**	**1150**	**2338**
Unused Water (ML)	**20**	**5**	**378**	**57**	**300**	**100**	**695**	**-1**	**1202**	**14**

Table 5 Steady state economic analysis of each case study farm "without" and "with" investment in the CPLM systems

	Farm A		Farm B		Farm C		Farm D		Farm E	
	Without	With	Without	With	Without	With	Without	With	Without	With
Land & Improvements	$8.00m	$8.25m	$4.38m	$4.38m	$10.00m	$10.00m	$2.60m	$2.60m	$2.10m	$2.10m
Plant & Equip	$0.48m	$1.84m	$1.08m	$1.37m	$1.55m	$1.78m	$0.76m	$1.07m	$0.79m	$1.11m
Asset Value	**$8.48m**	**$10.09m**	**$5.46m**	**$5.75m**	**$11.55m**	**$11.78m**	**$3.36m**	**$3.67m**	**$2.89m**	**$3.21m**
Total Gross Income	$1.34m	$1.86m	$1.13m	$1.40m	$2.22m	$2.49m	$0.78m	$1.05m	$0.45m	$1.03m
Farm Variable Expense	$0.80m	$1.08m	$0.57m	$0.70m	$1.16m	$1.35m	$0.44m	$0.54m	$0.19m	$0.44m
Farm Gross Margin	**$0.54m**	**$0.78m**	**$0.56m**	**$0.70m**	**$1.06m**	**$1.14m**	**$0.34m**	**$0.51m**	**$0.26m**	**$0.59m**
Total Operating Overheads	$0.23m	$0.27m	$0.24m	$0.26m	$0.60m	$0.62m	$0.24m	$0.25m	$0.20m	$0.22m
Annual Operating Return	**$0.31m**	**$0.51m**	**$0.32m**	**$0.44m**	**$0.46m**	**$0.52m**	**$0.10m**	**$0.26m**	**$0.06m**	**$0.37m**
Return on Assets	**3.6%**	**5.0%**	**5.9%**	**7.7%**	**4.0%**	**4.4%**	**3.1%**	**7.2%**	**2.3%**	**11.6%**

The annual farm gross margins for each farm increases with the investment in the CPLMs – an increase ranging from $75,000 to $327,000 across the five farms. The annual total operating overheads increase across the farms from $11,000 to $49,000. The annual operating return increases for all farms following investment in the CPLMs – the increase ranging from $49,000 for Farm C to $305,000 for Farm E. The increase in return on assets resulting from the investment in the CPLMs ranges from 0.3 to 9.3%. The most notable thing is the range in economic data across the five case study farms. This range in outcomes is clearly evident in the distribution in annual operating profit for Farms B and C in Figure 1 shown by the respective cumulative probability curves. The further right a cumulative probability curve is the more positive the outcome for the respective farming system.

For Farm B the existing and proposed farming system always generates a positive annual operating return, with the investment in the lateral move always better then the existing farming system. For Farm C there is a chance (around 20% or 1 in 5 years) that there will be a negative operating return with the existing farming system. The investment in the lateral move always increases the operating returns but the improvement is only slight – more intensification of the cropping system is possibly needed to increase the annual operating returns. The risk of a negative return is reduced to around 14% (1 year in 7) through investment in the lateral move.

It must be remembered that these outcomes are based on the ranges in yields and prices specified by the co-operators, and their assumption of a reliable water supply from year to year.

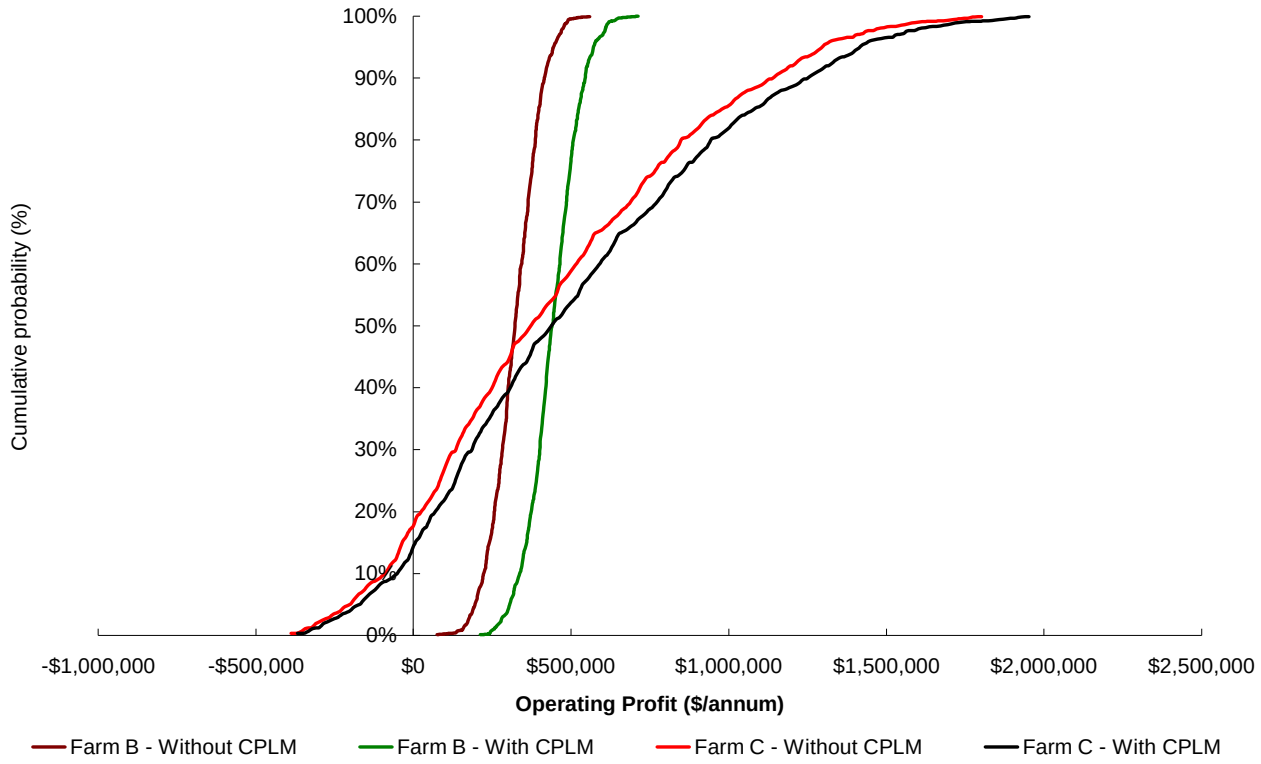


Figure 1 Distribution in annual returns for the "With" and "Without" scenarios for Farms B and C

FINANCIAL ANALYSIS

After the Steady State Profit Analysis a 20 year financial analysis was performed on two of the case study farms – (Farm A and Farm B). This analysis considered the cash flow of the business and included debt repayments, drawings by the investor and taxation. The expected values of the probability distributions for yield and price were used to generate the nominal cash flows for the "without" and "with" scenarios. The likely variability in the cash flow outcomes was assessed by simulating the expected business cash flow 1000 times using the range in yields and prices specified by each irrigator. This process enabled a comparison of the variability in cumulative cash flow between the "without" and "with" scenarios over the 20 year investment period to be made (see Table 6).

Table 6 Financial analysis for Farms A and B – "With" and "Without" investment in CPLMs (cumulative values in $ millions over 20 years)

	Farm A			Farm B		
	Without Centre Pivots	**With Centre Pivots**	**Difference**	**Without Lateral Move**	**With Lateral Move**	**Difference**
Cash Inflows	**$32.21**	**$44.66**	**$12.45**	**$27.81**	**$34.88**	**$7.06**
Variable Expenses	$18.84	$25.39	$6.55	$13.36	$16.53	$3.16
Overhead Expenses	$3.04	$3.10	$0.06	$2.89	$2.96	$0.07
Farm Drawings	$5.54	$6.54	$1.00	$5.07	$5.86	$0.79
Financial Expenses	$0.35	$4.44	$4.08	$1.64	$2.67	$1.02
Farm Cash Expenses	**$27.78**	**$39.47**	**$11.69**	**$22.96**	**$28.01**	**$5.05**
Cash balance	**$4.43**	**$5.19**	**$0.76**	**$4.85**	**$6.87**	**$2.02**

For both farms the investment in the CPLMs results in an increase in nominal returns over the 20 year investment period. The returns for Farm A are less ($0.76m) compared with that for Farm B ($2.02m). The cash inflows and cash expenses increase much more for Farm A compared to Farm B owing to the greater investment in land and infrastructure by the Farm A manager.

Analysis of the risk associated with the investments (based on the range of yields and price expectations by the farm managers) showed that the range in cumulative cash flows for Farm A

was less than that for Farm B. The greater range in possible outcomes for Farm B is due the greater range in crops grown on this farm compared to that on Farm A.

ECONOMIC ANALYSIS

An economic analysis over the life of the investment was then completed for Farm A and Farm B. This analysis examines the economic efficiency of the investment over the 20 year investment life. This analysis was based on a **Present Value** framework – this converts the future cash flows to their present cash equivalent, providing the decision maker with some of the information needed to make investment decisions between alternative farming systems. The **internal rate of return** (IRR) and the **net present value** (NPV) were then calculated for the investment in the CPLMs. The IRR is a measure of the rate of return on an investment and is calculated in nominal terms before tax and interest has been deducted – it can be compared to the average unfranked dividends paid on shares over a similar investment period or the return before tax on long term fixed investments. The NPV is the sum of discounted values of future income and costs associated with an investment. A distribution of outcomes for NPV was also generated using the range in yield and prices expected by the farm manager. This enabled the chances of achieving the investment goals to be determined. The results are presented in Table 7.

Table 7 Economic analysis indicators for the "Without" and "With" scenarios for Farms A and B

	Farm A		Farm B	
	Without CPLM	With CPLM	Without CPLM	With CPLM
IRR	5.6%	6.8%	9.0%	11.1%
NPV (10% Discount rate)	-$3.71m	-$3.08m	-$0.51m	$0.59m

The analysis indicates that investment in the CPLMs on both farms results in an increase in the IRR – the improvement is greater for Farm B.

The NPV values show that if the Farm A investor had an opportunity cost of capital of 10% over a 20 year investment period, then the present value of benefits foregone by continuing with the existing farming system would be $3.71 million. Investment in the centre pivots would reduce this to a loss of $3.09 million.

On the other hand, the Farm B investor with an opportunity cost of 10% over a 20 year investment period with the existing farming system would forego $0.51 million of present value benefits. Investment in the lateral move results in an increase in the net present value of benefits to $0.59 million.

The calculation of NPV in Table 7 was extended to a distribution of outcomes by simulating each investment model 1000 times. The distribution for NPV allows the chances of achieving the 10% return or better before tax and interest to be determined. The results of this analysis for Farms A and B are shown in Figure 2.

Farm A has no chance of achieving a 10% return or better before tax and interest with the existing furrow irrigation system. Similarly, investment in the centre pivot systems does not achieve a 10% return or better – although it is better then the current system. This is based on the current yield and price assumptions by the Farm A manager. If the farm manager has no opportunity to realise the farm assets and gain a greater return elsewhere, the future investment choice is between the farming systems.

The Farm B manager has a 26% chance of achieving a 10% return or better before tax and interest with the existing furrow irrigated farming system (and a 74% chance of not achieving this rate of return). This chance increases to 75% if the investment in the lateral move is made. The NPV of the investment in lateral move farming systems exceeds that from the original furrow irrigation system at all times.

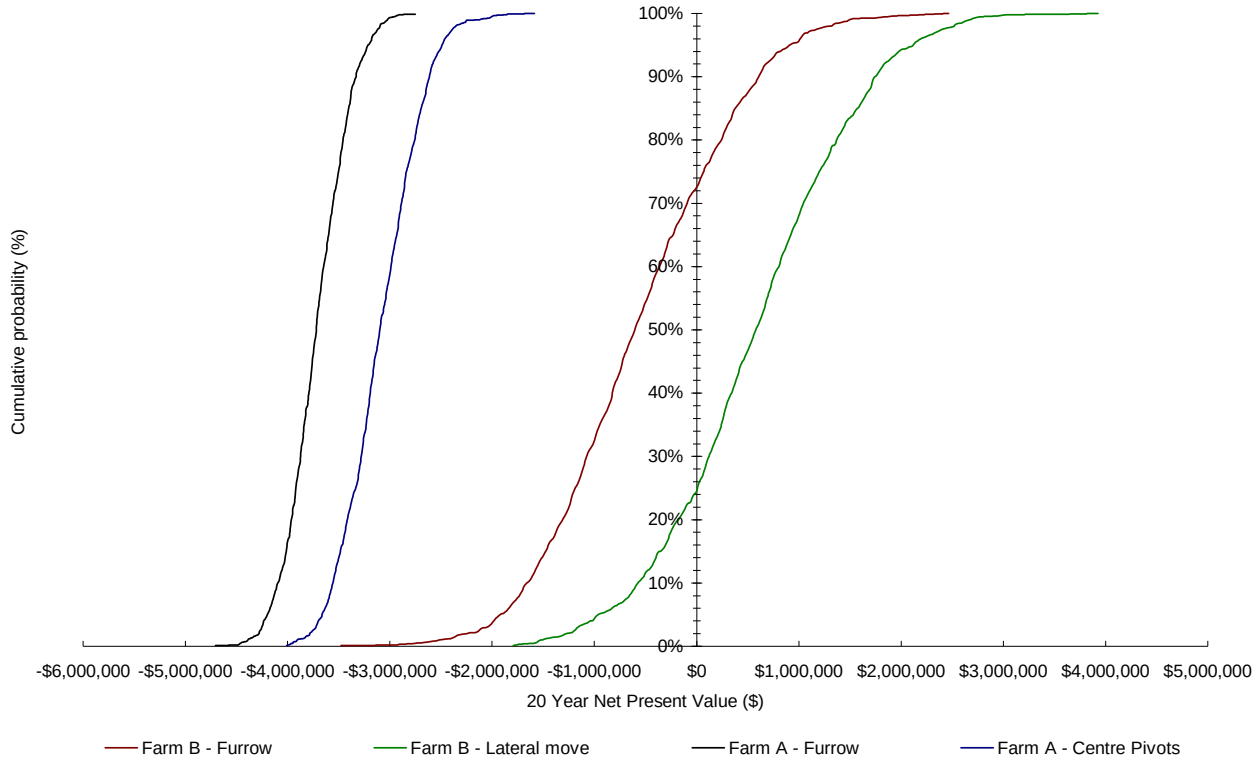


Figure 2 NPV distribution before financing and tax for Farm A and Farm B farming systems

MARGINAL ANALYSIS

Finally, a marginal analysis of the financial and economic impacts of investing in the CPLMs was conducted on Farms A and B. This analysis differs from that of the whole farm analysis. In the marginal analysis only the capital invested in the project and the extra or additional returns generated by the capital investment are considered. This method of calculation allows the benefits arising from the project alone to be accurately identified. This analysis examines the cumulative cash flow associated with the investment and calculates "pay-back" period – the time taken for the investment to generate sufficient cash to cover the initial set up cost. The distribution in NPV for the investment was also calculated.

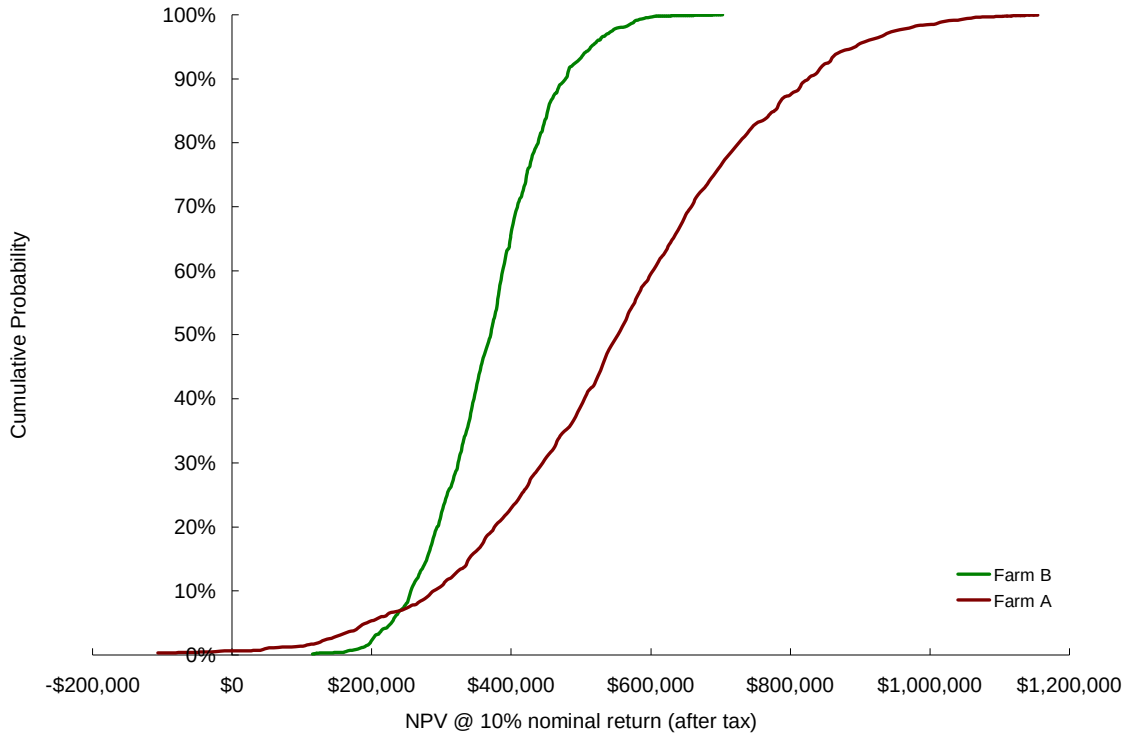
For Farm A the cost of the investment in the five centre pivots and additional land is about $1,755,000. The project generates sufficient cash to cover the initial set up cost within three to four years. The project is expected to produce a cash surplus of about $6 million over the economic life of the pivots.

For Farm B the cost of the investment in the lateral move is $295,000 (this includes an allowance for associated earthworks totalling $45,000). No additional farming plant is required to undertake the new cropping system using the lateral move. The lateral move investment is expected to generate sufficient cash to cover the initial set up cost within 5 years of installation. The project is also expected to produce a cash surplus of about $1,200,000 over the economic life of the project.

The results of the 1000 simulations to calculate the distribution in marginal NPV for the CPLM investment are presented in Figure 3.

The greatest range in NPV exceeding a 10% marginal return on capital occurs with Farm A - this is the result of fewer cropping activities for this farm compared to that for Farm B. For Farm B all returns exceed a 10% marginal return on capital.

Figure 3 Distribution of marginal NPV for the CPLM investments on Farms A and B



CONCLUSION

The “with” and “without” scenario analysis approach is a robust method to assess the economic and financial performance of investment in CPLMs. It is not possible to make a “rule-of-thumb” statement that the investment in CPLMs is or is not profitable – every farm business differs and so to do the water savings and yield benefits for the many crops that can be grown with these machines. Yield and prices risk, the extent of water savings and the risk of water availability all need to be considered when deciding on investment in alternative irrigation systems to current furrow systems. Other considerations include the availability of labour and the likely impact of changing energy costs on the viability of CPLM investments.