Developing a profit-risk decile calculator to capture farm risk

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Abstract
In dryland farming systems, farmers who increase their cropping intensity, tend to increase their downside risk. Consequently, farmers are increasingly exposed to financial and income risk due to additional costs of capital adjustment and increasing levels of enterprise debt. To help farmers analyse farm management decision across the growing season rainfall deciles, a farm-scale profit-risk decile calculator has been developed. A key feature of the profit-risk decile calculator is the ability to compare alternative strategies using a range of financial and economic measures in the same analysis. Site-specific versions of this calculator have been developed using workshop-based consultation between farmers, advisers and researchers for two regions in South Australia. We present a case-study farm developed for Cummins on the Lower Eyre Peninsula, South Australia to demonstrate the capability of the tool. We provide an overview of how the profit-risk decile calculator was developed, including input requirements, outputs generated and an interpretation of results. Using an example of high versus moderate nitrogen (N) management intensity, we demonstrate how farm risk can be explored for a range of outputs; either for a single calendar or rainfall decile year, or after a five-year run of seasons. The aim of this tool is to account for both production risk and business strength such that farmers and their advisors will make better informed decisions despite increased intensity and complexity of farming.

Key words
Profit – risk, decision support, Lower Eyre Peninsula, N management

Introduction

Assessing the merits of a new farming strategy can be challenging. Many farming decisions are based on projected profits in an average year. However, often maximising profit for an average year will not reduce risk, and understanding the trade-offs between profit and risk is complex (Monjardino et al. 2013; 2015). Risk varies with the climate, soil type, farm enterprise mix, commodities and input prices and the level of individual risk-aversion (Harwood et al.1999). A study of the perceptions of risk of Eyre Peninsula farmers ranked climatic variability as the most important source of risk, followed by financial risk and government policy (Nguyen et al. 2007). Farmers can manage risk by reducing variability, transferring risk or building the farm's capacity to deal with risk. Strategies are varied and include enterprise or geographical diversification, maintaining financial reserves and leveraging, leasing land or machinery, increasing liquidity, crop insurance, generating off-farm income, adjusting farm input, or changing farming practices (Harwood et al.1999). However, these strategies cannot be successfully evaluated without a careful analysis of the potential impacts on farm business performance. Therefore, a tool that allows individual farmers to explore these trade-offs is potentially useful. As climate is the key driver of crop production, and farmers perceive this risk to be the greatest. The calculator uses rainfall deciles and resulting yield responses as the primary driver for assessing business risk. The profit-risk decile calculator allows for comparison between current farm operations and alternative management strategies to examine how it may perform over a range of rainfall deciles.

The profit-risk decile calculator was developed with the aim of utilising the outputs of complex bio-economic modelling (Monjardino et al. 2013; 2015) in a format that farmers and advisers could more easily manipulate. The calculator requires farm-based data, and in this case it was generated through an iterative process involving researchers, farmers and consultants in a series of small workshops. This lead to the creation of case-study farm which enabled advisers and farmers to complete comparative scenario analysis, and in this paper we compare different N management strategies at the farm scale.

Methods

The profit-risk decile calculator requires inputs of seasonal crop production including local rainfall deciles (prefilled for the users), crop area according to soil type, enterprise mix, fixed and variable costs, farm ownership, farm assets, as well as crop yield associated with a given soil type, management strategy and rainfall decile (Figure 1). The input data was generated in workshop settings to develop a local case-study farm

which can then be tailored by the individual post-workshop. Rainfall deciles were calculated using 56 years of daily weather data, with rainfall the sum of growing season rainfall (April to October) plus 25% of the fallow rainfall (as is the case for water use efficiency calculations). The years within a given rainfall decile are listed together in the calculator as analogue years. The profit-risk decile calculator outputs are grouped by whole-farm economics and finance measures. Economic measures include profit and loss, earnings before interest and tax (EBIT), and farm net profit before tax (FNP). Farm finance measures include net worth, equity, return on capital and cash flow. The results can be viewed either for a single calendar, rainfall decile year, or after five-year run of seasons which are a historical sequence or user selected sequence of seasons.

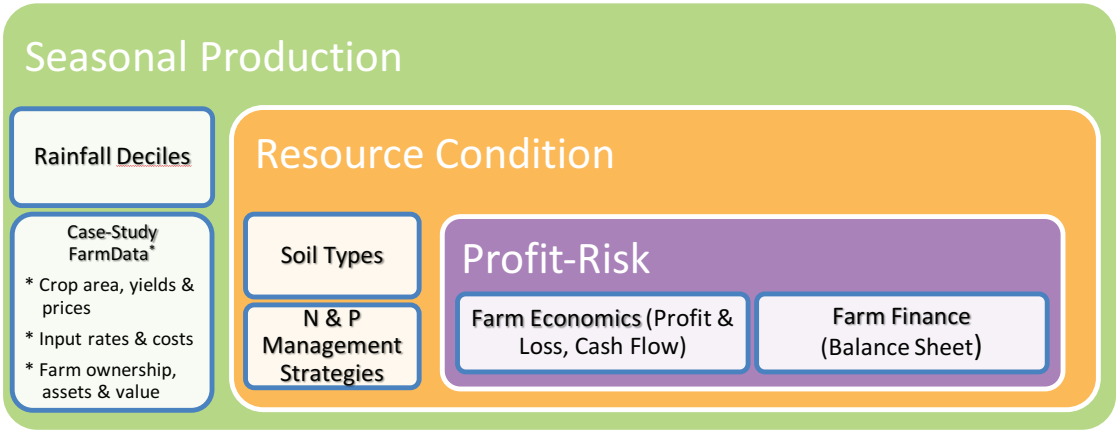

Figure 1 data requirements and outputs for the 'cash flow calculator'

This paper uses a Cummins case-study farm to illustrate features of the profit-risk decile calculator. Two profit-risk workshops were held at Cummins with local farmers, consultants and researchers to establish case-study farms that reflect the local conditions. Cummins is located on the Lower Eyre Peninsula (-34.26, 135.73) with average annual rainfall of 400 mm. The key attributes of the case-study were:

- 1400 ha farm valued at $7,000/ha
- Manager allowance of $50,000 and staff wages of $51,500/year
- An overdraft of -$2,000,000
- Plant and machinery inventory value of $1,120,000
- Total fixed costs of $96,750/year
- Two soil types, clay (75% of cropped area) and waterlogging clay (25% of cropped area)

The case-study farm at Cummins was used to compare two levels of N management intensity: a high intensity scenario where 700 ha wheat and 700 ha canola were cropped with applications of 100-300 kg urea/ha and a moderate intensity scenario which has 700 ha wheat, 350 ha canola and 350 ha beans with 100-300 kg urea/ha applied to the wheat and canola only.

Table 1. Yield (t/ha) in response to N management and season type for Cummins case-study farm. Yields were developed using farm records, local trial data and APSIM outputs.

	High N Management Intensity					*Moderate N Management Intensity*				
	Decile 1	Decile 3	Decile 5	Decile 7	Decile 9	Decile 1	Decile 3	Decile 5	Decile 7	Decile 9
	Wheat Yields (50% of farm area)					*Wheat Yields (50% of farm area)*				
Clay	2.4	2.9	3.4	4.5	5	2.7	3.2	3.8	5	5.5
Waterlogging Clay	2.4	2.9	3.4	4.5	4.1	2.7	3.2	3.8	5	4.5
Fertiliser Input (kg Urea)	100	140	180	250	275	100	140	180	250	250-300
	Canola Yields (50% of farm area)					*Canola Yields (25% of farm area)*				
Clay	0.9	1.3	1.6	2	2.2	1	1.4	1.8	2.2	2.4
Waterlogging Clay	0.9	1.3	1.6	1.6	1.6	1	1.4	1.8	1.8	1.8
Fertiliser Input (kg Urea)	140	180	240	275	300	140	180	240	275	300
						Bean Yields (25% of farm area)				
Clay						1.4	1.8	2.5	3.0	3.0
Waterlogging Clay						1.4	1.8	2.5	3.0	1.8

Yields varied according to N management, soil type and season (Table 1). The yields used in the Cummins case-study farm were based on a consensus of local trial data (in this case N management trials), APSIM modelled response to N management and historical farm data. Yields have been adjusted for the management scenario, such that the high N intensity has approximately 10% less yield despite equivalent N input (an outcome which appears sensible based on yield measurements available and estimates of the potential benefit derived from having a legume in the sequence).

Results and Discussion

The profit-risk decile calculator outputs economic measures indicating the financial performance of whole-farm business. Generally a higher EBIT indicates better business performance, the calculator compares how EBIT behaves in a average year versus low or high rainfall years, thus adding value to reviewing the farm business performance. The moderate intensity scenario is earning $124 K more than the high intensity scenario in a decile 5, increasing to $148 K in a decile-7 (Table 2). FNP follows a similar pattern, increased from decile 1 through to decile-7, but there was only a small increase from decile 7 to decile 9 due to the effect of waterlogging on yield (Table 2). The difference in FNP between management scenarios was greatest in a decile-7 year, with the moderate intensity scenario generating $151 K more FNP than the high intensity scenario. Cash flow is a measure of liquidity, a positive cash flow indicates that financial obligations are met, this is especially important in low rainfall/yield years (decile 1-3). Both management scenarios started with a -$2000 K overdraft. After one year the cash flow was negative with a decile-1 year; however all other rainfall seasons (decile-3 to 9) showed improved closing balances with the moderate intensity scenario $78-110 K ahead (Table 2). Net worth and equity both reflect how the farm business is performing after a single year. In both scenarios equity was greater than 80% and net worth had growth in decile 3 through to decile 9 (Table 2). Again the moderate intensity scenario performed better across all deciles.

Table 2. Profit-risk decile calculator outputs comparing the high and moderate N management intensity scenarios on the Cummins case-study farm after one year.

Decile	Start	Decile 1	Decile 3	Decile 5	Decile 7	Decile 9
High N Intensity						
[a]Earnings Before Interest, Leasing and Tax (EBIT)		$95k	$258k	$413k	$645k	$705k
[b]Farm Net Profit Before Tax (FNP)		-$211k	-$46k	$111k	$346k	$408k
[c]Cash Flow (Expected balance at bank)	-$2,000k	-$2,104k	-$1,939k	-$1,782k	-$1,547k	-$1,485k
[d]Net Worth	$8,920k	$8,709k	$8,874k	$9,031k	$9,266k	$9,328k
[e]Equity		81%	82%	84%	86%	86%
Moderate N Intensity						
Earnings Before Interest, Leasing and Tax (EBIT)		$175k	$334k	$537k	$792k	$812k
Farm Net Profit Before Tax (FNP)		-$129k	$32k	$238k	$497k	$517k
Cash Flow (Expected balance at bank)	-$2,000k	-$2,022k	-$1,861k	-$1,655k	-$1,396k	-$1,376k
Net Worth	$8,920k	$8,791k	$8,952k	$9,158k	$9,417k	$9,437k
Equity		81%	83%	85%	87%	87%

[a]EBIT = sum of gross margins - overheads, [b]FNP = EBIT – depreciation - interest, [c]Cash Flow = FNP - principal repayments -allowance for machinery or cash purchase, [d]Net Worth = total assets - total liabilities, [e]Equity = net worth/ total assets.

Measuring farm performance over a range of season types is beneficial, as it shows the resilience of the farm over time and the ability to recover from a financial shock. This is valuable for developing the ‘big picture’ in scenario analysis and shows how discounted cash flow, equity and net worth are expected to perform over time. In the case study, a run of historical years starting in 2002 and finishing in 2006 corresponding to decile 2, 7, 4, 8 and 1 was analysed. The moderate N input system consistently performed better regardless of season type, with small differences in the first couple years and the potential impact of the differences after five years more substantial (Figure 2), with $409 K better cash flow in the moderate intensity scenario.

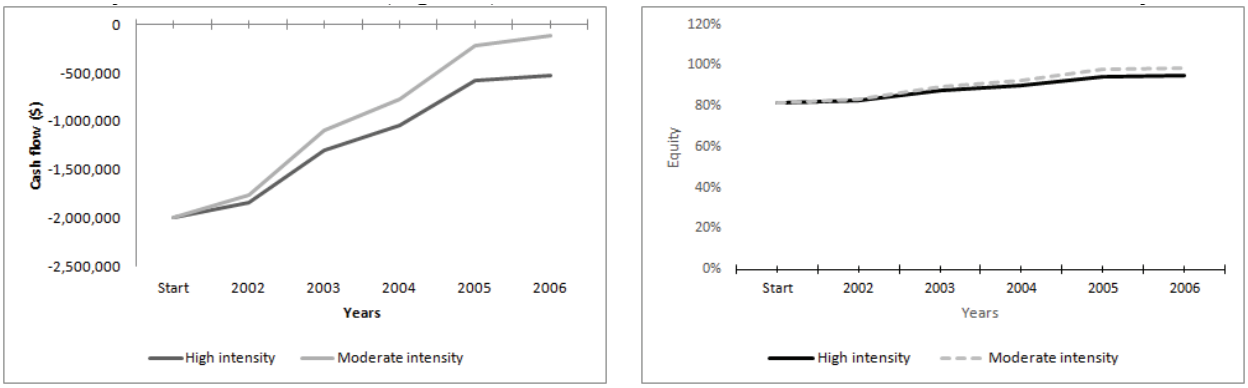

Figure 2 Graphical representation of the 5 year outputs discounted cash flow on the left and equity on the right. The black line shows the high intensity scenario and the grey line shows the moderate intensity scenario.

Conclusions

This paper demonstrated some features of the profit risk calculator by using a Cummins case-study farm. The tool was employed to compare N management scenarios impact on financial and economic measures in all rainfall deciles, allowing both downside and upside seasonal risk to be explored. We have established that the decile calculator is locally relevant, simple to use and practical tool that can help users to better understand how seasonal risk impacts on their farm business and their farming decisions. The tool has the flexibility to explore a range of farming scenarios with consideration given to maximising profit and minimising risk according to user preference.

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