An economic analysis of options for utilising additional land on a high rainfall Gippsland dairy farm

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Abstract

A range of options for utilising additional land on a dairy farm in the high rainfall area of Gippsland were analysed. The aim was to determine if additional land may assist the owners/operators in maintaining or increasing profit in the medium term (5-10 years). Historical trends have been towards fewer, larger, more intensive enterprises, and this project studies the value of additional land in continuing or altering this trend. A case study farm and spreadsheet modelling approach was used to examine these issues.

Five different uses for additional land were identified by an expert steering committee, and were compared to the base farm system over a 10-year development period.

The results suggest that expanding the milking area by purchasing additional land without a significant increase in herd size (2A) increased annual operating profit by approximately $70,000/year without increasing variability when compared to the base farm system. This was the only option examined to earn a high enough internal rate of return on additional capital investment to justify the investment without capital gains. Additional milking area with a substantial increase in stocking rate (2C) significantly reduced annual operating profit (by approximately $70,000/year) and notably increased the variability of these returns.

The purchase of an outblock for conserved fodder production improved profitability, but would require some capital gains to be an attractive option on profit measures alone.

The most appropriate changes to diary farm businesses in response to changes in the operating environment will vary from farm to farm. The analysis indicated that simple following previous industry trends may not be appropriate on many farms. Optimising the amount of home grown feed and efficiently using purchased supplements are important, particularly if the milk produced is subject to the fluctuations of an export milk price.

Introduction

The dairy industry is important to the Australian, Victorian and Gippsland economies. In 2007/08 farmgate production was valued at 4.6 billion dollars nationally, and contributed more than 50% of Gippsland's agricultural production. Between 1989/90 and 2006/07 Gippsland's milk production has grown from 1.2 to 1.9 billion litres annually. While the quantity of milk produced has increased, farm numbers have declined, highlighting a shift towards larger, more intensive dairy farms.

This trend has been supported by the rapid increase in the diversity of feeding systems used in Gippsland. Prior to 1980, dairy farms were predominantly pasture based, with minimal concentrates fed (Doyle *et al.* 2000). In 2007, over 90% of Gippsland dairy farmers fed concentrates, with an average of 1.4 t DM/cow. As farm businesses intensify there is the increased exposure of the farm business to fluctuations in prices of concentrates, fodder and milk. Exposure to these fluctuations has a significant impact on the variability of returns to the farm business. This is particularly important in farms supplying the export milk market.

The location of the Gippsland dairying region also provides a number of challenges to a farm business. The distance from grain production regions increases the cost of transport of concentrates above that of the other dairying areas in Victoria. The amenity value of the region, and its proximity to Melbourne have also led to substantial increases in the price of land over the last decade. In 2000, land prices were identified as a significant issue that may compromise the future expansion of the dairy industry in Gippsland (Ag Challenge 2000).

Farmers have always responded to changes in the external environment by altering their farm systems and approach to the businesses. As the future cannot be known with any certainty, it is important to continue to analyse different farming systems and their potential viability into the future. The aim of the analysis in this paper is to examine the performance of a range of options for a dairy farmer considering investment in additional land in the high rainfall area of Gippsland.

Method

Approach

The approach used was similar to that used by Ho *et al*. (2007) with several key elements: a case study farm; involvement of an industry steering committee; and spreadsheet modelling to analyse the biophysical and economic performance of the farm, and the variability of these performance measures. The whole farm case study approach enabled an in-depth analysis of the farm business. This method was chosen because decisions about managing farms involve the complex combination of human, production, environmental, economic, financial and risk components of the business (Malcolm *et al.* 2005). In analysing the farm performance, the main focus was on the economic, financial and production aspects. The case study farm examined was chosen because it had accurate records of physical and financial data, was well managed, profitable and made good use of the available resources. Data were collected from the farmer through interviews.

Considerable input was obtained from the steering group which comprised 6 farmers, a farm consultant, a rural counsellor, a dairy extension officer, several agricultural economists and scientists. This group provided overall direction regarding: the criteria for selecting the case study farm; the options that should be tested; the assumptions used in making farm system changes; and contributed to the interpretation of the results. This ensured the analyses were subject to rigorous questioning and a broad range of perspectives were considered.

Excel spreadsheets were used for both the biophysical and economic modeling. The biophysical component comprised a monthly feed budget based on estimated pasture consumption and supplementary feed inputs, estimated metabolisable energy (ME) concentrations of these feeds and livestock ME requirements (CSIRO 2007). Annual whole farm budgets were developed according to Malcolm *et al*. (2005). Inputs used in the spreadsheet model were: milk production; herd size; pasture/crop area; type and amount of brought-in supplements fed; milk income; stock purchases, sales, deaths and births; variable costs (feed, shed, herd and repairs and maintenance costs); and overhead costs (labour, depreciation and administration). Alternative farm development options were evaluated using discounted net cash flow budgets over a 10-year period. The key measures used in comparing the profitability and performance of the alternative development options were:

- Annual operating profit (gross income minus variable and overhead costs, before interest and tax) of the farm, estimated once the options had been implemented and were fully operational (Year 4);
- Real internal rate of return (IRR) for the whole farm business and for the additional capital invested in each option;
- Net Present Value (NPV) of the total investment at a discount rate of 5% per annum;
- Peak Debt in nominal dollars during the 10-year period analysed; and
- Value of the owners' capital in nominal dollars in Year 10.

Risk Analysis

Risk was assessed for the existing farm system (referred to as the 'base farm') and each of the development options analysed for the farm. Stochastic simulation was carried out using @Risk (Palisade 2009), an add-in package to Microsoft Excel, which allows uncertain variables to be defined as probability distributions. The Monte Carlo simulation method involves randomly selecting values for variable inputs, from the specified probability distributions, and whole farm outcomes are estimated. A large number of iterations were compiled to form a distribution of possible outcomes, such as annual operating profit and IRR. The results reported in this analysis are based on 10,000 iterations of 10-year periods.

The key inputs to the operation of the business for which probability distributions were defined were: milk price, supplementary feed prices, pasture consumed, and the crop yields in each year. The median, key percentiles and distribution type are presented in Table 1. The correlation matrix for the analysis is described in Table 2.

Table 1. The type, median, and key percentiles of the input distributions used in the analysis.

Inputs	Type	P5	P25	Median	P75	P95
Milk Price ($/kg milk protein + fat)	Log logistic	3.74	4.30	4.70	5.15	6.05
Grain Price($/t air dry)	Gamma	182	234	280	336	433
Hay Price ($/t air dry)	Loglogistic	137	178	210	249	334
Pasture Consumption (Perennial Ryegrass) (t DM/ha/yr milking area of base farm)	Weibull	7.3	8.0	8.5	9.0	9.7
Maize Yield (t DM/ha/yr)	Normal	7.6	11.4	14	16.6	20.4
Annual Ryegrass Yield (t DM/ha/yr)	Lognormal	3.5	3.7	4.0	4.5	5.9
Cereal/Pea Yield (t DM/ha/yr)	Lognormal	6.8	6.5	8.5	9.4	10.8
Millet/Brassica Yield (t DM/ha/yr)	Extreme Value	1.15	1.6	2.0	2.5	3.5

Table 2. Correlation matrix for input distributions.

	Milk price	*Grain price*	*Hay price*	*Pasture consumption**	*Maize Yield*	*Annual Ryegrass Yield*	*Cereal/Pea Yield*	*Millet /Brassica Yield*
Milk price	1							
Grain price	-	1						
Hay price	-	0.15	1					
Pasture Consumption* (PRG)	-	-	-0.35	1				
Maize yield	-	-	-	0.25	1			
Annual Ryegrass yield	-	-	-	0.6			1	
Cereal/Peas Yield	-	-	-	0.6	-		-	
Millet/Brassica Yield	-	-	-	0.25	-		-	-

* Pasture consumption is for milking area on home farm.

‘Base farm’ system.

The family-run enterprise was located in the South Gippsland region of Victoria, north-west of Korumburra, and consisted of 255 ha in total. The land available for pasture or feed production, when buildings, yards, laneways, and bush zones were excluded, was 245 ha. Approximately 140 ha of this area were grazed by the milking herd (referred to as the milking area). A 40 ha outblock about 7 km away was used for the production of hay and silage and was also grazed by the female yearlings. The milking area and most of the 40 ha outblock was accessible with a tractor, but there was approximately 65 ha of steeper land, adjacent to the milking area, that was used solely to run young stock.

The herd of 350 milking cows was predominantly based on Scandinavian Red genetics, was self-replacing, and calved in July/August/September. In a typical year, about 90 replacement calves were reared. Stocking rate on the milking area was 2.5 cows/ha for the majority of the year. Annual milk production for the ‘base farm’ system was 6,033 L/cow or 218 kg protein/cow and 263 kg butterfat/cow, with average fat and protein tests of 4.4 and 3.6%. The dairy was a 50 unit rotary and adequate for a considerably larger herd than the ‘base farm’ system.

During 2006/07, 600 t DM of concentrates (estimated ME of 12.5 MJ/kg DM) were fed to the milking herd in the dairy. A total of 118 t DM of purchased hay and 32 t DM of pasture hay (estimated average ME of 9 MJ /kg DM) conserved from the outblock were fed either in the paddock or on the feedpad. Approximately 42 t DM of palm kernel extract (estimated ME 11.5 MJ/kg DM) was used to supplement the diet.

Pasture consumption by the herd during a year was estimated using information on ME requirements of dairy cows, milk production and supplementary feed inputs for the case study farm, as described by Armstrong *et al*. (2000) and Heard *et al*. (2004). Pasture consumption on the milking area was estimated to be approximately 8.5 t DM/ha/year.

In the steady state year (Year 4), annual operating profit was $113,000 and return to total capital was 4.2% with average prices. The financial performance indicated that the business was robust. There was no urgency to make major changes in the short-term unless operating conditions changed. However, the children are considering coming back home to the farm, and so there will be pressure to make changes and to maintain profitability in the long-term.

Development options

The Steering Committee identified a range of development options that may maintain and/or increase profit of the farm. The options tested are summarised below.

Option 2: Expanding the milking area – by purchasing 40 ha of undulating land adjacent to the current milking area for $700,000. Three variations of this option were analysed:

- 2A. 380 cows (stocking rate decreased to 2.1 cows/ha) with a lower quantity of purchased supplements than the base farm, and the existing feedpad/effluent systems.
- 2B. 490 cows (stocking rate 2.7 cows/ha), and approximately $52,000 invested in upgrading the feedpad and effluent system.
- 2C. 630 cows (stocking rate of 3.5 cows/ha), and approximately $167,000 invested in upgrading the feedpad and effluent system.

It was assumed that the pasture consumption on the additional 40 ha was 7.5 t DM/ha for Years 1 and 2 in Option 2A, and for Year 1 in Option 2B and 2C. The median pasture consumption was 8.5 t DM/ha for all subsequent years. The cost to develop the extra 40 ha of land (fences, lanes, stock water etc) in each option was $50,000.

Option 3: Expanding the non-milking area – by purchasing 40 ha of land not adjacent to the milking area to produce fodder to be brought back to the milking area as hay or bale silage. The price of the 40 ha was $700,000. Perennial Ryegrass (PRG) was sown on the majority of the land, with two variations.

- 3B. 25% (10 ha) of the area double cropped with Maize in the summer and annual ryegrass (ARG) during the winter.
- 3C. 38% (15 ha) of the area double cropped with a Cereal/Pea blend during winter and a low yielding opportunistic Brassica/Millet blend during the summer months.

The area sown to perennial ryegrass had an average consumption of 7.5 t DM/ha for the first two years, and 8 t DM/ha for subsequent years. This was a lower average consumption than the grazed feed due to the wastage associated with conserving and then feeding out fodder. The median and distributions of the crop yields can be found in Table 1. It was assumed these levels could be achieved from year 1. Conserved fodder was stored as pit silage and fed out with a silage wagon. The costs of the wagon and pit were included in the capital expenditure for this option (Table 3).

These options were all compared to the 'base farm' system (*Status Quo*). Clearly, there are a much wider range of options that could be examined, some of which have been described in Armstrong *et al.* (2010).

Table 3. Details and assumptions relating to development options analysed.

	2A. Similar Herd Size	*2B. Similar Stocking Rate*	*2C. Increased Stocking Rate*	*3B. Outblock with Maize/ARG*	*3C. Outblock with Cereals/ Peas & Millet/Brassica*
Cow Numbers	380	490	630	380	380
Stocking Rate (cows/ha MA)	2.1	2.7	3.5	2.7	2.7
Calves reared	90	120	155	90	90
Milking Area (ha)	180	180	180	140	140
Total farm area (ha)	295	295	295	295	295
Median Consumption from new area from yr 3 (t DM/ha.yr)	8.5	8.5	8.5	PRG – 8 Maize - 14 ARG - 4	PRG – 8 Cereal & Peas – 8.5 Millet & Brassica – 2.0
Pasture Consumption (t DM/cow/yr)	4	3.1	2.4	3.1	3.1
Outblock feed consumed (t DM/cow/yr)	0.5	0.4	0.3	1.6	1.4
Oversow / Turnips / Topping	Additional $70/ha for fodder conservation	- Extra 3 ha Turnips - Extra 25 ha Oversown	- Extra 7 ha Turnips - Extra 25 ha Oversown		
Paid Labour (extra $40K/100 cows, and extra $50K/100 cows if stocking rate is over 3/ha)	No change	Extra $44,000 Total $114,000	Extra $125,000 Total $195,000	Extra $5,000 Total $75,000	Extra $5,000 Total $75,000
Repairs and maintenance	Extra $2,000	Extra $4,000	Extra $5,600	Extra $3,000	Extra $3,000
Purchased Supplements					
Grain (t DM/cow/yr)	1.3	2.0	2.1	1.28	1.43
Hay/silage (t DM/cow/yr)	0.1	0.4	1.1	0.02	0.02
Machinery & Infrastructure					
Feedpad and Effluent System Upgrade	Sufficient	$52,000	$168,000		
Dairy Shed	Sufficient	Sufficient	Larger Yards $10,000	Sufficient	Sufficient
Vat	Sufficient	Sufficient	Upgrade $45,000	Sufficient	Sufficient
Existing Tracks	-	$10,000	$20,000	-	-
Stock water	-	$5,000	$10,000	-	-
Silage wagon/pit	-	-	-	$45,000	$45,000

Other key assumptions

- No real capital gain in land value was included. Real increases in land value would be expected in this area, but the main purpose of the study was to analyse the economic efficiency of the dairying enterprise.
- The herd and shed costs varied directly with cow numbers.
- Additional milking cows were purchased for $1,000/head.
- For each option, the number of replacements reared was 24% of the milking cow numbers.
- The breakdown of the costs for producing and conserving crops and pastures can be found in Armstrong *et al*. (2009). The per-hectare totals are as follows.

Table 4. Costs of production for different areas

	Median Yield (t DM/ha)	*Production Cost ($/ha/year)*
Perennial Ryegrass (milking area)	8.5	$839
Turnips (inc pasture renovation - milking area)	8.5	$619
Perennial Ryegrass (existing outblock)	4.4	$285
Perennial Ryegrass (new outblock)	8.0	$1,374
Maize/Annual Ryegrass (new outblock)	18.3	$4,200
Cereals/Peas with Millet/Brassica (outblock)	10.7	$1,986

- For all the options reported here, milk production per cow was maintained at 480 kg protein + fat by varying supplementary feeding with seasonal conditions and farm system changes.
- There was no change in substitution of supplements for pasture as grain or hay feeding levels changed.
- No additional ME requirement was included for extra walking by cows in the options where milking area was expanded.
- The operators' allowance remained constant for all development options. All additional labour requirements were met through increases in paid labour.

Results and discussion

Development Options

Expand milking area and milk 380 cows (Option 2A)

Expanding the milking area by 40 ha and continuing to milk 380 cows was economically attractive for the case study farm. The annual operating profit in the steady state increased by about 63% once the change was implemented (Table 5). The increased profit came through a reduction in the proportion of purchased feed, from about 43% to 34%, of the total ME consumed.

The real internal rate of return to the extra capital invested for Option 2A was 9%. This suggests that purchasing additional land would be a reasonable investment even if there were no significant capital gains on that land. The IRR for the whole business under Option 2A was higher than the base farm (4.9% versus 4.2%). This option had similar variability in the profit measures as the base farm system (Figure 1), but with a higher average. This reduced the chance of a poor outcome for the farm system. For example, Option 2A had a 9% chance of generating annual operating losses compared to 19% for the 'base farm'.

Purchasing additional land increased debt substantially. Peak debt was about $1.8 million for Option 2A (Table 5). The capital achieved sufficiently high returns however, to justify these debt levels. Option 2A increased the owners' capital substantially above the expected nominal capital from continuing with the base farm by the end of the 10-year period ($5.6 versus $5.1 million in nominal dollars).

In reducing stocking rate per hectare (Option 2A), there may be some challenges associated with maintaining pasture nutritive characteristics and consumption and it would require a high level of pasture management skills to maintain quality and avoid wastage. However, it is possible to effectively manage this kind of farm system. Farm performance data (OnFarm Consulting, unpublished data) shows that there are a number of farms located in the area that regularly achieve levels consistent with the assumptions and results associated with this development option.

Expand milking area and milk 490 cows (Option 2B)

Expanding the milking area to 180 ha and herd to 490 cows (Option 2B) resulted in a projected 33% increase in mean annual operating profit compared to the base farm (Table 5). However, the variability and risk associated with Option 2B were greater than for the 'base farm' (Figure 1 and Figure 4). The real IRR of the extra capital invested was 2%, which reduced the IRR of the whole farm system slightly. This is not an attractive use of extra capital, unless the value of the extra land purchased increases. Real capital gains of 6% per annum would give an overall real return on extra capital of 8%. This may be satisfactory in some situations, but there are risks in investing with a heavy reliance on real capital gains in the value of land.

Compared to option 2A, where milking area was expanded and 380 cows were milked, Option 2B was a less profitable investment and there was no obvious return for the increase in herd size. While 490 milking cows on the expanded milking area resulted in a similar stocking rate per hectare of milking area to the base farm, it slightly intensified the system as a whole. More replacement stock were reared on the non-milking area and the quantity of conserved fodder from the non-milking area was divided amongst more cows. Also, an upgraded feedpad, effluent system and extra paid labour were included for Option 2B.

Expand milking area and milk 630 cows (Option 2C)

Expanding the milking area and increasing stocking rate per hectare (Option 2C) appears to reduce annual operating profit to 40% of the base farm level (Table 5). The variability of returns also increased substantially with the shift to the 2C system (Figure 1 and Figure 4). The probability of incurring an operating loss increased to 45%. The real IRR of the whole farm system was substantially (73%) lower than the base farm. Even the high capital gains of the last decade in the case study area (~7% real per year) would not be sufficient to provide a positive return on additional capital. A shift to this farm system from the base farm could be expected to reduce the nominal owners' capital in year 10 to be reduced by approximately $2 million (Table 5).

The results were sensitivity tested to estimate what would be required for the expanded and intensified system to be a reasonable investment. Factors tested included a substantial increase (24%) in pasture consumption, a slight increase (6%) in pasture quality, an increase in milk price (2%) due to a greater quantity of milk produced, lower expenditure for extra labour, and a cheaper feedpad construction (Table 6). The observation of the farmer and his consultant was that a significant increase in pasture consumption on this farm would require higher and more favourably distributed rainfall than had occurred in recent years.

If all of these savings were achieved together (Table 6) then annual operating profit was higher than Option 2A (11%) but with greater variability (21% chance of a negative annual operating profit). Returns to the whole farm system and additional capital were slightly lower than Option 2A, due to the magnitude of the capital invested.

Expand non-milking area: Cropping options (3B and 3C)

Buying an additional 40 ha outblock for fodder production (Options 3B and 3C) did increase mean annual operating profit, the mean IRR of the whole farm business, and the nominal owners' capital in year 10 from the base farm levels (Table 5). The results were similar for both of the cropping options. Annual operating profit was increased by 28%, mainly through a reduction in the quantity of purchased feed. This increase in average profit, combined with similar variability to the base farm, led to a reduced chance of an operating loss (12% versus the base farm 19%). Although the additional outblock does slightly increase the IRR of the whole farm system, the IRR of additional capital was borderline without real capital gains.

This option does not perform as well as the 2A option, primarily due to the inefficiencies of having to process the feed grown on the outblock and feed out to stock on the milking area rather than directly grazing by the herd. The costs (capital and operational) and wastage associated with the processing and feeding conserved fodder accounts for the difference in performance of these options. The two cropping options do perform slightly better than if the outblock was dedicated solely to perennial ryegrass production, and was harvested as bale silage (Armstrong, 2009).

Table 5. Summary results for status quo and development options.

	Mean Annual Operating Profit in Year 4 ($'000)	Mean Internal Rate of Return of total investment over 10 years* (%)	Mean Net Present Value at 5% discount rate ($'000)	Mean Internal Rate of Return of the extra investment in the option* (%)	Peak Debt ($'000,000)	Nominal Owner's Capital in Year 10 ($'000,000)
Base Farm	113	4.2	-202	-	-1.2	5.1
Option 2A	184	4.9	-31	9	-1.8	5.6
Option 2B	150	3.9	-325	2	-2.0	5.0
Option 2C	45	1.1	-1,192	-10	-3.8	3.3
Option 3B	156	4.3	-196	4.9	-1.9	5.2
Option 3C	157	4.3	-188	5.0	-1.9	5.2

*Not including any capital gains.

Table 6. Sensitivity testing of Option 2C to pasture consumption, pasture quality, milk price, paid labour and feedpad expenditure.

	2C	*Increased pasture consumption*	*All savings*
Pasture consumption (t DM/ha)	8.5	10.5	10.5
Milk price ($/kg P+F)	4.70	4.70	4.80
Pasture quality (MJ ME/kg DM)	11.0	11.0	11.3
Paid labour ($'000/year)	195	195	170
Feedpad cost ($'000)	16	167	50
IRR of whole farm system (%)	1.1	3.0	4.7
IRR of additional capital (%)	-10	-1.8	6.8
Annual operating profit ($'000)	45	133	205

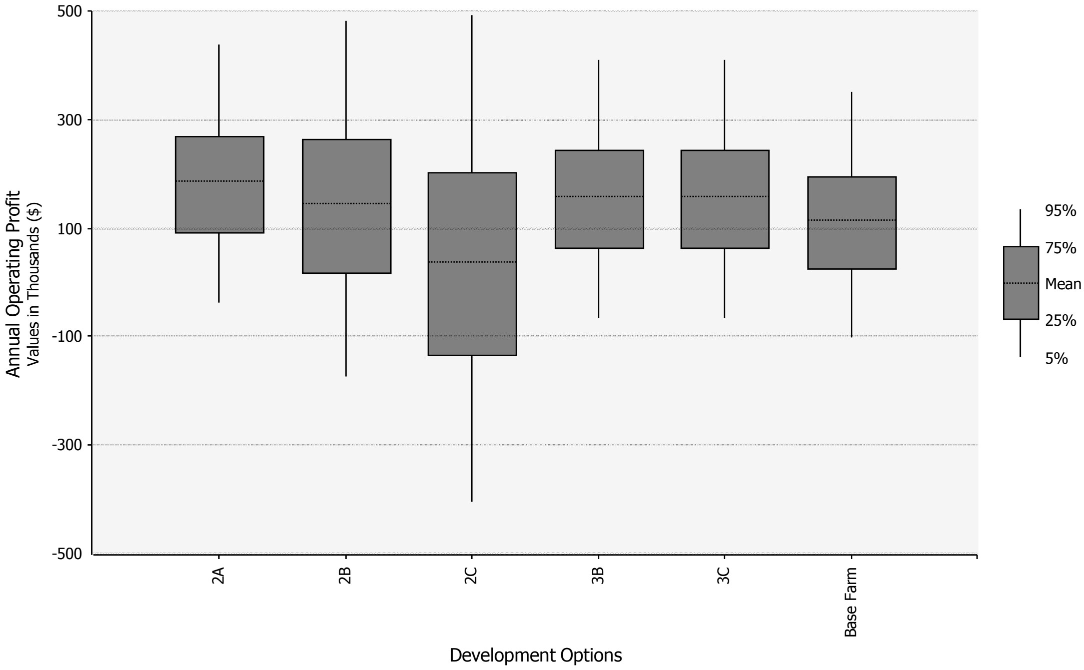

Figure 1. Mean and key percentiles for annual operating profit of base farm and development options.

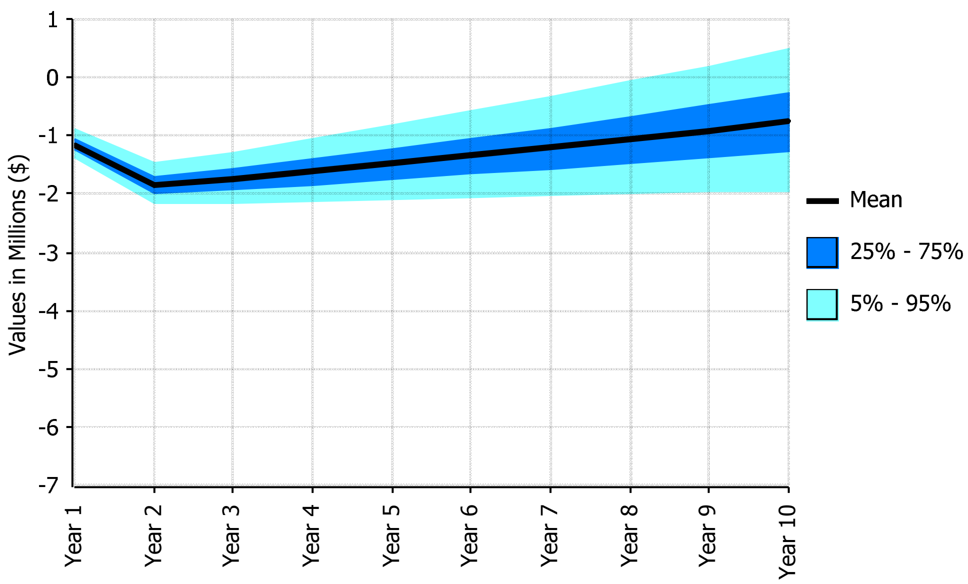

Figure 2. Cumulative net cash flow with key percentiles for Option 2A.

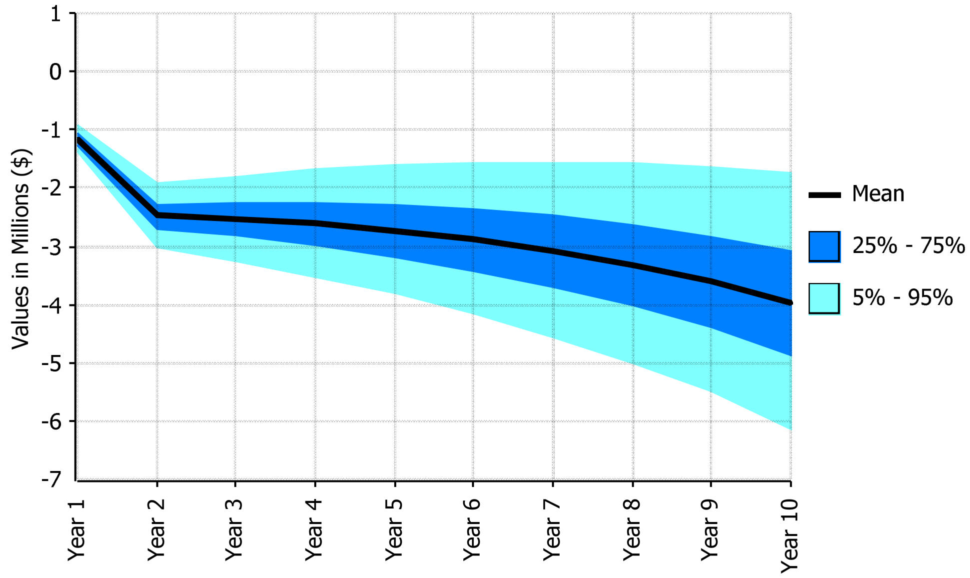

Figure 3. Cumulative net cash flow with key percentiles for Option 2C.

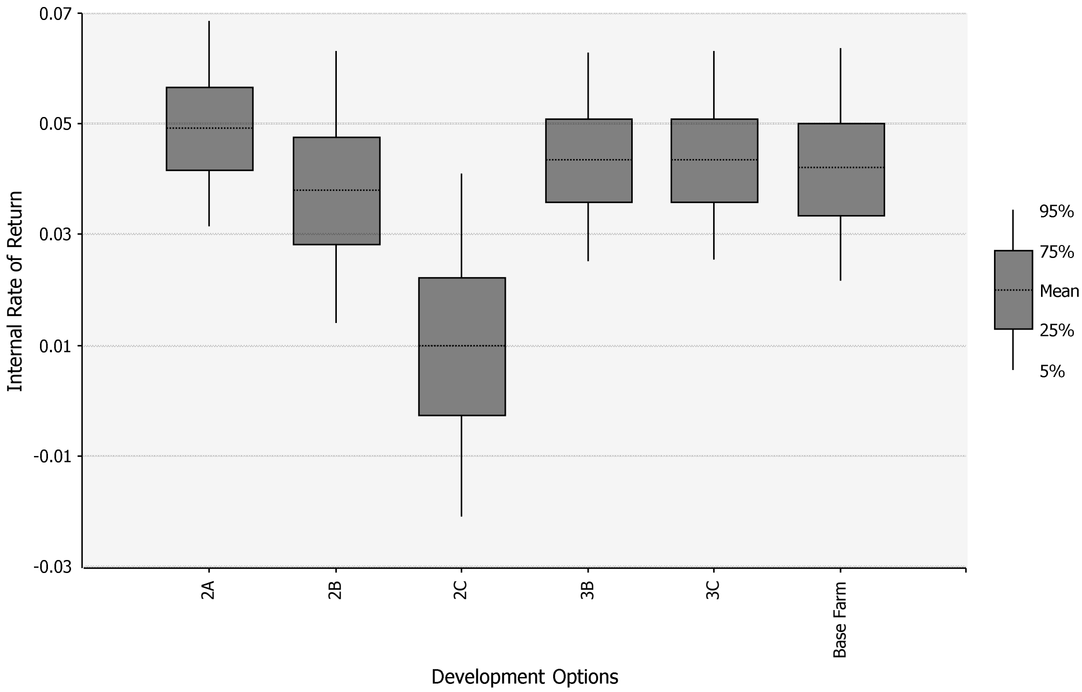

Figure 4. Mean and key percentiles for internal rate of return of the base farm and development options.

Conclusions

There are a wide range of options for managers of high rainfall Gippsland dairy farms to influence the future of their dairy business. Analysis suggests that the continuation of previous trends towards fewer larger and more intensive dairy farms may not create robust profitable farms going forwards. The options presented in this paper suggest that purchasing additional land, for grazing or fodder production, is a profitable option when it is used to reduce the reliance on purchased feed. When supplying milk to an export market, it is critical to manage exposure to supplementary feed markets by optimising home grown feed, and using purchased supplements efficiently.

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