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Future dairy farming systems in irrigation regions

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Abstract. The dairy industry in northern Victoria has been subject to rapid change in recent years, resulting in great diversity in the irrigated dairy farming systems in the region. Continuing analysis is needed of the various farming systems that may be viable in the future. This study examined possible development options for different farm systems to enable them to maintain financial viability. Four case studies, representative of different farm systems, were used. All four had options to combat the effects of declining terms of trade. However, the option most suitable for one case study may be unsuitable for another farm due to differences in resources, goals or skills. A key outcome of the study was the development of a robust approach to continually analyse farm physical and economic performance in a rapidly changing environment. Importantly, options can be analysed, enabling business managers to evaluate risks and reach informed decisions on investments.

Keywords: dairy farming systems, irrigated dairy

Introduction

The Murray dairying region currently produces around 27% of Australia's milk (Dairy Australia 2003). However, deregulation in July 2000, increasing water prices and a long dry period from 1996 to 2004, including 2002/03 when water allocation was only 57% of water right, have contributed to a decline in dairy farm numbers and uncertainty about the future for irrigated dairying.

Most of the milk produced in the region is manufactured into products for export and any growth in production will be for export. As Australia is a significant player, at 17% of world traded product, in a small world market, prices received by farmers vary considerably between years. For example, annual price per kg butterfat equivalent has varied from $5.20 to $7.80 in the last 10 years.

This presents significant challenges for dairy farmers in managing risks to business sustainability when development options are implemented.

Dairy farm systems in the region are diverse in terms of herd size, stocking rate, water and fertiliser use, forage production systems and supplementary feed usage. This diversity can be attributed to:

- variable resource inventories (land, water right and security, infrastructure, herd, labour)
- variable business management skills, business goals, farm family ages, and debt levels
- variable technical management skills and production goals
- varying enterprise mixes, including off-farm investments
- increasing diversity of milk payment systems.

In order to change and grow in the face of changes in the economic environment, farm businesses need to be profitable, meaning that productivity gains or increased milk solids per unit of input are necessary to overcome the impacts of the cost-price squeeze.

Bennink (2000) forecast that dairy farmers after deregulation would be large producers with economies of scale, who had low unit costs of production, derived in part from low average overhead costs per litre. However, economies of scale are often not significant in dairying and prices paid for milk by companies with an export focus may not be sufficient or reliable enough to manage the risks associated with undertaking development options. The diversity of systems on farms will remain with production systems for milk going into commodity products needing to be 'low cost' and flexible as these products are unlikely to command sustained high prices.

This investigation examined possible development options for four particular farm types/systems in terms of biophysical and economic performance.

Method and approach

A stakeholder steering group provided direction on the systems to be analysed and inputed into any assumptions used in the analysis.

The group comprised farmers, farm management consultants, a rural counsellor, an extension officer, a local water authority representative, funding body representatives, scientists and economists.

The group agreed on three key parameters to be used in distinguishing between different farming systems, namely:

- percentage energy input from pasture
- calving pattern, and
- labour required.

Herd size was considered to be a result of the management decisions made in relation to these three parameters.

The four systems used as the basis of case studies were defined as:

- System 1: Traditional 'family farm' with more than 50% of energy requirements from pasture, seasonal calving, a smaller herd (about 200 cows) and owner/operator labour.
- System 2: Modified 'family farm' with more than 50% of energy requirements from pasture, split or non-seasonal calving, small or medium herd size, owner/operator plus extra family or outside labour.
- System 3: High-input farm, less than 50% of energy from pasture, split or non-seasonal calving, larger herd, owner/operator plus extra family and outside labour.
- System 4: Feedlot, zero grazing, split or non-seasonal calving, larger herd, owner/operator plus extra family and outside labour.

A case study approach was used to describe the current farming system and milk production from four real farms. The performance of the current system for each farm was analysed over eight years, using a range of technical efficiencies applied to the feeding system of the current farm and a range of milk and feed price scenarios.

Technical efficiency of supplementary feeding in grazing systems is affected by interactions between feeds (pasture, forage and concentrates), cow factors (health and genetics), diminishing returns to extra supplement and the farmer's ability to manage the system. The sensitivity in technical efficiency of the feeding system has been reported in Doyle et al. (2004).

To examine potential development options for each farm type, abstracting from the real farm was used to develop the case studies. This was seen as intermediate between inventing the case study entirely and finding a real, but unique one-off example. By beginning with a real farm, the infrastructure was realistic, but by then using abstraction, there was the freedom to remove some of the people-specific characteristics of the real cases to make it more generally representative. The biophysical aspects of the potential future systems were modelled using spreadsheets and the results tested with the steering group. The performance of the future systems was again subjected to different price and cost scenarios.

The profitability and risks inherent in each system have been assessed by analysing and defining the current farm (before change) over a number of years as the starting point; and then the state of the business during and after change was investigated as step two. The farm management methods for economic and risk assessments are taken from Makeham and Malcolm (1993).

The development budgets included a real decline in profitability from a cost-price squeeze of around 1.6% per annum to account for continued deterioration in the farmers' terms of trade (ratio of prices received to prices paid). It was also assumed the farm had no initial debt before changing the business.

The key indicators used in comparing the performance and profitability of the different options were: Net Present Value (NPV) at a discount rate of 5% per annum, Operating Profit, Internal Rate of Return (IRR), Return on Marginal Capital, Peak Debt, and Years to Positive Net Cash Flow (NCF).

Risk in farm business was dealt with as business risk and financial risk. Business risk

refers to the volatility of production and market parameters. Financial risk refers to the risk to the liquidity and viability of the business, depending on the level of debt and equity (gearing). The effects of business risk, mainly the volatility of milk prices and seasonal conditions, were included in the budgets by sensitivity analyses. The sensitivity analysis involved changing the expected level of an important variable to show the effect of the key criteria on operating profit, return on capital and net cash flows. Important variables used were milk prices (10 and 20% decreases) and feed prices, applied to all feeds (10% increase). The effects of financial risk were accommodated by focusing explicitly on the expected net cash flow before and after debt servicing obligations.

System 1: Traditional family farm

Current farm system and potential future options

Located near Tongala, in the Goulburn Valley of northern Victoria, the System 1 case study farm has been operated by the current owners for around 18 years. The business was a family run enterprise with most of the labour coming from the husband and wife unit. The farm area comprised 55 effective hectares of perennial pasture, with a stocking rate of 4.4 cows/effective ha. Milk production has increased over the years, with the herd producing 5200 L/cow or 234 kg butterfat/cow in 2000/01. Pasture supplied around 56% of energy consumed, with grain contributing 27% (1.34 t DM/cow) and hay 17% (0.87 t DM/cow). Pasture consumption for this farm was calculated to be around 12.5 t DM/ha.

In consultation with the farmer, farm management consultants, research scientists and the steering committee, a number of technically feasible potential future options were developed for this farm system. The potential future options analysed for this farm system were:

- *Status quo* – No change to current system
- *Option 1: Better use of current resources* – Through pasture improvement, an additional 25 cows would be added to the milking herd, increasing the stocking rate to 4.9 cows/ha. No additional capital investment was required.
- *Option 2: Intensification* – Stocking rate was increased to 6 cows/ha, an additional 87 cows in the milking herd. It was assumed that all the new cows consumed 5.5 t DM/cow, which was supplied entirely from bought-in feeds (59% of energy from off farm).
- *Option 3: Expand* – Purchasing the neighbouring property of 18 ha increased effective production area to 73 ha. Maintaining current stocking rate of 4.4 cows/ha, 80 cows were added to the herd.
- *Option 4: Expand and intensify* – Effective production area was 73 ha. Stocking rate and feeding assumptions for this option were consistent with those for option 2. Increasing stocking rate to 6 cows/ha lifted peak milking herd by 115 to 438 cows.

Results

With good management in place and a reasonably strong medium term price of $7.00/kg butterfat, a steady state annual operating profit of around $43,000 and internal rate of return of 3.5% was expected to occur in the *status quo* situation, over the 8 year planning period (Table 1, see Appendix).

At 'most likely' levels of performance, Option 3 had the highest annual steady state operating profit and internal rate of return and a good return on the marginal capital invested to make the change. Intensification of the system by increasing stocking rate (option 2) was not an attractive option for this farm. The reason for this poor performance could possibly be attributed to the significant increase in purchased supplementary feed, necessary to support the extra 87 cows. By intensifying, feed costs per cow for the whole herd rose from $769/cow, for the *status quo* system, to $926/cow. This resulted in a decrease in gross margin per cow from $883/cow to $725/cow.

If per cow production was to increase in this scenario, improved rates of return or operating profit may be achievable (see Doyle et al. 2004). The transfer of bought-in energy from maintaining extra cows to increased milk output would improve economic performance.

The results of the analyses confirm the following basic principles for efficiency of the traditional family farm type system, namely:

- Concentrated spring calving
- A stocking rate that achieves high pasture utilisation
- A regular rotation with appropriate use of supplements
- Good water and fertiliser management.

This type of system, however, is highly exposed to fluctuations in milk price and input costs, and face significant challenges to make continuing productivity gains necessary

to counteract adverse terms of trade of -1.0% p.a. or greater.

Sensitivity analysis

All development options were very sensitive to changes in milk prices and/or feed costs with effects on internal rate of return shown in Figure 1 (see Appendix). Option 3 appeared to be the least risky, but even this was highly sensitive to changes in the milk price. The fluctuations in milk and feed prices used do not represent the extremes that might be experienced for this type of system. For example, price for milk used in manufacturing in this region can vary by 25% from year to year. Similarly, grain prices can vary from $120 per tonne to $300 per tonne between years.

System 2: Modified family farm

Current farm system and potential future options

The system 2 case study farm was located approximately 10 km south of Tatura at Toolamba and was owned and operated by a family who had been on the property for several generations. A full time employee (45 hrs/week) was employed as well as a casual relief milker (5 hrs/week) to assist the owners (50 hrs/week) in all tasks around the farm.

The property comprised 170 ha, of which approximately 138 ha was grazed by the milking herd, with the remaining 32 ha not suitable for irrigation and used for dry stock. An adjoining long-term lease of 32 ha and a neighbouring block of 24 ha was used for raising young stock. The 138 ha effective milking area consisted of 103 ha of irrigated perennial pasture, 18 ha are irrigated annual pasture and 16 ha of rainfed pasture. This was equal to 117 perennial pasture equivalent hectares.

The current dairy was adequate for the 230 cow Friesian herd, but it would be unsuitable once the herd reached 250 cows. Over the past decade, milk production has progressively increased, with an average of 249 kg butterfat/cow achieved in the 2000/01 season. Cows were split into two herds; a spring calving herd and an autumn calving herd.

Stocking rate in 2000/01 was relatively low at 2.0 cows/perennial pasture equivalent hectare. The carrying potential was considered by the owners to be 400-450 cows without significant increase in bought-in feed, given the ability to lay out more area to irrigated perennial pasture.

Pasture comprised 66% of the cow's diet, grain 19% (1.3 t DM/cow), hay 10% (0.67 t DM/cow) and silage 4% (0.25 t DM/cow).

Future development options examined for this farm were:

- *Status quo* – No change to the system
- *Option 1*: Further develop the home property – laser grade the 16 ha of rainfed pasture, increase pasture consumption and build a new dairy and loafing area. Increase stocking rate to 3.5 cows/ha.
- *Option 2*: Following development 1, purchase the neighbouring property (32.4 ha) and increase stocking rate by 200 cows to 4 cows/ha.
- *Option 3*: Intensify the system, after development 2. Purchase bought in feed to fully feed a further 150 cows to bring the final stocking rate to 4.9 cows/ha.

Results

Using a medium-term milk price of $7.00/kg butterfat, each option appeared to be more profitable than the previous, resulting in option 3 having the greatest return on investment (Table 2, see Appendix). All future development paths proved more profitable than the 'no change' scenario. However, the large increases in debt highlight the increased vulnerability to risk especially during the early stages of these development options.

Using the analysis, the mix of intensifying production by pasture development and improvement to grazing management and extensifying by acquiring addition land, would enable this business to combat the negative impacts of the declining terms of trade, to increase productivity and profitability and earn a competitive return to capital over the eight year planning period. However, the risks of development options become greater at a milk price lower than $7.00/kg butterfat equivalent and the long term average milk price is closer to $6.50/kg butterfat. In addition, as development options are implemented, production efficiencies will invariably decline until newly developed land is brought up to the production level of existing pasture and as the farmer develops the skills to manage more complex systems.

Sensitivity analysis

The risk involved in a investment in dairying not only includes the usual factors of season and markets, but also the level of response the investment will generate. The effect on IRR of various milk price and feed cost fluctuations for the *status quo* and development options are presented in Figure 2.

System 3: High input farm

Current farm system and potential future options

The System 3 case study farm was located near Kyabram. As a result of close proximity to an urban centre, the property was landlocked by industrial and commercial precincts, eliminating the possibility of acquiring adjacent land for business expansion. The family has owned and operated the property for the past 22 years. The home property had 100 ha made up of 10 ha of irrigated annual pasture and 90 ha irrigated perennial pasture. An additional 87 ha was owned 8 km north of the home property and used to grow feed for the milking herd. The peak herd size in 2000/01 was 550 cows, split into autumn and winter/spring calving. Approximately 45% of the total energy required was derived from grazed pasture. The remaining energy was made up of a total mixed ration, which included grain, a range of byproducts and conserved forage, fed on a feedpad. Prior to the 2000/01 season, production per cow was approximately 7500 L/cow. In 2000/01, production per cow was reduced to 6500 L/cow as a result of a large area of pasture taken out of production for laser levelling and feedpad construction. The data and costs associated with the 6500 L/cow production figure have been used in the analysis.

The potential future developments analysed for this farm system were:

- *Status quo* – No change to the system
- *Option 1*: Grain supplements were increased from 1.1 t DM/cow to 2.5 t DM/cow. The feedpad was expanded to cater for 1000 cows. Production was increased to 7000 L/cow or 300 kg butterfat/cow and 250 additional cows increased the stocking rate to 8.3 cows/perennial pasture equivalent ha.
- *Option 2*: Option 1, plus an increase in grain supplements to 3.0 t DM/cow. The feedpad was upgraded to a 1000 cow free-stall barn. Production was lifted to 7500 L/cow or 320 kg butterfat/cow and 200 additional cows increased stocking rate to 10.4 cows/ perennial pasture equivalent ha.
- *Option 2b*: Option 2, plus an annual price increase of $0.50/kg butterfat, to $8.00/kg BF for out of season milk.

Results

Each development appeared to be more profitable than the previous, resulting in development 2b having the greatest return on investment (Table 3, see Appendix), with internal rate of return at 14.2% and an operating profit of $664,022. All future development paths proved more profitable than the 'no change' scenario. However, they also change the risk profile of the business.

The success of this system is very sensitive to milk price received and feed costs. This system was better suited to supplying a fresh milk processor than relying on a volatile export market. The feeding system and calving pattern enable year-round supply of quality milk, which attracts a milk price premium to compensate for higher feed costs at some stages through the year. The price used for milk in this analysis was $0.50/kg butterfat higher than for System 1 and 2, at $7.50/ kg BF. At the time of this analysis these premiums existed, but the differences in price have now decreased.

Sensitivity analysis

Relatively small percentage decreases in milk price received reduce profits markedly for all options – and vice-versa (Figure 3 see Appendix).

These results highlight the need to carefully evaluate the total economic impact of changing a farming system. By overcoming factors which limit production, and eliminating inputs which cost more than they contribute, profitability and efficiency can be increased.

System 4: Feedlot farm

Current farm system and potential future options

Established in 1998 on a greenfield site, the system 4 case study farm was located in New South Wales. The main farm area comprised 810 ha, 465 ha of which was irrigated; 324 ha by flood and 140 ha by four centre pivots. For this analysis, the farm business was been divided into three enterprises, namely farm feed production, stock rearing and milk production (the dairy). The outputs from the feed production and stock rearing enterprises were treated as purchased inputs by the milk production business.

The peak miking herd consisted of 2048 cows, of which around 25% were first lactation cows. Seventy percent were Holstein-Friesian, while the remaining 30% were Jersey X Holstein-Friesian. The milking herd was divided into 8 groups of 256 cows – 2 high milk producing groups (~40 L/cow), 4 middle groups (~25 L) and 2 heifer groups.

Average herd production was 28-30 L/cow/day for a total of 60,000 L/day. Average fat test was around 4.3%, while average protein was 3.4%. The milking herd was milked three times per day in a 32-a-side ‘herringbone’ rapid exit dairy system.

All lactating cows were fed a total mixed ration with two rations being available depending on whether the cow was high

producing or medium producing. Both rations contained ~18% crude protein, with the high producing diet providing 11.9 MJ/kg and 27.5 kg DM, and the low, 11.3 MJ/kg and 23.5 kg DM. Lucerne greenchop and maize from the feed production enterprise provided most of the forage requirements.

Twenty-five people are employed in the farm business, as well as significant input from consultants and nutritionists.

Within the dairy business the opportunity existed to improve the genetics of the herd so that more cows entered the high producing category. Potential also existed to increase the average production of the high-producing cows from 40 to 45 L/day.

The farm was only licensed to milk around 2000 cows, so in terms of cow numbers, the farm was virtually at its limit. Management of cow nutrition and health was also excellent restricting the potential for improvements in these areas.

The potential future development options analysed for this farm were:

- *Status quo*: No change to the system
- *Option 1*: Increase the percentage of high production cows (40 L/day) to 50% of the herd. Given the herd has only been established over 6 years, it has been assumed these gains can be made without incurring additional costs for replacement cows. There would, however be increased feed costs.
- *Option 2*: Increase in the percentage of high production cows to 75% of the herd.

Results

With good management in place and using a relatively high milk price of $8.00/kg butterfat, a steady state annual operating profit of between $31,395 and $1,125,606, and internal rate of return of between 0.37 and 10.41% was achieved across the options (Table 4, see Appendix).

The results of the analyses confirm the following basic principles for efficiency of the feedlot type system, namely:

- Uniform production year round with a premium price for fresh milk is required
- High quality feeds must be used
- Feeding high genetic merit cows to approach their potential production is important
- A skilful and stable labour force is required.

Sensitivity analysis

The system was extremely sensitive to price fluctuations and to per cow production (Figure 4, see Appendix). The internal rate of return for the *status quo* and option 1, when milk price was decreased and feed price was increased and that for the *status quo* when milk price was decreased by 20%, were negative off the scale of Figure 4 (see Appendix). It should be noted that the analyses of the effects of variations in prices and costs did not use the most extreme levels that could be experienced for this type of system. A key aspect of this business was that feeds, particularly concentrates, were sourced up to 18 months in advance to buffer against short-term volatility in prices.

Conclusions

In this study, potential development options and performance of four case study dairy farm businesses were investigated. The biophysical detail of real case studies formed the basis of the analysis, with some of the actual human and financial resources 'abstracted out'.

The dairy farm businesses investigated had several feasible options for change, all of which were very sensitive to change in prices and costs. In all analyses, it was assumed the businesses continued to be managed at a high standard. In any development option, there will initially be decline in technical productivity as new land is developed or as farmers develop the management and technical skills to deal with increasing system complexity. This adds to risks in businesses that are subject to marked and rapid fluctuations in price.

The main finding from the analysis of the pasture-based dairy businesses (traditional family farm and modified family farm) analysed was that there are several feasible productivity-increasing options available that, done well, will enable such businesses to combat the effects of the cost-price squeeze and maintain or increase profitability. However, systems that are exposed to highly variable export market prices, climatic conditions and price or availability of a significant input, are not compatible with high levels of financial gearing. Therefore developing systems 1 and 2 to something like system 3 and 4 would be extremely risky.

The main conclusion from the high input system and feedlot is that the relationship between milk prices and feed costs is critical. A small change in this relationship has large effects, negative or positive, on the important economic, financial and net worth measures of performance. Thus, these systems are not well suited to selling milk on volatile export markets, nor to producing milk that is made from feed supplies that are highly variable in quantity or cost. The key to success of these high input systems is having some 'control'

over the effects of market and environmental volatility. This is achieved through selling milk on domestic liquid markets where demand is stable, and short to medium term prices can be 'locked in'. This opportunity, however, will not be available to many farms as the domestic market is small and could be satisfied by a relatively small number of farms like the system 4 case study.

If short- to medium-term milk prices locked in, feed costs can be forward-priced. In these ways, the financial exposure of high input businesses can be managed sufficiently to withstand the down-side risks, and achieve attractive returns from producing large quantities of output, at low margins per unit of output.

This investigation has provided the irrigated dairy industry with a robust approach to continually analyse the performance of different farm types in a rapidly changing operating environment. It has shown clearly that options for different farms need to be analysed with a range of likely price and cost scenarios if business managers are to evaluate risks and to reach informed decisions on investments.

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Appendix

Table 1. Financial indicators for System 1 for the *status quo* and for four potential future options

	Annual steady state operating profit ($)	Internal rate of return (%)	Return on marginal capital (%)	Peak debt	Years to positive Net Cash Flow
Status quo	$43,000	3.5	-	-	-
Option 1	$46,000	3.9	15.7	-	2
Option 2	$14,000	1.1	-17.2	$141,000	6
Option 3	$71,000	4.9	6.2	$402,000	5
Option 4	$25,000	3.2	-15.2	$402,000	-

Table 2. Financial indicators for system 2 for the *status quo* and for three potential future developments

	Annual steady state operating profit ($)	Internal rate of return (%)	Return on marginal capital (%)	Peak debt	Years to positive Net Cash Flow
Status quo	$63,000	2.3%	-	-	-
Option 1	$234,000	7.6%	24.1%	$347, 000	Year 5
Option 2	$339,000	8.6%	17.8%	$594,000	Year 6
Option 3	$386,000	9.1%	34.7%	$593,000	Year 7

Table 3: Financial indicators for system 3 for the *status quo* and for three potential future developments

	Annual steady state operating profit ($)	Internal rate of return (%)	Return on marginal capital (%)	Peak debt	Years to positive Net Cash Flow
Status quo	$180,090	5.01%	-	-	-
Option 1	$295,282	8.21%	20.6%	$132, 000	Year 3
Option 2	$484,022	9.61%	26.6%	$143,000	Year 3
Option 2b	$644,022	14.15%	22.5%	$33,000	Year 2

Table 4: Financial indicators for system 4 for the *status quo* and for two potential future developments

	Annual steady state operating profit ($)	Internal rate of return (%)	Return on marginal capital (%)	Peak debt	Years to positive Net Cash Flow
Status quo	$31,000	0.4%	-	-	-
Option 1	$586,000	4.8%	55.5%	-	-
Option 2	$1,126,000	10.4%	109.4%	-	-

Figure 1. System 1 and potential options – Sensitivity analysis to changes in milk and feed prices.

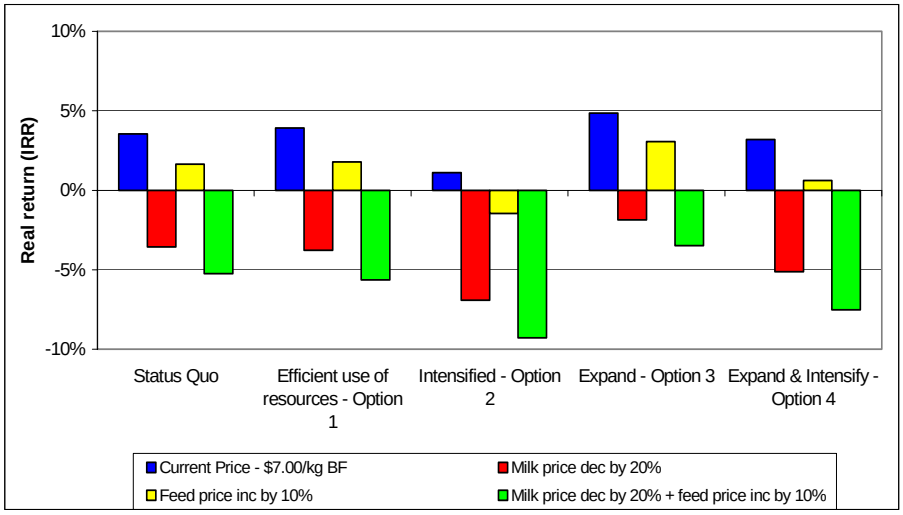

Figure 2: Sensitivity analysis to changes in milk and feed prices – System 2 and potential options

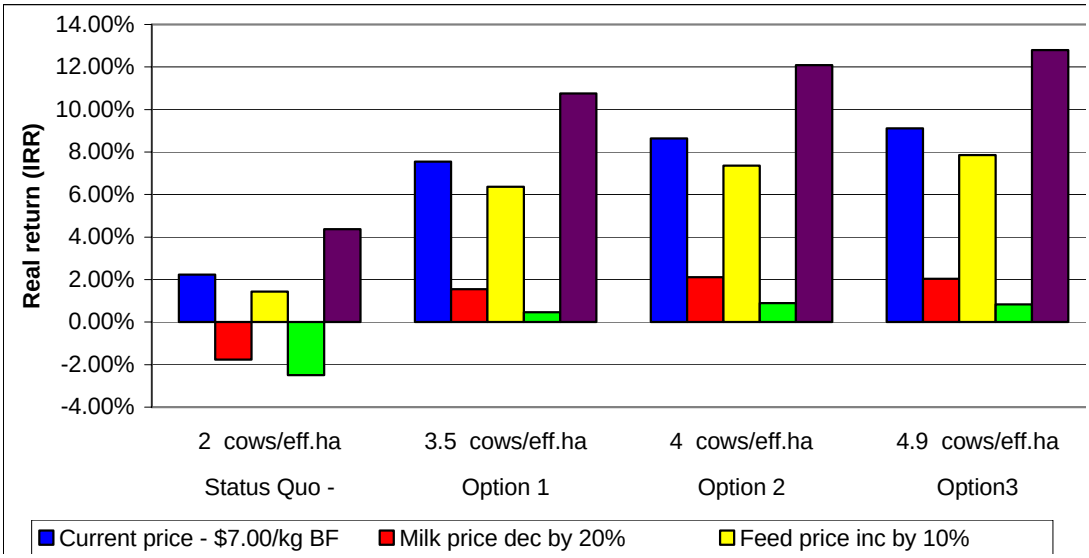

Figure 3: Sensitivity analysis to changes in milk and feed prices – System 3 and potential options.

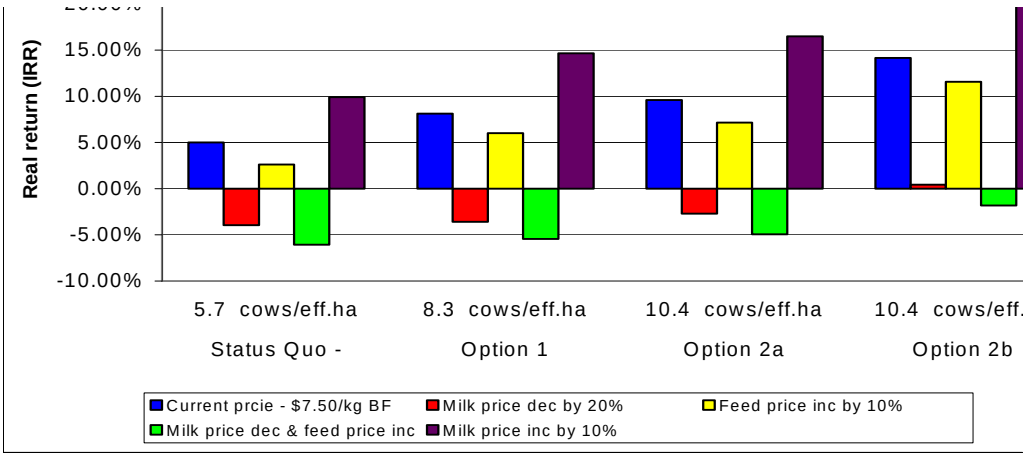

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Figure 4: Sensitivity analysis to changes in milk and feed prices – System 4 and potential options