Implications of changing a Friesian dairy system to a Friesian-Jersey crossbred dairy system

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Abstract. In this study, budgets of herd dynamics, feed and energy supply, production and profit of alternative dairy farm systems were used to examine the effects of changing a 230 cow Holstein-Friesian (HF) dairy system to a Holstein-Friesian Jersey (HFJ) crossbred dairy system. In the comparison of the two dairy systems, the energy supplied to the 230 cow HF system was kept the same in the HFJ system. As HFJ cows weighed 90% of HF cows, the equivalent herd size for the HFJ system was 242 cows. If both herds produced milk, fat and protein at the national herd average for their breed, the 242 cow HFJ herd produced $12,000 higher operating profit before tax per annum than the equivalent 230 cow HF herd. The gain in operating profit came from increased fat and protein produced from the farm energy supply as a result of less energy used in maintenance energy costs of the HFJ herd, and a reduced volume penalty. There was also some gain from the HFJ cows having superior reproduction performance that enabled a different herd age structure and thus lower herd depreciation and costs of feeding replacement heifers. If a feed conversion efficiency advantage of 3% existed for the HFJ cows over the HF cows, the gain in operating profit over the HF herd was estimated to be $18,000 before tax per annum.

The results from this investigation suggest that for some dairy farm systems currently operating as HF systems there is likely to be some advantage in changing to HFJ crossbred dairy systems. As well as potential gains in annual operating profit, the scope for further pecuniary and non-pecuniary gains from changes to the farm system that could be brought about by improved reproduction performance of HFJ cows is also likely to be significant for some dairy farmers

There seems to also be a reasonable probability that superior feed conversion efficiency of HFJ cows over HF cows would be a sound source of productivity gains that could help maintain or add to profits in some dairy systems across Australia in the face of rising real costs of production and static or falling real milk prices.

Keywords: Jersey Friesian cross, benefit cost analysis, farm economics, farm business management

Introduction

The current dairy herd in Australia comprises a mix of 83 per cent Holstein-Friesian (HF), 12 per cent Jersey and 5 per cent Holstein/Friesian X Jersey (HFJ) crossbreds. This study investigates whether there are economic benefits to be had in some dairy herds by changing from dairy herds currently made up of Holstein/Friesian cows to Holstein/Friesian X Jersey crossbred cows.

Changing a HF dairy herd to a HFJ crossbred herd would have implications for the way a farm system performs in the following main areas:

(i) Conversion of farm energy supply to particular quantity and quality of saleable product (e.g. live-weight carried per hectare, feed utilization);

(ii) Choice of farm system (e.g. seasonal calving, split/batch calving);

(iii) Herd reproduction performance (e.g. in calf rates over a range of length of mating periods, calving interval);

(iv) Animal health (e.g. dystocia, post calving diseases, metabolic diseases); and

(v) Herd age structure and dynamics (e.g. not in calf cull rates; cull rates other than not in calf)

Flowing from changes to the performance of a farm system that might result from the above changes in herd performance are potential changes in profit, with labour, management and non-economic implications. Some implications for dairying systems and the people who run them may not be readily quantifiable into dollar terms but can nevertheless be significant factors.

Important possible changes that may have significant economic impacts for any given system will have to do with energy production and utilization, milk production and composition, herd reproduction performance, changes in herd structure and dynamics and animal health. A change away from a purebred Holstein/Friesian based herd to an Holstein/Friesian X Jersey crossbred herd may require some substantial change in the whole farm system. An example might be a change from split calving that is practised because of reproduction difficulties with a HF herd to a seasonal calving system with a HFJ crossbred herd, made possible by say, improved reproduction performance of the crossbred herd. This is but one possible example amongst many.

To conduct such a comparison it is necessary to evaluate impacts of change from milking HF herds to HFJ herds at the levels of some typical dairy farm operations.

Investigating and comparing the two systems

In order to investigate the profitability of a dairy system running Holstein/Friesian cows and compare it with the same system running Holstein/Friesian-Jersey cross cows. The following methods were used:

First, the operation of an actual dairy farm milking 230 split calving Holstein-Friesian cows was modelled. The Kyabram future farming systems model and a real case study farm was used (Armstrong et al. 2002). This model has a detailed energy budget of animal requirements.

The key parameters of the dairying system on an annual basis were:

- Herd size
- Milk production, fat and protein
- Live weight per cow. HFxJ 90% of HF
- Total energy quantity supplied to herd and per cow
- Energy used for non-milk and fat production (maintenance, pregnancy, exercise, change in body weight, replacements)
- Energy supplied for milk and fat per cow and per herd
- Shed costs/hd, feed costs/hd, herd costs/hd, overhead costs
- Reproduction performance, herd cull rates
- Fat and protein prices and volume charge were included
- Livestock trading profit
- Farm operating profit.

The 230 cows in the case study HF herd produced an average of 6,546 litres/hd and 257 kg fat/hd (3.9%). Protein was 3.2%, 210 kg/hd. Total milk production was 1,505,350 litres, 59,100 kg fat and 48,292 kg protein. The protein: fat ratio was 0.82. Price received was $2.34/kg fat, $5.84 kg protein and -0.028 volume adjustment. This came to $6.41/kg butterfat equivalent. Price per kg MS was $3.52. Price per litre was $0.25. Operating profit was $36,000.

The herd structure was:1yo 55; 2yo 50; 3yo 50; 4yo 50; 5yo 60; 6yo+ 20. Total milkers 230. The cull rate of the HF herd was 24% pa. This is derived from a conception rate of 85% over a 9 week mating period (62% in calf after 6 weeks). This gives a not-in-calf cull rate of 15%, plus another 10% culled for other reasons.

The next step was to run this dairy farm model in the same manner, with the same feed supply (same total energy supply), but with HFJ cows producing at the Victorian crossbred herd average of 5,844 litres of milk, 253 kg fat (4.3%), 201 kg protein (3.4%) (Pyman 2003). For this case, because heifer rearing feed costs are part of the farm total costs it was assumed that the HFJ herd numbers were maintained by annually retaining, agisting and growing out HFJ x J or HFJ x HF back-cross heifers that perform similarly to the HFJ cows. However, in the future when a market develops, it would be practical to maintain the cow numbers in the system by purchasing crossbred replacement heifers for a similar cost to the farm system as rearing replacements.

Prices used in the analysis were fat $2.34, protein $5.84 and volume charge $-2.8 c/litre, giving $6.33/kg butterfat equivalent for the HFJ herd. Price of milk solids was $3.53/kg and milk was $0.27/l.

The HFJ cows were assumed to weigh 90% of the bodyweight of the HF cows (Auldist and Grainger, 2004). The farm energy supply not required for maintenance of the HFJ cows compared to the heavier HF cows was available to carry more cows producing at the national HFJ herd average fat and protein production. According to the model of the case study farm, using the substitution rate of 90% of HF live weight, a total of 242 HFJ cows could be run, each producing 5,844 litres of 4.43% fat and 3.43% protein. The protein: fat ratio was 0.78. The energy spared from maintenance energy costs of the lighter HFJ cows would lead to an improvement in feed conversion efficiency (FCE) of 2.36% (Table 2) because the energy can then be used to run extra HFJ cows. The 242 HFJ cows have a higher total farm milk solids production than the 230 HF cows.

As the increase in cow numbers milked for the HFJ farm system was marginal in this case, it was assumed the farm had the existing infrastructure and labour to handle the extra cows. However, with larger herds and therefore larger increases in cows being milked after conversion to HFJ cows, extra labour and capital investment may be required.

The different milk production by cows of different ages in the HFJ herd, and different reproduction performance as cows age, is accounted for by using the average litres/head and average reproduction performance of herds surveyed by Pyman (2003). These herds comprise cows of a range of ages, thus the age-production affects are incorporated in the average.

At an annual replacement rate of 20 per cent, the steady state herd structure was: 1yo 45; 2yo 42; 3yo 46; 4yo 45; 5yo 45; 6yo+ 63. Total milkers 242.

Improved reproduction and longevity performance of the HFJ cows was accounted for by changing the age composition of the HFJ herd (more older cows) and reducing the overall cull rate from 24% for the HF herd to 20% for the HFJ herd. The crossbred herd cull rate derives from 90% in calf after 9 weeks mating (68% in calf after six weeks). This gives an 11% not-in-calf cull rate plus another 11% culled for other reasons. The economic effect of different herd cull rates is to change the herd structure, with different numbers of sale animals (culls and calves), and less one year old heifers and calves required.

- The results for the 242 HFJ Herd with the same farm energy supply were:
- 5,844 litres of milk per head, total milk production 1,414,248 litres.
- 4.43% fat, 249kg fat/hd, total fat 61,226 kg.
- 3.4% protein, 201 kg protein/hd total protein 48,642 kg.
- The protein: fat price in the analysis was $5.84:$2.34; a ratio of 2.5:1.
- Operating Profit was $48,000.
- Gain over Holstein/Friesian herd was $12,000 (before extra income tax).

The operating profits and differences between the two systems for a range of live weights of HFJ cows are shown in figure 1, while the milk solids production of the two systems are shown in Figure 2.

At a protein: fat price ratio of 5:1 ($7.20/kg protein, $1.45/kg fat, $6.63/kg butterfat equivalent for HF, $6.52/kg butterfat equivalent for HFJ), the HFJ herd profit was $62,000 and the HF herd profit was $49,000. At a protein: fat ratio of 5.27:1 ($7.65 /kg protein, $1,45/kg fat, $7/kg butterfat equivalent for HF, $6.88/kg butterfat equivalent for HFJ), the HF herd profit was $71,000 and the HFJ herd profit was $84,000. The net profit advantage of the HFJ herd over the HF herd, at a higher price of protein to price of fat ratio, increased only marginally.

Figure 1. Farm Operating Profit and Gains

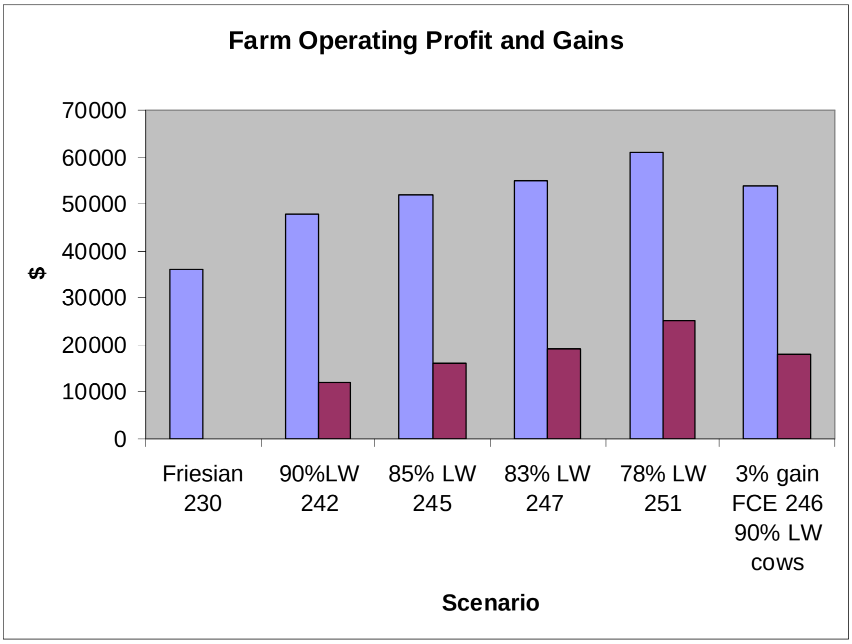
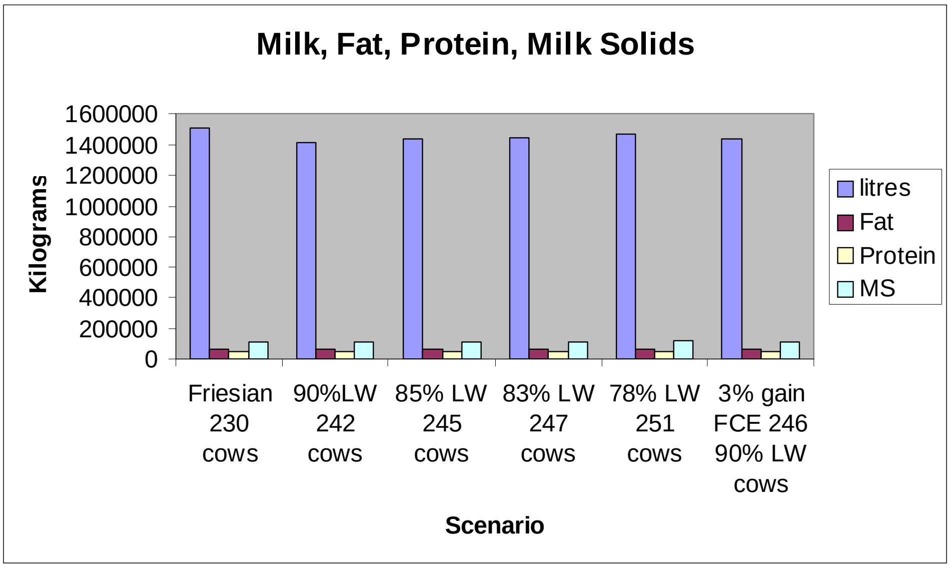


Figure 2. Total milk, fat, protein, milk solids produced



Another consideration is that the total capital tied up in the HFJ herd is less than the HF herd because there are less replacement heifers retained. Average livestock capital tied up in the HF herd with 24% replacements is $240,000. For the crossbred herd with 20% replacements this is $200,000. As mature animals are valued approximately in line with their live weight and age, the difference in total herd capital between the HF and HFJ herds for the 90% HFJ live weight substitution rate has mostly to do with the capital tied up in 1year old and 2 year old replacements. The opportunity cost of 8% on a capital difference of $30,000 would come to $2,400. However, it is arguable that if HFJ cows had some benefits in productivity and profitability in some systems over alternative cows, the capital value of HFJ cows will be bid up to reflect this, and apparent differences in capital tied up in such herds would not exist.

The analysis here is for an established HFJ whole herd with steady-state structure, and the transition process has not been considered. Having established that for some systems, the idea of converting from a straight-bred HF herd to a crossbred HFJ herd might be worth closer investigation, then the details of the alternative paths of transition need to be analysed closely. With such changes, the more rapidly the transition is achieved and the sooner the benefits received the more profitable the change will be.

Figure 3 shows the breakdown of the factors that contributed to the overall gain of $12,000 estimated to apply in this case comparison. The largest components of the gain from the HFJ herd compared with the HF herd are the extra income from extra fat and protein, around $4,500 and $2,500 respectively. Saving on the volume penalty is also significant, around $2500. There is a saving of $8,000 in feed costs associated with carrying and rearing less replacement heifers. This happens because of the different herd structure there being more cows that are older and less annual culls of cows that are not in calf. However, much of this feed saving is offset by $6,000 less trading profit from less sales of cull cows and less reared calves to one year old heifers to springing heifers, with more sales of young calves.

The conclusion is that for the case analysed, a change from the HF herd to a HFJ herd with 90% of the bodyweight of the HF cows and consequent lower total energy requirement for non-milk production (total of maintenance, pregnancy, body weight change, exercise energy requirement, replacement energy requirements) that produces more fat/litre and protein/litre and has a lower replacement rate of not-in-calf cows, may result in an increase in annual operating profit (before extra tax) of the order of $12,000 (before extra tax).

In Table 1 is shown the results for the 230 cow HF herd and for HFJ herds for a range of live weight substitution rates. Figure 4 shows total farm live weight for each of these scenarios. If the HFJ cows are smaller animals than the assumed 90% of HF cows live weight used in the above analysis, the gain in operating profit increases. For HFJ cows at 85% of HF cows live weight, 245 HFJ cows are milked and operating profit is $51,000, a gain of $15,000 before tax. If HFJ cows are 83% of HF cow live weight, 247 HFJ cows are milked and produce an operating profit of $55,000, a gain of $19,000 before extra tax. At 78% LW, 251 HFJ cows are milked and operating profit is $61,000 and the gain is $25,000.

Figure 3. Components of total $12,000 HFJ gain over HF herd

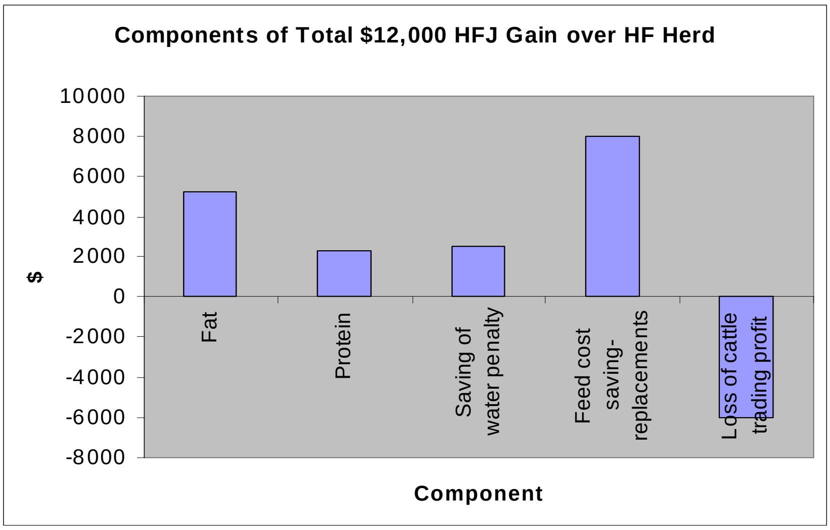


Figure 5 shows the different major uses of energy in the two systems, HF and HFJ. Slightly less energy is required for maintenance of the HFJ herd than for the HF herd, and therefore slightly more energy goes into producing less litres of milk but with a higher fat and protein content and an overall higher total yield of milk solids.

Table 1. HF-HFJ Comparison: Production and Profit

	Operating Profit	Gain Before Tax	Milk Litres	Fat kgs	Protein kgs	MS kgs	Energy/yr MJ	Live Weight kgs
Friesian 230	36,000	-	1,505,350	59,100	48,292	108,415	1,4508,098	126,500
90%LW 242	48,000	12,000	1,414,248	61,226	48,642	109,868	1,4508,098	119,790
85% LW 245	51,000	15,000	1,431,780	61,985	49,245	111,230	1,4508,098	114,538
83% LW 247	55,000	19,000	1,443,468	62,491	49,647	112,138	1,4508,098	112,756
78% LW 251	60,000	24,000	1,466,844	63,503	50,451	113,954	1,4508,098	107,679
3% FCE gain 246 90% LW cows	54,000	18,000	1,437,624	62,238	49,446	111,684	1,4508,098	121,270

Comparing some technical efficiency ratios and profit.

From a meta-analysis of research about feed conversion efficiency of dairy cows, Grainger and Goddard (2004) have started to make the case that it is possible that efficiency of feed conversion, measured as kg.MS/kg.DM, could differ between HF and HFJ cows. They report results from published research comparisons of kg.DM/kg.LW and kg.MS/kg.DM and kg.MS/kg.LW for HF and Jersey cows.

They concluded that Jersey cows ate more DM per kg LW than did Friesian and Holstein cows (7.6% more for NZ and 14.4% for the USA). Higher intake per kg of LW can lead to higher MS per kg. of LW.

Grainger and Goddard (2004) reported that Jerseys had an average 23% higher ratio of kgMS/kgLW than did HF cows. When FCE was expressed as kg.MS/kgDM, Jersey cows averaged a kg.MS/kg.DM ratio that was 6.2% higher than Friesians and Holstein. The 23% advantage in MS/LW for the Jerseys reported in the literature would equate to an 11.5% advantage in MS/LW over the HF for the HFJ crossbreed cows.

Figure 4. Total farm live weight of cows

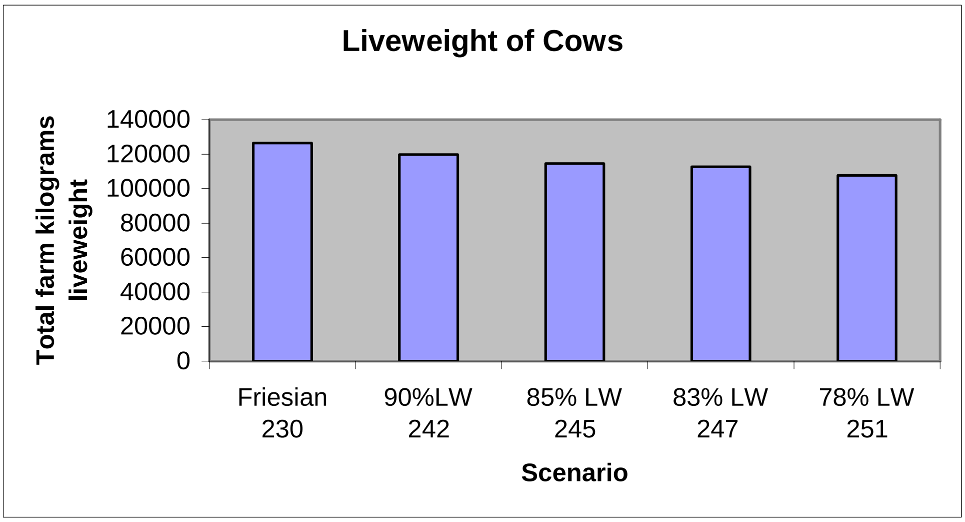


Figure 5. Comparison of major uses of energy, HF and HFJ systems

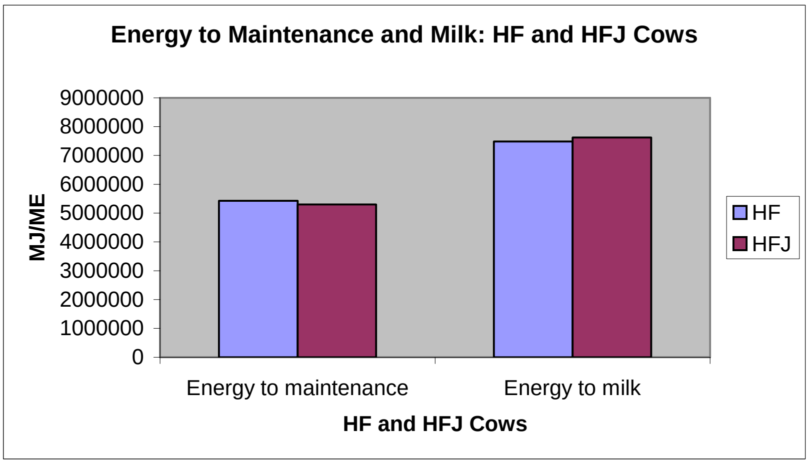


Table 2 shows the above-mentioned technical efficiency ratios for these feed conversion ratios of the case study HF and HFJ herds.

Table 2. HF and HFJ Comparison - Feed Conversion Indicators

FCE Ratios	Gms MS/kg DM whole year	% Difference HF base	Whole year kgDM/kgLW	% Difference HF base
Friesian 230 cows	79.3		10.7	
90% LW 242 cows	81.1	2.3%	11.3	5.6
85% LW 245 cows	82.2	3.6%	11.8	10.4
83% LW 247 cows	82.8	4.4%	12.0	12.1
78% LW 251 cows	84.2	6.1%	12.6	17.5
3% gain FCE 246 90% LW cows	82.9	4.5%	11.1	3.4

The interpretation of these ratios is as follows. In the HFJ 90%LW 242 cow scenario, an overall advantage of FCE was calculated to be 2.31% higher than the 230 HF cow system. In this scenario, it was assumed that the HF and HFJ cows had the same requirements of energy for maintenance per unit of live weight. Energy requirements for milk solids were based on the energy in milk derived from the composition of fat and protein in the milk of HF and HFJ cows. The FCE advantage of the HFJ cows in this scenario comes from more, slightly lower LW cows, and the allocation of energy not required for maintenance to fat and protein production. Another scenario was to assume that the 90% LW HFJ cows also had an advantage in FCE of 3% over the HF cows. To do this the feed supply was set at 1.03 times the original supply to see how many extra 90% LW HFJ cows could be fed. In this scenario, an extra 4 cows could be fed to produce milk solids at the HFJ average, over and above the 90% LW 242 cow scenario. The total HFJ advantage over the HF cows in FCE was then calculated to be 4.5%. This is the combined effect of lower LW and using excess energy for fat and protein, and also a 3% higher FCE.

The estimated gain in annual operating profit of $12,000 is for the 90% LW, 242 cow farm (with 12 more cows than the 230 HF case) where there is a 2.3% HFJ advantage in FCE. This advantage is due to less energy being required for maintenance, which can then be used for running more cows that produce MS at the HFJ average. Included in this $12,000 extra profit is cost savings because of a lower replacement of not-in-calf cows in the HFJ herd.

The $12,000 profit may well be a conservative estimate as there is evidence from Grainger and Goddard (2004) suggesting that there could be a higher FCE advantage for HFJ cows over HF cows. If true, then this would make the estimate of $12,000 HFJ gain in annual operating profit for the farm system in question a conservative estimate. Running the HFJ model such that the FCE was 3% higher than the HF cows meant that less energy was required to produce MS with HFJ cows compared to the HF cows. This spared feed energy on the farm could then be used for running 16 extra HFJ cows producing at the average production for HFJ cows. This results in an operating profit of $54,000; a gain over the HF herd of $18,000 before tax over the HF case, and an extra 4 cows and $6000 extra operating profit over the 242 HFJ cow case.

In this analysis, the crossbred herd had higher FCE than the HF herd, at values similar to and consistent with those reported in the literature by Grainger and Goddard (2004). The differences between the FCE ratios for HF and HFJ cows cited in the literature were most reasonably approximated in this analysis by the HFJ cows that were 90% of the HF cow live weight. For the benefit cost analysis that follows for the whole of Victorian herd, HFJ cows weighing 90% of the HF herd are used as the basis for the estimate of extra annual operating profit from HFJ crossbred dairying. This results in an increase in annual operating profit of $12,000 before extra tax for the 230 HF herd that changed to an HFJ operation. After income tax at 20%, this gain would be $9,600.

Points to note about the comparison

Effects on pasture production and utilization of the higher stocking rate of the crossbreeding system are not taken into account. This is likely to be important as it could lead to a higher pasture utilisation.

No extra capital investment in infrastructure or extra labour is involved to run the additional cows. However, a larger herd of, for example, 600 cows that changed to HFJ cows with the same feed supply could be milking an extra 50 cows or more. This would require half an extra labour unit ($12,500), and probably some capital investment in infrastructure. If the $12,000 advantage of HFJ cows in the 230 cow HF case study farm were simply scaled up (though reality is not usually as simple as this) the 800 cow operation could increase operating profit before extra labour by $42,000 and $30,000 after extra labour (but before any amortized annual extra capital costs for extra infrastructure investment). The economics of converting a real case of a larger sized operation than the 230 cow case study investigated in this report warrants analysing.

The appropriate live weight conversion for HFJ cows as a percentage of HF cows is a critical issue. Empirical survey data for Victorian herds suggests average crossbred cows weigh 92% of average HF cows (Auldist and Grainger 2004). Evidence from the UK and NZ suggests ranges of HFJ:HF cow live weight percentages from 75% to 90%. In practice, animals of the size that promise to give the greatest gain would in future be developed and used.

Direct herd health and reproduction costs are the same for the crossbred herd as for the HF herd (though anecdotal information strongly suggests these could be lower for the crossbred cows).

No allowance has been made for milk quality effects, though there could be some lower cell count advantages of crossbreds over HF cows.

The detail of the breeding system that would be followed in the crossbreeding herd has not been accounted for in the analysis. That is, in practice many crossbred herds would move from first cross to cross back and forwards towards either breed. The results of this analysis could be interpreted as though the crossbred herd was replaced by buying in first cross heifers as required each year. (This simplifies the analysis, eschewing the need to analyse a herd that may be part straight-bred and part crossbred, with the straight-bred cows used to produce replacement heifers, for instance).

A further point to note is that there is some suggestion in the research results investigated by Grainger and Goddard (2004) that a HFJ cow may have lower maintenance requirements per kg.

live weight (metabolic live weight; $LW^{0.75}$) than that of HF cows. This could lead to higher feed conversion efficiency because energy spared from maintenance could be used for milk production.

Importantly, significant benefits often come from the way a change in part of the system (e.g. less reproduction and animal health problems) enables other changes to be implemented in particular systems, with associated pecuniary and non-pecuniary benefits. For instance, in the case investigated in this analysis the system could be changed to a tight seasonal system if the crossbreds could get in calf better than the HF. Such a change could enable overall profitability of the system to be at least maintained and most likely improved. Apart from the profit angle, for some farm families there could be significant but non-pecuniary benefits associated with being able to operate a tight seasonal calving system.

A potentially very significant result of a change to crossbreds facilitating a change to a tight seasonal calving system could be a better match of herd requirements to pasture growth patterns. This has the potential to make extra feed energy available as the result of improving pasture utilisation – a potentially significant productivity gain. Better production and pasture utilization could also result from running a system with an increased stocking rate, cows with lower bodyweight, and that may have in some respects some different grazing behaviour, e.g. better tolerance to heat, higher consumption per unit live weight.

Conclusions

It is likely that in some of the dairy farm systems in Victoria, there could be some productivity and profit gains from a change from using HF dairy cows to using HFJ dairy cows. Net benefits from such a change come from changed proportions and quantities of milk solids produced in the system for a given energy supply, and reduced herd depreciation and herd replacement costs, resulting in additional operating profit. The detailed applicability or otherwise of such a change has to be worked out on a farm case-by-case basis.

The types of net benefits identified from crossbred dairying may have a higher probability of being realized if, in the future, HFJ cows are produced that are below the current live weight, which is around 90% of the live weight of HF cows.

Possibly the major effect of a change from a HF to a HFJ dairy system would lie in the associated system changes that may follow. Some of these changes will result in monetary net benefits, as well as some non-monetary gains. While the net gains from a change to HFJ dairying can only be identified on a farm system-by-system basis, if improved reproduction performance resulted in a changed system this could in turn make it possible to change from a multiple calving to single seasonal calving system. Or, a change in the utilization or balance of feed supplies may become possible.

To substantiate the types of conclusions indicated in the analysis of the performance of a HF dairy farm system that was converted to a HFJ dairy system, more information about the reproduction, fat and protein performance, and grazing performance of various crosses of HFJ cattle in particular types of farm systems is needed. The development of an adequate and reliable supply of male and female dairy cattle with the required genetic make-up to sustain an increased number of crossbred herds would be an important pre-requisite to potential gains from such a change being realized.

References

Auldist M and Grainger C 2004, A comparison of milk production, body condition, live weight and feed intakes of pure Friesian and Friesian x Jersey cross-bred dairy cattle in Victorian pasture-based dairying systems, Final Report to GippsDairy and the DPI, Ellinbank, April, 2004.

Armstrong D, Ho C, Doyle P and Malcolm B 2002, Future Dairy Farming Systems in Irrigation Regions, Final Report to DRDC, Melbourne, 2002.

Grainger C and Goddard ME 2004. A review of the effects of dairy breed on feed conversion efficiency – an opportunity lost?, ed. R Stockdale et al, *Proceedings of Australian Society of Animal Production Conference*, Melbourne, July 2004. pp.77-80.

Pyman M 2003, Crossbreeding at the crossroads, Newsletter of Melbourne University-Gardiner Foundation Crossbreeding Project, Melbourne, October 2003.

