HIGH GENETIC MERIT DAIRY COWS CONTRIBUTE MORE TO FARM PROFIT: CASE STUDIES OF 3 AUSTRALIAN DAIRY HERDS

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SUMMARY

One of the barriers to the adoption of Australian Breeding Values (ABVs) is not having evidence that high genetic merit dairy cows actually contribute more to farm profit in practice. Using historical financial data collected as part of the Dairy Farm Monitor (DFM) Project, and historical cow production, health and mating records, a method was developed to compare the estimated contribution to farm profit of cows of differing genetic merit. High genetic merit cows contributed between $150 and $235 per cow more to farm profit each year without compromising their productive life, or incurring higher breeding or mastitis treatment costs.

INTRODUCTION

Although the Australian dairy industry is making genetic progress, the rate of actual genetic gain, $8/year ($\approx$0.1 genetic standard deviations) increase in the Balanced Performance Index (BPI), is less than half of what is theoretically feasible. Under optimal conditions, genetic gain is projected to increase between 0.21 and 0.5 genetic standard deviations per year for progeny-testing and genomic selection respectively (Schaeffer 2006). The ImProving Herds project was established with the goal of improving farm profit through demonstrating the value of genetics and herd improvement in the dairy industry, a key goal recognised in the national Herd Improvement 2020 Strategy. Dairy Australia recommended that increased focus be placed on case studies and regionally specific extension activities to increase knowledge, trust and use of genetic tools in the dairy industry. To incorporate this suggestion, the ImProving Herds project is centred around 34 focus farms.

An across herd study of Irish dairy herds (n= 1131) found a 1 unit increase in the Economic Breeding Index was associated with a €1.94 ($\approx$ AU$2.76) increase in net margin per cow, after adjustment for year, stocking rate, herd size and purchased feed (Ramsbottom *et al.* 2012). This value was very close to the €2 increase in net margin per cow predicted. The Australian dairy industry is not suited to an across herd economic analysis due to climatic variability, diverse feeding and management practices and variability in milk payment systems which exacerbate between herd variation in economic performance. To control for this variability, we elected to perform a within herd analysis, with focus farms from the ImProving Herds project as case studies.

The aims of this study were to 1) develop a method to calculate the contribution an individual cow makes to farm profit over her lifetime, and 2) investigate the relationship between cow genetic merit, profit and performance at the individual farm level.

MATERIALS AND METHODS

Two historical and independent databases were used for this study of 3 Victorian dairy farms: 1) the DFM database; the DFM project is a joint initiative between Agriculture Victoria and Dairy Australia which annually collects and analyses detailed financial and farm production data from

dairy farms, and 2) DataGene; the national database of cow production, pedigree and ABV records. Within-herd long term averages over the 2008 to 2016 financial years, inclusive, were calculated for farm financial data, adjusted to present day values, and herd production data. All herds had cow lactation, health and mating records and at least 2/3 of cows had ABVs. To be included in this analysis, a cow's entire productive life had to fall within the 2008 to 2016 financial years, inclusive.

The individual contribution that each cow made to farm profit over her lifetime (Cow$) was calculated using the equation:

$$Cow\$ = \$_{milk} + \$_{calf} + \$_{cull} - (\$_{rear} + \$_{feed} + \$_{mastitis} + \$_{repro} + \$_{herd})$$

Lifetime milk income ($\$_{milk}$) was calculated by multiplying total milk solids (MS) by average milk price ($/kg MS). Income from calf sales ($\$_{calf}$), and costs of mastitis treatment ($\$_{mastitis}$) and animal mating ($\$_{repro}$) were calculated by summing the number of incidences of each event and multiplying by the dollar value, in $ per cow, of one occurrence of that event. A cow's salvage value ($\$_{cull}$) was assumed to be the average within-herd cull cow price unless she was recorded as dead, then $\$_{cull}$ was $0. If more than 12 months had passed since the cow was last seen in the herd she was assumed to have been sold. The initial investment in rearing the cow to the point of entering the milking herd ($\$_{rear}$) was assumed to be $1606 (Byrne *et al.* 2016). Feed costs were calculated by multiplying the within-herd average cost of feed consumed ($/Megajoule of metabolisable energy, $/MJ ME) by each cow's energy requirements. Cow energy requirements were calculated using the equations in CSIRO (2007). They accounted for cow age and breed, lactation and pregnancy records and herd level information about distance walked each day, farm topography, liveweight and condition score loss during lactation. Dairy and general herd health costs ($\$_{herd}$) were assumed to be proportional to the cow's productive life. Day 1 was taken as the date of first calving. To account for discounting over time, all elements of the profit equation were calculated in 365 day periods, a 5% discount rate applied and then summed together.

Cow ABVs are breed specific. The 3 herds had Holstein (Herd C), Jersey (Herd A) and mixed Jersey and Holstein (Herd B) cows. DataGene presents breed specific genetic evaluations (with different bases for each breed), so the original solutions were obtained (from multi-breed models) and rescaled using the Holstein ABV parameters, enabling a within-herd, but across breed analysis to be used. The BPI is the Australia dairy industry's main index. It was developed using a bio-economic model to balance improvements in longevity, health, type, fertility and production to maximise farm profit (Byrne *et al.* 2016). For this study, within each herd each cow was classified into two sub-herds, either low or high BPI based on whether she was below or above the median BPI for her contemporary group; herd and year of first calving. A linear model weighted by cow productive life (in days) was used to test for differences in annualized physical and financial measures of cow performance in the low and high BPI sub-herds. This analysis was performed separately for each herd. The results below are presented as the estimate of the difference between the two sub-herds within each of the 3 herds from the weighted linear model.

RESULTS AND DISCUSSION

In all 3 herds, splitting the herd based on median BPI resulted in significant ($p<0.05$) differences in ABV between the high and low BPI sub-herds (Table 1). The difference in BPI between the two sub-herds ranged from $78 to $116. All high BPI sub-herds had significantly ($p<0.001$) higher BPI, milk production and survival ABVs than the below BPI sub-herds (Table 1). Two out of three high BPI sub-herds also had significantly higher cell count ABVs and lower fertility ABVs.

Cows in the high BPI sub-herds produced significantly ($p<0.05$) more litres of milk, and kilograms of fat and protein each year than their low BPI counterparts (Table 2). All high BPI sub-herds tended to have cows with a longer productive life, but this difference was only significant ($p<0.05$) for 1 herd.

Table 1 Estimated difference (s.e) in ABVs between high and low BPI sub-herds from weighted linear model. Significance of p-value (NS >0.05,* = <0.05, ** = <0.01, *** = <0.001)

Herd	BPI	Protein	Milk	Fat	Cell count	Fertility	Survival
A	78 (5)***	10 (1)***	269 (71)***	17 (2)***	3 (2)NS	0 (1)NS	2 (0)***
B	94 (6)***	13 (1)***	376 (66)***	18 (2)***	6 (2)**	-1 (1)*	2 (0)***
C	116 (4) ***	14 (1)***	340 (45)***	21 (2)***	3 (1)*	-1 (0)**	3 (0)***

Table 2 Estimated difference (s.e) in average physical parameters between cows in high and low BPI sub-herds from weighted linear model. Significance of p-value (NS>0.05,* = <0.05, ** = <0.01, *** = <0.001)

Herd	Milk (L/yr)	Fat (kg/yr)	Prot (kg/yr)	Productive life (months)	Calving interval (days)	Lactation length (days)	No. calves (calves/yr)
A	434 (154) **	26 (6) ***	19 (5) ***	4 (3) NS	-11 (10) NS	1 (10) NS	0.0 (0.0) NS
B	411 (131) **	20 (5) ***	19 (4) ***	5 (3) NS	22 (16) NS	19 (14) NS	0.0 (0.0) NS
C	265 (125) *	27 (4) ***	19 (4) ***	4 (2) *	34 (10) ***	25 (8) **	-0.1 (0.0) ***

All high BPI sub-herds were significantly (p<0.01) more profitable, with the average difference ranging from $150 to $235 per cow/year (Table 3). The main source of this difference was greater yearly milk income, with cows in high BPI sub-herds generating on average between $185 and $258 more income from milk sales each year. Although feed costs were higher in the high BPI sub-herds, the extra cost of feed ranged from $30 to $42, which was more than compensated for by additional milk income. Increases to milk income were achieved without decreasing ,and in one case significantly (p<0.05) increasing, the average productive life of the high BPI sub-herds (Table 2) and without significantly (p>0.05) increasing mastitis costs (Table 3). This finding goes some way to dispel the widely-held belief that high producing animals break down earlier and are more prone to mastitis. Although cows in high BPI sub-herd C had significantly (p<0.001) longer calving intervals and fewer calves per year (Table 2), they also had significantly longer lactations (p<0.01) and a tendency (p=0.10) for lower AI costs each year.

Table 3 Estimated difference (s.e) in the contribution each cow makes to profit (Cow$) and Cow$ components between high and low BPI sub-herds from weighted linear model. Significance of p-value (NS >0.05,* = <0.05, ** = <0.01, *** = <0.001)

		Income ($/yr)		Costs ($/yr)				
Herd	Cow$ ($/yr)	Milk	Calf	Feed	AI	Preg test	Mastitis	Rearing
A	178 (50) ***	208 (51) ***	-2 (4) NS	-42 (16) **	6 (4) NS	0 (0) NS	-3 (3) NS	52 (44) NS
B	150 (49) **	185 (43) ***	-7 (4) NS	-34 (12) **	-4 (4) NS	0 (0) NS	-3 (3) NS	55 (39) NS
C	235 (40) ***	258 (49) ***	-10 (2) ***	-30 (12) *	6 (3) NS	0 (0) NS	1 (3) NS	31 (29) NS

At the national level the regression of profit and BPI is expected to be a $1 increase in profit for every unit increase in BPI (Byrne *et al*. 2016). In the three case study herds, the ratio between Cow$ and BPI was higher than this at $2.28, $1.60, $2.03 for herds A, B, C respectively. This differs from Ramsbottom *et al*. (2012) whose €1.94 (≈AU$2.76) increase in net margin per cow was very close to the expected increase of €2.00. A possible reason is that the Victorian herds in our study are not representative of the national average, whereas Ramsbottom *et al.*'s (2012) larger study of 1131 herds better captures the national variation in Irish dairy herds. An indication this may be the case is that average feed cost for the herds in our study ranged from $0.016 to $0.022/ MJ ME whilst the national average purchased feed cost is $0.025 /MJ ME (Byrne *et al*. 2016).

The phenotypic records that were used to calculate Cow$ have also been used in cow ABV estimation. An alternate approach that uses ABVs derived from parent average or genomic prediction could also be used. A parent average analysis was conducted, with similar results obtained. Differences in Cow$ between the sub-herds selected based on parent average BPI were significant ($p<0.05$) in two herds and approached significance ($p<0.1$) in the third herd. In choosing which set of results to present, the end goal of the ImProving Herds project needs to be considered. The goal of the ImProving Herds project is to increase knowledge, trust and usage of genetic tools, such as ABVs and the BPI index, in the Australian dairy industry. For the purposes of demonstrating that ABVs "work" to farmers it is therefore most relevant to use the ABVs in the format they appear in existing industry tools.

This analysis required in depth historical financial, pedigree, performance and management information from the case study herds which is not available on all focus farms to such a high level of detail. A simplified approach using regional historical financial information will enable a similar analysis of the project's 34 focus farms, and potentially other dairy farms, who have cow ABVs and accurate lactation records. The transferability of the approach used here to other livestock species will be determined by the availability of detailed phenotypes for key contributors to farm profit and validated financial records.

CONCLUSION

Using an independent financial data source, the DFM project, it was successfully shown that the assumption made at the national level about the positive relationship between cow genetic merit and cow contribution to farm profit holds true at the individual farm level. Although high genetic merit animals have higher feed costs, these are more than compensated for by greater milk income. Furthermore, our analysis indicates that high BPI cows do not have a shorter productive life, nor higher mastitis incidence or mating costs. These case studies provide the opportunity to contribute to localised extension activities and help build the dairy industry's trust, knowledge and use of ABVs.

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