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Economic values for dairy production traits under different milk payment systems in South Africa

C.B. Banga[1#], F.W.C. Neser[2], J. van der Westhuizen[1] and D.J. Garrick[3]
[1] ARC Animal Production Institute, P/Bag X2, Irene 0062, South Africa
[2] Department of Animal Science, University of the Free State, P O Box 339, Bloemfontein 9300, South Africa
[3] Department of Animal Science, Iowa State University, Ames, IA 50011, USA

Abstract

Economic values of milk volume (VOL), fat yield (FYLD), protein yield (PYLD), live weight (LWT), longevity (LON), calving interval (CIV) and somatic cell score (SCS) were derived for Holstein and Jersey cattle, based on milk payment systems of four major milk buyers in South Africa. The economic value of somatic cell score was calculated for only two of the payment systems. A bio-economic model was used to calculate economic values by determining changes in profit arising from an independent unit increase in each trait. Economic values for VOL, FYLD and PYLD varied substantially among the payment systems; particularly PYLD which ranged from ZAR 7.62/kg to ZAR 21.88/kg. Payment systems that do not pay for milk volume resulted in a negative economic value (-ZAR 0.49/l) for VOL. Live weight and CIV had constant economic values across payment systems (-ZAR 6.62/kg and –ZAR 5.75/day for Holstein and –ZAR 7.49/kg and –ZAR 4.19/day for Jersey, respectively, for LWT and CIV). Economic value of LON varied slightly with payment system (ZAR 1.09/day to ZAR 1.23/day in the Jersey and ZAR 3.59/day to ZAR 3.68/day in the Holstein). The economic value of SCS differed substantially between the two payment systems and was higher in the Holstein (-ZAR 949.26/score and –ZAR 1795.57/score) than in the Jersey (-ZAR 433.87/score and –ZAR 912.90/score). Relative emphasis of traits in the breeding objectives for South African dairy cattle should take due cognisance of the diversity in milk payment systems.

Keywords: Breeding objective, economic value, Jersey, Holstein
[#] Corresponding author. Email: Cuthbert@arc.agric.za

Introduction

A well-defined breeding objective forms the basis of a sound breeding programme. Such a breeding objective is developed by systematically identifying traits to improve and determining their economic values. The economic value of a trait is defined as the increase in profit resulting from a unit genetic improvement in that trait, while all other traits in the breeding objective are kept constant (Hazel, 1943).

Breeding objectives for dairy cattle in South Africa are not clearly defined. The South African National Dairy Cattle Genetic Evaluation Programme routinely publishes EBVs on 23 traits; however there is no consensus on the traits that should be improved and their relative importance. Genetic trends show that selection in South African dairy cattle has, in the past, focussed mainly on increased yield and improved type (Theron & Mostert, 2004; Banga *et al*., 2007). Substantial increases in genetic merit for yield traits have unfortunately been coupled with deterioration in fitness traits (Banga *et al*., 2007; Dube *et al*., 2008; Makgahlela *et al*., 2008). It has thus become acutely imperative to develop sound and broader breeding objectives for dairy cattle in South Africa. The aim of this study was to calculate economic values for breeding objective traits of South African Holstein and Jersey cattle breeds under the intensive concentrate-fed production system.

Materials and Methods

A bio-economic herd model, simulating an average farm for each breed, was developed. Data collected through the National Dairy Animal Improvement Scheme were used to derive base herd parameters. Base herd parameters for the two breeds are given in Table 1. Traits included in the breeding objective were milk volume (VOL), fat yield (FYLD), protein yield (PYLD), live weight (LWT), longevity (LON), calving interval (CIV) and somatic cell score (SCS). Somatic cell score was somatic cell count (SCC) transformed to $\log_e$.

Table 1 Base herd parameters for Holstein and Jersey cattle in concentrate-fed herds

Parameter[1]	Breed	
	Holstein	Jersey
Milk volume (L/cow)	9 746	6 252
Fat yield (kg/cow)	383	303
Protein yield (kg/cow)	319	237
SCC (x1000 cells/mL)	332	308
Age at first calving (months)	26	25
Calving interval (days)	413	395
Productive lifetime (lactations)	2.4	2.7
Herd life (months)	45.3	47.8
Cows culled (%)	34.6	31.9

Farm economic data and milk pricing information were provided by the Milk Producers' Organisation of South Africa (MPO, 2007; MPO, 2008; Koos Coetzee, 2008, personal communication, koos.coetzee@mpo.co.za; Dawie Maree, 2008, personal communication, dawie@mpo.co.za) and the milk buyers (Berlo Coetsee, 2008, personal communication, berlo.coetsee@parmalat.co.za; Pieter van Zyl, 2008, personal communication, P.O. Box 6161, Weltevreden Park, Roodepoort, RSA, 1715). Beef prices were obtained from the South African Meat Industry Company (SAMIC, 2008). Table 2 contains milk component prices of the four payment systems used. Due to the sensitivity of milk pricing in South Africa, milk buyers are not referred to by name.

Table 2 Milk component prices of four major milk buyers

	Milk Buyer			
Component	A	B	C	D
Fat (ZAR/kg)	16.00	20.60	17.26	19.00
Protein (ZAR/kg)	16.00	30.26	28.26	28.50
Volume (ZAR/L)	0.77	0.00	0.00	0.77

Live weight was predicted using the von Bertanlanffy equation as given by Bakker & Koops (1978) and the metabolisable energy system (AFRC, 1993) was used to calculate energy requirements for maintenance, growth, pregnancy and milk production. It was assumed that increased feed (energy) requirements were met by buying in extra feed and that non-feed costs remained constant.

The partial budget approach was used to compute economic values by simulating the marginal change in profit resulting from a unit increase in the trait of interest, while all other traits remained constant. This was done by considering incomes and expenses for seven alternative herds, each herd differing from the base herd in only one trait. Economic value was calculated as the change in profit (income less costs) per unit change in the trait (*i.e*. difference in profit between alternative and base herd). Profit was expressed per cow in the herd per year.

The model used probably underestimated the economic value of CIV as it did not account for other costs related to cow fertility, e.g. replacement and insemination costs.

Results and Discussion

Economic values of all traits by breed and payment system are presented in Table 3. It is difficult to compare these economic values with those reported by Du Plessis & Roux (1998) for South African Holstein cattle as methods of expression are different. Du Plessis & Roux (1998) calculated economic values as percentage change in economic efficiency.

Economic values of milk components (FYLD, PYLD and VOL) were the same for both breeds; hence they are only shown for the Jersey breed in Table 3. Breed has no effect on economic values of these traits because, in the simulated production system, change in profit per unit increase of a milk component is determined only by the payment price per unit of that component and the cost of the extra feed required to produce it.

Table 3 Economic values[1] (ZAR per unit) by breed under different milk payment systems

Breed	Trait	Milk Buyer			
		A	B	C	D
Jersey	Fat (kg)	1.21	5.81	2.47	4.21
	Protein (kg)	7.62	21.88	19.88	20.21
	Milk (L)	0.28	-0.49	-0.49	0.28
	Longevity (days)	1.15	1.11	1.09	1.23
	Live weight (kg)	-7.49	-7.49	-7.49	-7.49
	Calving interval (days)	-4.19	-4.19	-4.19	-4.19
	Somatic cell score	-433.87	-912.90		
Holstein	Longevity (days)	3.68	3.59	3.59	3.67
	Live weight (kg)	-6.62	-6.62	-6.62	-6.62
	Calving interval (days)	-5.75	-5.75	-5.75	-5.75
	Somatic cell score	-949.26	-1795.57		

[1]Economic values of milk production traits (fat, protein and volume) the same for both breeds.

VOL had a negative economic value (-ZAR 0.49 per litre) under those payment systems not paying for volume (buyers B and C). This is due to the fact that no revenue is received for producing any extra volume of milk; however it costs energy (feed) to produce the milk. Where milk volume is paid for (buyers A and D) an increase in milk volume by 1 litre resulted in an increase in profit of ZAR 0.28 per cow per year. Negative economic values for VOL have been reported in markets where milk volume is either not paid for or is negatively priced (e.g. Keller & Allaire, 1990; Visscher *et al*., 1994; Holmes *et al*., 2000; Veerkamp *et al*., 2002).

The milk payment system for buyer B gave the largest economic values for both FYLD and PYLD. This is not unexpected as buyer B offers the highest price per kg of FYLD and per kg of PYLD. On the other hand the payment system for buyer A, which had the lowest FYLD and PYLD prices, resulted in the lowest economic values for the two traits. The fact that it is more costly (*i.e*. more energy is required) to produce a kg of fat than of protein, is reflected in the much higher economic value of PYLD (ZAR 7.62) compared to FYLD (ZAR 1.21), even under a payment system where both components are equally priced (buyer A).

Economic values of LWT and CIV were only affected by the difference in maintenance energy costs and beef revenue (for LWT) between the base and alternative herds. They were therefore constant across payment systems. Increases in LWT or CIV resulted in a decrease in profit, in concurrence with several other studies (Visscher *et al*., 1994; Du Plessis & Roux, 1998; Holmes *et al*., 2000; Olori *et al*., 2002; Veerkamp *et al*., 2002). A kg increase in LWT resulted in a larger decrease in profit in the Jersey (ZAR 7.49/cow/year) compared to the Holstein (ZAR 6.62/cow/ year). This is attributable to the higher culling rate for the Holstein, which results in a larger increase in beef revenue in the alternative (higher LWT) herd, compared to the Jersey. The converse was, however, true for CIV (decreases of ZAR 4.19/cow/year in Jersey and ZAR 5.75/ cow/year in Holstein). This is explained by the fact that it is more costly to maintain the bigger-sized Holstein than the Jersey. Economic value of LON varied slightly among payment systems and this was due to the variation in milk revenue resulting from the difference in herd structure between the base herd and the increased LON herd. The increased LON herd had a bigger proportion of higher producing (older) cows and therefore had more milk revenue per cow than the base herd. The magnitude of such increase in revenue is dependent on the payment system.

An increase in SCS by 1 score resulted in about a double reduction in profit for both breeds under the payment system for buyer B compared to that for buyer A. This is due to the fact that buyer B has a more strict SCC payment scheme (lower SCC threshold for bonus and higher penalties for high SCC milk). The economic value of SCS was approximately double in the Holstein than in the Jersey, probably due to the fact that the mean SCS is higher for the Holstein than the Jersey. The economic value of SCS is well known to be sensitive to the population mean (Dekkers *et al*., 1996). A unit reduction in SCS will thus result in better marginal returns in the Holstein than in the Jersey.

Conclusions

The study obtained economic values that can be combined with EBVs to compute aggregate breeding values for Holstein and Jersey cattle in concentrate-fed herds in South Africa. Economic values of milk production traits (VOL, FYLD and PYLD), however, show considerable variation among different payment systems. Application of breeding objectives for dairy cattle in South Africa should therefore pay due regard to this fact.

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