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Derivation of Economic Values of Longevity for Inclusion in the Breeding Objectives for South African Dairy Cattle

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Abstract. Objective and accurate determination of economic values is critical to the development of sound breeding objectives. The current study determined economic values of longevity in South African Holstein and Jersey cattle. A bio-economic model, simulating typical South African pasture-based and concentrate-fed herds, was used to calculate economic values by determining changes in profit arising from a marginal increase in longevity, while all other traits remained constant. Economic values ranged from ZAR1.09/day to ZAR3.68/day and varied slightly with the milk payment system. Longevity was the third most important trait in the breeding objective. These economic values form the basis for incorporating longevity in the breeding objectives for South African dairy cattle.

Keywords: economic value, longevity, Holstein, Jersey.

1. Introduction

Longevity or length of productive life is a trait of major economic importance in dairy cattle as it has a large influence on herd profitability [1]-[8]. Longer productive life, which is an indication of lower involuntary culling, implies an increased proportion of higher yielding mature cows in the herd leading to improved herd production. There is also a corresponding decline in the number of replacement heifers required, which lowers replacement costs. The reduction in replacement heifers required also increases the number of heifers available for marketing and spreads cow maintenance costs over a larger number of calves. Increased longevity also creates more opportunities for voluntary culling, resulting in higher selection intensity.

Due to its high economic importance, longevity has been incorporated in many national dairy cattle breeding objectives [9] and [10]. In the past, selection in the South African dairy cattle population has been focussed mainly on increased milk yield and, to a lesser extent, on improved conformation as shown by genetic trends [11]. Large increases in genetic merit for yield traits and considerable genetic change in linear type traits, particularly in the Holstein breed, has been effected in the past two decades [11] and [12]. A sound breeding objective should, however, include all traits of economic importance. Serious concern has also been raised about the correlated deterioration in fitness traits such as longevity, udder health and cow fertility observed in this population [13]-[15]. It has therefore become increasingly imperative to broaden breeding objectives for South African cattle to include these traits.

Economic values are a prerequisite to incorporating a trait into the breeding objective [16]. Earlier studies to determine economic values for dairy production traits in South Africa [17] and [18] were limited to the Holstein breed. Keller and Allaire [19], however, noted that economic values may vary significantly

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among breeds. Furthermore, the work of Du Plessis and Roux [17] was based only on the concentrate-fed production system and Tesfa [18] did not consider any particular feeding system. The objective of this study was, therefore, to calculate the economic values of longevity in the two major dairy cattle breeds in South, namely Holstein and Jersey, under the major production systems.

2. Materials and Methods

Economic values were calculated separately for the two major dairy cattle breeds (Holstein and Jersey) in each of the two major dairy production systems in South Africa (intensive concentrate-fed and pasture based systems). A bio-economic herd model, simulating an average farm (base herd) for each breed in each production system, was developed. Data collected through the National Dairy Animal Improvement Scheme were used to derive the base herd parameters, shown in Table 1.

Table 1. Base herd parameters for each breed in each production system

Parameter[1]	Concentrate		Pasture	
	Holstein	Jersey	Holstein	Jersey
Milk volume (l/cow)	9 746	6 252	7 049	5 152
Fat yield (kg/cow)	383	303	277	248
Protein yield (kg/cow)	319	237	233	198
Age at first calving (months)	26	25	28	27
Productive lifetime (lactations)	2.4	2.7	2.9	3.0
Productive lifetime (months)	45.3	47.8	52.8	53.3
Cows culled (%)	34.6	31.9	26.1	26.6

[1]*Yields standardised to 305 day lactation*

Milk payment systems used by the four major milk buyers in the country, hereafter referred to as PS_A, PS_B, PS_C and PS_D (Table 2), were used. The prices of beef (ZAR21.46/kg for heifers and R18.89/kg for cull cows, live weight) were obtained from the South African Meat Industry Company (SAMIC).

Table 2. Milk component prices of four major payment systems

Component	Payment System			
	PS_A	PS_B	PS_C	PS_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

The partial budget approach, as described by Garrick [20], was used to compute economic values by simulating the marginal change in profit resulting from a unit increase in longevity, while all other traits remained constant. This was done by considering incomes and expenses for the base herd and an increased longevity herd. Profit was expressed per cow in the herd per year and its marginal change was calculated as the difference between marginal change in revenue and marginal change in costs. It was assumed that increased feed (energy) requirements for additional milk production and raising replacement heifers were met by buying in extra feed and that non feed costs remained constant. In the pasture-based production system, it was assumed that purchased feed is obtained at opportunity cost, defined as average revenue in the base situation, following Garrick [20].

Standardised relative economic values were determined, across breeds and payment and production systems, to enable comparison of the relative importance of traits. These were expressed in genetic standard deviation units relative to the standardised value for protein yield, as in, among others, Visscher *et al.* [21] and Veerkamp *et al.* [22].

3. Results and Discussion

Economic values (ZAR/day) by breed and production system are presented in Table 3 for each payment system. Payment systems PS_D and PS_A gave higher economic values compared to PS_B and PS_C. The increased longevity herd had a larger proportion of higher producing older cows and therefore had more milk revenue per cow than the base herd. Such increase in revenue was dependent on the payment system; hence economic value of longevity varied slightly among payment systems. Economic values were larger for the Holstein than the Jersey.

Table 3. Economic values of longevity (ZAR/day) for each breed and production system

Payment	**Concentrate**		**Pasture**	
System	**Holstein**	**Jersey**	**Holstein**	**Jersey**
PS_A	3.68	1.15	2.16	1.77
PS_B	3.59	1.11	1.93	1.73
PS_C	3.59	1.09	1.68	1.54
PS_D	3.67	1.23	2.83	2.29

Fig. 1 shows the relative economic values of traits in the breeding objective, standardised to protein (the most important trait). Longevity was the third most important traits, its value being 58 % compared to that of protein.

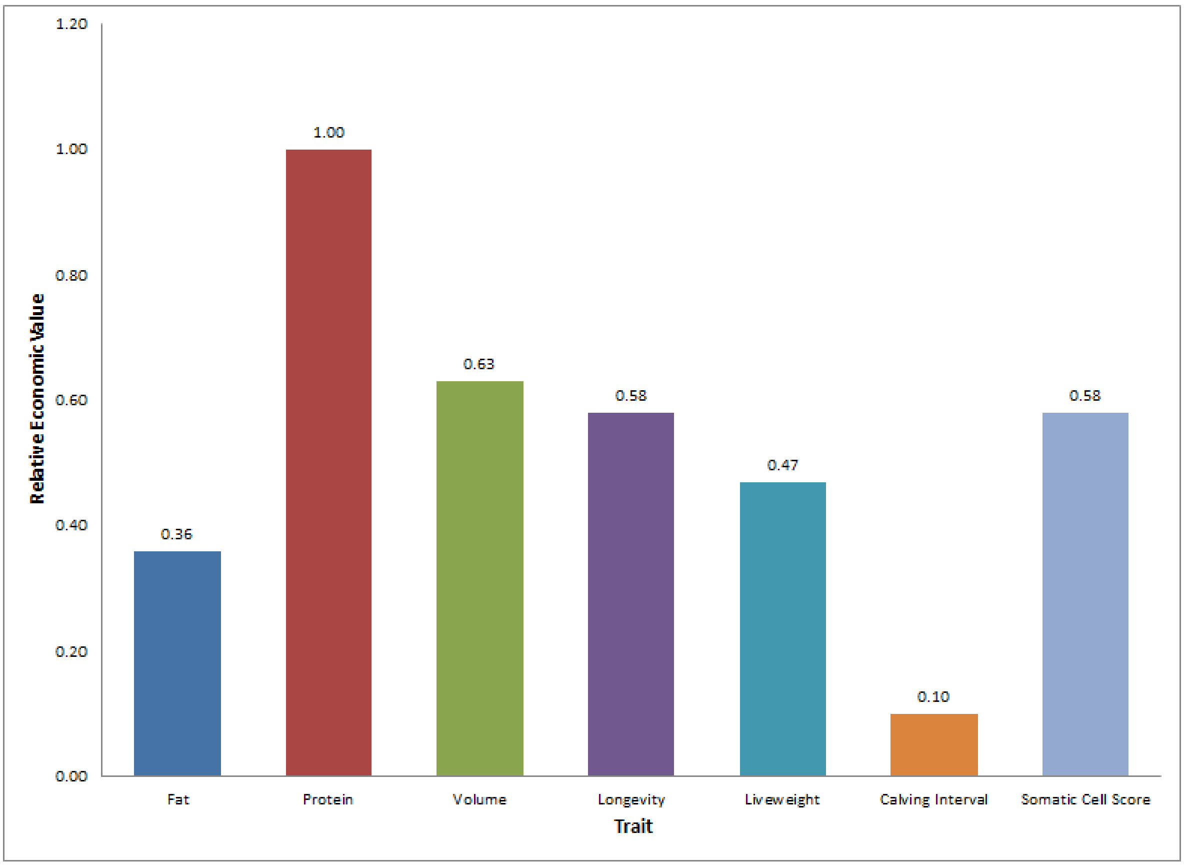

Fig. 1: Relative economic values of traits in the breeding objective standardised to protein

An increase in longevity resulted in an increase in profit, in agreement with several other studies [17], [23]-[25], [22], [21] and [26]. In the current study, longevity shows up as one of the most important traits in breeding objectives for dairy cattle in South Africa. Du Plessis and Roux [17] however found longevity to rank relatively low in South African Holsteins. This disparity may partly be attributable to differences in models, definition of traits, payment systems and other parameters used. Du Plessis and Roux [17] calculated economic weights, expressed as percentage change in economic efficiency, under a fluid (fresh milk and yoghurt) and a manufacturing (cheese and butter) market. It is not clear if the milk component prices they used for these markets represent any of the payment systems used in the current study.

The fact that longevity is more important in the Holstein than Jersey breed may be explained, in part, by the difference in population means. Economic values are known to be sensitive to the population mean, for non-production traits. Jersey cows have longer average productive life than the Holsteins. Improvement in longevity in the Holstein population is therefore expected to result in a higher increase in profit than in the Jersey.

4. Conclusions

Longevity is one of the most important traits in the breeding objectives for South African dairy cattle. Efforts therefore need to be made to incorporate this trait in these breeding objectives, using the economic values calculated in the current study.

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6. References

[1] J.C.M. Dekkers, L.K. Jairath, B.H. Lawrence. Relationships between sire genetic evaluations for conformation and functional herd life of daughters. *J. Dairy Sci*. 1994, 77: 844-854.

[2] M.R. Dentine, B.T. McDaniel, H.D. Norman. Evaluation of sires for traits associated with herd life of grade registered Holstein cattle. *J. Dairy Sci.* 1987, 70: 2623-2634.

[3] A. Essl. Longevity in dairy cattle breeding: a review. Livest. Prod. Sci. 1998, 57: 79-89.

[4] G.S. Gill, and F.R. Allaire. Relationships of age at first calving, days open, days dry and herdlife to a profit function for dairy cattle. J. Dairy Sci. 1976, 59: 1131-1139.

[5] R. Rizzi, A. Bagnato, F. Cerutti, J.C. Alvarez. Lifetime performances of Carora and Holstein cows in Venezuela. J. Anim. Breed. & Gen. 2002, 119: 83-92.

[6] G.W. Rogers, B.T. McDaniel, M.R. Dentine, L.P. Johnson. Relationships among survival rates, predicted differences for yield, and linear type traits. J. Dairy Sci. 1988, 71: 214-222.

[7] M.D. Schneider, P.H. Monardes, R.I. Cue. Effects of type traits on functional herd life in Holstein cows. Interbull Bulletin . 1999, 21: 111-116.

[8] A. Sewalam, G.J. Kistemaker, V. Ducrocq, B.J. Van Doormal. Genetic analysis of herd life in Canadian dairy cattle on a lactation basis using a Weibull proportional hazards model. J. Dairy Sci. 2005, 88:368-375.

[9] F. Miglior, B.L. Muir, B.J. Van Doormaal. Selection indices in Holstein cattle of various countries. J. Dairy Sci. 2005, 88:1255-1263.

[10] B. Wesseldijk. Secondary traits make up 26% of breeding goal. Holstein Inter. 2004, 11(6):8–11.

[11] National Dairy Animal Improvement Scheme. Annual Report. 2011, 31. Agricultural Research Council, South Africa.

[12] H.E. Theron, and B.E. Mostert. Genetic analyses for conformation traits in South African Jersey and Holstein cattle. S. Afr. J. Anim. Sci. 2004, 34 (6): 47-49.

[13] B. Dube, C.B. Banga, K. Dzama, D. Norris. Genetic analysis of somatic cell score and linear type traits in South

African Holstein cattle. S. Afr. J. Anim. Sci. 2008, 8 (1): 229-232.

[14] B. Dube, K. Dzama, C.B. Banga, D. Norris. An analysis of the genetic relationship between udder health and udder conformation traits in South African Jersey cows. *Animal.* 2009, 3/4: 494-500.

[15] M.L. Makgahlela, C.B. Banga, D. Norris, K. Dzama, J.W. Ngambi. Genetic analysis of age at first calving and calving interval in South African Holstein cattle. Asian J. Anim. Vet. Adv. 2008, 3: 197-205.

[16] L.N. Hazel. The genetic basis for constructing selection indexes. Genetics. 1943, 28: 476-490.

[17] M. Du Plessis, and C.Z. Roux. Economic weights for Holstein Friesian traits in South Africa. S. Afr. J. Anim. Sci. 1998, 28 (3/4): 140-145.

[18] K.N. Tesfa. The effect of different milk pricing schemes on a selection index for South African Holstein cattle. M.Sc. Dissertation. 2002. University of the Free State, Bloemfontein, South Africa.

[19] D.S. Keller, and F. R. Allaire. Economic weights for genetic changes in milk component yields at the herd level. J. Dairy Sci. 1990, 73:1631.

[20] D.J. Garrick. Selection objectives for dairy cattle improvement. In: Holmes et al. (eds). Milk Production from pasture. Massey University, Palmerston North, New Zealand. 2000, pp. 531-550.

[21] P.M. Visscher, P.J. Bowman, M.E. Goddard. Breeding objectives for pasture based dairy production systems. Livest. Prod. Sci. 1994, 40: 123-137.

[22] R.F. Veerkamp, P. Dillon, E. Kelly, A.R. Cromie, A.F. Groen. Dairy cattle breeding objectives combining yield, survival and calving interval for pasture-based systems in Ireland under different milk quota scenarios. Livest. Prod. Sci. 2002, 76: 137-151.

[23] B.L. Harris, and A.E. Freeman. Economic weights for milk yield traits and herd life under various economic conditions and production quotas. J. Dairy Sci. 1993, 76: 868-879.

[24] A.K. Kahi, and G. Nitter. Developing breeding schemes for pasture based dairy production systems in Kenya. I. Derivation of economic values using profit functions. Livest. Prod. Sci. 2004, 88: 161-177.

[25] H.M. Nielsen, A.F. Groen, J. Pedersen, P. Berg. Stochastic simulation of economic values and their standard deviations for production and functional traits in dairy cattle under current and future Danish production circumstances. Acta Agric. Scand., Sec. A, Animal Sci. 2004, 54: 113-126.

[26] M. Wolfová, J. Wolf, J. Kvapilík, J. Kica. Selection for profit in cattle: I. Economic weights for purebred dairy cattle in the Czech Republic. *J. Dairy Sci*. 2007, 90: 2442-2455.