Short communication

The economic value of somatic cell count in South African Holstein and Jersey cattle

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Abstract

Somatic cell count (SCC) is of economic importance in dairy production as it directly influences the revenue from the sale of milk. The current study was carried out to determine the economic value of SCC in South African Holstein and Jersey cattle, in order to establish its relative emphasis in breeding objectives. Bulk-tank SCC was calculated from individual cow test-day SCC for 183 Jersey and 209 Holstein herds that participated in the national milk recording scheme in 2012. SCC premium schemes of the two major milk buyers in the country were used, and herds belonged to either a concentrate-fed or pasture-based production system. The economic value of SCC was determined as the simulated change in profit per cow per year, following a 1% increase in individual bulk-tank SCC. Estimated breeding values (EBVs) are based on $\log_{10}$ transformed SCC (somatic cell score, SCS); therefore the final economic value was expressed in South African rand (ZAR) per SCS. Relative economic values, standardized to the value of protein, were used to compare the relative importance of SCS with other objective traits. An increase in SCS by one unit resulted in decreases in profit ranging from ZAR 491.48 to ZAR 1795.57 per cow per year, depending on the breed, production system and payment system. Economic value was nearly double in the Holstein compared with the Jersey, as well as in the concentrate-fed system relative to the pasture-based system. SCS was among the most important traits in the breeding objective, its value ranging from 26% to 118% compared with the most important trait, protein. High relative emphasis should therefore be placed on SCS in breeding objectives for Holstein and Jersey cattle in South Africa.

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Milk quality is of major economic importance in dairy production. Low milk quality is associated with dairy products of inferior quality, which translates to economic losses. The concentration of somatic cells, commonly known as somatic cell count (SCC), is the most widely used measure of raw milk quality. Most milk buyers worldwide routinely test for SCC of bulk-tank samples of milk from producers. Premium prices are awarded for milk quality that exceeds certain thresholds, and penalties are imposed on milk that falls below minimum quality thresholds, as determined by SCC. Thus, SCC directly affects revenue from the sale of milk.

There are numerous milk buyers in South Africa that use different milk payment systems. Most of these buyers are regionally based. However, the major companies have a nationwide customer base and account for most of the market (MPO, 2013). SCC premiums and penalties are predominant features of the payment systems of the major milk buyers.

SCC is relatively easy and inexpensive to measure, and individual cow SCC is routinely recorded and genetically evaluated in most developed countries (Interbull, 2013). In addition to SCC being used as a herd management tool to monitor milk quality and udder health, efforts are made in many dairy cattle breeding programmes to improve SCC through selection. Routine genetic evaluation for SCC is carried out in several countries and was introduced in South Africa in 2004 (Mostert *et al*., 2004). Although the main interest in

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SCC stems from its utility as an indicator trait for mastitis, it is economically relevant in its own right, as it directly affects income from dairy production. Thus, resistance to mastitis and SCC may be included separately in the breeding objective. Some studies (Sender *et al.*, 1992; Colleau & Le Bihan-Duval, 1995; Sadeghi-Sefidmazgi *et al*., 2010) have determined relative economic values for SCC and resistance to mastitis separately. Sender *et al.* (1992) noted that such an approach was better at improving resistance to mastitis and milk quality than using only one of the traits.

There are ongoing efforts to implement scientifically and economically based breeding objectives for dairy cattle in South Africa (Banga, 2009). A sound breeding objective must incorporate all economically relevant traits. Furthermore, deteriorating trends in genetic merit for SCC observed in the South African dairy cattle population (National Dairy Animal Improvement Scheme, 2007; Dube *et al*., 2008; 2009) highlight the need to include this trait in breeding objectives. Hence, the primary objective of this study was to calculate the economic value of SCC in the major dairy cattle breeds in South Africa, namely Holstein and Jersey, as well as its relative importance. This will enable appropriate emphasis to be placed on SCC in the breeding objectives.

Milk quality payment schemes in South Africa are based on rolling geometric means of three herd-bulk-tank SCC tests. Bulk tank SCC, however, were not available; hence they were calculated from individual cow test-day SCC. Bulk tank SCC was computed as the average test-day SCC, weighted by each cow's milk yield. Individual cow test-day records used were from 183 Jersey and 209 Holstein herds that participated in the National Dairy Animal Improvement Scheme between 1 January and 31 December 2012. Data were edited according to Mostert *et al*. (2004). Records with SCC (x1000 cells/mL) less than 10 or greater than 100 million were discarded. Each herd test-day had a minimum of 10 cows, and there were at least three consecutive tests per herd, with not more than 45 days between successive tests. The overall bulk-tank SCC rolling means and average milk yield per cow per year by breed and production system are shown in Table 1.

Table 1 Bulk tank SCC rolling means and average milk yield by production system and breed

	Concentrate		**Pasture**	
	Jersey	**Holstein**	**Jersey**	**Holstein**
Number of herds	40	95	143	114
Number of SCC rolling means	858	2 154	3 110	2 538
Overall SCC mean (x1000 cells/mL)	298	397	192	252
Milk yield (litres/year)	6 252	9 746	5 152	7 049

There are several milk buyers in South Africa, which use different payment systems, and it was not possible to consider all of them. SCC premium schemes of the two major milk buyers, referred to as PS_A and PS_B, were used. The two premium schemes are summarized in Table 2.

The impact of increased SCC on milk revenue was determined by first calculating the average SCC premium in the base (average herd) situation, based on premiums for the individual rolling herd bulk-tank means. Next, a high SCC situation was simulated by incrementing each herd bulk-tank SCC by 10%. The average premium for the high SCC situation was then computed from recalculated rolling herd bulk-tank means. The revenue from SCC premiums in a herd (ZAR/cow/year) was obtained as the product of the average premium and average milk yield per cow per year.

Economic value was calculated as the change in profit per percentage increase in SCC per cow per year (i.e. difference in revenue from SCC premiums between base and high SCC situations, scaled to 1% increase in SCC). The distribution of SCC is positively skewed and its variances among groups or herds are heterogeneous (Ali & Shook, 1980); hence in genetic evaluation SCC is usually transformed logarithmically to somatic cell score (SCS). In South Africa, breeding values are expressed as SCS, calculated as $\log_{10}$(SCC). The final economic value was therefore expressed in ZAR per SCS.

Table 2 Somatic cell count premium schemes of two major South African milk buyers

SCC band (x1000 cells/mL)	Premium/Penalty (cents/litre)
Premium Scheme A	
<400	+0.4 for every 10 000 reduction in SCC up to maximum of +4
400 - 500	0.00
>500	−0.1 for every 10 000 increase in SCC up to maximum of −4
Premium Scheme B	
<350	+0.4 for every 10 000 reduction in SCC up to a maximum of +4
350 - 400	0.00
>400	−0.4 for every 10 000 increase in SCC up to a maximum of −10

Table 3 presents average SCC premiums for the average (base) and high SCC herds and economic values of SCS for each breed in each production system. Income owing to positive premiums was realised from the SCC premium schemes in all situations, except for the Holstein breed under the concentrate-fed production system. Average premiums were lower and economic values higher under PS_B relative to PS_A. An increase in SCS by one unit resulted in almost double the reduction in profit under PS_B compared to PS_A, for both breeds and production systems.

Table 3 Average somatic cell count premiums and economic values of somatic cell score by production system and breed

SCC Premium Scheme	Parameter	Production system: Concentrate		Production system: Pasture	
		Jersey	**Holstein**	**Jersey**	**Holstein**
A	Average penalty (c/L)				
	Base herd	2.74	1.59	3.57	3.06
	High SCC herd	2.43	1.18	3.41	2.73
	Economic value (ZAR/cow/year)	−433.87	−949.26	−178.65	−491.48
B	Average penalty (c/L)				
	Base herd	1.48	−0.64	3.11	2.02
	High SCC herd	0.82	−1.44	2.78	1.42
	Economic value (ZAR/cow/year)	−912.90	−1795.57	−367.37	−938.00

SCC: somatic cell count: SCS: somatic cell score; ZAR: South African Rand.

The economic value of SCS was much higher in the Holstein compared with the Jersey. This difference was more pronounced in the pasture-based system, where the economic value for the Holstein was nearly treble that for the Jersey. An increase in SCS caused lower decreases in profit (i.e. smaller economic value) in the pasture-based production system compared with the concentrate-fed system, with the largest difference (2.5 times) being observed for the Jersey under PS_A.

Standardized economic values indicate the relative importance of the different traits in the breeding objective. Figure 1 shows the relative economic values of traits in the breeding objective, standardized to protein (the most important trait), and averaged across breeds and production systems. Somatic cell score is among the most important traits; its value is 49% and 68%, respectively, relative to that of protein, under payment system PS_A and PS_B.

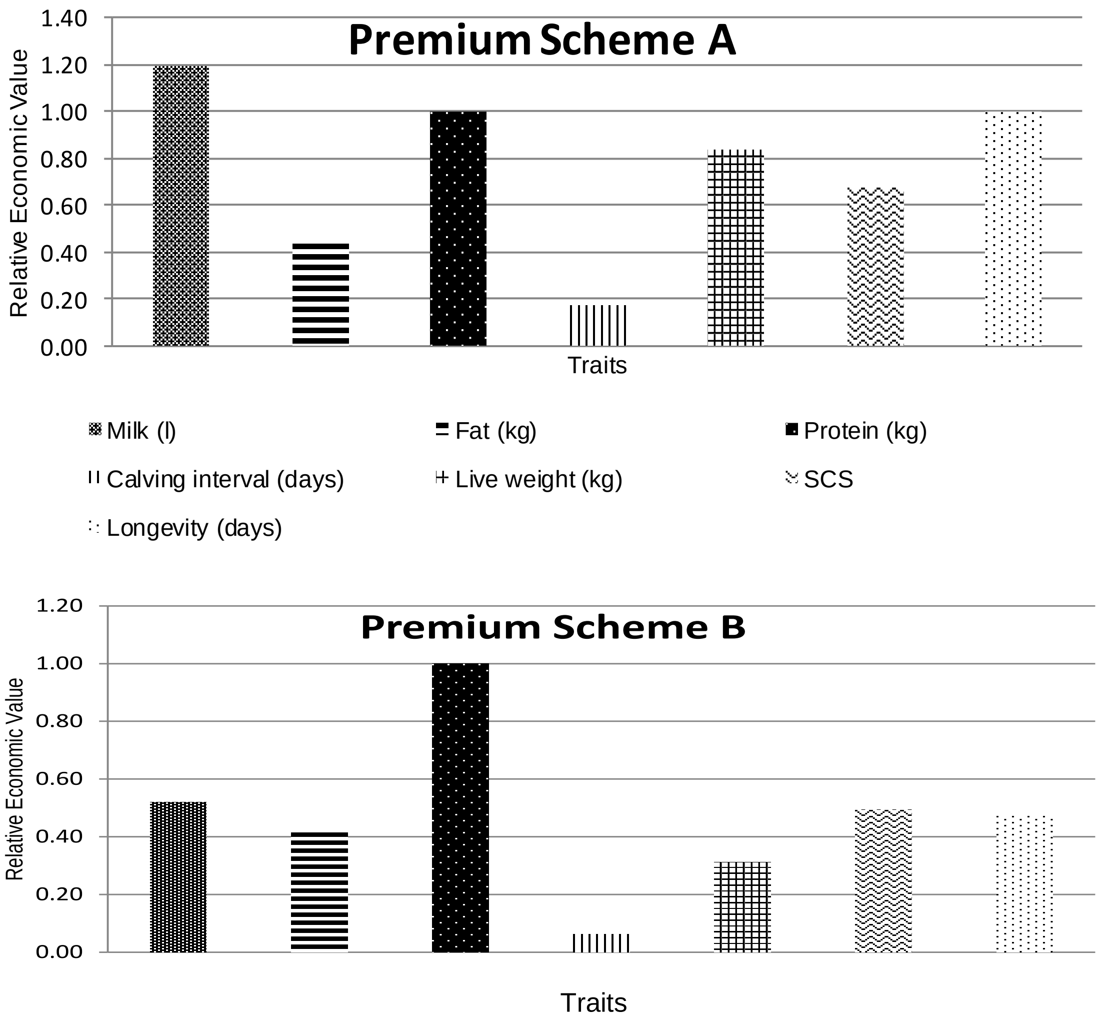

Figure 1 Relative economic values among breeding objective traits for two major SCC premium schemes.

SCC premiums are based on rolling bulk-tank SCC means. In the current study, bulk-tank SCC were not available; hence they were calculated from individual cow test-day SCC. Veerkamp *et al*. (1998) noted that when used to predict payment scheme penalties, these calculated bulk-tank SCC are representative of real bulk-tank SCC. Furthermore, Sadeghi-Sefidmazgi *et al*. (2010) observed that such an approach, which they termed the milk collection method, is a more robust method of deriving economic values for SCS than methods that assume premiums are calculated at the level of individual cows.

The economic value of SCS, as determined in the current study, represents the marginal loss in revenue attributable to penalties/reduced premiums resulting from marginal increases in SCC. It does not include losses related to mastitis, such as increased labour and therapy costs, discarded milk and premature culling of cows. Winkelman *et al.* (2003) calculated the economic value of SCC in New Zealand dairy cattle based on the costs of dry cow therapy, incidence of clinical mastitis, penalty for high SCC milk, lost days in milk and inhibitory substances. The approach of the current study has been used by several other researchers (Sender *et al*., 1992; Dekkers *et al*., 1996; Veerkamp *et al*., 1998; El-Awady, 2009; Sadeghi-Sefidmazgi *et al*., 2010), and is based on the premise that SCC is an economically relevant trait in its own right. Other benefits related to a decrease in SCC (i.e. resistance to mastitis) may thus be included in the breeding objective separately (Sender *et al*., 1992; Colleau & Le Bihan-Duval, 1995; El-Awady, 2009; Sadeghi-Sefidmazgi *et al*., 2010). Sender *et al.* (1992) noted that such an approach was better at improving resistance to mastitis and milk quality than using only one of the traits. In South Africa, available data do not allow benefits related to reduced mastitis incidence to be quantified using the approach of Winkelman *et al*.

(2003). The economic value of resistance to mastitis, however, may be calculated using data from a limited number of farms, as demonstrated by Sadeghi-Sefidmazgi *et al*. (2010).

Milk quality premium schemes vary among and within countries. In addition, the economic value of SCS is strongly dependent on the population mean (Dekkers *et al*., 1996; Veerkamp *et al*., 1998). These factors result in considerable variation in the economic value of SCS among studies. The current work shows SCS to be of high relative economic value. On the other hand, Colleau & Le Bihan-Duval (1992) reported an economic value of SCS relative to production of only 0.07 under French conditions. The sensitivity of the economic value of SCS to the mean is reflected in its variation between breeds and production systems in the present study. Mean SCS is lower in the pasture-based system than in the concentrate-fed production system, and the Holstein breed has a higher mean SCS compared with the Jersey. Accordingly, economic value is higher in the concentrate-fed system than in the pasture-based production one and in the Holstein relative to the Jersey. A reduction in SCS will thus result in better marginal returns in the concentrate-fed production system than in the pasture-based production system and in the Holstein compared with the Jersey. These observations highlight the need to determine economic values for each population and production system. Since mean SCS is likely to change with time, this means that it is important to calculate economic values regularly.

Economic values were about double under PS_B compared with PS_A. This is because PS_B is more strict (lower SCC threshold for bonus and higher penalties for high SCC milk) than PS_A. It is thus important to calculate economic values appropriate to the milk payment systems used in any particular country.

The current study creates the basis for assigning appropriate emphasis to SCS in the breeding objectives for South African Holstein and Jersey cattle. SCC is one of the most economically important traits in these dairy cattle populations; its economic value varies with breed, premium scheme and production system.

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