Opportunities in Southern Africa using animal economic values

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Abstract

Comprehensive new selection indices have been developed for Holstein, Jersey (Dairy) and Bonsmara (Beef) breeds in South Africa. In all cases the developments were based on the common practices followed in local production systems, biological knowledge, prices realised for the products, costs of inputs and the genetic (co)variances among the recorded traits. Although selection indices are in use with Holstein (BVI) and Jersey (SA-Inet) the application in beef cattle, based on cow profitability, will be new. The proper use of a monitory genetic value therefore heralds new opportunities for Bonsmara breeders, as the breed dominates beef cattle breeding in Southern Africa.

Measured traits included in the Beef index are: Birth Weight (direct and maternal), Weaning Weight (direct and maternal), Post Wean Weight (at about 540 days of age), Mature (Cow) Weight, Age at first calving and Calving interval. B-values are positive for the growth traits (and wean maternal) and negative for birth (direct and maternal), mature weight and the reproduction traits. This index will also supplement the current "Feedlot Profit Index" that has been available for some time. Measured traits included in the Dairy index are: Milk, Protein, Butterfat, Longevity, Somatic Cell Score, Calving Interval and Live Weight. B-values differ between the two breeds and among four different payment systems.

Keywords: Selection index, beef cattle, dairy cattle, cow profitability.

1. Introduction

Livestock production is the most important agricultural activity in South Africa and accounts for more than 40% of the total value of the agricultural output. This is a reflection of the environmental constraints as 80% of the agricultural land is suitable only for animal husbandry. Livestock production is therefore largely natural resource based. The only way that rangel and (grassland ecosystems) can be used for food production is through herbivores. Therefore, rangeland with its wide diversity of vegetation types, is the major natural resource that provides the main source of fodder for the 12,4 million beef cattle, 1,6 million dairy cattle, 29 million sheep and 7 million goats within South Africa. With regard to herbivores, beef cattle accounts for 45% of the gross value of herbivore products while livestock earnings amount to about 10% of agricultural export and through import plays a significant role in stabilizing the economies of SADC countries (Source: South Africa National Beef Cattle Strategy).

Of the 139 000 dairy cows (accounting for approximately 22% of the national dairy cow population) in the South African National Milk Recording Scheme, respectively 65 000 (47%) and 60 000 (43%) represent Holstein and Jersey cows (2009 Annual Report: National Milk Recording and Improvement Scheme). Of the 135 000 beef cows from participating farmers in the National Beef Recording and Improvement Scheme, 56 000 (41%) are from the Bonsmara breed (2009 Annual Report: National Beef Recording and Improvement Scheme).

Two projects, one aimed at adjusting the selection indices for dairy cattle and the other to develop a new index for beef cattle have recently been undertaken. Appropriately the Holstein and Jersey breeds were used for the dairy cattle index and the Bonsmara breed for the beef breed.

2. Methodology and results

2.1 Dairy Index methodology

A bio-economic herd model simulating an average farm, for each breed in each production system, was developed. Data collected through the National Dairy Animal Improvement Scheme (NDAIS) were used

to derive base herd parameters. Farm economic data and information on milk pricing were obtained from the Milk Producers' Organisation (MPO) of South Africa. Two of the milk buyers, Parmalat SA and Clover SA, also provided information on their milk payment schemes.

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. 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. Economic values obtained this way can be converted so that they are expressed according to selection goals.

The herd model simulated typical breeding and management practices in the two major production systems in South Africa (pasture and concentrate-based system). Breeding and calving took place all year round, with constant herd size being assumed. Replacement rate was therefore equal to death plus culling rate. All replacement heifers were raised on the farm. It was assumed that 55 % of calves born were male and they were all sold at a fixed price, within one week of birth. All heifer calves were retained until culling took place at 12 months of age and 3 months after reaching breeding age (for failure to conceive). Conception rate and mortality rate were assumed to be 85% and 5% respectively, across breed and production system. Surplus heifers were sold for slaughter, with the price per animal being based on carcase weight. Culled cows were disposed of at the end of a 305-day lactation and their slaughter price was determined by carcase weight. Carcase weight was calculated as 49% of live weight for both heifers and cows.

Calf rearing was the same in both production systems. After receiving 3 or 4 litres of colostrum a day (respectively for Jersey or Holstein) in the first 3 days of life, Jersey calves were fed 3 litres and Holstein calves 4 litres of whole milk a day until weaning at 8 weeks of age. In addition, Jersey and Holstein calves were given, respectively, 2 kg and 3 kg of calf meal a day from day 3 of age. Average weaning weight was 50 kg and 60 kg respectively for the Jersey and Holstein.

Cows in the pasture-based production system were grazed on pasture, comprising predominantly Kikuyu grass, and given 6 to 10 kg (as fed) of concentrate per cow per day during lactation. In winter (June-July), 10 kg (as fed) of maize silage were provided per cow per day as supplementary feed. Cows in the concentrate based production system were fed a total mixed ration (TMR), with quantities being based on production. The average energy content of feed (MJ ME/kg DM) was 9.0, 9.5, 11.0 and 14.0 respectively for pasture, silage, TMR and concentrate.

Base herd parameters used to simulate the average performance level of each breed in each production system. These values were derived from data recorded under the NDAIS on cows that calved between 1 January and 31 December 2006. It was assumed that all Jersey cows remaining in the herd were culled after completing their tenth lactation. There were however extremely few (less than 1%) Holstein cows calving after the eighth lactation, therefore it was assumed that all Holstein cows were only allowed to last in the herd for up to 8 lactations.

Live weight (LW) of animals at each month of age was predicted from the first month after weaning (month 3), using the von Bertalanffy growth function

2.1 Beef Index methodology

In order to derive to relative economic values for traits included in a selection objective, the first step was to identify all traits with a direct economical impact on a typical beef enterprise and could be quantified. A simulation program had to be developed that will included all the traits of relative economical value. The aim of the simulation program is to determine what the change in income or profit is with a one unit of change in such a relative economical trait while the rest of these traits' magnitude in the simulation program stays constant.

Qualifying traits identified as those of relative economic value for typical extensive South-African beef cattle farm were: survival percentage (from birth to weaning age), calving interval, weaning weight (wean direct), milk production (wean maternal), 18 months weight, mature weight and average daily gain (post wean).

In order to achieve the objective calculations were based on yearly gross income per hectare given the availability of a fixed amount of energy. This simulation is therefore based on farm size and grazing capacity (large stock units/hectare). The program require the averages (the national averages for the Bonsmara used) for weaning weight (228.5 kg), 18 months weight (371 kg), mature weight of cows and bulls (510 kg and 800 kg), milk production (14 kg/day), daily gain post wean (300 g), average fluctuations in daily gain for growing bulls during an average year (200 g per day), calving interval

(416 days), calf and wean percentages, replacement percentage (10%), herd age structure as well as the weaner (R14.50/kg) and slaughter (R18.50/kg) price per kilogram. Furthermore the program assumes an extensive beef production system where input costs are limited.

Based on this information the simulation program calculates (based on feed requirement specifications from the National Research Council) the number of animals that can be kept on a standard farm, according to the herd age structure presented. By using the given weaning percentage, replacement percentage, mature and weaning weights, the program calculates a total farm income. It is assumed that young animals are sold at weaning and replacement breeding stock are all sold to an abattoir. Because of the unavailability of slaughter data, it was furthermore assumed that all animals sold to the abattoir, obtained the same classification and therefore the same price per kilogram with a dressing percentage of 55%.

Herd profitability values were simulated for every unit change within biological levels for weaning survival percentage, weaning weight, milk production, 18-months weight, mature weight, average daily gain and calving interval.

To include the traits indicated, it was furthermore decided to fit newly developed models and re-estimate the genetic variances and co-variances for these traits. Two multi trait genetic analyses were done. The first analysis was a multi trait including all weight related traits where all the direct and maternal components were considered. The second genetic analyses was also a multi trait including heifer and cow fertility traits namely, age at first calving and calving intervals between the 1st and 2nd calf, 2nd and 3rd calf and between the 3rd and 4th calf. The resultant genetic variances and co-variances from these analyses were used in the development of the cow profitability index.

2.3 Dairy Index results

Tables 1 and 2 depict the resultant b-values for the two dairy breeds, production systems and the different payment systems.

Table 1. Economic values[1] (ZAR per unit) for concentrate-fed production system.

Breed	Trait	Payment System			
		A	B	C	D
Jersey &	Fat (kg)	1.21	5.81	2.47	4.21
Holstein	Protein (kg)	7.62	21.88	19.88	20.21
	Milk (l)	0.28	-0.49	-0.49	0.28
Jersey	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.*

Table 2. Economic values (ZAR per unit) for pasture-based production system.

Breed	Trait	Payment System			
		A	B	C	D
Jersey	Fat (kg)	6.26	10.91	8.59	6.51
	Protein (kg)	10.48	24.77	23.35	21.42
	Milk (l)	0.45	-0.32	-0.28	0.36
	Longevity (days)	1.77	1.73	1.54	2.29
	Live weight (kg)	-4.63	-4.60	-3.93	-6.46
	Calving interval (days)	-2.47	-2.45	-2.19	-3.18
	Somatic cell score	-178.65	-367.37		
Holstein	Fat (kg)	6.36	11.52	9.10	6.76
	Protein (kg)	10.54	25.11	23.63	21.56
	Milk (l)	0.45	-0.30	-0.27	0.37
	Longevity (days)	3.68	3.59	3.59	3.67
	Live weight (kg)	-4.12	-3.78	-3.22	-5.71
	Calving interval (days)	-3.19	-3.00	-2.68	-4.05
	Somatic cell score	-491.48	-938.00		

2.4 Beef Index results

Table 3 depicts the b-values for the selection index for the Bonsmara beef breed.

Table 3. Economic values (ZAR per unit) for the Bonsmara beef breed on an extensive farming system.

Trait	Economic value (South African Rand)
Birth Direct	-1.82437
Birth Maternal	-1.05686
Weaning weight Direct	+3.31048
Weaning weight Maternal	+4.56219
Eighteen months old weight (Direct)	+0.42546
Mature weight (Direct)	-0.42666
Age at first calving	-0.02954
Calving Interval ((Interval 1*0.44)+(Interval 2*0.33)+(Interval 3*0.23)	-4.26335

Figure 1 depicts the genetic change in the Bonsmara breed, based on the economic selection index Farm profitability).

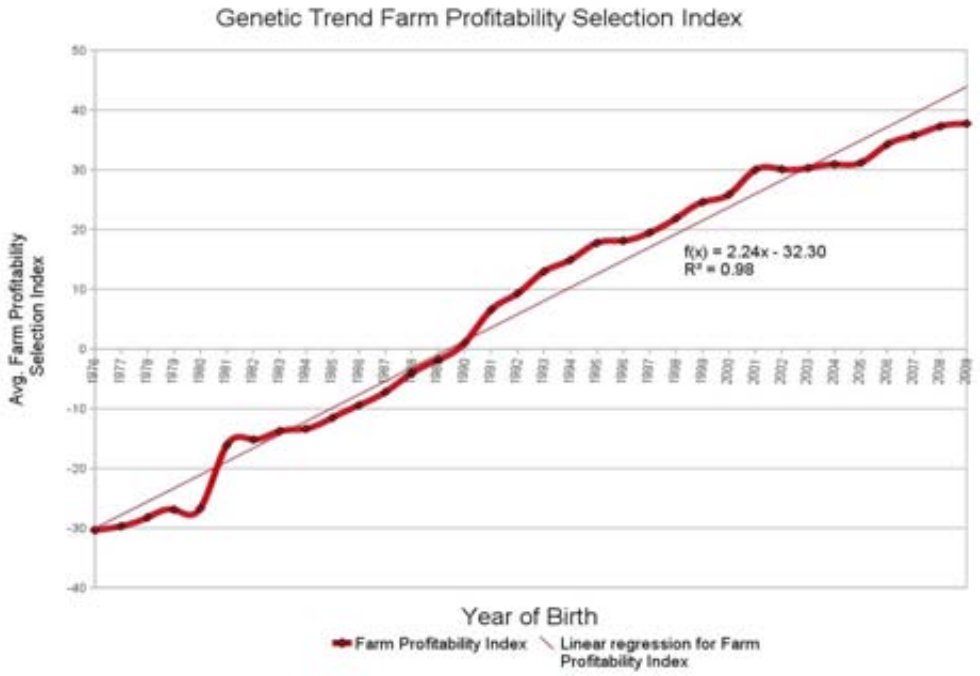

Figure 1. Genetic change in cow profitability index in Bonsmara cattle.

3. Future prospects and opportunities

Figure 2 depicts the gene-flow structure for beef (and dual purpose) cattle in South Africa (from the National Beef Cattle Strategy for South Africa).

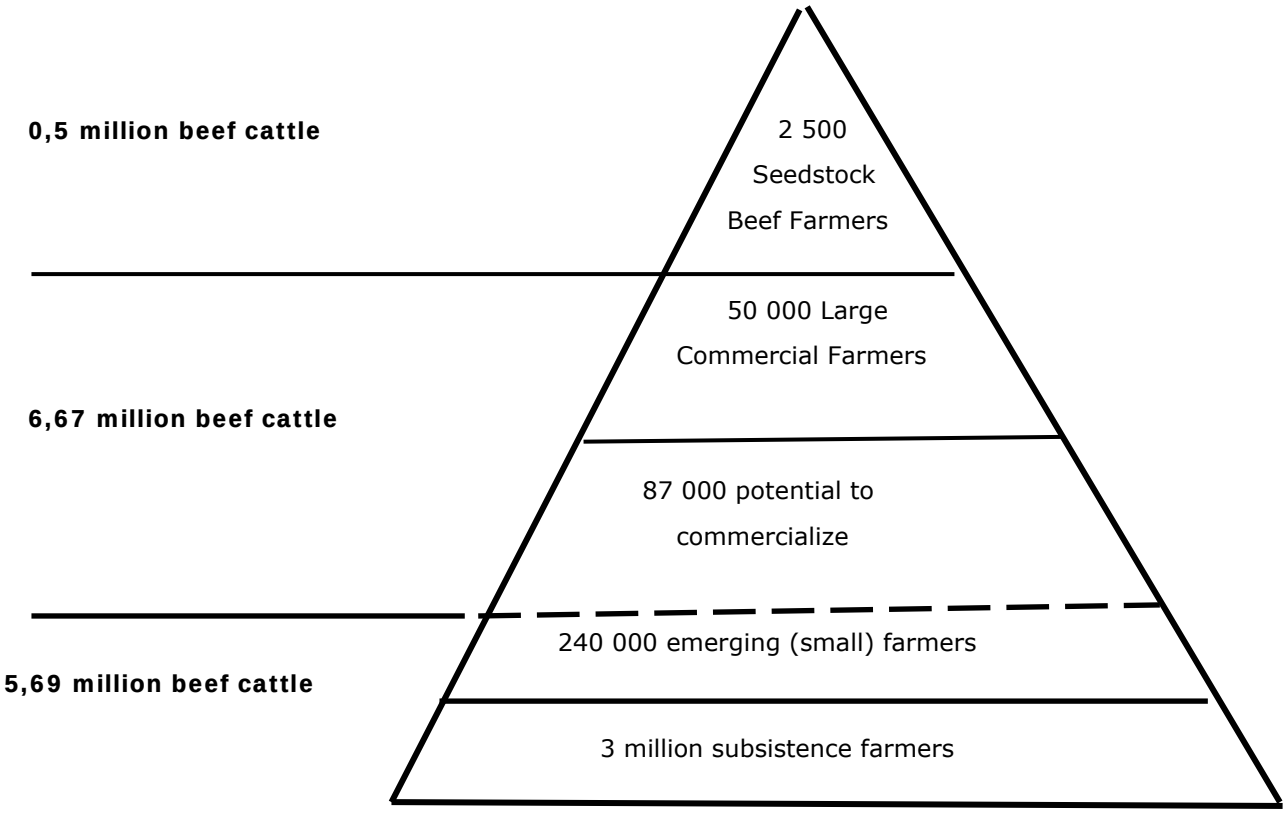

Figure 2. Gene flow pyramid for beef and dual purpose cattle in South Africa.

From the gene flow pyramid (Figure 2) it is clear that it is possible to impact a large number of cattle if positive genetic change based on cow profitability or dairy economic values are possible. If the trend in the most prominent beef breed, the Bonsmara can be achieved, given the genetic lag and "gene dilution" in the commercial cattle population, positive genetic change in the profitability of beef cattle is possible.

The use of selection indices has been practice in the dairy industry (SAINET for Jersey and BVI for Holstein) for some time, although the underlying principles in drafting these values were not based on the same sound principles as the currently proposed economic values. The beef industry, on the other hand, has been used to selection based on independent culling levels. The reduction of the current number of traits, presented on a typical sale catalogue, from more than 13 traits to a single monitory genetic value will simplify selection plans while also ensuring change in the desirable direction.