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Economic values for disease resistance traits in dairy goat production systems in Kenya

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ABSTRACT

This study estimated economic values (EVs) for disease resistance traits for dairy/crossbred goats in Kenya. The traits mean somatic cell count (SCC, cells/μl) and faecal worm egg count (FEC, epg) were taken as indicator traits for the most prevalent diseases in the smallholder farms i.e., mastitis and helminthiosis, respectively. Economic weights were objectively assigned to these indicator traits in a selection index such that the overall gains in the breeding objective traits were maximised. Four options for calculating EVs for SCC and FEC were considered. Option 1, response from single trait selection was set equivalent to index response for the trait. Option 2, response from single trait selection was set equivalent to maximum gains achievable. Option 3, level of FEC/SCC was set to zero; and option 4, response in FEC/SCC was set to the minimum gains achievable. In all the options, EVs with/without risk for breeding objective traits 12-month live weight (LW-kg); ADG, average post-weaning daily gain (ADG-g); DMY, average daily milk yield (DMY-kg) were used. For each production trait selected for improvement, a less positive response in the traits FEC and SCC would be desirable. Maximum negative EVs were achieved at a point where the response in SCC was set at zero (option 3) while EVs for SCC were zero when response for DMY was maximised (option 2). In addition, considerable differences in EVs for SCC were obtained when EVs with/without risk were used. Similar results were also observed for FEC when LW was the objective of improvement. However, more positive EVs for FEC were estimated relative to ADG and DMY. The results confirm that there is a scope to incorporate disease resistance traits in a breeding program with objective of reducing disease incidences and the costs of disease control.

1. Introduction

Dairy goats (manly crossbreds) potential have been well recognised in Kenya and their contribution to the densely populated areas remains high to-date. Despite this, the sector remains largely marginalised when compared to other ruminants i.e., cattle and sheep, due to lack of well designed and executed breeding programs. Recently, Bett et al. (2011) observed that a crossbreeding program targeting 75% crossbreds was optimal and desirable for implementation in the smallholder production systems. In the study, breeding objectives incorporating farmer's preferences and risk, which were lacking, were defined. Economic values (EVs) for production (12-month live weight, average post-weaning daily gain, average daily milk yield) and functional (mature weight and number of kids weaned) traits were

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also estimated. However, EVs for disease resistance traits were not considered.

Disease resistance traits have multi-fold influence on input and output of a production system, which in turn affects profits and EVs (Sivarajasingam, 1995; Gicheha et al., 2005). They are further complicated by environmental factors, nonlinearity effects and interactions (Sivarajasingam, 1998), and therefore cannot be estimated using the conventional approaches. Economic values for disease resistance traits can be predicted by assigning relative weights of indicator traits to matched specific breeding objectives (Sivarajasingam, 1995; Gicheha et al., 2005).

In Kenya, disease resistance traits were perceived by dairy goat farmers to be of primary importance in their production systems (Bett et al., 2009a). The most important diseases noted in these systems were mastitis and helminthiosis. Economic consequences of mastitis include loss of milk production, increased culling rate, and increased cost of labour for detection and veterinary treatment. Infection to gastro-intestinal parasites is associated with delayed and reduced productivity, increased susceptibility to other infections and increased use of anthelminthics or cost of controlling helminths. Conventionally, use of drugs (antibiotics) and anthelmintics have been used to control mastitis and helminthiosis, respectively. However, with the emergence of drug resistant parasites, high costs of pharmaceutical products, chemical residues in animal products and changes in consumer preferences (Baker, 1995; Barillet et al., 2001; Barillet, 2007), selection for improved disease resistance in animals is becoming more common in livestock breeding (Stear and Murray, 1994; Gicheha et al., 2005). Selection for disease resistance however requires its incorporation in the breeding objectives. Development of breeding objectives involves identification of important traits of a production system and estimation of their economic values. This study estimates EVs for disease resistance traits for dairy goats in the smallholder production systems in Kenya.

2. Methodology

2.1. Data source

The selected study sites were in Central, Rift Valley, Coast and Nyanza administrative provinces of Kenya (Bett et al., 2009a). In these regions, there is widespread dairy goat production under low input smallholder systems supported by different donor organizations (see Bett et al., 2009a,b). Biological and economic data used in the parameterization of the models (Bett et al., 2011) were derived from dairy goat records (Krause, 2005) and follow-up field studies (Bett et al., 2009a,c). Performance traits are recorded by farmers registered with the Dairy Goat Association of Kenya (DGAK) since 1992. The EVs estimated by Bett et al. (2011) (Table 1) for production traits were used as input parameters in the selection index to derive EVs for disease resistance traits.

Table 1
Economic values with (λ = 0.002)[a] and without risk for average daily milk yield (DMY), average post-weaning daily gain (ADG) and 12-month live weight (LW) obtained from crossbreds with 75% German Alpine blood level (B1).

	Traits		
	DMY	ADG	LW
Economic values without risk[b]	49.50	51.94	77.65
Risk-rated economic values[b]	35.91	45.42	65.59

[a] Arrow Pratt coefficient of absolute risk aversion see Bett et al. (2011).
[b] In Kenya Shillings – KES, where 1 USD = 70.00 KES.

2.2. Disease resistance traits

Even well-researched definition of breeding objectives and selection criteria may never be used in practise if those definitions do not take into account the perception and wishes of the breeders for whom they are designed. In this study, disease resistance traits were ranked highly by farmers in a field survey (Bett et al., 2009a). Mastitis and helminthiosis were the most common diseases in these smallholder farms. In genetic evaluation schemes however indirect selection is necessary in order to lower the prevalence of these two diseases. Mean somatic cell count (SCC, cells/μl) and faecal worm egg count (FEC, epg) can be taken as indicator traits for mastitis and helminthiosis, respectively (Baker et al., 1999; Rodriguez-Zas et al., 2000; Barillet et al., 2001; Barillet, 2007). The indicator traits SCC and FEC can be selected for in a breeding program without any detrimental effect on each other (Sechi et al., 2009).

2.3. Estimation of economic values

Incorporation of disease resistance traits in a breeding program requires calculation EVs for indicator traits, FEC and SCC. Methods for estimating EVs for disease resistance traits in a single trait index (Sivarajasingam, 1995) and multi-trait index (Sivarajasingam, 1998; Gicheha and Bett, 2010) were applied. The approach objectively assigns economic weights to an indicator trait in a selection index such that the overall gains in the breeding objective traits are maximised. This method is based on a selection index theory (Hazel, 1943), thus a vector of selection index weights is calculated as:

$$b = P^{-1}\ \ \mathrm{Ga} \tag{1}$$

where b is a vector containing the coefficients of the index traits, and P^{-1} the inverse phenotypic (co)variances matrix of the characters in the selection index. The genetic (co)variance matrix of selection criteria traits and traits in the breeding objective is represented by the G matrix, and a is a vector of economic weights in Kenya Shillings (KES) of traits in the breeding objective.

Response (g) after one round of selection on the index for each trait, assuming a selection intensity of 1, is calculated as:

$$g = \frac{b'G}{\sigma_I} \tag{2}$$

where σ_I is the standard deviation of the selection index ($\sigma_I = \sqrt{b'Pb}$) which equals overall response for traits.