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Definition of breeding objectives and optimum crossbreeding levels for goats in the smallholder production systems

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ABSTRACT

The objective of this study was to define breeding objectives and consequently determine optimum crossbreeding levels for goats in the smallholder production systems. Profits and economic values (EVs) were estimated for four genotypes namely (a) original stock or local goat breeds with 0% German Alpine blood level (OS), (b) F1 with 50% German Alpine blood level (F1), (c) first backcross with 75% German Alpine blood level (B1) and (d) second backcross with 87.5% German Alpine blood level (B2). The EVs were estimated for average daily milk yield (DMY, kg), average post-weaning daily gain (ADG, kg), number of kids weaned (NKW), mature weight (MW, kg) and 12-month live weight (LW, kg). Profitability in Kenyan Shilling (KES) without risk was optimal (KES 6038.02) for the B1 genotype. Economic values without risk for most traits were highest for the F1 genotype, i.e., KES 64.85 (ADG), 24.02 (NKW), −27.55 (MW) and 84.51 (LW). There was, however, a 23% reduction in profits in the F1 genotype. It was evident that crossbreeding would improve the profitability of the smallholder farms, but not beyond the 75% grade level. A similar trend was observed when risk was incorporated. Differences in profitability with and without risk were less than 0.005% for all the genotypes. However, differences in EVs were large, ranging from −28% to +19%; DMY had the largest differences. Therefore, incorporation of risk in estimation of EVs for traits of importance is necessary. This study has also demonstrated that crossbreeding to a higher grade level is not necessarily compensated for by a high performance in most traits. Therefore, a crossbreeding program targeting B1 (75%) crossbreds would be desirable for implementation in the smallholder production systems.

1. Introduction

The goat industry plays a very important role in the economic and social life of many Kenyans, contributing meat, milk and skins (MLFD, 2007). The population of goats is estimated at about 11.08 million meat goats and 80,000 dairy goat breeds (mainly crossbreds) (MLFD, 2007). This population has increased at the rate of about 5.36% p.a. over the last 10 years, with dairy goats and their crosses registering the highest growth of about 27.4%. The growth of the latter sub-sector was attributable to the high demand for these animals in the high rainfall areas where farming land sizes are small and to their contribution to better human nutrition especially milk (Ahuya et al., 2005; Kosgey and Okeyo, 2007; MLFD, 2007; Kosgey et al., 2008).

Non-Governmental Organizations (NGOs) and bilateral organisations that have implemented projects upgrading local goats using the exotic male dairy goat breeds

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include; the German Agency for Technical Co-operation (GTZ)/Integrated Small Livestock Project (ISLP), FARM-Africa Dairy Goat and Animal Health-Care Project, Heifer Project International (HPI) and USAID (Small Ruminant Collaborative Research-Support Program – SR-CRSP). However, in all these projects there was inadequate involvement of the farmers in implementation of the breeding programmes and their practices, behaviour, values and objectives were rarely integrated (Sölkner et al., 1998; Kosgey, 2004; Krause, 2005; Ahuya et al., 2005; Kosgey et al., 2006; Bett et al., 2009a,c).

Definition of the breeding objectives forms the initial step in the development of genetic improvement programmes. Logically, this definition should start with consideration of all the relevant traits. Thereafter, the number can be limited to a few traits of major interest while considering producers preferences in order to reduce the risk of it being neglected, being unproductive or not performing its intended function. Trait preferences by the producers are influenced by the either costs or revenues associated with these traits in a production system or social reasons (Kosgey, 2004; Kosgey et al., 2006; Bett et al., 2009a). Only few studies have incorporated farmers' preferences into breeding objectives (Tozer and Stokes, 2002; Nielsen and Amer, 2007).

Uncertainty over future product prices is an important component to be considered when developing breeding objectives (Kulak et al., 2003). This involves including producers' risk preferences in the definition of breeding objectives because of its influence on the cost-benefit of the breeding programmes (Kulak et al., 2003; Pruzzo et al., 2003). Risk can be defined as the variance of profit and producers risk attitude (Kulak et al., 2003). Variance of profit is derived from the input and output prices, while risk aversion is assigned a coefficient value in the calculation of profit.

In this study, the Dairy Goat Association of Kenya (DGAK) programme established by the GTZ/ISLP in 1992 was taken as a case study. The programme utilises imported German Alpine male goats as the foundation stock for crossbreeding with the Kenyan local goat breeds (the Galla and Small East African). A 2-way crossbreeding strategy was adopted where local goats were improved through upgrading to 87.5% Alpine blood level. However, similar to other goat breeding programmes in the East and Central Africa regions, crossbreeding trials to define the optimum level of upgrading to fit the prevailing production conditions and market economic prospects were often overlooked.

In the DGAK programme, four genotypes are present, namely (a) original stock or local goat breeds with 0% German Alpine blood level (OS), (b) F1 with 50% German Alpine blood level (F1), (c) first backcross with 75% German Alpine blood level (B1) and (d) second backcross with 87.5% German Alpine blood level (B2). The objective of this study was to define breeding objectives and consequently determine optimum crossbreeding levels for goats in the smallholder production systems. The influence of incorporating risk and producer's preferences in the definition of breeding objectives was also assessed.

2. Methods

2.1. Definition of breeding and production systems

Most goat farmers in the project areas, i.e., in medium and high rainfall areas of Kenya, have resorted to commercial (market-oriented) dairy goat farming; a deviation from the original project objectives of providing for basic livelihood. Farmers in these regions are mainly smallholders applying improved husbandry techniques. Generally, goats are confined in improved standard goat pens and stall-fed. Pastures and forages are cut and carried to the animals, and pest and disease control measures are undertaken (Kosgey et al., 2008; Bett et al., 2009b).

In the DGAK programme, farmers are organised into groups to facilitate delivery of important services such as trainings in animal healthcare, husbandry and performance recording, and utilisation of breeding bucks. The programme also performs breed improvement activities, selection, registration of the crossbreds, cost-sharing and cost recovery activities. The management regimes, including feeding and management of selection and restricted culling policies between the farmer groups are almost similar. Upgrading of the local goats from OS to B2 using pure exotic bucks is performed at the farm level. Nearly all the farm households in this programme keep all the genotypes, and under one management unit with no special treatment given to any of the genotypes. Breeding bucks for upgrading are provided for at a cost in a buck rotation scheme, where each allotted buck in a farmer group is rotated after every 15 months to minimise inbreeding. A breeding buck is used for approximately four rotations which is equivalent to a useful life of five years. A minimum of 25 breeding does in a farmer group was recommended, and, therefore, a mating ratio of 1:25 was assumed.

In this study, out of the four genotypes evaluated three were crosses (F1, B1, and B2). Since, local goats were upgraded directly from OS to B2, with subsequent plans to stabilise the crossbreds at B2 as synthetics, only F1 and B1 primary crossbreds were available. Therefore, the performance parameters presented in Table 1 for these genotypes consider only the heterotic effects of the primary crossbred generation. For B2 genotype, performance parameters of the primary crossbred generation were assumed to avoid any bias in the comparison of the genotypes. This is because the performance of the crossbreds is not only a consequence of additive effect (complementarity between breeds used) but also due to the interaction between breeds (heterosis). Similarly, the performance data for the *inter se* mated population of B2 genotype was scarce in the farm households. Farmers opted to sell the offspring of this genotype rather than create a foundation stock for formation of synthetics because they fetched higher prices in the market as breeding stock (Krause, 2005).

For the purpose of this study and to determine the optimum crossbreeding levels, resultant crossbreds' genotypes (F1, B1 and B2) were treated independently from each other with the notion that the smallholder farmers were to evaluate the stock as they produce. Calculation of net benefits was assumed to begin when the crossbred doe gives birth and end when the kids born qualify as breeding stock. All the genotypes are dependent on each other for either breeding or replacement stock and therefore they constitute part of a complex integrated production system. Fig. 1 illustrates the continuous crossbreeding system assumed. Briefly, within the OS group purebred local females and males are produced for own replacements. In addition, young female progeny with 50% gene proportion produced in this group are assumed to move to the F1 group as breeding stock. Groups B1 and B2 are similar to F1 group, but utilises breeding stock with 75% and 87.5% gene proportion of the Alpine breed, respectively.

2.2. Farmers preferences for different traits and logical tradeoffs

Table 2 presents four categories of traits; milk yield, body size, growth rate and fertility that were identified using weighted averages of rankings (Bett et al., 2009b). These traits were ranked first, second and third respectively, and explained about 70% of the total weighted indices. Briefly, indices were calculated using a ranking procedure where indices represent weighted averages of all rankings for a particular trait. These estimates explain the weight and the preference for traits by the goat farmers. Additionally, logical trade-offs in the choice of traits were accounted for and comparisons made using Spearman's non-parametric correlation coefficient (r) of ranks ($p < 0.05$). The traits' correlation coefficient (r) signs and significance indicates the strength and direction of a linear relationship between two traits. These trait categories were then