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Participatory definition of breeding objectives and selection indexes for sheep breeding in traditional systems

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ABSTRACT

A farmer participatory approach was used to define breeding objectives and selection indexes for short-fat-tailed sheep in sheep–barley systems and Black Head Somali sheep in pastoral systems in Ethiopia. Breeding-objective traits were identified based on producers' preferences for traits collected during interviews. The desired gains in the various traits were calculated based on the producers' preferences for traits and were used to weigh traits in the breeding objective using selection-index methodology. This study recognized subsistence producers (producing yearlings) and subsistence + producers (producing and finishing yearlings) within sheep–barley and pastoral systems. Producers' preferences for traits showed that adaptive traits are more important (pastoral system) or as important (sheep–barley system) as production traits. Subsistence producers gave more weight to adaptive traits than did the more market-oriented subsistence + producers. A low correlation (0.31) was found between selection indexes constructed for subsistence and subsistence + producers in the sheep–barley system. This demonstrates that breeding objectives need to be tailored to the specific needs of the different groups of farmers. The results of our study can be used to design sheep breeding programs in Ethiopia and elsewhere with similar production circumstances. We present an approach to incorporate producers' preferred breeding objectives into conventional selection tools.

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1. Introduction

Sustainable animal breeding strategies require a broad definition of breeding objectives that emphasize maintaining adaptation and biodiversity in addition to profitability (Olesen et al., 2000; Nielsen et al., 2005, 2006). Sölkner et al. (1998) and Kosgey et al. (2004) argued that when defining animal breeding objectives, particularly for subsistence farmers in marginal situations, the needs and interests of the target group should be incorporated. This involves incorporating both tangible and intangible benefits of livestock keeping.

Defining breeding objectives involves identifying breeding-objective traits, deriving their relative importance, and constructing the aggregate genotype that can subsequently be translated into a selection index. It is important to involve the stakeholders in the process of defining breeding objectives. Most studies on participatory definition of breeding objectives have been limited to identifying breeding-objective traits (e.g., Perezgrovas, 1995; Jainter et al., 2001; Tano et al., 2002; Wurzinger et al., 2006; Ndumu et al., 2007). These “traits” are usually defined in general composite terms such as “adaptation”, “growth”, or “reproduction”. Little emphasis has been placed on using information from participatory studies to derive relative weights and selection indexes for such traits.

Here, we used subsistence sheep-farming in Ethiopia as a case study for developing participatory breeding objectives

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and selection indexes. In Ethiopia, sheep are produced in two main types of systems: 1) sheep–barley systems in sub-alpine areas, and 2) pastoral systems in arid lowlands (Gizaw et al., 2008). Sheep production in these systems is characterized by subsistence-level management, a wide range of production objectives and marketing strategies, and marginal production environments. Breeding objectives are defined by the farmers' and pastoralists' preferences for different traits. We present an approach for weighing traits in the breeding objective based on farmers' preferences.

2. Materials and methods

2.1. Definition of production systems

Holders of two short-fat-tailed traditional sheep breeds, Menz and Wollo, representing the sub-alpine sheep–barley production system, and the Black-Bead-Somali breed, representing the arid lowland pastoral production system in Ethiopia were surveyed. For a detailed description of breeds, see Gizaw et al. (2007a). One hundred and sixty-one farmers from sheep–barley systems and 101 pastoralists were interviewed individually.

Proportional piling method was used to determine the priorities of farmers and pastoralists. Proportional piling is a semi-quantitative method to determine community priorities (FAO, 2000). Each person was asked to allocate 20 pebbles to seven functions of sheep (regular cash income, financing/insurance benefits, socio-cultural importance, meat, fleece, manure, and milk). The functions were presented using drawings, as described in more detail below. Respondents were also interviewed about their finishing and marketing strategies using the items presented in Table 2. These results were used to allocate farmers to one of two groups within each production system:

1. Subsistence lamb producers (S): produce unfinished yearlings for sale to consumers or finishers.
2. Subsistence lamb + producers (S^+): produce unfinished and finished yearlings and culled rams.

2.2. Identification of breeding-objective traits

Six categories of traits that influence the important functions of sheep (Table 1) were identified (Table 3): adaptation, growth/weight, *qumena* (farmers' general physical description of an animal in relation to its market value, which includes size, conformation, tail, horn, and color), reproduction, fleece, and milk. We defined a trait category as a 'characteristic' consisting of one or more biological component traits. Defining such broad trait categories facilitated discussions with farmers since farmers describe animal performance using such expressions. In addition, individual biological traits could be too detailed and their numbers too large to be used in discussions with farmers.

The six trait categories were described to producers using drawings of six hypothetical types of sheep. Generally, each sheep type encompassed one of the trait categories, but trade-offs between the different trait categories were also described verbally and with the aid of drawings. For example, the adapted sheep type was shown in the drawing as smaller in size than a less adapted but fast-growing sheep type. The trait categories were rated by producers using 20 pebbles. Wilcoxon Signed Rank test was used to evaluate similarities between the ratings of the six trait categories. Trait categories that did not differ significantly in rating were assigned the same ranking (Table 3).

The trait categories used during the interviews with the farmers were too broad to be used directly in the selection indexes. Therefore, each trait category was translated into component traits. Component traits for which estimates of genetic parameters were available were chosen for this study. The component traits (abbreviations in parenthesis) identified for each trait category were:

1. *Adaptation*: fecal worm egg count (FEC)
2. *Growth/weight*: yearling weight (YW), mature weight (MW), and daily gain during finishing (ADG; S^+ producers only)
3. *Qumena*: chest girth (CG)
4. *Reproduction*: number of lambs weaned (NLW)
5. *Fleece*: greasy fleece weight (GFW; sheep–barley system only)
6. *Milk*: daily milk yield (MY; pastoral system only)

2.3. Desired-gain selection indexes

2.3.1. Derivation of relative weights

We used a desired-gain selection-index method to derive relative weights for breeding-objective traits that result in gains desired by producers. Producers' desired gains were established based on their preferences for trait categories (Table 3). Two desired selection indexes were constructed for each of S and S^+ producers in sheep–barley and pastoral systems. For the first index, desired gains for component traits that were ranked first were set equivalent to maximum gains achievable. For the second index, gains were maximized for component traits that ranked first and second. Weights for component traits in the breeding objective were set to zero if their respective trait categories ranked below first in the case of first index and below second in the case of second index. The genetic response observed for these traits is the correlated response that results from selecting for the traits included in the breeding objective.

The maximum gain for each trait was the gain achieved from single-trait selection on that trait only, i.e. with only this trait in both the aggregate genotype and the selection index.

Table 1
Sheep producers' ratings [a] of the relative importance of functions of sheep in sheep–barley and pastoral production systems.

Function of sheep	Sheep–barley system	Pastoral system
Regular cash income	6.12	4.84
Financing/insurance benefits [b]	7.28	7.26
Socio-cultural importance	1.25	3.51
Meat (home consumption)	1.82	1.68
Fleece (home use and sale)	1.33	0.00
Manure (home use)	1.96	0.34
Milk (home consumption)	0.04	2.46

[a] Number of pebbles allocated to each function out of 20 pebbles.
[b] For sheep–barley systems, this includes insurance against crop failure.

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