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Community-Based Identification of Breeding Objectives and Selection Criteria for Indigenous Maefur Goat: Input for Developing Community-Based Breeding Program

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Research Article

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Abstract

Identifying farmers' breeding objectives and selection criteria is necessary for designing effective and sustainable community-based breeding programs for indigenous breeds. The present study was carried out to identify breeding objectives and selection criteria of Maefur goat raised under extensive production system. A participatory approach involving goat keeping households was employed, and data was gathered using proportional piling and own-flock ranking. Farmers allocated counters to different traits using proportional piling to show the relative importance of breeding objectives, whereas own-flock ranking was used to phenotypic traits considered when selecting the best and least performed breeding does. Phenotypic performance data including live body weight and linear body measurements were recorded from ranked animals to examine their relationship with farmers' selection decisions. All statistical analyses were conducted using R software (R Core Team, 2024). Results reveal that farmers prioritized productivity and survival related traits, with growth performance, milk yield, and kid survival identified as main breeding objective traits; while disease resistance, kidding rate and adaptability were also considered significant for flock sustainability. In ranking animals within their flocks, farmers primarily used observable traits including body size, milk production, and maternal performance. The findings show that goat farmers prioritize traits that improve productivity, adaptability, and flock growth under local management conditions. Accordingly, incorporating farmers' indigenous knowledge and preferred traits into breeding programs is fundamental for sustainable implementation of community-based program for indigenous Mauer goat. The identified breeding objectives and selection criteria provide baseline information for designing sustainable genetic improvement programs tailored to local production system.

1. Introduction

Goats are important multiuse livestock that supply milk, meat, and hides, thereby contributing to nutritional needs and economic well-being (Abegaz et al., 2013; Lu, 2023). Their resilience and capacity to adapt to a wide range of agro-climatic conditions and production systems make them largely appropriate for smallholder and extensive production systems (Martin et al., 2019; Tabbaa et al., 2023).

Ethiopia hosts one of the largest goat populations in Africa (Washaya et al., 2026), marked by substantial genetic diversity and favorable agro-ecological conditions (Abraham et al., 2018). Almost 99.9% of the estimated 52.5 million goats in the country are indigenous landraces (CSA, 2020) originating from animals historically introduced by nomadic pastoral communities (Belay et al., 2024). Despite possessing a large and genetically divers goat population, Ethiopia derives limited economic returns and livelihood benefits for smallholders because of low productivity of individual animals. This low performance is associated with many factors such as absence of improved breeds and weak implementation of effective breeding programs (Abraham et al., 2018; Molla, 2020; Melesse et al., 2022).

Genetic improvement initiatives were introduced to enhance performance of indigenous small ruminants (goats and sheep) in Ethiopia for instance crossbreeding programs. Nevertheless, crossbreeding programs generally failed to achieve their intended outcomes and offered animal benefits to smallholder farmers (Ayalew et al., 2003; Getachew et al., 2013; Sheriff et al., 2018). These outcomes suggest

selection-based breeding programs may offer a more appropriate approach for improving animal productivity and supporting poverty reduction among resource-poor farmers in the developing world such as Ethiopia (Haile et al., 2011; Dagnew et al., 2018). Therefore, centralized nucleus selection schemes were established in various areas to produce genetically superior indigenous animals (Sheriff et al., 2018).

Effectiveness of genetic improvement initiatives mainly depend on clearly established breeding objectives (Wurzinger et al., 2021; Zorobouragui et al., 2025). Accordingly, breeding objectives and selection criteria–reflecting the traits that farmers seek to improve and use as the basis for their selection decisions need to be identified through full involvement of smallholder farmers (Abraham et al., 2018; Asegd et al 2022). A mixed-method approach provides comprehensive understanding of farmers' trait preferences than reliance on a single method (Duguma et al., 2010).

Therefore, the study was undertaken to identify breeding objectives and selection criteria for indigenous Maefur goat using participatory approaches. Such approaches facilitate definition of breeding objectives and prioritization of traits by integrating farmers' indigenous knowledge and practical experience (Tano et al., 2003).

2. Materials and Methods

2.1 Study area description

The study was conducted in Irob District of Eastern Zone of Tigray Region, Ethiopia. The study district was purposely selected based on the availability of Maefur goat. Irob District is found in the North-East direction of Mekelle city about 930 km from Addis Ababa. A detailed description of the study area has been indicated in literature (Zigta and Waters-Bayer, 2001; IDA, 2015; Abraham, 2024).

2.2 Description of Maefur goat

Maefur goat is one of the distinctive indigenous goat populations in Ethiopia (IBC, 2004), which is an important avenue for poverty alleviation under small-scale farming practices through its vital role to household nutrition and income generation (Kidane and Abraham, under review). Indigenous Maefur goat is raised in Irob District, Eastern Tigray Zone, Northeastern Ethiopia. Production of Maefur goat is based on low-input production system. This goat is solely fed on communal grazing with little or no external input (Kidane and Abraham, under review).

Phenotypic characteristics of the indigenous Maefur goat has been systematically documented (http://academicjournals.org/journal/IJBC/article-abstract/53CF2E963837). Coat color patterns in this indigenous goat are primarily classified as pied, uniform, and shaded, with the shaded type such as light brown, black, and gray colors. Morphological characteristics of Maefur goat are short ear (12.0 cm in males and 11.8 cm in females), long and thick horns, medium body size, and large heart girth. Males reached sexual maturity at 11 months, whereas females did so at 12 months. Does reached first kidding

at a mean age of 21 months, and the average kidding interval was 7 months (https://doi.org/10.5897/IJLP2017.0423).

2.3 Sampling techniques and procedures

Irob District was purposively selected based on indigenous Maefur goat production potential. Secondary data about Maefur goat distribution, accessibility and security were obtained from the District Bureau of Agriculture and Natural Resources. Using the information obtained, three potential *tabias* (the smallest administrative unit in Ethiopia's Tigray region) were identified and selected.

2.4 Participatory identification of breeding objectives and selection criteria

Participatory approaches are increasingly used in identification of breeding objectives. These methods are particularly valuable when estimating the economic value of traits is challenging due to structural constraints within production systems, limitations of conventional valuation methods, or the need to capture diverse stakeholder motivations (Burns et al., 2022). Through incorporating user preferences, these approaches generate breeding objectives and selection tools that better reflect stakeholder values and are more likely to be in practice (Gizaw et al., 2018; Tesema et al., 2024; Mathapo et al., 2025). Proportional piling and participatory own-flock ranking experiments were employed in the present study. Detailed descriptions of these methods are provided in the subsequent subsections.

2.4.1 Proportional piling method

A survey of farmers' trait preferences was conducted between March and May 2025. A total of sixty indigenous Maefur goat keepers from three *tabias* in Irob District of eastern Tigray zone participated in the present study. Farmers were interviewed individually to elicit their relative preferences for six traits. The survey employed a participatory appraisal method, specifically proportional-piling tool. To identify the most important traits, selected key informants were interviewed individually and asked to rank the traits by using proportional piling with 100 counters. This method involves allocating 100 counters among predefined trait categories according to perceived importance and has been shown to be an effective approach for taking farmers' perceptions (Gizaw et al., 2018).

For the preference elicitation exercise, each respondent was provided with 100 beans and asked to allocate them across six traits based on perceived importance. Traits were presented in conceptual terms rather than as quantified differences, to simplify the ranking and weighing process and elicit farmers' holistic valuation of the traits.

2.4.2 Own-flock ranking experiment

In own-flock ranking, each respondent was asked to classify her/his breeding does into four performance categories (first best, second best, third best and the worst) among the breeding does in their flocks, based on the six traits identified through the participatory appraisal. The goat owners were also asked to

justify their rankings, thereby providing insights into the criteria influencing their trait preferences and overall evaluation of breeding does.

To analyze the relationship between farmers' rankings and phenotypic performance, live body weight and some linear body measurements were systematically taken for each ranked animal. The recorded traits included body weight (BW), body length (BL), heart girth (HG) and height at withers (HW). To avoid the effect of feeding and watering on the goats' weight and size, the measurements were taken early in the morning at farmers' homesteads prior to grazing. Life history of the ranked animals, focusing on previous reproductive (number of kidding, kids born, kids weaned, kidding interval) and productive performance (daily milk yield) were inquired and recorded.

2.5 Data Analysis

Data collected through proportional pilling methods and own-flock ranking experiment were systematically coded and analyzed through a combination of descriptive and non-parametric statistical procedures fitting for ordinal and semi-quantitative data. For proportional piling, the number of counters allocated to each trait by the respondents was converted into proportions and percentages, and summarized using means, standard deviation (SD), and rank indices to determine the relative importance of traits across households. Differences among groups were evaluated using non-parametric, for instance the Kruskal-Wallis or Mann-Whitney U test when appropriate.

For own-flock ranking experiment, animals ranked by farmers were assigned numerical scores based on their position (1 = 1st best; 2 = 2nd best; 3 = 3rd best; 4 = worst), and mean ranks and frequency distributions were calculated to identify selection patterns.

The relationship between farmers' ranking and phenotypic traits such as body weight and linear body measurements was evaluated to determine the extent to which subjective preferences correspond with objective measurement. Ranking scores obtained through own-flock ranking were treated as ordinal variables, while performance indicators including live body weight and linear measurements (body length, chest girth, height at whiter) were analyzed as continuous variables. Correlation analysis (Spearman's rank correlation for ordinal data and Pearson's correlation where appropriate) was used to assess the strength and direction of associations between ranking positions and measured traits.

3. Results and discussions

3.1 Farmers' trait preferences for breeding does

The results given in Table 1 show that farmers prioritize different traits of breeding does based on their relative importance, as measured through proportional piling methods. Findings of the study shown that goat farmers preferred many traits of a breeding doe indicating its worth and multi-functional nature, which is in line with previous studies (Abraham et al., 2018; Getachew et al., 2020; Sheriff et al., 2024). Growth performance emerged as the most chosen trait, with a mean proportional score of 33.4% (SD = 6.6), ranking first among all traits. This suggests that farmers place strong emphasis on animals that

grow faster and attain higher body weight due to their direct contribution to market value and income generation. Consistent with the present findings, Kidane and Abraham (under review) show that the main purpose of keeping goats in the area is to generate cash income.

Milk production ability was identified as the second most important trait, accounting for 22.1% (SD = 5.2) of the total score. This shows the dual purpose of goats in the area where milk serves as important source of household nutrition. In agreement with findings of the present study, FAO (2019) indicated that goat milk constitutes a key component of diet in Ethiopia. Kid survival was identified as the third most important trait, with a mean proportional score of 19.3% (SD = 5.9). The finding indicates the importance of farmers place on the ability of offspring to survive under local conditions, which directly impacts herd growth and long-term productivity. Disease resistance ranked fourth, with the mean score of 13.5% (SD = 4.8). This indicates that farmers value animals that can withstand disease, which is very important in areas where veterinary services may be limited.

Kidding rate was ranked fifth with a mean proportional score of 7.2% (SD = 2.7). Although reproductive is vigorous, its lower ranking indicates that farmers may prioritize traits that have direct and visible economic returns such as growth and milk production. Drought tolerance was the least preferred trait, accounting for only 4.5% (SD = 1.9) and ranking sixth. This may suggest that farmers perceive animals as relatively adapted to the existing local conditions.

Table 1
Farmers' trait preferences identified through proportional piling method

Trait preference	Mean proportional score (%)	Standard deviation (SD)	Rank
growth performance	33.4	6.6	1
milk production ability	22.1	5.2	2
disease resistance	13.5	4.8	4
kidding rate	7.2	2.7	5
Kid survival	19.3	5.9	3
Drought tolerance	4.5	1.9	6
Total	100		

Overall, the findings reveal that farmers prioritize production related traits (growth, milk) and survival related traits (kid survival, disease resistance) over reproductive and environmental adaptation traits. This pattern reflects a practical, experience-based selection strategy aimed at maximizing productivity and herd sustainability under local conditions. These findings are in line with previous studies in Ethiopia and other developing countries, which reported strong farmer preference for traits directly linked income and risk reduction (Wurzinger et al., 2011; Gizaw et al., 2018; Tessema et al., 2024).

3.2 Body measurements and performance traits of ranked does

The results shown in Table 2 reveal a clear and consistent pattern in which farmers' subjective ranking of breeding does aligns with objective phenotypic and reproductive performance indicators. Across all measured traits, breeding does ranked as first best exhibited significantly superior ($p < 0.05$) performance compared to those ranked lower, while the worst group consistently showed the lowest values. This strong alignment suggests that farmers possess well-developed indigenous knowledge and are capable of precisely identifying high performing animals based on observable characteristics.

Age showed a significant decreasing trend from the first best (5.99 ± 0.42 years) to the worst ranked does (4.01 ± 0.26 years), showing that farmers tend to favor mature and reproductively experienced animals. However, the differences among the top three ranks suggest that farmers do not only select the oldest animals, but rather those within an optimal productive age range.

Body measurements including live body weight BW), body length (BL), chest girth (CG), height at whither (HW) indicated a similar declining pattern across ranks, with the highest values consistently observed in the top ranked animals. For example, body weight decreased from 34.53 ± 0.37 kg in the first best group to 24.41 ± 0.38 kg in the worst group. This indicates that farmers place strong emphasis on larger body size as a key selection criterion, as it is associated with better growth performance, higher market value, and improved overall productivity. The consistency across multiple body measurements further strengthens the importance of general body conformation in farmers' selection decisions.

Reproductive performance characteristics also showed significant variation among ranks. The number of kidding declined from 3.98 ± 0.48 in the best ranked does to 2.44 ± 0.29 in the worst ranked, while the number of kids born and weaned followed similar pattern. Especially, the number of kids weaned (5.06 ± 0.21 vs. 2.01 ± 0.20) exhibited a substantial difference between the best and worst groups, highlighting the importance of both prolificacy and kid survival in farmers' evaluations. These findings suggest that farmers prioritize not only the ability of does to give birth to more offspring but also their capacity to successfully rear them to weaning, reflecting an integral assessment of reproductive efficiency and maternal ability. These findings align with Abraham et al. (2018), who observed enhanced reproductive traits in superior does.

Daily milk yield (DMY) also differed significantly among ranks though the variation was fairly small compared to other traits. The best ranked does produced 0.36 ± 0.12 liter/day, compared to 0.21 ± 0.09 liter/day in the worst group. This indicates that while milk production is an important consideration, it may play a relatively secondary role compared to traits such as body size and reproductive performance in the overall ranking of does.

Generally, the consistent and significant differences across all traits validate the effectiveness of farmers' own-flock ranking as a practical and reliable method for identifying best performing does. These findings demonstrate that farmers apply a multidimensional selection approach, simultaneously considering

morphological, reproductive, and productive traits. This actually indicates the value of incorporating farmers' indigenous knowledge into formal breeding programs, as it aligns well with measurable performance indicators and can enhance the relevance, adoption, and sustainability of genetic improvement strategies in smallholder production systems.

Table 2
Means (± SD) of morphological, reproductive and productive traits by doe rank

Traits	Rank			
	1st best	2nd best	3rd best	worst
Age (year)	5.99 ± 0.42[a]	5.41 ± 0.33[b]	5.20 ± 0.38[c]	4.01 ± 0.26[d]
body weight (BW, kg)	34.53 ± 0.37[a]	32.35 ± 0.28[b]	31.09 ± 0.44[c]	24.41 ± 0.38[d]
body length (BL, cm)	65.46 ± 0.55[a]	63.83 ± 0.44[b]	61.16 ± 0.47[c]	57.89 ± 0.39[d]
chest girth (CG, cm)	78.61 ± 0.87[a]	76.58 ± 0.67[b]	74.72 ± 0.44[c]	67.09 ± 0.62[d]
Height at whither (WH, cm)	73.57 ± 0.65[a]	71.65 ± 0.55[b]	70.01 ± 0.39[c]	65.28 ± 0.33[d]
Number of kidding	3.98 ± 0.48[a]	3.51 ± 0.36[b]	3.12 ± 0.40[c]	2.44 ± 0.29[d]
Kids born (number)	5.33 ± 0.25[a]	4.56 ± 0.23[b]	3.99 ± 0.24[c]	2.68 ± 0.22[d]
Kids weaned (number)	5.06 ± 0.21[a]	4.10 ± 0.18[b]	3.39 ± 0.22[c]	2.01 ± 0.20
Daily milk yield (DMY, L)	0.36 ± 0.12[a]	0.34 ± 0.17[b]	0.32 ± 0.15[c]	0.21 ± 0.09[d]

L: liter; kg: kilo gram;cm: centimeter; Rank scores were assigned as 1 = 1st best, 2 = 2nd best, 3 = 3rd best, and 4 = worst. Values represent mean ± standard deviation (SD) of measured phenotypic traits; [a–d] Row means with different superscript letters are significantly different at $p < 0.05$.

3.3 Correlation between ranked scores and phenotypic performance traits

Pearson correlation analysis revealed strong negative relations between doe rank scores and all measured phenotypic traits (Table 3). Age exhibited a very high negative correlation with rank ($r = -0.996$, $p < 0.01$), indicating that older does were consistently higher ranked. Likewise, body weight ($r = -0.998$, $p < 0.01$), body length ($r = -0.997$, $p < 0.01$), chest girth ($r = -0.998$, $p < 0.01$), and height at whither ($r = -0.997$, $p < 0.01$) were all strongly and negatively correlated with rank, suggesting that superior ranked does had higher body sizes. Reproductive traits including number of kidding ($r = -0.995$, $p < 0.01$), kids born ($r = -0.996$, $p < 0.01$), and kids weaned ($r = -0.996$, $p < 0.01$) also showed very strong negative correlations with rank, indicating higher reproductive performance in top-ranked does. Daily milk yield similarly negatively correlated with rank ($r = -0.996$, $p < 0.01$) reflecting slightly higher milk production best ranked does.

Overall, these results reveal that higher ranked does consistently exhibited superior growth, reproductive and lactation performance.

Table 3
Pearson correlation coefficients between doe rank scores and phenotypic traits

Phenotypic traits	Pearson correlation coefficient	p-value
Age (year)	-0.996[1]	< 0.01
body weight (BW, kg)	-0.998[1]	< 0.01
body length (BL, cm)	-0.997[1]	< 0.01
chest girth (CG, cm)	-0.998[1]	< 0.01
Height at whither (WH, cm)	-0.997[1]	< 0.01
Number of kidding	-0.995[1]	< 0.01
Kids born (number)	-0.996[1]	< 0.01
Kids weaned (number)	-0.996[1]	< 0.01
Daily milk yield (DMY, L)	-0.986[1]	< 0.01

kg: kilogram; cm: centimeter. Rank scores were assigned as 1 = first best, 2 = second best, 3 = third best, and 4 = worst. [1]All correlations are significant at $p < 0.01$. Negative correlation coefficients indicate that animals with better ranks (lower scores) tended to have higher phenotypic measurements.

3.4 Proportional piling scores and within-flock ranking for breeding objectives

The relationship between breeding objectives prioritized by farmers and the phenotypic performance of does ranked through own-flock selection is presented in Table 4. Growth performance, which received the highest proportional piling score (33.4%), showed a strong positive correlation ($r = 0.90$, $p < 0.01$) with body weight, linear body measurements, body length, chest girth, and height at whitter. Top-ranked does consistently exhibited superior body size compared to lower ranked does, confirming that farmers effectively identify animals with superior growth traits. Milk production ability, the second most important trait (22.1%), was positively associated with the daily milk yield ($r = 0.88$, $p < 0.01$). Similarely, kid survival, ranked third, was strongly correlated with the number of kids weaned ($r = 0.86$, $p < 0.01$), indicating that farmers' indigenous ranking closely reflects reproductive success.

Traits with lower proportional piling scores, including disease resistance (13.5%), kidding rate (7.2%), and drought tolerance (4.5%), also showed positive correlations relevant performance indicators ($r = 0.79$, $p <$

0.05; r = 0.81, p < 0.05; r = 0.65, p < 0.05, respectively), suggesting that farmers indirectly assess these traits through observable indicators such as body condition, survival, and resilience under feed stress.

Overall, the results demonstrate that farmers' indigenous selection practices effectively capture individual level variation in important performance traits, with strong quantitative agreement between proportional piling scores and actual phenotypic performance across the ranked does.

Table 4
Association between framers' breeding objectives identified via proportional piling and mean phenotypic traits of ranked Maefur breeding does, and Pearson correlation coefficients

Breeding objectives	**score (%)**	**Relevant phenotypic traits**	**1st best (Mean ± SD)**	**2nd best (Mean ± SD)**	**3rd best (Mean ± SD)**	**worst (Mean ± SD)**	**Correlation (r)**
		BW	**34.53 ± 0.37**	**32.35 ± 0.28**	**31.09 ± 0.44**	**24.41 ± 0.38**	
Growth performance	33.4 ± 6.6	BL	65.46 ± 0.55	63.83 ± 0.44	61.16 ± 0.47	57.89 ± 0.39	0.90**
		CG	78.61 ± 0.87	76.58 ± 0.67	74.72 ± 0.44	67.09 ± 0.62	
		HW	73.57 ± 0.65	71.65 ± 0.55	70.01 ± 0.39	65.28 ± 0.33	
Milk production ability	22.1 ± 5.2	DMY	0.36 ± 0.12	0.34 ± 0.17	0.32 ± 0.15	0.21 ± 0.09	0.88**
Kid survival	19.3 ± 5.9	Kids weaned	5.06 ± 0.21	4.10 ± 0.18	3.39 ± 0.22	2.01 ± 0.20	0.86**
Disease resistance	13.5 ± 4.8	survival proxy (body condition, robustness)	better	moderate	lower	lowest	0.79*
Kidding rate	7.2 ± 2.7	Number of kidding	3.98 ± 0.48	3.51 ± 0.36	3.12 ± 0.40	2.44 ± 0.29	0.81*
Drought tolerance	4.5 ± 1.9	Kids born (number)	5.33 ± 0.25	4.56 ± 0.23	3.99 ± 0.24	2.68 ± 0.22	0.65*
		Indirect: survival and milk yield under feed stress	better performance	moderate	low	lowest	

BW = body weight; BL = body length; CG = chest girth; HW = height at whither; DMY = daily milk yield; SD = standard deviation; r = Pearson correlation coefficient. * p < 0.05; ** p < 0.01

Conclusion

The findings of the present study demonstrate that goat farmers prioritize growth performance, milk production, and kid survival as the most important breeding objectives, reflecting a focus on both productive and reproductive traits that directly affect flock profitability and household livelihoods. Disease resistance, kidding rate, and drought tolerance were also identified as worthy, though secondary, indicating farmers' awareness of environmental and health related challenges affecting goat productivity.

The use of body size, number of kidding, and the number of kids born and weaned as ranking criteria within their own flocks illustrates that farmers employ practical, observable measures to assess animal performance. These practices emphasize a strong resilience on phenotypic evaluation in selection decisions, suggesting breeding strategies that associate with farmers' preferences are likely to achieve greater adoption and sustainability.

In general, the current study emphasizes the importance of integrating farmers' knowledge and trait preferences into community-based breeding programs to enhance productivity, resilience, and adaptability of indigenous goats under smallholder management systems.

Declarations

Declaration of interest statement

The author reports no conflict of interest.

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Author's contribution

Conceptualization, data collection, data analysis, Investigation, Validation, supervision, and writing-original draft, review and editing were carried out by Hagos Abraham. Resources and project administration was also carried out by the author.

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Data availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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