RESEARCH ARTICLE Asian Journal of Dairy and Food Research, Volume 45 Issue 1: 164-170 (February 2026)

Dairy Cattle Traits Preference Ranking to Define a Balanced Breeding Objective for Small and Large Dairy Farms in Ethiopia Highlands

Mohamed Aliy[1,2], Kefelegn Kebede[2], Selam Meseret[3], G. Gebreyohanes[4], Martin H. Lidauer[5], Mrode Raphael[4], Mawi Okeyo[4], Mengistu Urge[2], Enyew Negussie[5]

10.18805/ajdfr.DRF-536

ABSTRACT

Background: A study defining breeding goal traits pertinent to the smallholder and large commercial dairy farms in Ethiopian highlands is limited. Accordingly, this study was designed to identify the most important dairy cattle traits to be incorporated into breeding objectives for dairy cattle herds belonging to the small and large commercial farms in Ethiopian highlands.

Methods: This study used data collected from a representative sample of 400 respondents from 20 districts participating in dairy herd registration and record-keeping initiatives in Ethiopia. The survey design purposively incorporated both smallholder and large-scale dairy farms to accurately reflect the diverse structural characteristics of dairy production within the Highlands system. To analyze the collected data and assess the preference ranking order, a multinomial ordered logit regression model was employed.

Result: The study pinpointed the existence of differences in the ranking order of traits among the top five traits between small and large dairy farms. The order of ranking for disease resistance, feed requirement and animal size varied for large farms with unique preference for higher milk yielder and larger size cow, demanding a separate selection criteria. Respondents' from small farm placed disease resistance as the second most important trait, underscoring the need in adaptive capabilities of cows. As a result, the adoption of breeding strategies to maintain low levels of exotic inheritance or apply a restricted selection index to address the preference for adaptive capabilities is expected from responsible institution. Therefore, the dairy cattle breeding goals for smallholder and large commercial farms incorporating these identified dairy cattle traits as aggregate merit should be set as balanced breeding objective. Hence, it's necessary to establish suitable economic weights for these traits to apply a selection index for dairy cattle evaluation.

Key words: Breeding objective, Dairy cattle, Rank analysis, Trait preference.

INTRODUCTION

The Ethiopian highland is considered to be suitable for dairy cattle farming due to its relatively favorable climate, which creates a promising environment for dairy development (Yilma *et al.*, 2011). Crossbreeding program as a strategy of choice has been adopted in many tropical countries to enhance productivity and maintain adaptability of crossbred animals (Haile *et al.*, 2009; Roschinsky *et al.*, 2015; Ojango *et al.*, 2016). However, the local cattle breeds still make a significant contribution to the national economy and market milk supply in Ethiopia, accounting for 96% the supply, whereas, the crossbred and adapted exotic cows account for only 4% (CSA, 2016/17, 2017). Locally adapted dairy cattle breeds maintained as source of young bulls and their crossbred population accounted for nearly 2.08% of the estimated 61.5 million total cattle population which are mainly owned by the large commercial and smallholders farms, respectively (Gebrehiwet, 2020; Begna *et al.*, 2024). The crossbreeding breeding program operational in collaboration with dairy cattle owners as stakeholders for dairy cattle improvement was focusing on milk production trait as the major breeding goal for decades. As a result, there is a growing concern regarding the performance of crossbred and adapted high-grade cows in Ethiopia, specifically in terms of their functional and

[1]College of Agriculture and Veterinary Medicine, Jimma University, Po. Box 307, Jimma, Ethiopia.
[2]Haramaya University, Po.Box 137, Dire Dawa, Ethiopia.
[3]International Livestock Research Institutes, Po. Box 5689, Addis Ababa, Ethiopia.
[4]International Livestock Research Institutes, Po. Box 30709, Nairobi Kenya.
[5]Natural Resources Institute Finland (Luke), Tietotie 431600 Jokioinen, Finland.

Corresponding Author: Mohamed Aliy, College of Agriculture and Veterinary Medicine, Jimma University, Po. Box 307, Jimma, Ethiopia. Email: rakko2004@gmail.com
ORCID: https://orcid.org/0009-0003-8066-827X, https://orcid.org/0000-0001-9278-9173, https://orcid.org/0000-0002-1178-1821, https://orcid.org/0009-0001-5042-2848, https://orcid.org/0000-0003-0508-9991, https://orcid.org/0000-0003-1964-5653, https://orcid.org/0000-0003-2379-7801, https://orcid.org/0000-0003-3552-6689, https://orcid.org/0000-0003-4892-9938

How to cite this article: Aliy, M., Kebede, K., Meseret, S., Gebreyohanes, G., Lidauer, M.H., Raphael, M., Okeyo, M., Urge, M. and Neggusie, E. (2026). Dairy Cattle Traits Preference Ranking to Define a Balanced Breeding Objective for Small and Large Dairy Farms in Ethiopia Highlands. *Asian Journal of Dairy and Food Research*. **45(1):** 164-170. doi: 10.18805/ajdfr.DRF-536.

Submitted: 04-04-2025 **Accepted:** 21-10-2025 **Online:** 04-11-2025

adaptive traits (Negussie *et al.*, 1999; Ombura *et al.*, 2007; Tolasa *et al.*, 2020). As a result crossbred dairy cows were not exploited to their potentials in smallholder system of Ethiopian highland (Getahun, 2022).

The major challenges associated with breeding programs in the smallholder sector of tropical regions include environmental factors, ill-defined strategies and the inability of farms to adopt management and nutritional needs of new genotypes, ultimately resulting in low productivity and high mortality rates among animals, as noted by (Philipsson *et al.*, 2006). Similarly, the lack of farmer involvement in breeding program development, had resulted in unsuitable breeding objectives (Galukande *et al.*, 2013; Kebede *et al.*, 2018). Implementing an appropriate breeding program is crucial to control fluctuation in performance, enhance adaptation and further improve the crossbred and adaptive dairy cattle population (Hunde *et al.*, 2024).

A successfully breeding program that meets the needs of farmers requires understanding on the dairy cattle breeding goals. This approach ensures the program targets the specific traits that farmer's desire, customized to their unique production conditions (Sölkner *et al.*, 2008). The literature reviewed on dairy farmer preferences for cattle traits revealed diverse priorities influenced by farm size and socio-economic condition that includes the level of market linkage and management level (Ule *et al.*, 2024). A study from Tanzania reported smallholder farmers prioritize high milk yield, good fertility and easy temperament (Chawala *et al.*, 2019), whereas, the study from Kenya reported dairy trait preferences vary based on production intensity, with high-intensity (large scale farms) producers favoring production lifetime and milk yield, while low-intensity (smallholder farms) producers prioritize calving interval and production lifetime (Kariuki *et al.*, 2017). There are limited information on dairy cattle trait preference difference existing across the smallholder and large commercial farmers in predominantly smallholder systems of the Ethiopian Highlands (Duguma and Janssens, 2016; Seid *et al.*, 2025). Most of these studies were conducted using qualitative methods and had a limited geographical focus within the country. Therefore the primary goal of this research was to identify the most preferred dairy cattle traits based on practical experience of dairy farmers by using ranking order techniques across smallholder and large private commercial farms participating in the national dairy performance recording scheme along the key milk-shade districts of the Ethiopian Highlands.

MATERIALS AND METHODS

Description of the study areas

The survey study was conducted between 2022-06 and 2022-12 at the Post-graduate Program School of Haramaya University, Ethiopia. The survey study represents dairy farming households residing in twenty (20) dairy project districts found across five regional states: Amhara, Oromia, the Southern Nations and Nationalities Peoples, Sidama and the Addis Ababa city council. Data were collected from 400 purposively sampled farms participating in the dairy herd performance recording scheme led by the Livestock Development Institute (LDI) and the African and Asian Dairy Genetic Gain (AADGG) program of the International Livestock Research Institute (ILRI). The study area lies within the coordinates (11°37′N and 37°23′E at Bahir-dar to 7°40′N, 30°50′E at Jimma, due west of the country and 9°41′N, 39°32′E at Debre-Brehan to 6°58′N, 37°52′E due east at Boditi, for longitude and latitude coordinate points, respectively, representing the Ethiopian highlands. The altitude ranges from 2,840 meter at Debre-Brehan in central Ethiopia to 1,673 meter above Sea level at Adama in eastern Ethiopia (Fig 1).

Sampling procedure

The sampling on dairy farms across the survey districts was based on the level of engagement in herd recording at the time of data collection, whereas the criteria to classify small and large farms were decided based on the number of dairy cows owned and the purpose of the production goal. The classification of farms into categories of small size (<10 cows) and large farms (≥10 was made based on the methods employed for the Ethiopian dairy sector

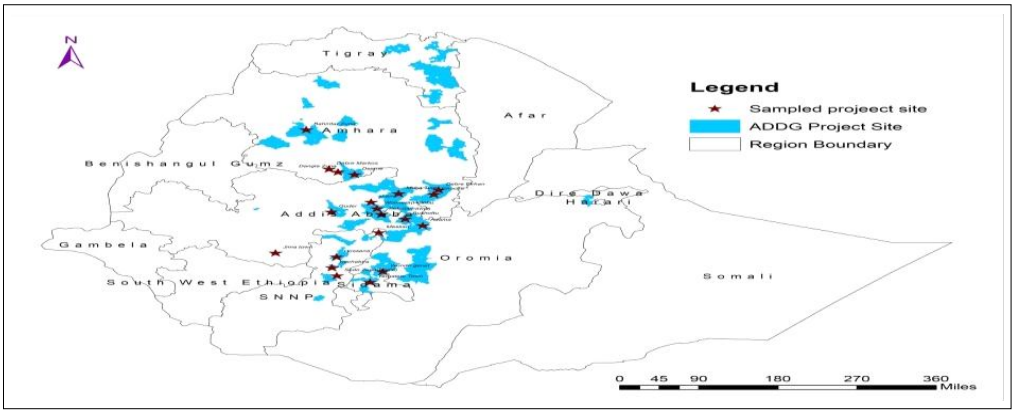


Fig 1: The map of ADGG project districts and sampled survey districts for Ethiopian highlands.

(FAO 2050, 2017 Report, 2018). A sample of 345 small-sized farms, accounting for 86.75% and 55 large farms, representing 23.25% of the total sampled farms, were chosen at a sampling ratio of 6:1, respectively. The sample size for household surveys was computed using a formula intended for large population sizes, as outlined by (Taherdoost, 2017).

Sample size:

$$n = \left(\frac{p\,(1 - p)z^2}{e^2} \right) \quad \text{....(1)}$$

Where,

n= Required sample size.

p= Expected proportion occurrence of event.

e= Acceptable margin error term.

z= Expected level of confidence interval for the survey response.

Data collection and preparation

The survey commenced with the development and evaluation of structured questionnaires aimed at gathering individual response on preference given to the list of dairy cattle trait. The trait ranking was performed on the scale of 1 to 18, where the most important trait was given rank order 1 and the least important trait was given rank order 18. The ranking criteria traits were adopted from the study by Kariuki *et al*. (2017), that was modified and translated into local languages to ensure respondents understand it. Definitions of these traits for ranking were made to ensure a consistency in understanding as shown in the description of traits (Table 1). Furthermore, data were gathered on the number of dairy animals across various age groups, including bulls and semen, along with market price details for all age categories of animals and dairy products, to support the rationale behind the trait preference. When participants found it difficult to rank all 18 characteristics, they were asked to select and rank the ten most significant traits.

Statistical analysis

Ranking response were analyzed using descriptive statistics and parametric multinomial ordered logit models. The analyses on descriptive statistics include the mean rank, pair wise and marginal ranking that estimates the relative importance of each trait. Analysis for descriptive statistics were made using the destat function within the pmr R library (Lee and Yu, 2013). The Plackett-Luce model with covariates (PLMC) was fitted to analyze the model to test the effect of the scale of dairy operation on trait preference (Finch, 2022). The overall preference response model was fitted to determine the most preferred traits for Ethiopia highland and to assess the effect scale of farm operation on traits preference.

Models:

$$\text{Logit}(\alpha i) = \beta_0 + \beta_1 + \beta_1 x_{j1} + \beta_1 x_{j2} \ldots\ldots\ldots + \beta_p x_{jp} \quad \text{....(2)}$$

Where,

αi = Dairy traits preference ranking value by respondent (i).

β_0 = Intercept that is fixed by the constant $\Sigma\, \alpha i = 1$.

β_p= Coefficient for covariate p.

x_{jp}= Value of covariate p for rater.

RESULTS AND DISCUSSION

Breeding objective traits

The overall preference for dairy cattle traits for both small and large private and institutional farms were daily milk yield, feed requirement, disease resistance, calving interval and size of an animal which ranked as the first five important traits with statistically significant positive values in marginal distance at ($p<0.001$ and $p<0.05$) in Table 2. This findings indicates that the types of dairy cows aspired by respondents in this study generally preferred high milk yielding cows, affordable feed requirements against body size, tolerant to disease and good viability of a cow to replace itself within the prevailing tropical highland environments. This result is in line with reports from East African studies (Kariuki *et al.*, 2017; Chawala *et al.*, 2019).

Farm size effect

The study also identified that the ranking order of preferred dairy traits varied significantly with the size of the dairy operations at ($p<0.05$). There is evidence of disparity of preference in the types of traits and cows' they want to keep at the farm level. Preferences for traits among small farms have indicated the rank order of daily milk yield, disease resistance, feed requirement, calving interval and mature body size, listed from first to fifth ranking as shown in Table 3. The shift in ranking order at the second and third positions compared to the rank order for pooled analysis in Table 2 highlights the significant vulnerability of crossbred dairy cattle among the smallholder farms to diseases and feed availability. It confirms, disease and feed scarcity is often the most pressing issue in smallholder dairy operations.

Analysis on data from large private and institutional farms had given a different order of ranking against the small farms, except for daily milk yield as the first rank and all other traits after the rank order of sixth, the traits like, feed requirement, mature body size, calving interval, disease resistance are in the rank of second to fifth consecutively (Table 3). The size of an animal that was not in the best three ranks for small-sized farms had taken the rank of third for large farms, which might suggest the desire to own larger size cow with an expectation of higher yield. Similarly, the preference for disease resistance trait ranked fifth, indicating the availability of better farm management situation among the large farms to control disease incidence level. Analysis with the first ten best raking traits also confirmed the same heterogeneity in order of ranking between the two farm types. Accordingly, these traits identified as the best preferred traits for small farms and large dairy farms should be considered as a breeding goal trait when developing a balanced breeding objective forpredominantly smallholder dairy production systems in Ethiopian highlands.

Table 1: Lists of dairy cattle traits included in preference ranking survey and their definition.

Traits	Trait description	Traits	Trait description
Milk yield	Amount of milk a cow produces per day of lactation	Mastitis resistance	A measure of a cow's inherent resistance to mastitis.
Disease tolerance	A measure of cow's inherent resistance to all disease	Survival to first calving	The ability of a calf to survive up to an age of first calving.
Easy of handling	A measure of non-aggressiveness to other cows and handlers	Milk fat content	Relative milk fat content a cow judged during lactation.
Feed requirement	Feed requirement of a cow judged based on daily roughage use	Strong bone structure	A measure of the strength of a cow's backbone.
Mature body size	Body size of a cow judged for a mature cow based on the feed requirements	Heat tolerance ability	Ability to perform well under high-temperature conditions.
Calving interval	The period between two consecutive calving	Coat color	The external appearance of a cow expressed in pattern of color.
Calving ease	A measure of difficulty in delivering a calf	Udder attach and teat length	A measure of how firmly the udder is attached and teat length.
Reproductive ability	A measure of fertility or conception rate of a cow in its lifetime	Feed on low quality feed	Capacity of an animal on poor quality roughage feeds.
Production lifetime	The number of lactations a cow will have before culling	Others	Other traits not included for ranking.

Table 2: The overall parameters of marginal worth distance of traits against the null mean from pooled data of all dairy farms.

Trait	Worth co-eff[a]	SE[b]	Z	Rank	Trait	Worth co-eff[a]	SE[b]	Z	Rank
Milk yield	1.80***	0.07	25.5	1	survival to 1st lac	-0.15**	0.05	-2.6	10
Disease resistant	0.60***	0.05	10.0	2	Easy of handling	-0.16**	0.06	-2.7	11
Feed requirement	0.55***	0.06	8.8	3	milk fat content	-0.35***	0.06	-5.7	12
Calving interval	0.37***	0.06	6.1	4	Backbone and Leg strength	-0.58***	0.05	-9.8	13
Size of animal	0.24***	0.05	4.0	5	Mastitis Resistance	-0.53***	0.05	-9.1	14
Reproductive eff,	0.22***	0.05	3.9	6	Aesth, value	-0.77***	0.06	-12.5	15
Productive lifetime	0.20***	0.05	3.5	7	Udder and teat length	-0.96***	0.06	-15.3	16
Calving ease	0.00[ns]	0.05	0.14	8	H. Tolerance	-1.94***	0.07	-24.9	17
Feeding low quality feeds	-0.12*	0.05	-2.1	9	Others	-5.64***	0.3	15.4	18
					Farm size	1.58***	0.07	19.9	

"a"- Trait worth coefficient; Z- Standard normal distribution value; SE[b]- Standard error of worth coefficient.

*Significant at P<0.05; **Significant at P<0.01; ***Significant at P<0.001; ns- Non significant at P>0.05.

Table 3: Parameter estimates of trait worth for the small size vs. large farms as deviation of null mean.

Trait	Small farms			Large farms		
	Worth co-eff[a]	SE[b]	Rank	Worth co-eff[a]	SE[b]	Rank
Milk yield	2.01***	0.07	1	3.33***	0.25	1
Disease resistant	0.92***	0.06	2	1.19***	0.17	5
Feed requirement	0.92 ***	0.06	3	1.13***	0.17	2
Calving interval	0.70***	0.06	4	1.04***	0.19	4
Size of animal	0.58 ***	0.06	5	0.83***	0.17	3
Reproductive eff,	0.57***	0.06	6	0.79***	0.17	6
Productive lifetime	0.53***	0.06	7	0.57***	0.17	7
Calving ease	0.36***	0.06	8	0.36*	0.16	8
Feeding on low quality feeds	0.27***	0.063	9	0.32^{ns}	0.18	9
survival to 1st lac	0.21**	0.063	10	0.05 ^{ns}	0.17	10
Ease of handling	0.21**	0.065	11	-0.09^{ns}	0.18	11
Milk fat content	0.069 ^{ns}	0.0	12	-0.26^{ns}	0.18	12
Bone and leg strength	-0.13*	0.063	14	-0.76***	0.17	13
Heat tolerance	1.32***	0.077	17	-0.81***	0.17	14
Aesthetics value	-0.33**	0.065	15	-0.89***	0.17	15
Mastitis resistance	0.061^{ns}	0.06	13	-1.77***	0.20	16
Udder and teat length	-0.42**	0.065	16	-3.41***	0.28	17
Others	-5.09***	0.28	18	-5.75***	0.46	18

"a"- Trait worth coefficient; Z- Standard normal distribution value; SE[b]- Standard error of worth coefficient.

*Significant at P<0.05; **Significant at P<0.01; ***Significant at P<0.001 and ns- Non Significant at P>0.05.

The finding in study demonstrated that the preference of dairy cattle trait by small sized herd farms is different from the preference by large private and institution farms. This result is in line with literature reports from East African studies that the large farms are more inclined to higher milk production than for functional traits mostly preferred by less intensive farms (Kariuki *et al.*, 2017; Chawala *et al.*, 2019; Ule *et al.*, 2024). These research finding confirmed that small farms preferred functional traits such as disease tolerance, feed requirement and fertility as the most pressing goal in parallel with milk production in smallholder dairy operations. Therefore, to meet the intended breeding objective under a single trier breeding program aspired for Ethiopian highlands an animal evaluation system differentially addressing the need of both farm types has to be established. In Smallholder farms, which will serve as the foundational population and where a basic recording scheme is applied strategy of crossbred bulls semen distribution to limit the level of exotic blood level and maintain adaptive capability of progenies is recommendable. Accordingly, the large private and institutional dairy farms are regarded as elite herds, distributed throughout the milk shade in and around major towns and will function as nucleus breeding units for bull recruitment by the national institution of LDI. The LDI will take the lead in managing the program, overseeing data collection, processing and decision-making to guarantee suitable heifer and bull replacement for the various types of farms. These scheme had been supported by the recent published work (Hunde *et al.*, 2024).

Limitation of the study

The limitation of this work might emanate from the bias attributed to unproportioned representation the dairy farm types where the large dairy farms (23%) against the small dairy farms (77%) might have contributed to the bias observed in the finding of ranking order from pooled data analysis appeared quite outweighed by the finding from small farms. Therefore, we recommend possible future work either to confirm or negate this piece of work with better sample represntation.

CONCLUSION

The overall breeding goal traits preferred by the small and large private and institutional farms were daily milk yield, feed requirement and disease resistance, calving interval and body size of an animal, with ranking order of first to fifth, respectively. However, the different order of ranking at rank order for disease resistance, feed requirement were observed for small size farms. Accordinlgly, a breeding program for dairy cattle in the Ethiopian highlands should incorporate these traits into the selection index with distinct economic weights tailored to benefit both smallholder farms as a base population for selection and crossbreeding and large farms as elite herds for young bull and heifer replacements. The authors of this work concluded that, the level of trait preference differences in ranking patterns is limited to a few traits that can be handled within a single breeding program organized at national institution that supply crossbred young bulls to smallholder farms to limit the proportion of exotic inheritance level so as to maintain

adaptive attribute of crossbred population. These can be achieved through a restricted selection index and strategic young bull use approach. It is therefore important to derive differential economic weights to accommodate the desire of both dairy farm types connected through data based decision to be made to meet the breeding goal identified from the study. Similarly, the demand for higher milk yielders with larger size cow can be also addressed through adoption of strategies capable of creating elite herds with appropriate selection index that can be used as seed sources for the crossbreeding program while addressing the breeding goals of the large private and institutional farms.

ACKNOWLEDGEMENT

The authors extend their gratitude to Haramaya and Jimma University for their support in partially funding the research and facilitating the study program. The Ethiopian Livestock Development Institute (LDI), of the Ministry of Agriculture, played a crucial role in financially supporting the field survey and the engagement of field enumerators for data collection, with the funding support from the ILRI-AADGG project. This research was funded through a non-competitive process, as the findings aim to improve the dairy cattle breeding strategy within the mandate of LDI. Additionally, the publication costs associated with this work were supported as part of the Sustainable Animal and Aquatic Foods (SAAF) Science Program of the CGIAR groups.

Informed consent

Ethical approval on survey tools and the modality of handling data from survey participant were obtained from the Committee of Ethical Board of the School of Animal and Range Sciences of Haramaya University. Informed consent was also obtained from all individuals who participated in this study.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

REFERENCES

Begna, D., Kuma, T. and Yohannes, Z. (2024). The tendency of livestock growth in Ethiopia: A review. *Agricultural Reviews*. **45(3):** 502-507. doi: 10.18805/ag.RF-291.

Chawala, A.R., Banos, G., Peters, A. and Chagunda, M.G.G. (2019). Farmer-preferred traits in smallholder dairy farming systems in Tanzania. *Tropical Animal Health and Production*. **51(6):** 1337-1344. https://doi.org/10.1007/s11250-018-01796-9.

CSA,2016/17. (2017). Federal Democratic Republic of Ethiopia Central Statistical Authority (Report on Livestock and Livestock Characteristics (Private Peasant Holdings PRI, [Annual Report, 2016/17]. CSA. pp. 149.

Duguma, B. and Janssens, G.P.J. (2016). Smallholder dairy farmers' breed and cow trait preferences and production objective in Jimma Town, Ethiopia. *European Journal of Biological Sciences.* **8(1):** 26-34.

FAO 2050, 2017 Report. (2018). African Sustainable Livestock Sector (Snapshot on Ethiopia Cattle sector). https://openknowledge.fao.org/server/api/core/bitstreams/6a1bba9a-2018-4e62-893b-e814e73503f0/content.

Finch, H. (2022). An introduction to the analysis of ranked response data. *Practical Assessment, Research and Evaluation*. **27(7).** https://scholarworks.umass.edu/pare/vol27/iss1/7.

Galukande, E., Mulindwa, H., Wurzinger, M., Roschinsky, R., Mwai, A.O. and Sölkner, J. (2013). Cross-breeding cattle for milk production in the tropics: Achievements, challenges and opportunities. *Animal Genetic Resources/Ressources Génétiques Animales/Recursos Genéticos Animales*. **52:** 111-125. https://doi.org/10.1017/S2078633612000471.

Gebrehiwet, B.H. (2020). Dairy cattle cross-breeding in Ethiopia: Challenges and opportunities: A review. *Asian Journal of Dairy and Food Research*. **39(3):** 180-186. doi: 10.18805/ajdfr.DR-157.

Getahun, K. (2022). Milk yield and reproductive performances of crossbred dairy cows with different genotypes in Ethiopia: A review paper. *Multidisciplinary Reviews*. **5(1):** 1-9. https://doi.org/10.31893/multirev.2022003.

Haile, A., Joshi, B.K., Ayalew, W., Tegegne, A. and Singh, A. (2009). Genetic evaluation of Ethiopian Boran cattle and their crosses with Holstein Friesian in central Ethiopia: Milk production traits. *Animal*. **3(4):** 486-493. https://doi.org/10.1017/S1751731108003868.

Hunde, D., Tadesse, Y., Tadesse, M., Abegaz, S. and Getachew, T. (2024). Community-based breeding programs can realize sustainable genetic gain and economic benefits in tropical dairy cattle systems. *Frontiers in Genetics*. **16(15):** 1106709. https://doi.org/10.3389/fgene.2024.1106709.

Kariuki, C.M., Van Arendonk, J.A.M., Kahi, A.K. and Komen, H. (2017). Multiple criteria decision-making process to derive consensus desired genetic gains for a dairy cattle breeding objective for diverse production systems. *Journal of Dairy Science*. **100(6):** 4671-4682. https://doi.org/10.3168/jds.2016-11454.

Kebede, T., Adugna, S. and Keffale, M. (2018). Review on the role of crossbreeding in improvement of dairy production in Ethiopia. *Global Veterinaria*. **20(2):** 81-90.

Lee, P.H. and Yu, P.L. (2013). An R package for analyzing and modeling ranking data. *BMC Medical Research Methodology*. **13(65)**. https://doi.org/10.1186/1471-2288-13-65.

Negussie, B.E., Brannang, E. and Rottmann, O.J. (1999). Reproductive performance and herd life of dairy cattle at Asella Livestock Farm, Arsi, Ethiopia. II: Crossbreds with 50, 75 and 87.5% European inheritance. *Journal of Animal Breeding and Genetics*. **116(3):** 225-234. https://doi.org/10.1046/j.1439-0388.1999.00191.x.

Ojango, J.M.K., Wasike, C.B., Enahoro, D.K. and Okeyo, A.M. (2016). Dairy production systems and the adoption of genetic and breeding technologies in Tanzania, Kenya, India and Nicaragua. *Animal Genetic Resources/Ressources Génétiques Animales/Recursos Genéticos Animales*. **59:** 81-95. https://doi.org/10.1017/S2078633616000096.

Ombura, J., Wakhungu, J.W., Mosi, R.O. and Amimo, J.O. (2007). An assessment of the efficiency of the dairy bull dam selection methodology in Kenya. *Livestock Research for Rural Development.* **19(1).**

Philipsson, J., Rege, J.E.O. and Okeyo, A.M. (2006). Sustainable breeding programmes for tropical farming systems. *Animal Genetics Training Resource*. **2.**

Roschinsky, R., Kluszczynska, M., Sölkner, J., Puskur, R. and Wurzinger, M. (2015). Smallholder experiences with dairy cattle crossbreeding in the tropics: From introduction to impact. *Animal*. **9(1):** 150-157. https://doi.org/10.1017/S1751731114002079.

Seid, M.E., Seid, M.E., Kefenie, K.K., Gebreyohannes, G., Meseret, S., Mwai, O. and Negussie, E. (2025). Cattle breeding programs and trait preferences in Ethiopia. *American Journal of Animal and Veterinary Sciences*. **20(2):** 124-132. https://doi.org/10.3844/ajavsp.2025.124.132.

Sölkner, J., Grausgruber, H., Okeyo, A.M., Ruckenbauer, P. and Wurzinger, M. (2008). Breeding objectives and the relative importance of traits in plant and animal breeding: A comparative review. *Euphytica*. **161(1-2):** 273-282. https://doi.org/10.1007/s10681-007-9507-2.

Taherdoost, H. (2017). Determining sample size; How to calculate survey sample size. *International Journal of Economics and Management System*. **2:** 237-239.

Tolasa, B., Onto, E. and Badeso, B. (2020). Status of production, reproduction and management practices of dairy cow in Ethiopia: A review. *Asian Journal of Dairy and Food Research*. **39(4):** 267-272. doi: 10.18805/ajdfr.DR-192.

Ule, A., Erjavec, K. and Klopčič, M. (2024). Farmers' preferences for breeding goal traits and selection indexes for Slovenian dairy cattle. *Journal of Dairy Science*. **107(1):** 412-422. https://doi.org/10.3168/jds.2022-23202.

Yilma, Z., GuerneBleich, E. and Sebsibe, A. (2011). A Review of the Ethiopian Dairy Sector. https://openknowledge.fao.org/server/api/core/bitstreams/d42e0ec5-aaca-4f4b-b327-673f3db3aebc/content.