American Journal of Animal and Veterinary Sciences

Research Article

# Multidimensional Sustainability Assessment of Marica Goat Farming in Contrasting Agroecological Zones of South Sulawesi, Indonesia

**[1]A. Amidah Amrawaty, [1]Indrawirawan, [1]Agustina Abdullah and [2]Muhammad Ihsan Andi Dagong**

*[1]Department of Livestock Socio Economics, Faculty of Animal Science, Hasanuddin University, Makassar, South Sulawesi, Indonesia*
*[2]Department of Animal Production, Faculty of Animal Science, Hasanuddin University, Makassar, South Sulawesi, Indonesia*

*Article history*
Received: 27-03-2025
Revised: 27-05-2025
Accepted: 17-07-2025

Corresponding Author:
A. Amidah Amrawaty
Department of Livestock Socio Economics, Faculty of Animal Science, Hasanuddin University, Makassar, South Sulawesi, Indonesia
Email: amidah@unhas.ac.id

**Abstract:** The Marica goat, a local breed in South Sulawesi, Indonesia, is highly adaptable to arid environments but faces a continuous population decline. This study assessed the sustainability of Marica goat farming in Jeneponto Regency, South Sulawesi, Indonesia. The research focusing on two agroecological zones: the mountainous Kelara District and the coastal Tamalatea District. A rapid appraisal approach was employed, integrating Multidimensional Scaling (MDS) to evaluate sustainability across ecological, economic, and social dimensions, followed by sensitivity analysis to identify key influencing attributes. Data were gathered through focus group discussions and interviews with 23 Marica goat farmers. The findings revealed a "less sustainable" status, with an overall sustainability index of 48.72%. Among the three assessed dimensions, the social dimension scored highest (55.17%), followed by ecological (49.25%) and economic (41.73%) dimensions lagged behind, highlighting critical areas requiring targeted intervention. Key areas for improvement include expanding forage land (economic), enhancing farmer participation in organizations (social), and increasing the frequency of goat shed cleaning (ecological).

**Keywords:** Agroecological Zones, Marica Goat, Multidimensional Scaling (MDS), Sustainability

## Introduction

The Marica goat, an indigenous breed of South Sulawesi, is currently threatened with extinction due to a significant decline in its population (Septiyawan *et al*., 2020). According to BPS-Statistics Indonesia (2022), Jeneponto Regency remains the primary center for goat farming in the province, with a goat population of 249,292 heads representing 29.73% of South Sulawesi's total goat population (838,502 heads). Despite this contribution, the population of Marica goats continues to decline. This breed possesses unique characteristics, such as a small body size, short and erect ears, and small horns, which distinguish it from other local goat breeds (Batubara *et al*., 2011; Ngitung *et al*., 2020). However, these unique traits have not been sufficient to prevent its population decline.

The Marica goat, which is endemic to South Sulawesi, is critically endangered, with its population confined to the Jeneponto and Maros Regencies (Ashari *et al*., 2017; Septiyawan *et al*., 2020). This restricted distribution indicates the urgency of investigating sustainable livestock farming practices before the breed disappears entirely. The decline in the Marica goat population is attributed to crossbreeding practices with other goat breeds and farmers' preference for larger goat breeds (Ngitung *et al*., 2020). Despite this, the Marica goat exhibits remarkable adaptability to arid environments, thriving even during prolonged dry seasons on limited forage (Ngitung, 2016). This highlights the potential of the Marica goat as a valuable local genetic resource, particularly in regions with challenging agroecological conditions.

Several studies have addressed sustainability in the goat farming sector, with indicators encompassing aspects of animal health, socioeconomics, and the environment (Paraskevopoulou *et al*., 2020). Production efficiency and land conservation are also key to sustainable goat farming (Nahed-Toral *et al*., 2021). A multidisciplinary approach

Science Publications

© 2025 A. Amidah Amrawaty, Indrawirawan, Agustina Abdullah and Muhammad Ihsan Andi Dagong. This open-access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.

that integrates biological, financial, and management indicators is essential for enhancing goat production's sustainability (Godber *et al*., 2020). Additionally, goats play a significant role in food security and economic livelihoods, particularly for smallholder farmers in rural areas, as they provide economic autonomy, especially for women involved in goat rearing (Monau *et al*., 2020). A study in Malang demonstrated that goat farming can yield significant economic benefits, although high feed costs remain a major challenge (Utami and Dian, 2019). Despite all, research on the sustainability of Marica goat farming, particularly in different agroecological zones, remains limited.

Understanding how economic, social, and ecological factors affect Marica goat farming influence the sustainability of different agroecological zones. For instance, there has been no in-depth analysis of farmers' distinct challenges and opportunities in mountainous and coastal areas. However, such an understanding is crucial for designing appropriate development strategies to protect the Marica goat as a local genetic resource. If this knowledge gap is not addressed, the threat of the Marica goat's extinction will intensify, potentially resulting in the loss of a unique genetic resource adapted to arid environments. Furthermore, the disappearance of the Marica goat could have negative implications for food security and the livelihoods of smallholder farmers, particularly in rural areas.

This study, therefore, aims to analyze the sustainability status of Marica goat farming in Jeneponto Regency, South Sulawesi, by examining the economic, social and ecological dimensions and identifying the sensitive attributes that influence sustainability. This research focuses on two distinct agroecological zones: the mountainous region of Kelara District and the coastal region of Tamalatea District. The findings are expected to fill the current knowledge gap and provide recommendations for developing more sustainable Marica goat farming practices while supporting its conservation as a valuable local genetic resource.

## Materials and Methods

### *Study Area*

This study was conducted in Jeneponto Regency, South Sulawesi Province, Indonesia. The selection of research locations was based on agroecological differences, specifically in coastal and highland areas. These zones were chosen based on variations in altitude, rainfall patterns, and dominant vegetation. This selection aims to understand the diversity of challenges and opportunities for sustainability in different environments. The coastal area was represented by the Tamalatea District, located at 100 m above sea level (masl), while the highland area was represented by the Kelara District, with altitudes ranging between 500 and 1,000 masl.

According to data from the Jeneponto Regency Agriculture Office, two villages in each district were selected as research locations because they were considered to still have populations of Marica goats, albeit very small and nearing extinction. The selected villages in Tamalatea District were Manjangloe and Tonrokassi. Meanwhile, in Kelara District, the chosen villages were North and East Tolo. These four villages were the units of analysis in this study. The research was conducted from June to September 2024.

The primary data for this study were collected through field observations and in-depth interviews using structured questionnaires. The respondents included all farmers who still raised Marica goats in the research locations (n = 23). Because the number of Marica goat farmers is minimal, all of the population in the Jeneponto Regency area was used as research respondents. The small sample size reflects the critically low population of this breed, which is endemic to only two regencies in South Sulawesi (Jeneponto and Maros). Nevertheless, this sample adequately represents the entire Marica goat farming system, as no populations exist outside these areas. In addition, a Focus Group Discussion (FGD) was conducted to obtain more comprehensive and in-depth information involving various stakeholders, including agriculture department officials, university experts, and experienced goat farmers.

### *Data Analysis*

The analysis method used in this study was a modification of Rapfish (Rapid Appraisal Technique for Fisheries), which was adapted into RAP-goat (Rapid Appraisal Technique for Goat). The analysis was conducted using the R programming language to evaluate the sustainability of Marica goat farming across three main dimensions: economic, social, and ecological. The analysis identified 24 attributes that were scored based on a literature review and expert assessments (Table 1). These attributes encompass key aspects relevant to the sustainability of Marica goat farming across three dimensions.

Each attribute was assessed using an ordinal scale, in which scores were assigned based on predefined criteria to reflect the sustainability level of each attribute. The scoring standard followed a 0–10 scale, with higher scores indicating better sustainability. This approach allowed for a systematic and quantitative evaluation of the sustainability status of Marica goat farming in the study area (Pitcher *et al*., 2013).

After the attribute assessment was completed, the data were analyzed using the multidimensional scaling (MDS) technique to determine the sustainability index of Marica goat farming. This analysis produced the sustainability status for each dimension and the multidimensional

sustainability index (Table 2). The results of the MDS analysis were visualized in a kite diagram to facilitate interpretation and comparison of the sustainability status across dimensions.

**Table 1:** Dimensions and attributes of the sustainability status of Marica goat farming

| Economic | Social | Ecological |
|---|---|---|
| The goat ownership status | Support from neighbors | Goat shed location |
| Duration of goat farming | Level of education | Frequency of goat feces collection |
| Agricultural land area | Number of organizational memberships | Frequency of goat shed cleaning |
| Forage land | Relationship with family and friends | Type of feces processing |
| Goat ownership | Satisfaction as a goat farmer | Utilization of crop residues |
| Income diversification | Social interaction with neighbors | Frequency of vaccination and deworming |
| Number of family members | Type of healthcare services | Water sources for goat breeding |
| | Housing type | |
| | Type of transportation | |
| | Drinking water | |

**Table 2:** The sustainability of Marica goat farming

| Value Index | Categories |
|---|---|
| 0–25.0% | Poor (Unsustainable) |
| 25.1–50.0% | Less (Less Sustainable) |
| 50.1–75.0% | Quite (Moderately Sustainable) |
| 75.1–100% | Very (Highly Sustainable) |

Subsequently, leverage analysis was conducted to identify sensitive attributes that significantly influence the sustainability status improvement. The sensitivity of the attributes was measured based on changes in the Root Mean Square (RMS) of the ordination. The more significant the change in RMS for an attribute, the more significant its role in determining the sustainability status. This approach helped identify the key attributes that require attention to enhance the overall sustainability of Marica goat farming.

## Results and Discussion

### *Sustainability Status*

The results of the multidimensional RAP-goat analysis revealed that Marica goat farming in Jeneponto Regency, Indonesia, is classified as less sustainable, with an overall sustainability index of 48.72%. The sustainability indices were calculated for each dimension (Table 3). The social dimension recorded the highest index at 55.17% (categorized as moderately sustainable), while the economic dimension had the lowest index at 41.73% (categorized as less sustainable). The ecological dimension fell between the two, with an index of 49.25% (categorized as less sustainable). The kite diagram generated from the combination of all MDS analysis fields illustrates the variation in sustainability indices across regions such as East Tolo, Manjangloe, Tonrokassi, and North Tolo (Fig. 1).

**Table 3:** Sustainability index for each dimension

| Dimension | MDS index (%) | Category |
|---|---|---|
| Economic | 41.73 | Less Sustainable |
| Social | 55.17 | Moderately Sustainable |
| Ecological | 49.25 | Less Sustainable |

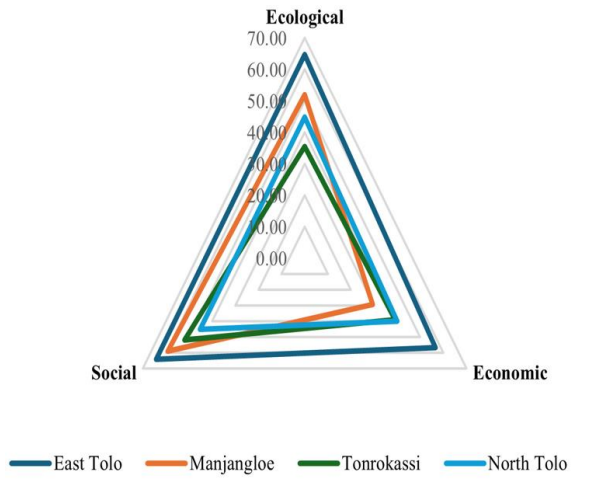


**Fig. 1:** Kite diagram of the sustainability index of Marica goat farming over three dimensions

The findings related to the economic and ecological dimensions appear to align with previous research suggesting that goats are often the primary choice in regions with challenging landscapes, such as arid areas, due to their adaptability and lack of alternative income sources (Davran *et al*., 2009). However, the sustainability of small-scale livestock farming, such as sheep and goats, requires a thorough examination of factors such as disease, environment, and management practices (Al-Barakeh *et al*., 2024). This is further supported by findings that the main limiting factors for the sustainability of goat farming in Northwestern Tunisia, particularly at the socio-territorial scale, include inadequate product quality, lack of social engagement in collective work, and multi-activity among farmers, even though the highest sustainability scores were found in the

economic dimension (Khemiri *et al*., 2021). Additionally, research on the sustainability of small-scale sheep and goat farming in semi-arid Mediterranean environments highlights governance delays, weak social capital, poor manure management, landscape heritage, and economic aspects, which are attributed to the lack of strategic planning in land, environmental, livestock, genetic resource, human, and farm structure management (Timpanaro and Foti, 2024). This indicates that while the Marica goat has the genetic potential to thrive in the challenging environments of Jeneponto Regency, its long-term sustainability requires a holistic approach that encompasses multiple dimensions.

### *Economic Sustainability*

In the economic dimension ordination plot distributed along the horizontal axis, based on their relative sustainability levels in the economic dimension. In the economic dimension ordination plot (Fig. 2), three villages—Manjangloe, Tonrokassi, and North Tolo—are positioned below 50%, indicating that these villages have a less sustainable economic status. Meanwhile, only East Tolo is above 50%, suggesting that this village has a relatively sustainable economic status. The overall analysis results show that the sustainability index for the economic dimension is 41.73%, confirming its less sustainable status (Table 3).

The sensitivity level of each economic dimension attribute, based on changes in the RMS (Fig. 3). The sensitive attributes influencing the sustainability status of Marica goat farming in the economic dimension are the forage land area, income diversification, and goat ownership status. These findings indicate that the availability of forage land, income diversification, and goat ownership status play critical roles in determining the economic sustainability of Marica goat farming.

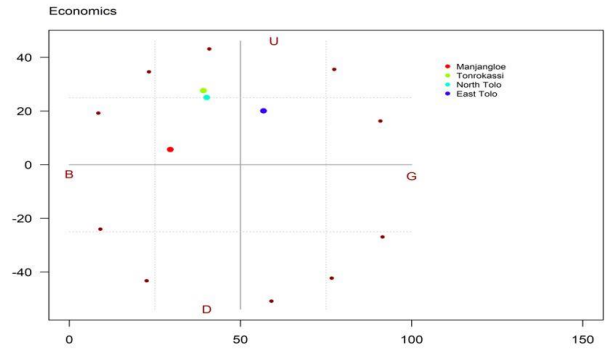


**Fig. 2:** Ordination plots for the economic dimension

Research on Awassi sheep and Baladi goat farming in Northern Jordan, which is considered sustainable mainly because more than half of the farmers own land and cultivate their forage, reinforces the importance of forage land area ownership in supporting farming sustainability (Al-Barakeh *et al*., 2024). In Java, Indonesia, most goat farmers have self-owned livestock, whereas a small proportion use a profit-sharing system. Farmers with self-owned livestock tend to raise goats for commercial purposes, whereas those using profit-sharing systems focus more on savings (Prabawati *et al*., 2021; Budisatria *et al*., 2021). Additionally, integrating goats with crops provides significant economic benefits for farmers, mainly through income diversification and cost savings. Farmers help reduce input costs through manure use.and save on feed costs by using crop residues as feed sources (Pouchepparadjou *et al*., 2024; Tala *et al*., 2022). Furthermore, goat farming in Chitima, Mozambique, plays a crucial role in diversifying rural household income, as goats are considered economic assets that can be sold or used as collateral for loans (Del Valle M *et al*., 2023). In the context of Marica goat farming in Jeneponto, Indonesia, the findings suggest that improving economic sustainability requires a focus on increasing forage land availability, income diversification, and strengthening goat ownership status. These interventions can be supported through training programs, resource access, and policies that empower smallholder farmers.

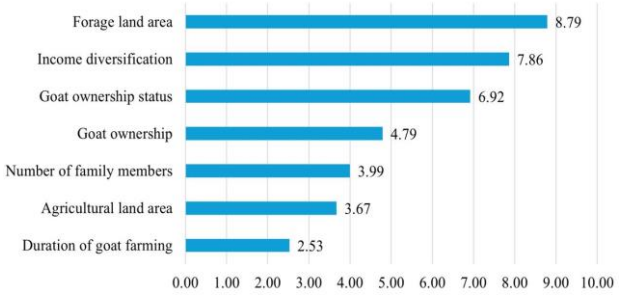


**Fig. 3:** Leverage analysis of attributes for the economic dimension

### *Social Sustainability*

In the social dimension ordination plot, three villages—Tonrokassi, Manjangloe, and East Tolo—are positioned above 50%, indicating that this village has a less sustainable social status (Fig. 4). Meanwhile, North Tolo has less than 50% of the total population, suggesting that this village has a less sustainable social status. The sustainability index for the social dimension is 55.17, as presented in Table 3, indicating a relatively sustainable status. The sensitive attributes influencing the sustainability status of Marica goat farming in the social dimension were the number of organizational memberships, type of transportation available, and social interaction with neighbors (Fig. 5).

These findings support prior research showing that cooperative membership positively influences market

performance and pricing outcomes, with goat farmers in Nepal receiving higher prices and demonstrating greater technical efficiency than non-members (Neupane *et al*., 2022). Transportation, identified as one of the sensitive attributes in the social dimension (Fig. 5), is also emphasized in previous research as a key factor in building sustainable farming systems (Van-Heurck *et al*., 2020). Social interaction with neighbors is equally important because regular interactions with other farmers can build trust and influence agricultural decision-making (Gu, 2024; Sharp and Smith, 2003). Efforts to strengthen social sustainability should therefore focus on increasing organizational membership, enhancing mobility and transportation options, and fostering strong social interactions among farmers. These attributes can be supported through community empowerment programs, improved transportation infrastructure, and social activities that encourage farmers to collaborate.

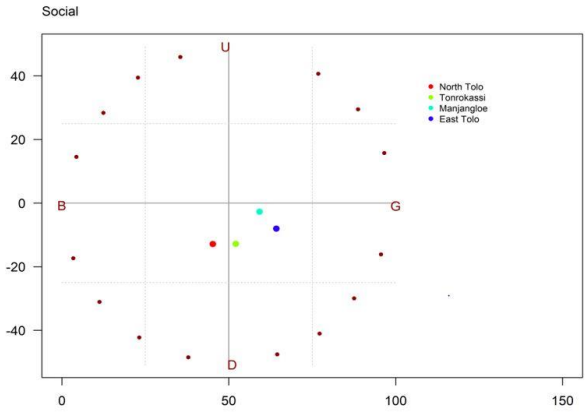


**Fig. 4:** Ordination plots for the social dimension

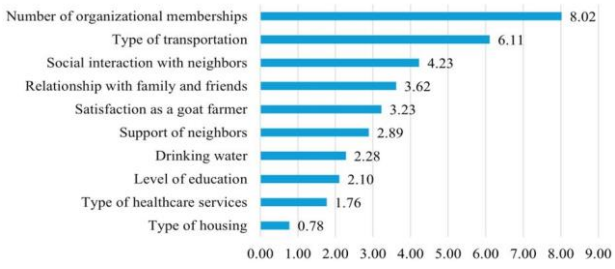


**Fig. 5:** Leverage analysis of attributes for the social dimension

## *Ecological Sustainability*

The analysis results indicate that the sustainability index for the ecological dimension is 49.25%, classifying this dimension as less sustainable (Fig. 6). The sensitive attributes influencing the sustainability status of Marica goat farming in the ecological dimension are the frequency of goat shed cleaning, the frequency of goat feces collection, and the frequency of vaccination and deworming (Fig. 7). These findings suggest that practices related to shed cleanliness, manure management, and vaccination and deworming schedules play critical roles in determining the ecological sustainability of goat farming.

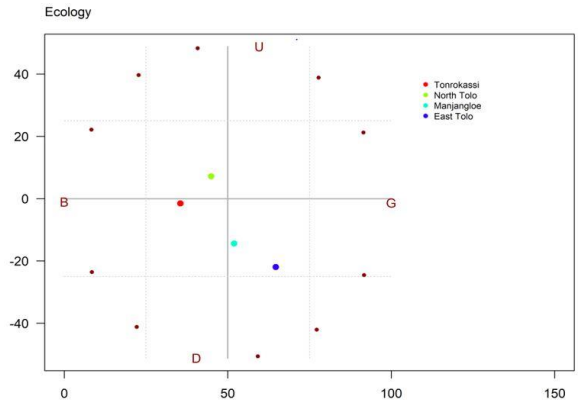


**Fig. 6:** Ordination plots for the ecological dimension

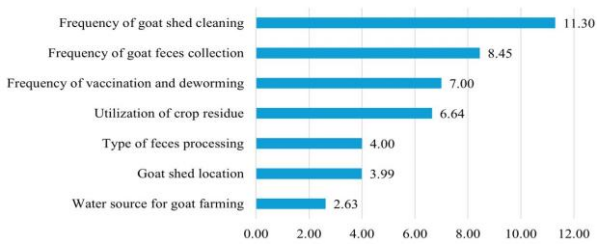


**Fig. 7:** Leverage analysis of attributes for the ecological dimension

These findings align with research by Simões *et al*. (2021), who found that a well-designed health management plan is essential for the success of sheep and goat farming, where environmental and management factors are key elements in disease prevention. Another study showed that 97.92% of goat farmers in West Muna Regency, Southeast Sulawesi, clean their sheds regularly, although the frequency varies from daily to once a week (Rahadi *et al*., 2020). However, small-scale farmers (with 1-3 goats) and those using semi-intensive systems tend not to utilize goat manure optimally (Baba *et al*., 2023). Additionally, Siompu goat farmers in Southeast Sulawesi who use extensive systems (8.11%) often lack proper sheds, resulting in poor manure management (Rahadi *et al*., 2022). These results indicate that improving the ecological sustainability of Marica goat farming requires: consistent sanitation practices, effective manure utilization. in the management of shed cleanliness, manure utilization, and regular animal health programs. These factors can significantly contribute to the ecological resilience and long-term

sustainability of Marica goat farming in the region.

## Conclusion

The sustainability status of Marica goat farming is categorized as less sustainable, with an overall sustainability index of 48.72%. The social dimension recorded the highest sustainability value (55.17%), while the ecological and economic dimensions scored lower, at 49.25 and 41.73%, respectively. To improve sustainability, attention must be given to sensitive attributes such as increasing forage land area (economic dimension), participation in organizational memberships (social dimension), and enhancing the frequency of goat shed cleaning (ecological dimension). Strengthening these aspects is expected to support the overall sustainability of Marica goat farming and contribute to preserving this endangered local breed. In line with this, local governments and relevant ministries need to formulate policies for the genetic preservation of Marica goats. In addition, future research should focus on improving the production performance of this breed.

## Acknowledgment

The authors gratefully acknowledge the Marica goat farmers and Jeneponto Regency Agriculture Office for their cooperation and support throughout this research.

## Funding Information

The authors would like to express their gratitude to the Chancellor of the Institute for Research and Community Service at Hasanuddin University for providing funding for this research under the Collaborative Fundamental Research Scheme, with grant number 00309/UN4.22/PT.01.03/2024.

## Author's Contributions

**A. Amidah Amrawaty:** Conceptualization, methodology, writing original draft, and supervision.

**Indrawirawan:** Writing original draft, data curation, and validation.

**Agustina Abdullah:** Methodology and writing – review and editing.

**Muhammad Ihsan Andi Dagong:** Conceptualization and data curation.

## Ethics

This study did not involve any animal experimentation. Data were collected through surveys and interviews with goat farmers. All respondents were informed about the purpose of the study and gave their consent prior to participation.

## References

Al-Barakeh, Dr. F. S., Khashroum, A. O., Tarawneh, R. A., Al-Lataifeh, F. A., Al-Yacoub, A. N., Dayoub, Dr. M., & Al-Najjar, Dr. K. A. (2024). Challenges, Economics, and Sustainability of Sheep and Goat Farming in Drylands. *Biology and Life Sciences*. https://doi.org/10.20944/preprints202403.1478.v1

Ashari, F., Bugiwati, S. R. A., Rahim, L. O., & Dagong, M. I. A. (2017). Identification of Quantitative Characteristic Diversity of Marica Goat in Jeneponto District. *Jurnal Ilmu Dan Teknologi Peternakan*, *5*(2), 66–71. https://doi.org/10.20956/jitp.v5i2.3068

Baba, S., Hastang, H., Asnawi, A., Dagong, M. A. I., Hendra, H., Indrawirawan, I., Khasanah, A. U. N., Risal, M., Sohrah, S., & Dariyatmo, I. M. (2023). The Influence of Subjective Norms on Farmers' Behavior in Handling Goat Waste. *Hasanuddin Journal of Animal Science (HAJAS)*, *5*(1), 56–65. https://doi.org/10.20956/hajas.v5i1.29173

Batubara, A., Noor, R. R., Farajallah, A., Tiesnamurti, B., & Doloksaribu, M. D. (2011). Morphometric and Phylogenic Analysis of Six Population Indonesian Local Goats. *Media Peternakan*, *34*(3), 165–174. https://doi.org/10.5398/medpet.2011.34.3.165

Davran, M. K., Ocak, S., & Secer, A. (2009). An analysis of socio-economic and environmental sustainability of goat production in the Taurus Mountain Villages in the Eastern Mediterranean Region of Turkey, with consideration of gender roles. *Tropical Animal Health and Production*, *41*(7), 1151–1155. https://doi.org/10.1007/s11250-008-9295-2

Del Valle M, M., Hernández, R., Boden, L., & Riveros, J. L. (2023). Redefining Food Sources: Exploring the Disconnect between Goat Farming and Its Perceived Sustainability—A Case Study in Chitima, Mozambique. *Sustainability*, *15*(14), 11071. https://doi.org/10.3390/su151411071

Godber, O. F., Chentouf, M., & Wall, R. (2020). Sustainable goat production: modelling optimal performance in extensive systems. *Animal Production Science*, *60*(6), 843. https://doi.org/10.1071/an18481

Gu, J. (2024). Neighborhood Does Matter: Farmers' Local Social Interactions and Land Rental Behaviors in China. *Land*, *13*(1), 76. https://doi.org/10.3390/land13010076

Khemiri, H., Darej, C., Khaoula, K. A., M'Hamdi, N., Sghir, C., Kthiri, M., & Nizar, M. (2021). Evaluation of the Sustainability of Goat Farms in the North-western Region of Tunisia. *Malaysian Animal Husbandry Journal*, *1*(2), 54–59. https://doi.org/10.26480/mahj.02.2021.54.59

Monau, P., Raphaka, K., Zvinorova-Chimboza, P., & Gondwe, T. (2020). Sustainable Utilization of Indigenous Goats in Southern Africa. *Diversity*, *12*(1), 20. https://doi.org/10.3390/d12010020

Nahed Toral, J., López Tecpoyotl, Z. G., Aguilar Jiménez, J. R., Grande Cano, D., & Delgadillo Puga, C. (2021). Compliance of Goat Farming under Extensive Grazing with the Organic Standards and Its Contribution to Sustainability in Puebla, Mexico. *Sustainability*, *13*(11), 6293. https://doi.org/10.3390/su13116293

Neupane, H., Joshi, N., Kafle, K., Adhikari, M., & Kharel, S. (2022). Impact of Cooperative Membership on Adoption of Improved Goat Production Practices in Chitwan District of Nepal. *Journal of Agriculture and Environment*, *23*(1), 188–200. https://doi.org/10.3126/aej.v23i1.46927

Ngitung, R. (2016). Marica Goat's Response to The Provision of Superior Feed. *Proceedings of ICMSTEA 2016: International Conference on Mathematics*, 297–301.

Ngitung, R., Taiyeb, M., & Idris, I. S. (2020). Identifikasi Morfologi dan Perilaku Makan Kambing Marica yang Dipelihara di Luar Habitat. *Bionature*, *21*(1), 1–7. https://doi.org/10.35580/bionature.v21i1.13934

Paraskevopoulou, C., Theodoridis, A., Johnson, M., Ragkos, A., Arguile, L., Smith, L., Vlachos, D., & Arsenos, G. (2020). Sustainability Assessment of Goat and Sheep Farms: A Comparison between European Countries. *Sustainability*, *12*(8), 3099. https://doi.org/10.3390/su12083099

Pitcher, T. J., Lam, M. E., Ainsworth, C., Martindale, A., Nakamura, K., Perry, R. I., & Ward, T. (2013). Improvements to Rapfish: a rapid evaluation technique for fisheries integrating ecological and human dimensions[a] *Journal of Fish Biology*, *83*(4), 865–889.https://doi.org/10.1111/jfb.12122

Pouchepparadjou, A., Umamaheswari, L., George Paradis, S., Swaminathan, N., Vidhya, C., & Gokul, V. (2024). Role of Goat Farming in Livelihood Security of Rural Households in Union Territory of Puducherry. *The Indian Journal of Agricultural Economics*, *79*(3), 589–601. https://doi.org/10.63040/25827510.2024.03.018

Prabawati, S. A., Nugroho, B. A., & Azizah, S. (2021). Social Economic Status of Etawa (Pe) Goats Farmers in Tamansari Village, Ampelgading District, Malang Regency, Indonesia. *International Journal of Scientific Advances*, *2*(5), 60–65. https://doi.org/10.51542/ijscia.v2i5.12

Rahadi, S., Kusumawati, E. D., Isnaini, N., Hakim, L., Ciptadi, G., Susilawati, T., & Nurgiartiningsih, V. M. A. (2020). Characterization and typology of goat production systems in West Muna Regency, Southeast Sulawesi, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *465*(1), 012057. https://doi.org/10.1088/1755-1315/465/1/012057

Rahadi, S., Kuswati, Isnaini, N., Hakim, L., Ciptadi, G., Susilawati, T., & Nurgiartiningsih, V. M. A. (2022). Typology and Characterization of Siompu Goat Production Systems in Siompu Island, Southeast Sulawesi, Indonesia. *Advances in Biological Sciences Research*, 268–274. https://doi.org/10.2991/absr.k.220309.044

Septiyawan, G. A., Bugiwati, S. R. A., & Dagong, M. I. A. (2020). Identification performance of quantitative traits of Marica goats in Maros and Jeneponto regencies. *IOP Conference Series: Earth and Environmental Science*, *492*(1), 012104. https://doi.org/10.1088/1755-1315/492/1/012104

Sharp, J. S., & Smith, M. B. (2003). Social capital and farming at the rural–urban interface: the importance of nonfarmer and farmer relations. In *Agricultural Systems* (Vol. 76, Issue 3, pp. 913–927). https://doi.org/10.1016/s0883-2927(02)00083-5

Simões, J., Abecia, J. A., Cannas, A., Delgadillo, J. A., Lacasta, D., Voigt, K., & Chemineau, P. (2021). Review: Managing sheep and goats for sustainable high yield production. *Animal*, *15*, 100293. https://doi.org/10.1016/j.animal.2021.100293

Suparta Budisatria, I. G., Panjono, P., Ngadiyono, N., Udo, H. M. J., & Andri Atmoko, B. (2021). The Productivity Comparison Between Bligon and Kejobong Goats in Indonesia, Based from On-Farm and On-Station Research. *Journal of Animal Health and Production*, *9*(3), 262–270. https://doi.org/10.17582/journal.jahp/2021/9.3.262.270

Tala, T. W., Chalil, D., & Salmiah. (2022). Analysis of Integration of Coffee Plantations and Goats Farm on Farmer's Income in The Atu Lintang District Aceh Tengah Regency. *International Journal of Research and Review*, *9*(6), 473–479. https://doi.org/10.52403/ijrr.20220650

Timpanaro, G., & Foti, V. T. (2024). The sustainability of small-scale sheep and goat farming in a semi-arid Mediterranean environment. *Journal of Sustainable Agriculture and Environment*, *3*(3), 1–13. https://doi.org/10.1002/sae2.12111

Utami, H. D., & Dian, M. (2019). Economic Performance on Small Holder Ettawah Cross Breed Goat Farming at Malang Indonesia. *Egyptian Journal of Sheep and Goats Sciences*, *14*(1), 1–9. https://doi.org/10.21608/ejsgs.2019.32554

Van-Heurck, M., Alegre, J., Solis, R., Del Castillo, D., Pérez, L., Lavelle, P., & Quintero, M. (2020). Measuring sustainability of smallholder livestock farming in Yurimaguas, Peruvian Amazon. *Food and Energy Security*, *9*(4), e242. https://doi.org/10.1002/fes3.242