



Article

Ecological Land Suitability of Goats in The Highland Region

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ABSTRACT

Goat farming has a lot of promise in the highland area of Limapuluh Kota Regency in West Sumatra. However, ecological pressure may result from goat population development that is not balanced with land suitability assessments. Goats' ecological land suitability will be examined in this study using biophysical, socioeconomic, and environmental carrying capacity metrics. The research methodology include field surveys, local farmer participation, and geographic analysis utilizing Geographic Information Systems (GIS). The findings indicated that 91.7% of the district of Limapuluh Kota is suitable for goat rearing. Because of the land elevation over 1,500 meters above sea level and the excessive rainfall exceeding 2,500 mm, 8.3% of the area is categorized as not suitable (N). According to the study's findings, the growth of goat farming in Limapuluh Kota District must take ecological zoning into account, giving precedence to land areas that are appropriate for intense development and the use of silvopastura systems. These results offer a solid foundation for planning cattle sustainably in tropical highlands.

INTRODUCTION

In highland areas with limited access to other animal protein sources, goat rearing is especially important for bolstering local economy and food security [1]. Highlands' distinct environmental features, such as their hilly terrain with 15–30% slope gradients, high relative humidity (>80%), and low daily temperatures (average 15–20°C), present both opportunities and challenges for livestock productivity [2,3]. Deforestation for pasture expansion, surface erosion (which can reach 15–30 tons/ha/year in overgrazed areas), and declining forage quality due to unmanaged grazing selectivity are some of the ecological pressures caused by the unchecked growth of goat populations. It is often motivated by the high demand for meat and dairy and disregards the principles of land carrying capacity [4,5].

Goat farming has a lot of promise in the highland region of Limapuluh Kota Regency in West Sumatra, which is 500–1,500 meters above sea level and has undulating terrain (15–40% slopes). Ecological stresses, such as 12% degradation of grazing areas and diminishing feed quality, have resulted from the yearly 4.2% increase in goat population that has not been accompanied by sufficient land suitability assessments [6].

Even while earlier study has looked at goat productivity in a variety of agroecosystems, there are still a number of important research gaps. Limapuluh Kota-specific geomorphic unit-based land suitability

mapping has not been carried out in previous studies [4]. Previous studies have mostly ignored ecological carrying capacity factors in favor of dietary elements [7]. Analysis of local adaptive capability is not the basis for current livestock development policies [8].

This research makes a number of novel contributions. integrated multidisciplinary approach that combines high-resolution spatial modeling, farmer adaptive capability, and pedo-ecological assessment. Creation of particular assessment criteria for the suitability of tropical highland wetland ecosystems. Local farmers participate in a citizen science process to validate land suitability zones.

METHODOLOGY

In-depth interviews with farmers in Limapuluh Kota District, biophysical field surveys, and quantitative spatial analysis (GIS and remote sensing) were all integrated into this mixed-methods study [9,10]. Primary data in the form of measurements of soil properties (texture, pH, and C-organic) at 50 sampling locations dispersed throughout Limapuluh Kota District served as the basis for the initial mapping. Secondary data for evaluation analysis in the form of a resolution DEM (SRTM) and daily climatic data (CHIRPS).

Additionally, 30 farmers were included in field verification and local knowledge-based appropriateness scoring as part of participatory validation with citizen science. The tools and data analysis methods included the FAO classification of S (suitable) and N (not suitable), with adjustments for upland habitats, and map overlay using weighted overlay in ArcGIS. The following are the criteria for assessing ecological suitability [11].

Table 1. Ecological Environment Suitability Assessment Criteria for Goats

Characteristics	Ruminant Livestock Environmental Suitability Classes	
	S (Suitable)	N (Not Suitable)
<i>Temperature Humidity Index (THI)</i> - THI (°C)	22-24	<22, >24
Water availability (w)		
Dry months (<100 mm)	< 8 montsh	>8 months
Rainfall/year (mm)	< 4.000	>4.000
Presence of water sources	Available	Unavailable
Kualitas air (q)		
- pH water	6,5-9,0	<6,5, >9,0
Terrain (e)		
- Elevation (meters above sea level)	500-1000	>1000

RESULTS AND DISCUSSION

By aligning the land criteria with the environmental needs of goats, the ecological environment is deemed suitable for them. Elevation, water quality, and climate all influence environmental requirements. Regarding rainfall and water availability, the Limapuluh Kota Regency area is thought to have uniform dry and wet months. A shared database on land suitability attribute tables and queries was used in the Geographic Information System (GIS) approach to the investigation.

According to [12,13] land appraisal is the process of determining whether a piece of land is suitable for a given use. Maps representing the outcomes of land evaluation serve as the foundation for logical land use planning, allowing for the most efficient and sustainable use of land. The two-stage technique and the parallel approach are the two types of approaches used in land evaluation. Figure 1 shows the land suitability map for Limapuluh Kota Regency.

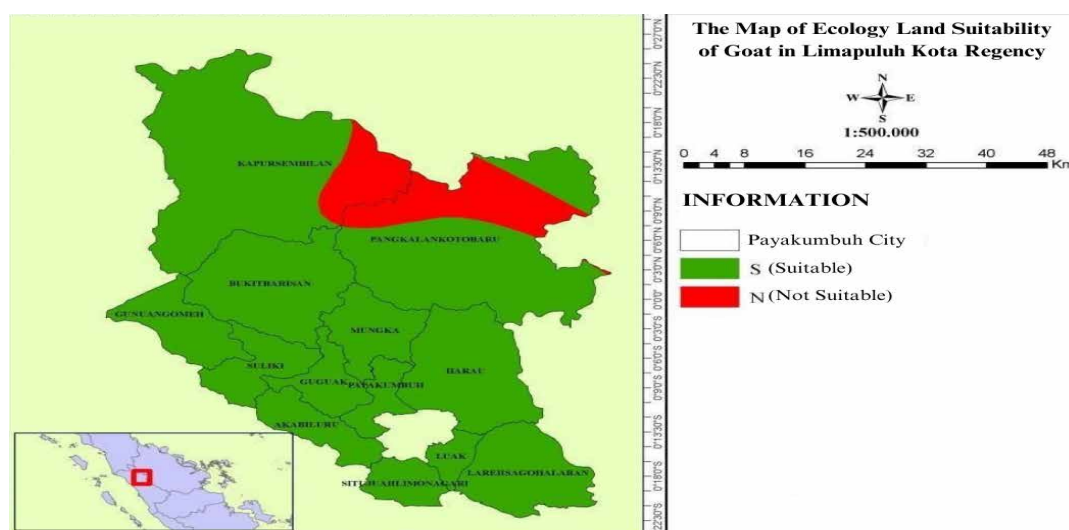


Figure 1. The Map of Ecology Land Suitability of Goat in Limapuluh Kota Regency

Since both ruminants require forage as a main meal, goats and cattle are classified as ruminant commodities with similar ecological needs [14,15]. Table 2 shows the distribution of land suitable for goats in Kabupaten Limapuluh Kota by regency.

Table 2. The Result of Ecology Land Suitability for Goats in Limapuluh Kota Regency

Ecology Land Suitability (Ha)								
No	District	THI (°C)	Dry Month	Rainfall (mm)	pH Water	Slope (%)	Elevation (m)	Suitable (S)
1	Kapur Sembilan			≥1750		16-25	0-700	25.945,50
2	Situjuh Limo Nagari			≥2500		16-20	300-1000	4.672,88
3	Luak			≥2500		16-20	600-1000	4.548,99
4	Lareh Sago Halaban			≥2500		16-20	600-800	8.680,05
5	Akabiluru			≥2500		8-15	600-1000	5.962,57
6	Payakumbuh	22-24	≤4	≥2500	6,65	0-3	600-800	4.896,61
7	Gunuang Omeh			≥2300		16-20	800-1500	7.585,31
8	Suliki			≥2000		16-25	700-1000	8.246,44
9	Bukit Barisan			≥1750		16-20	500-1500	23.263,87
10	Guguak			≥2300		8-20	300-700	7.414,16
11	Mungka			≥2300		10-20	500-1000	9.417,78
12	Harau			≥2500		8-20	700-1000	13.327,17
13	Pangkalan Koto Baru			≥2300		8-20	0-800	24.750,72
Total								148.712,04
								13.465,24

Based on estimates using spatial analysis, 148,712.04 hectares of environmentally acceptable area were found for the development of goat livestock. Clearly, over half of the land is favorable for goat development; specifically, 91.70% of the land is ecologically compatible. According to [16] research, 157,822 hectares of land were deemed acceptable for the ecological habitat of beef cattle in Limapuluh Kota Regency.

Harau, Pangkalan Koto Baru, Kapur Sembilan, and Bukit Barisan are the areas with the broadest applicability. This appropriateness is dependent on the temperature conditions, water availability, slope, and height of the location [17,18]. The sub-district's land area may also have an impact on these suitability features. The subdistricts of Kapur Sembilan, Bukit Barisan, and Pangkalan Koto Baru are larger than the other eleven. Consequently, while determining the ecological land area's suitability, it surpasses that of other sub-districts with lesser areas [19].

The land's unsuitability is also influenced by the ecological suitability standards. The temperature

and altitude in areas like Kapur Sembilan, Bukit Barisan, and Pangkalan Koto Baru sub-districts are unsuitable for goat rearing because they do not match ecological requirements.

According to [20,21], goats prefer temperatures between 18 and 30 degrees Celsius. However, because THI is between 22 and 24°C, the goats in Limapuluh Kota Regency are often comfortable. According to [22], a THI of less than 74 indicates normal, a THI of 75–78 indicates alert level, and a THI of more than 85 indicates dangerous status. Since Limapuluh Kota District has both IIC and IVC climate patterns, there is no issue with the district's water availability requirements. Limapuluh Kota Regency has a wet climate because of its annual rainfall, which ranges from 2000 to 4000 mm.

As a result, water availability for goat livestock development can be effectively met. According to [23], dry months that occur less than eight months out of the year are suitable for grazing and confined livestock. Limapuluh Kota Regency's rainfall parameters (mm) are hence appropriate for goat rearing.

Kabupaten Limapuluh Kota has an average land slope of 8–20%, according to the slope results. This state is suitable, particularly for goat husbandry. However, [14] state that a good slope is 8%. Additionally, Kabupaten Limapuluh Kota's elevation is 500–1000 meters above sea level [11]. Kabupaten Limapuluh Kota has an average elevation of 700–1000 meters above sea level. in order for the elevation and slope data to be appropriate for goat breeding.

An excessively steep land slope, which raises the risk of erosion and makes it difficult for livestock to enter the area, is one of the characteristics that makes a piece of land unsuitable. The availability of fodder may then be impacted by scarce water sources. Additionally, there is too much rainfall, which raises the risk of illness because of the excess moisture.

CONCLUSION

In Kabupaten Limapuluh Kota, there are excellent prospects for the growth of this industry because the vast majority of the land is ideal for goat rearing. Creating a silvopastura system to boost forage availability all year round is one suggestion that can be put into practice. Using agroforestry practices and terracing in hilly terrain can help conserve soil and water. enhancing roads leading to agricultural areas and granting access to clean water in order to facilitate the delivery of livestock products. interaction with farmers to broaden their knowledge of farming methods that are suited to regional ecological circumstances.

CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication of this paper.

AUTHOR CONTRIBUTIONS

Cori Qamara conducted the research, Dani Nur Arifin conducted the Cori Qamara and Aditya Alqamal Alianta calculations, Andi Nurmasythia AS, Karenina Dwi Yulianti, and Kirana Dara Dinanti Adiputra wrote and revised the manuscript. All authors agreed to the final version of this manuscript.

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