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ANALYSIS OF LAND USE AND COVER AND ITS PROPORTION FOR RUMINANT FARMING IN LIMA PULUH KOTA REGENCY

Analisis Penggunaan Dan Tutupan Lahan Serta Proporsinya Untuk Peternakan Ruminansia Di Kabupaten Lima Puluh Kota

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ABSTRAK

Tujuan dari penelitian ini adalah untuk menilai potensi pengembangan ternak ruminansia di Kabupaten Lima Puluh Kota dengan menganalisis tutupan lahan dan penggunaan lahan. Peta tutupan lahan dengan tingkat akurasi tinggi (kappa = 0,97) dibuat dengan menggunakan Citra Satelit Landsat 8-9 Path/Row 127/060 dan metode klasifikasi Random Forest (RF). Analisis dilakukan dengan menggunakan proses Sistem Informasi Geografis (GIS) untuk mengevaluasi kesesuaian lahan. Kemiringan, ketinggian, dan kedekatan dengan sumber air merupakan kriteria yang digunakan dalam proses evaluasi kesesuaian lahan. Hasilnya, sekitar 35% dari kabupaten ini sangat sesuai (S1) untuk beternak ruminansia. Karena kelimpahan pakan alami dan kondisi yang kondusif untuk sistem penggembalaan yang luas, wilayah-wilayah yang ideal ini sebagian besar merupakan zona pertanian lahan kering, kebun campuran, dan semak belukar. Namun, karena terbatasnya pasokan pakan ternak dan kendala geografis, lingkungan yang berhutan lebat dan lingkungan perkotaan dikategorikan sebagai lingkungan yang cukup sesuai atau tidak sesuai. Pentingnya meningkatkan pengaturan tata ruang peternakan disorot oleh ketidaksesuaian yang signifikan yang ditemukan ketika data populasi ternak yang ada ditumpangsusunkan secara spasial dengan peta kesesuaian. Kesimpulannya, Kabupaten Lima Puluh Kota memiliki dasar biofisik yang kuat untuk membantu pengembangan ternak ruminansia. Namun, untuk memastikan penggunaan sumber daya lahan yang berkelanjutan dan efektif untuk peternakan, perencanaan tata ruang dan kebijakan penggunaan lahan harus selaras.

Kata kunci : Kesesuaian, lahan, pakan, protein hewani, spasial.

ABSTRACT

The purpose of this study was to assess the potency of ruminant livestock development in Lima Puluh Kota Regency by analyzing land cover and land use. A high-accuracy land cover map (kappa = 0.97) was created using Landsat 8-9 Path/Row 127/060 satellite imagery and the Random Forest (RF) classification method. Analysis was conducted using Geographic Information System (GIS) processes to evaluate land suitability. Slope, elevation, and proximity to water sources are criteria used in the land suitability evaluation process. As a result, about 35% of the regency is highly suitable (S1) for ruminant farming. Due to the abundance of natural fodder and conditions conducive to extensive grazing systems, these ideal areas are predominantly zones of dryland agriculture, mixed gardens, and shrublands. However, due to limited fodder

supply and geographical constraints, densely forested environments and urban environments are categorized as moderately suitable or unsuitable. The significant mismatches highlighted the importance of improving livestock spatial arrangements found when existing livestock population data were spatially overlaid with suitability maps. In conclusion, Lima Puluh Kota Regency has a strong biophysical basis to support ruminant livestock development. However, to ensure sustainable and effective use of land resources for livestock, spatial planning and land use policies must be aligned.

Keywords : animal protein, feed, land, spatial, suitability

INTRODUCTION

West Sumatra Province contains the region known as Lima Puluh Kota Regency. Its topography is varied, encompassing both alpine and lowland regions. Over 335,000 hectares make up the entire area. Particularly in the fields of agriculture and livestock, this diversity in topography and climate offers both opportunities and challenges for the management of natural resources (Qamara et al., 2023). The primary source of income for the locals in Lima Puluh Kota has historically been agriculture. The local economy and food security are greatly aided by ruminant cattle (Umar & Dewata, 2018).

There is huge potency for raising ruminant animals in Lima Puluh Kota especially goats, buffaloes, dairy cattle, and beef cattle. These animals are valuable commodities in addition to being providers of animal protein (Qamara et al., 2024). They also supply organic fertilizer to aid in farming operations. However, there are significant obstacles in the way of cattle farming's growth. The quality of natural feed and land availability are important considerations (Rolando et al., 2025). The amount of fodder land that ruminants can use declined in recent years. The primary reason is the growing trend of turning agricultural land into residential and tourist destinations (Yusyaf & Wilis, 2024).

In addition, land productivity and the availability of feed for cattle have also been adversely affected by environmental stresses like pest assaults and soil deterioration (Xu et al., 2019). For instance, in 2024, insect assaults impacted around 215 hectares of agricultural land (Livestock and Animal Health Service Office of Lima Puluh Kota Regency, 2023) and ruminant fodder supplies therefore are at risk. An integrated strategy to land management is necessary to address these issues. To guarantee the best possible land use that promotes the development of ruminant livestock, this strategy needs to be grounded in spatial data (Qamara et al., 2025; Walsh et al., 2024).

The majority of current research concentrate on the quantitative aspects of livestock numbers or general land usage (Eriksson et al., 2025). There is a substantial research deficit on combining land cover data with the spatial potential of suitable land for ruminant farming. For adaptive and sustainable spatial planning and management, comprehensive spatial data is necessary (Fu et al., 2025).

This study maps land cover and land use in detail using a Geographic Information System (GIS). Additionally, it pinpoints prospective regions that could be developed as ruminant livestock support land. This method enables a thorough and fact-

based analysis. Policymakers can use the findings as a starting point for developing sustainable livestock development plans. Moreover, it aids in striking a balance between the preservation of natural resources and productive land usage.

MATERIAL AND METHODS

Geographic Information System (GIS)-based spatial analysis techniques are used in this study's descriptive quantitative methodology. Based on spatial data, this method makes it possible to map land cover in great detail and identify possible area for ruminant livestock production (Creswell & Creswell, 2018). To confirm the actual land use conditions and the potential of land for the production of ruminant feed, field surveys are carried out. The study makes use of administrative maps, land cover data from the Geospatial Information Agency, livestock statistics from the Department of Livestock and Animal Health of Lima Puluh Kota Regency, and high-resolution satellite images (Landsat 8-9 Path/Row Satellite Imagery: 127/060).

Processing Satellite Images

1. Satellite imagery is pre-processed for geometric and radiometric corrections (Lillesand et al., 2015).
2. Accurate land cover maps are produced by employing supervised classification techniques, which apply Random Forest or Support Vector Machine (SVM) algorithms (Pal & Mather, 2005).
3. Types of land cover that are appropriate for ruminant feed are identified, including pastures, grasslands, and agricultural regions that sustain forage crops.

To estimate the area and spatial distribution of potential land, administrative boundaries and land use data are superimposed on the classified land cover map (Burrough & McDonnell, 1998). GIS software is used to objectively analyse the generated mapping data, which is then shown as descriptive tables and thematic maps. The classified land cover maps are checked for correctness using a confusion matrix, which computes measures like Kappa Coefficient and Overall correctness (Congalton & Green, 2009).

By comparing the land requirements per livestock unit with the available land area and carrying capacity based on pasture yield, this study determines the land proportion (Tian et al., 2021). The association between the cattle population and land cover variables is investigated through statistical analysis. Through stakeholder focus groups and cross-referencing GIS data with field conditions, results are verified (Reba & Seto, 2020). The percentage of sustainable land usage for ruminant livestock production, suggestions for the best way to allocate land, and thematic maps of land suitability are among the research's outputs.

RESULT AND DISCUSSION

The results are shown in Table 1 below, which is based on the computation of digital maps of land cover and land use interpretation of Landsat 8-9 Path/Row Satellite Imagery: 127/060 and then superimposed with the Lima Puluh Kota Regency administrative map from the National Survey and Mapping Coordinating Agency.

Table 1. Area of Lima Puluh Kota Regency by Land Cover and Use Land Use Based on Spatial Analysis

No	Land Cover Type	Land Area (Ha)	Proportion (%)
1	State Forest	63,207.81	25.24
2	Production Forest	3,325.00	1.33
3	Mixed Garden	64,659.93	25.82
4	Plantation	8,423.69	3.36
5	Settlement	37,989.00	15.17
6	Rice Field	16,346.04	6.53
7	Shrub/Grassland	17,288.17	6.90
8	Open Land	14,664.23	5.86
9	Dry Fields/Yard	20,054.84	8.01
10	Water Bodies (lakes and/or rivers)	4,488.00	1.79
	Total	250,446.71	100.00

Source: Data Processed (2025)

Accuracy of Land Cover Classification

Landsat 8-9 images classification using the Random Forest (RF) method produced high accuracy, with a kappa value of 0.97. This result is in line with the research by Arikan & Yildiz (2023), which showed that RF performs better in LULC classification than other algorithms like SVM and CART, especially when it comes to differentiating between vegetation and agricultural classes. A study carried out in Manisa, Turkey, which indicated an overall accuracy of 98% for LULC classification using RF on Landsat 8-9 imagery, lends more credence to the effectiveness of RF in classification (Arikan & Yildiz, 2023). These findings suggest that in regions with significant vegetation complexity, like Lima Puluh Kota Regency, RF is a suitable option for classifying land cover.

Distribution of Adequate Land and Space for Ruminant Livestock

According to a land suitability analysis, over 35% of the Lima Puluh Kota Regency area is very appropriate (S1) for the development of ruminant livestock, especially in lowland areas with excellent feed availability and high accessibility. These results are consistent with research conducted in the Thrace region of Turkey by Altürk et al. (2022), which employed AHP and GIS techniques to assess the feasibility of land for cattle ranching while taking into account variables including slope gradient, soil type, and proximity to water sources.

The significance of environmental elements like slope and vegetation availability in determining the viability of land for small ruminant cattle was also highlighted in a related study conducted in Turkey by Deri & Ünal (2017). Within the Lima Puluh Kota Regency, regions with elevations below 1,500 meters, slope gradients less than 15%, and NDVI values higher than 0.5 have a high potency for ruminant production.

Combining Livestock Population and Spatial Data

The result ot this research indicates that when the land suitability map was aoverlaid by the current

livestock population, there are several regions with large livestock populations are located in zones of medium to poor land suitability. This suggests that the ideal land potential and the existing locations of livestock farms are not aligned. The location of cattle farms frequently does not match ecological site suitability, which could result in soil degradation and lower productivity.

In order to prevent adverse environmental effects and guarantee sustainable livestock production, research conducted in China by Qiu et al. (2017) emphasized the significance of land suitability evaluation in livestock development planning. This research highlights the necessity of reviewing the locations of current livestock farms in the Lima Puluh Kota area and designing future farms using land suitability analysis.

Climate Change's Effects on Land Suitability

Silva et al. (2024) demonstrated that in Brazil's semi-arid region climate change might had impacted the suitability of land for cattle and other uses. According to their prediction model, agricultural lands might decrease by about 8% under the RCP 8.5 scenario, while grassland-suitable regions could grow by up to 30%. Climate change may have an impact on the productivity and distribution of fodder lands in Lima Puluh Kota Regency, which could have an impact on the suitability of the area for raising ruminant animals. Planning for cattle development and land suitability assessments must therefore take climate factors into account.

Classification of Land Cover and Its Significance for Ruminant Livestock Production

When assessing whether a piece of land is suitable for raising ruminant livestock, land cover is a crucial consideration. Since they offer a wealth of natural fodder, land cover types including grasslands, shrublands, and agricultural areas are typically regarded as the most appropriate. In contrast, the ability of dense woods and populated areas to support cattle activity is limited. More detailed results can be seen on the following map.

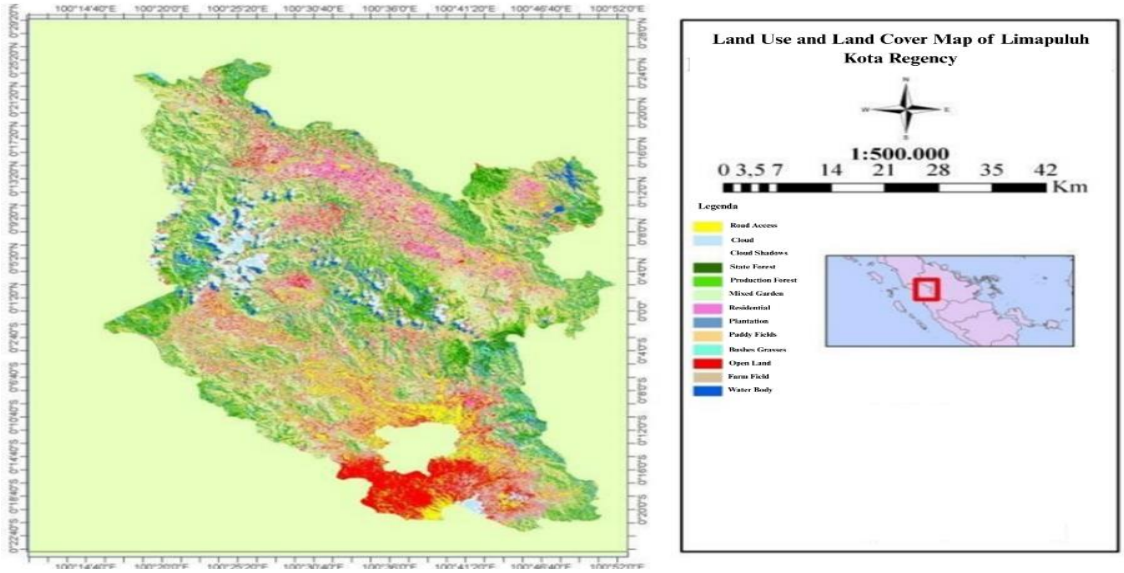

Figure 1. Land Use and Land Cover Map of Lima Puluh Kota Regency Based on Spatial Analysis

The spatial distribution of different land cover types is depicted on the land use map of Lima Puluh Kota Regency. This has important ramifications for the possible growth of ruminant livestock husbandry. State forests, production forests, mixed plantations, towns, estates, rice fields, bushes, open ground, dry fields/fallow land, and bodies of water are among the several land coverings found in the area, according to the map legend. Because they offer natural feed and allow for extended grazing, shrubland, mixed plantations, and dry fields/fallow land are the best options for the development of ruminant livestock (Bojer et al., 2024; Atassi et al., 2022).

Large tracts of fields and shrubland may be seen in the middle and northern regions of the regency, which are primarily shown on the map as light green to yellowish-brown. According to research by Balew et al. (2022) and Kumar et al. (2022), which indicates that regions with open vegetation, access to highways, and water supplies greatly support livestock activities, these places (S1 and S2) are ideal for ruminant livestock farming. Conversely, the red-colored southern region denotes less appropriate communities (S3–N1) because of the high population density and lack of open space.

Land appropriateness is determined by a number of environmental characteristics, including accessibility, elevation, and slope gradient, in addition to land cover. The center section often has land with a slope of less than 15%, which makes it easier to handle and more accessible for animals. The study by Qiu et al. (2017) further highlights how crucial it is to plan livestock using a multi-criteria approach that takes socioeconomic and ecological issues into account. Overall, the map shows that Lima Puluh Kota Regency has a lot of potential for the growth of ruminant livestock farming, especially in the fields, mixed plantations, and shrub-covered areas. As suggested by De la Vega et al. (2022), Vázquez-Quintero et al. (2020), and Mutua et al. (2021), GIS- and Analytic Hierarchy Process (AHP)-based methods must be used to combine land cover data with environmental and infrastructural data in order to support sustainable development. Furthermore, spatial planning that accounts for urbanization impacts and forest conservation should be prioritized to ensure the availability of suitable land for future livestock development.

Maximum Land Resource Potential

The Maximum Potential based on Land Resources (MLRP), is calculated by adding the total amount of cultivated land, grasslands, and wetlands (Adrian et al., 2022; Ramamurthy et al., 2020). These three factors have a direct bearing on the amount of land that may be used to boost livestock productivity, which can result in a rise in the number of cattle. The potential for livestock numbers to increase in a particular location increases with the quality of the land resource potential. Table 2 displays the specifics of the MLRP (AU) results for Lima Puluh Kota Regency.

The MLRP results for Lima Puluh Kota Regency are derived from a comparison of the feed requirements per unit of livestock (AU) and the current feed potential, as shown in Table 2. Table 2 shows the MLRP (AU) of 226,373.79. This is calculated by dividing the total feed availability of 524,121.71 tons of dry matter/year by the dry matter requirement for 1 AU of ruminants, which is 2.3 tons of dry matter/year (Qi et al., 2023). This indicates that the Lima Puluh Kota Regency's land resources can support

226,373.79 AU of ruminant animals, including goats, buffaloes, and cattle.

The Kapur Sembilan sub-district achieved the highest MLRP (AU) at 30,892.30 LU due to the agricultural land's capacity to meet significant feed requirements. As a result, a significant amount of agricultural waste is generated. The Gunuang Omeh sub-district, on the other hand, only received a MLRP (AU) of 8,684.03. This is due to the fact that there is a lot less agricultural land available for ruminant fodder than there is in Harau, which means that less agricultural waste is generated. There is a significant discrepancy between the potential and actual exploitation of these capacities in both regions when compared to the current ruminant populations.

Table 2. Maximum Potential Land Resources per Sub-district in Lima Puluh Kota Regency

No	Sub-District	Total availability feed (tons of dry matter/year)	MLRP (AU)
1	Kapur Sembilan	71,172.28	30,892.30
2	Situjuh Limo Nagari	28,774.64	12,446.14
3	Luak	26,001.00	11,169.32
4	Lareh Sago Halaban	49,083.70	21,229.00
5	Akabiluru	29,421.23	12,840.67
6	Payakumbuh	50,687.16	22,006.77
7	Gunuang Omeh	20,476.33	8,684.03
8	Suliki	35,396.22	15,381.05
9	Bukit Barisan	42,628.39	18,389.33
10	Guguak	26,399.56	11,295.29
11	Mungka	34,477.27	15,017.00
12	Harau	58,894.47	24,989.89
13	Pangkalan Koto Baru	50,709.46	22,033.00
	Total	524,121.71	226,373.79

Source: Data Processed (2025)

Cattle, buffalo, and goats make up the current ruminant population of about 2,234 head in Kapur Sembilan (Lima Puluh Kota Regency in figures, 2024), which is well below its estimated carrying capacity. The ruminant population of Gunuang Omeh is approximately 1,825 head (Lima Puluh Kota Regency in figures, 2024), which is likewise much less than its 8,684 AU potential.

CONCLUSIONS

According to an analysis of land cover and land use in Lima Puluh Kota Regency, there is a lot of room for ruminant livestock farming to grow there, especially in regions that are covered by drylands/fallow fields, mixed gardens, and shrublands.

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