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Beef Cattle Farming Area Planning Based on LQ and GIS Analysis in West Kutai Regency

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Abstract. Beef cattle are a strategic commodity in supporting animal food security and strengthening the regional economy.West Kutai Regency has significant potential for beef cattle development, but is not yet supported by targeted, data-driven livestock planning. This study aims to identify base and non-base areas for beef cattle and map priority zoning for beef cattle center development through the integration of Location Quotient (LQ) and Geographic Information System (GIS) analysis. The study was conducted from April to October 2025 using primary data from field observations and secondary data from relevant agencies. LQ analysis was employed to assess the level of specialization within the beef cattle population at the sub-district level, while GIS spatial analysis was utilized to integrate the LQ results with information on land use and regional accessibility networks. The results showed that of the 16 sub-districts, five are base areas (LQ > 1): Long Iram, Sekolaq Darat, Linggang Bigung, Nyuatan, and Penyinggahan, with Long Iram having the highest LQ value (2.79). The integration of LQ results and spatial modeling resulted in a priority zoning map that highlighted the primary concentration of beef cattle development in areas with high livestock populations, adequate accessibility, and available cultivation space. This study emphasizes the significance of quantitative and spatial approaches in livestock spatial planning, thereby supporting the development of sustainable beef cattle centers in West Kutai Regency.

Keywords: Beef Cattle; GIS; Livestock Planning; Location Quotient; West Kutai

1. INTRODUCTION

Beef cattle are a strategic commodity in the livestock subsector, playing a significant role in the national supply of animal protein. Demand for beef continues to increase in line with population growth, increased purchasing power, and changing consumption patterns that favor higher-quality animal products. At the regional level, the development of this commodity is also a crucial instrument in supporting local economic growth, as beef cattle farming not only contributes to meat production but also generates by-products such as organic fertilizer, hides, and bones, while supporting employment and other agribusiness activities. Therefore, the existence of well-planned and distributed beef cattle development centers is a crucial part of achieving animal food independence and strengthening regional economies.

West Kutai Regency, situated in East Kalimantan Province, possesses socio-economic characteristics and is a promising region for beef cattle development. With an area of 20,381.59 km² and a projected population of 180,310 by 2025, local demand for beef consumption is expected to continue increasing in line with regional economic growth. Based on recent data, the large ruminant population in this region is dominated by beef cattle, at 3,875 heads, which is higher than the goat and buffalo populations. This condition confirms that beef cattle are a leading ruminant livestock commodity in West Kutai. However, the growth of this strategic commodity has not been accompanied by a targeted regional development system. Most livestock businesses are still managed traditionally on a small scale, without the support of an

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integrated production chain, including markets, institutions, or a competitive agribusiness system (Poulton et al., 2010).

One of the fundamental challenges in developing the beef cattle business in this region is the lack of spatial planning based on quantitative and spatial data (Leta & Mesele, 2014). The irregular allocation of livestock areas often results in overlapping land use with other sectors, such as forestry, plantations, conservation, and even nature tourism. As a result, livestock development often competes unfairly with other sectoral interests. This situation hinders business scale-up, reduces investment interest, and hinders the emergence of sustainable and competitive production centers. Therefore, a data-driven planning approach is needed that can accurately and measurably identify livestock population distribution, production base areas, and the potential for new center development. To address these needs, the use of Geographic Information System (GIS) technology is highly relevant as a spatial analysis tool in livestock planning (Tadesse & Amare, 2021). GIS technology can provide visualization and analysis of livestock population distribution, regional accessibility, market accessibility, and biophysical and socioeconomic characteristics that influence the development of beef cattle businesses. The integration of GIS into regional evaluations enables a more precise planning process through mapping priority livestock centers, identifying potential spatial conflicts, harmonizing land use across sectors, and determining business development locations based on livestock population growth.

The novelty of this research lies in the integration of Location Quotient (LQ) analysis with GIS spatial modeling to identify and map beef cattle development centers in West Kutai Regency. This approach not only quantitatively determines livestock base areas but also produces spatial priority zoning through a combination of indicators: (1) livestock population concentration (LQ results), (2) spatial distribution of livestock production, (3) regional accessibility to supporting facilities and infrastructure, and (4) spatial suitability according to the RTRW/land use characteristics. The resulting spatial composite index serves as a multi-source data-based regional evaluation model that is rarely applied in an integrated manner in Indonesia, particularly in Kalimantan. Considering that West Kutai is a region with limited livestock research, this study is expected to make new contributions to the development of adaptive and sustainable livestock spatial planning policies that support regional food security, particularly in beef cattle production.

2. RESEARCH METHODS

Research Location and Time

This research was conducted in West Kutai Regency, East Kalimantan Province, a region with a diverse settlement distribution and land use, including dryland agricultural areas, plantations, scrublands, and other open areas that facilitate beef cattle farming. These characteristics mean that each sub-district has different potential for livestock development, necessitating the identification of base and non-base areas for beef cattle. The selection of West Kutai Regency as the research location was determined based on the dynamics of the beef cattle population in recent years, which showed a development trend and indications of an increase in smallholder livestock businesses oriented towards meat production. The research was conducted from April to October 2025, encompassing data collection on livestock populations and field verification of beef cattle business distribution, statistical data processing, and Geographic Information System (GIS)-based spatial analysis to identify priority zoning areas for beef cattle development.

Data Types and Sources

This research uses a quantitative approach, enhanced by the use of spatial analysis technology, to analyze beef cattle population concentrations and identify potential areas for livestock development centers. The data used comprises both primary and secondary sources. Primary data were collected through field observations to verify the location of beef cattle populations, identify livestock husbandry practices, and assess the accessibility of livestock areas to supporting facilities, including road networks, livestock markets, and residential centers. Additionally, brief interviews were conducted with local livestock farmers to gather information on husbandry practices, livestock ownership, business scale, and livestock population distribution, drawing on their community experience.

Meanwhile, secondary data was obtained from official agencies, including the West Kutai Regency Agriculture and Livestock Service as the provider of livestock population data, the Central Statistics Agency (BPS) as the provider of population and demographic data, and the Geospatial Information Agency (BIG) as the source of spatial data in the form of road network maps, land use maps, and administrative boundary shapefiles. This secondary data was used to calculate the Location Quotient (LQ) and to compile a spatial database for mapping priority areas for beef cattle development.

Location Quotient Analysis (LQ)

The Location Quotient (LQ) analysis method in West Kutai Regency is used to identify superior commodities in a base/non-base area. LQ analysis is used to calculate the ratio between Si and Ni. Si is the ratio between the livestock population in a region/sub-district and the population in the same region. Ni is the ratio between the livestock population in a specific region and the population in West Kutai Regency (Wirawati et al., 2021). The LQ formula is as follows:

$$LQ = \frac{Si/S}{Ni/N}$$

Description:

Si: population of livestock species i at the sub-district level

S: population at the sub-district level

Ni: population of livestock species i at the district level

N: population at the district level

The LQ calculation is grouped into three criteria:

a. LQ>1 means the livestock commodity is a basic sector. The potential of this livestock commodity can be developed to meet the needs of the region itself and also those of the surrounding areas.
b. LQ=1 means the livestock commodity is a non-basic sector. Its potential can only meet the needs of its own region without meeting the needs of surrounding areas.
c. LQ<1 means the livestock commodity is a non-basic sector. This area does not have good livestock potential for development.

GIS-Based Spatial Analysis

A Geographic Information System (GIS)-based spatial analysis was conducted to integrate the results of the LQ calculation with maps of spatial use and regional accessibility networks, thereby identifying priority zones for beef cattle development. This spatial analysis plays a crucial role in visualizing the distribution of regional potential and assisting the process of geographic data-based livestock development planning. The analysis phase involves collecting spatial data in the form of regional administration shapefiles, road networks, and land use data, followed by georeferencing and data cleaning to ensure the suitability of the map formats and coordinates (Patel et al., 2025). The LQ analysis map was then overlaid with spatial data on the road network and land use to identify areas that are not only superior in terms of livestock population but also suitable in terms of accessibility and spatial planning. The next phase involves classifying priority areas for beef cattle development based on the spatial index

derived from the overlay and spatial suitability analysis. This classification is then visualized in the form of a priority zoning map for beef cattle development centers, which serves as a scientific recommendation for the local government and stakeholders in formulating livestock development strategies in West Kutai Regency. Thus, the GIS analysis in this study serves not only as a mapping tool but also as an evidence-based decision-making instrument that supports regional livestock development policies.

3. RESULTS AND DISCUSSION

Potential Beef Cattle Development Areas in West Kutai Regency

West Kutai Regency is one of the regions with significant potential for beef cattle development in East Kalimantan Province. Geographically, West Kutai features a landscape comprising drylands, plantations, scrublands, and scattered settlements, offering a diverse ecological environment for smallholder livestock farming activities. With an area of 20,381.59 km² and a projected population of 180,310 by 2025, the demand for beef in this region is expected to continue increasing in line with economic growth and improvements in living standards. In terms of livestock population, beef cattle are the largest ruminants, with the highest number reaching 3,875 head, far surpassing both buffalo and goats. This confirms that beef cattle are a superior livestock commodity with significant potential for development as a center for meat production in this region.

From a regional economic perspective, the existence of beef cattle farming significantly contributes to the provision of animal protein, job creation, and the strengthening of local agribusiness. Most livestock farms in West Kutai are still managed on a household scale, employing traditional husbandry practices, and have not yet been fully integrated into the market. Nevertheless, certain sub-districts show a trend of faster beef cattle population growth than other areas. The results of the Location Quotient (LQ) calculation provide a quantitative overview of sub-districts that are considered base areas for beef cattle development. Sub-districts with an LQ value greater than 1 indicate production centers capable not only of meeting local needs but also of supplying the surrounding area. Conversely, sub-districts with an LQ value < 1 have a low level of specialization and only serve as supporting areas. The imbalance in livestock population distribution identified through this LQ analysis provides a crucial basis for formulating strategies to develop livestock areas based on beef cattle commodities (Santoso & Prasetiyono, 2020).

In addition to economic and livestock aspects, the potential for beef cattle development in West Kutai is also significantly influenced by social and institutional factors. The local

community, which largely relies on agriculture and plantations for its livelihoods, makes beef cattle farming a relatively stable sideline. The availability of community livestock groups, the role of livestock extension workers, and support from local government programs contribute to strengthening the social foundation for beef cattle business development. However, the lack of a strong agribusiness institutional structure, limited capital for livestock farmers, and limited access to technological innovation are challenges that need to be addressed systematically. This highlights the need for targeted, evidence-based livestock development planning, enabling West Kutai to maximize its regional potential and establish competitive beef cattle production centers.

Spatially, Geographic Information System (GIS) analysis yields a more comprehensive picture of the distribution of beef cattle farming activities in West Kutai Regency (Laumonier et al., 2020). The overlay map of LQ values, land use, and accessibility networks indicates that potential beef cattle development is concentrated in sub-districts characterized by a combination of high livestock populations, adequate road access, and the availability of open land for cultivation. Sub-districts with clustered population distribution patterns tend to have greater potential because they are supported by road infrastructure connecting rearing areas with residential centers and local markets. Meanwhile, several sub-districts with extensive land expanses but limited accessibility show long-term potential if supported by infrastructure improvements and livestock spatial planning development. This spatial pattern is crucial for avoiding conflicts over land use, especially in areas bordering forested areas, large plantations, or conservation areas.

Overall, the results of the quantitative LQ analysis, combined with GIS spatial modeling, indicate that West Kutai Regency has significant potential for developing a region-based beef cattle center. By maximizing the base area, increasing the production capacity of smallholder farmers, and integrating livestock development with regional spatial planning, West Kutai has the potential to become one of the centers of beef production in East Kalimantan. This data-driven and spatially integrated approach is crucial in supporting sustainable, adaptive livestock development policies that can improve regional food security. The success of this strategy will have a significant impact on strengthening the rural economy and transforming the livestock sector into a more modern and competitive business.

Location Quotient Analysis (LQ)

Location Quotient (LQ) analysis is a crucial tool for determining priority areas for the development of superior commodities, including beef cattle, in West Kutai Regency. LQ is used to identify whether a sub-district has a comparative advantage or a higher level of specialization in beef cattle farming compared to the average condition at the regency level. LQ calculations are performed by comparing the ratio of beef cattle population to the total population in each sub-district with the same ratio at the regency level. Thus, LQ not only reflects the size of the cattle population but also emphasizes the sector's dominance in the regional economic structure. A sub-district is categorized as a base region if its LQ value is greater than 1, which means the beef cattle farming sector makes a greater contribution than other sub-districts (Perwitasari et al., 2024). If the LQ value is < 1, the sub-district is a non-base sector, or in other words, its contribution to the regional economy is relatively low. An LQ value of 1 indicates that the region is only able to meet internal needs without a surplus for the external market.

The results of the LQ analysis are presented in Table 1 (see Table 1). Based on this table, of the 16 sub-districts, five are classified as base areas: Penyinggahan, Nyuatan, Linggang Bigung, Sekolaq Darat, and Long Iram. These five sub-districts have LQ values greater than 1, indicating that the beef cattle farming sector in these areas has a higher level of specialization compared to other sub-districts.

Table 1. Results of Location Quotient (LQ) Analysis of Beef Cattle in West Kutai Regency

Subdistrict	Population (People)	Cattle Population (Head)	LQ	Base/Non-Base
Bongan	12.442	158	0,543765	Non-Base
Jempang	12.671	128	0,432557	Non-Base
Penyinggahan	4.093	106	1,108,942	Base
Muara Pahu	9.153	120	0,561387	Non-Base
Siluq Ngurai	6.708	94	0,598851	Non-Base
Muara Lawa	8.126	149	0,783598	Non-Base
Bentian Besar	3.7	84	0,970201	Non-Base
Damai	11.85	121	0,436366	Non-Base
Nyuatan	7.092	184	1,108,749	Base
Barong Tongkok	37.246	867	0,994772	Non-Base
Linggang Bigung	17.006	580	1,457,505	Base
Melak	15.555	184	0,505513	Non-Base
Sekolaq Darat	11.477	660	2,462,409	Base
M.Manaar Bulatn	9.307	127	0,583147	Non-Base
Long Iram	7.788	509	2,793,032	Base
Tering	11.367	263	0,988767	Non-Base
Total	185.581		4.334	

Source: *BPS West Kutai Regency 2025 and Department of Agriculture and Animal Husbandry West Kutai Regency 2025

Note: LQ >1: Base; LQ =1: Non-Base; LQ <1: Non-Base

The Location Quotient (LQ) analysis results show that Long Iram is the sub-district with the highest score, at 2.79, indicating the strong dominance of the beef cattle sector in the region's economic structure. This very high score indicates that Long Iram has excellent potential as a development center or cluster for beef cattle production. A similar condition is also observed in Sekolaq Darat, with an LQ score of 2.46, which reinforces its position as a region with a very intensive concentration of beef cattle farming activities. Meanwhile, Linggang Bigung and Nyuatan sub-districts, with LQ scores of 1.45 and 1.10, respectively, indicate that both areas already have a relatively stable beef cattle production base that is integrated with local economic activities. Interestingly, Penyinggahan sub-district, despite having a cattle population of only 106, still shows an LQ score of more than 1. This condition illustrates that the dominance of the beef cattle sector is not solely determined by the number of cattle, but is more influenced by the ratio between the livestock population and the population (Veysset et al., 2019). Due to the relatively low population in this region, the beef cattle sector remains a dominant economic activity compared to other sectors in the area.

In contrast, 11 other sub-districts are categorized as non-basic areas because they have an LQ value of less than 1. In several areas, including Bongan, Jempang, Muara Pahu, Siluq Ngurai, Muara Lawa, Melak, and Barong Tongkok, the cattle population is quite large. However, the contribution of the livestock sector to the sub-district's economic structure remains low (Moore et al., 2014). This phenomenon may be caused by a high population, resulting in a small cattle-to-population ratio, as seen in Barong Tongkok, where the population is 37,246 people, and the cattle population is 867, resulting in an LQ value of only 0.99. Furthermore, more developed economic diversification, suboptimal livestock production capacity, and limited supporting infrastructure, such as access to production roads, livestock markets, and transportation facilities, also influence the position of these sub-districts in the livestock economic structure.

These findings confirm that areas with small populations are more likely to achieve high LQ scores if they have developed livestock activities. Meanwhile, developed and densely populated sub-districts require a significantly larger cattle population for the livestock sector to dominate the local economy truly. Overall, the LQ analysis results indicate that several sub-districts in West Kutai Regency have strong potential as centers for beef cattle development, particularly base areas such as Long Iram, Sekolaq Darat, Linggang Bigung, and Nyuatan. These areas can be directed as production centers, seed development centers, or livestock integration areas. Non-base sub-districts still have the potential to develop, but require more

targeted interventions, such as increasing production capacity, strengthening livestock institutions, and improving supporting infrastructure (Saleh et al., 2020).

Grouping of Regions Based on the Capacity to Increase Ruminant Livestock Population (KPPTR) and LQ

Livestock area development not only considers the LQ value but also the Ruminant Population Increase Capacity (KPPTR), which reflects the carrying capacity of forage in each sub-district. Therefore, regional grouping is carried out by combining these two indicators to produce a more comprehensive assessment. The results of the grouping are presented in Table 2.

Table 2. Grouping of Beef Cattle Development Areas in West Kutai Regency

Subdistrict	KPPTR (ST)	LQ
1. Potential areas for beef cattle development		
Penyinggahan	0,09	1,10
Nyuatan	1.104,96	1,10
Linggang bigung	1.584,09	1,45
Sekolaq darat	834,01	2,46
Long iram	891,21	2,79
2. Areas with no potential for beef cattle development		
Bongan	2.309,46	0,54
Jempang	1.632,04	0,43
Muara pahu	99,39	0,56
Siluq ngurai	883,95	0,59
Muara lawa	605,16	0,78
Bentian besar	626,18	0,97
Damai	655,75	0,43
Barong tongkok	2.317,99	0,99
Melak	357,68	0,50
M.Manaar Bulatn	2.044,97	0,58
Tering	891,21	0,98

Description: KPPTR (+): more forage carrying capacity; KPPTR (-): less forage carrying capacity; LQ>1: base area; LQ=1: non-base area; LQ<1: non-base area

The clustering results indicate that five sub-districts are categorized as areas with potential for beef cattle development: Penyinggahan, Nyuatan, Linggang Bigung, Sekolaq Darat, and Long Iram. These five areas have LQ values greater than 1, thus being classified as base areas, meaning the beef cattle sector has a significant contribution to the economic structure of their regions. Sub-districts such as Nyuatan, Linggang Bigung, and Long Iram have very high KPPTR values, indicating that in addition to their economic dominance, these sub-districts have very adequate forage carrying capacity. This high KPPTR indicates that these areas have the availability of grasslands, open land, and vegetation conditions that support the

sustainable development of beef cattle populations (Salendu & Elly, 2013). This condition strengthens the potential of these areas as excellent candidates for the development of production centers, breeding areas, and integrated livestock systems at the sub-district level.

Sekolaq Darat District stands out with an LQ of 2.46, indicating a very high level of economic specialization in the beef cattle sector. Although its KPPTR value is not as high as Nyuatan or Linggang Bigung, the economic dominance of the livestock sector in Sekolaq Darat suggests that development activities are already intensive and have a strong base in livestock farming. Therefore, Sekolaq Darat is a primary target for interventions aimed at increasing production capacity, improving livestock genetic quality, and developing livestock farming institutions. On the other hand, Penyinggahan District is an interesting case because it has a low KPPTR value, yet it is still categorized as a potential area due to its LQ value being above 1. This condition indicates that despite the limited carrying capacity of natural forage, the beef cattle sector remains a dominant economic activity (Gerber et al., 2015). This may occur due to a small population, minimal other economic activity, or more intensive cattle husbandry practices, even at a limited population scale. Penyinggahan is a strategic area for interventions such as increasing the availability of supplementary feed, forage processing technology, and feed management, as the region is already economically oriented towards cattle farming (Azizah et al., 2025).

In contrast, eleven other sub-districts are categorized as areas with no potential because they have LQ values of less than 1, meaning the beef cattle sector does not yet dominate the economic structure of their regions. Interestingly, several sub-districts, such as Bongan, Barong Tongkok, and M. Manaar Bulatn, have high KPPTR values but are still not categorized as potential because the beef cattle sector is not a dominant economic activity. This condition indicates that the availability of forage or an abundance of natural resources does not automatically make a region a livestock center if a strong economic structure, community preferences, or livestock farming institutions do not support it. This case is typical in regions with high economic diversification, such as those with more developed agriculture, plantations, or service sectors, where livestock farming is often a secondary activity. Other sub-districts, such as Jempang, Muara Pahu, and Siluq Ngurai, exhibit a combination of low LQ and KPPTR values, necessitating a more complex approach to their development, including infrastructure improvements, livestock empowerment, and community-based development strategies (Kumar et al., 2021).

Overall, the combination of LQ and KPPTR indicators shows that the potential for beef cattle development cannot be assessed from a single aspect. Base areas with high KPPTR are

the main priority zones for large-scale development, while base areas with low KPPTR require feed technology support for sustainable development. Meanwhile, non-base areas with high KPPTR have long-term opportunities but require more gradual policy interventions to increase the beef cattle sector's contribution to the regional economic structure. This approach provides more precise mapping for formulating livestock development policies that are appropriate to the ecological, demographic, and economic conditions of each sub-district in West Kutai Regency.

General Interpretation and Development Implications

The analysis shows that the LQ value is strongly influenced by the balance between cattle population and population, so that districts with small populations but relatively high livestock populations tend to produce high LQ values. This condition explains why some non-basic districts still obtain low LQ values despite having quite large cattle populations—the high population reduces the cattle-to-population ratio and makes the livestock sector's economic contribution appear smaller. Cases such as Barong Tongkok demonstrate that a high cattle population does not always equate to the dominance of the livestock sector, particularly if the regional economic structure is more diverse or densely populated.

The implication is that base areas such as Long Iram, Sekolaq Darat, and Linggang Bigung should be prioritized as centers for beef cattle development due to their clear economic advantages and strong potential for production expansion. Interventions in these areas can focus on strengthening livestock institutions, increasing productivity, and developing supporting facilities such as livestock markets and distribution infrastructure. Meanwhile, non-base areas still have growth opportunities, particularly sub-districts with high forage capacity (Aprylasari et al., 2025). In these areas, more appropriate strategies include gradually increasing livestock populations, improving cultivation management, and optimizing the use of feed resources to encourage the beef cattle sector to contribute more significantly to the regional economic structure.

Spatial Analysis (GIS) of Population Distribution and Beef Cattle-Based Commodities in West Kutai Regency

Geographic Information System (GIS)-based spatial analysis plays a crucial role in enriching the interpretation of Location Quotient (LQ) calculations for beef cattle development in West Kutai Regency. Through thematic mapping using GIS, the distribution of beef cattle populations across sub-districts can be visualized with greater precision, allowing for the identification of clear spatial patterns, livestock concentration levels, and priority zones. The map indicates that beef cattle populations tend to concentrate in sub-districts with favorable

biophysical characteristics, such as dryland areas, flat to gently sloping landscapes, and regions that have traditionally been centers of livestock activity. Sub-districts such as Long Iram, Linggang Bigung, and Sekolaq Darat appear to have larger cattle population concentrations, which spatially resemble clusters of closely spaced livestock production centers.

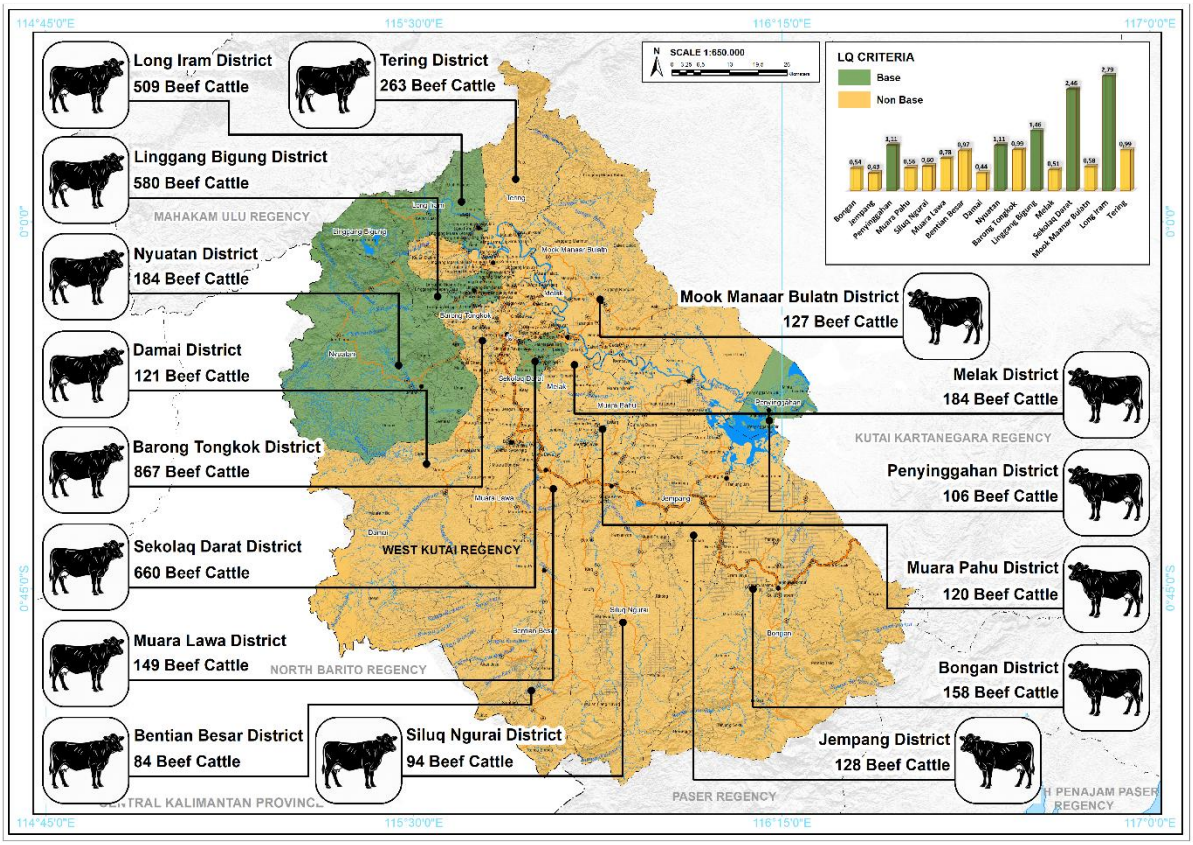

Figure 1. GIS Beef Cattle Farming in West Kutai Regency

Source: GIS Analysis Results, 2025

Integrating livestock population data and LQ values in a GIS map enables a more accurate identification of base and non-base areas than numerical analysis alone. Base areas with LQ values > 1, such as Long Iram, Sekolaq Darat, and Linggang Bigung, emerge as core zones for beef cattle development due to their significant contribution to the sub-district's economic structure. On the map, these sub-districts appear to form strategic production corridors, with relatively good accessibility to major transportation routes, thus supporting livestock distribution and marketing of products. Meanwhile, non-base sub-districts such as Bongan, Jempang, Siluq Ngurai, and Muara Lawa, despite having extensive land availability or even high KPPTR values, remain underdeveloped as centers due to the lack of dominance of the beef cattle sector in the local economic structure. This situation is evident, for example, in Barong Tongkok, which has a reasonably large livestock population, but the highly diverse economic activities of the population cause its LQ value to approach 1, thus preventing it from

being categorized as a base area. GIS mapping also revealed that biophysical factors, land use, settlement patterns, and access to infrastructure significantly influence the distribution of beef cattle businesses. Non-base districts tend to be located in areas with more complex land use variations, including swampy areas, waterways, or areas that have developed into non-agricultural economic centers, resulting in increased competition for land use (Aprylasari & Toyibulah, 2025). Conversely, base districts have higher land suitability, lower land pressure, and adequate space for cattle business development. This information is crucial because it demonstrates that the success of beef cattle development is determined not only by livestock population size but also by geospatial conditions that support the sustainability of the farming system.

Overall, the results of this spatial analysis clarify the direction of beef cattle development in West Kutai Regency. The integration of LQ and GIS provides a more comprehensive picture for determining intervention priorities, particularly in determining production centers, new development areas, and areas requiring intensive assistance (Yeh & Li, 1997). Local governments can utilize these findings to design evidence-based policies, such as allocating funds for livestock population increase programs, developing supporting livestock infrastructure, strengthening farmer-livestock groups, and developing spatial management strategies that are more adaptive to potential and limitations at the sub-district level. Through this more precise spatial approach, beef cattle development in West Kutai Regency can be directed more effectively, efficiently, and sustainably.

4. CONCLUSION

This study shows that West Kutai Regency has significant potential for beef cattle development as a strategic regional sector. Through the integration of Location Quotient (LQ) analysis and Geographic Information System (GIS)-based spatial modeling, the study successfully identified sub-districts that serve as base areas for beef cattle development, namely Penyinggahan, Nyuatan, Linggang Bigung, Sekolaq Darat, and Long Iram. These sub-districts have a higher level of specialization and concentration of livestock populations than other areas, making them suitable for designation as priority centers for beef cattle production. GIS spatial analysis strengthens the LQ results by providing a comprehensive overview of the relationship between livestock populations, regional accessibility, and spatial suitability. The resulting development zoning map indicates that base areas are typically situated in areas with a combination of potential land and supporting infrastructure networks. These findings provide evidence that a quantitative and spatial data-based approach is highly effective in avoiding

conflicts over land use and improving the accuracy of livestock spatial planning. Overall, this study emphasizes the importance of more targeted, adaptive, and evidence-based livestock development planning. Local governments need to strengthen livestock farming institutions, increase access to technology, and develop supporting infrastructure in key areas. Thus, West Kutai has the potential to develop into a competitive and sustainable beef cattle center capable of supporting regional animal food security in East Kalimantan.

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