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Sustainability Assessment and Strategies Development for Individual Livestock Rearing in Cikedung District, Indramayu Regency, West Java.

P. H. Saputra[1*], A. Yani[2], L. Cyrilla E. N. S. D.[2], & B. W. Putra[2]
[1]Post Graduate Student, Department of Animal Production and Technology, Faculty of Animal Science, IPB University
[2]Department of Animal Production and Technology, Faculty of Animal Science, IPB University
Jl. Agatis, Kampus IPB Darmaga Bogor 16680, Indonesia
*Corresponding author: hadis252permadi@apps.ipb.ac.id
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ABSTRACT

Individual livestock farmers in Cikedung Subdistrict, Indramayu Regency, play a crucial role in supporting national beef production. However, they encounter significant challenges, including limited technological access, weak management efficiency, restricted market access, and minimal institutional support. This study aims to evaluate the sustainability of individual rearing systems using the Multidimensional Scaling (MDS) analysis method through the Rap-UPTS model, covering five dimensions: economic, socio-cultural, ecological, legal-institutional, and technological-infrastructure. A total of 15 respondents were involved, and the analysis employed leverage and Monte Carlo techniques. Findings revealed a "less sustainable" status, with the highest score in the ecological dimension (49.80) and the lowest in the legal-institutional dimension (37.61). The model was deemed valid, with a stress value of 0.133 and an R^2 of 0.95. Strengthening institutional support and enhancing human resource capacity are key strategies for improving sustainability in smallholder livestock systems.

Keywords: individual farmers, MDS, Rap-UPTS, sustainability

ABSTRAK

Peternak individu di Kecamatan Cikedung, Kabupaten Indramayu, memainkan peran penting dalam mendukung produksi daging sapi nasional. Namun, mereka menghadapi berbagai tantangan yang cukup signifikan, termasuk terbatasnya akses teknologi, lemahnya efisiensi manajemen, terbatasnya akses pasar, dan minimnya dukungan kelembagaan. Penelitian ini bertujuan untuk mengevaluasi keberlanjutan sistem pemeliharaan sapi perorangan dengan menggunakan metode analisis Multidimensional Scaling (MDS) melalui model Rap-UPTS yang meliputi lima dimensi: ekonomi, sosial-budaya, ekologi, hukum-kelembagaan, dan teknologi-infrastruktur. Sebanyak 15 responden dilibatkan, dan analisis menggunakan teknik leverage dan Monte Carlo. Temuan menunjukkan status "kurang berkelanjutan", dengan nilai tertinggi pada dimensi ekologi (49,80) dan terendah pada dimensi hukum-kelembagaan (37,61). Model ini dianggap valid, dengan nilai stress sebesar 0,133 dan R^2 sebesar 0,95. Memperkuat dukungan kelembagaan dan meningkatkan kapasitas sumber daya manusia merupakan strategi utama untuk meningkatkan keberlanjutan dalam sistem peternakan rakyat.

Kata kunci: keberlanjutan, MDS, peternak individu, *Rap*-UPTS

INTRODUCTION

The growing demand for animal protein is the main driver behind the expansion of the livestock sector, including ruminant farming. Ruminant farming in Indonesia is dominated by individual farmers who still face various challenges, such as limited technology and suboptimal management. According to BPS (2020), the number of farming households in Indonesia reached 13.56 million in 2018. One of the districts with the largest beef cattle population is Indramayu Regency. The cattle population in Indramayu District is 6,507 heads (BPS 2024). This great potential is often not efficiently utilized in individual farming systems, with problems in feed management, livestock health, and waste from farms. Individual farming systems still have many shortcomings and have the potential to be unsustainable, while the sustainability of livestock businesses is essential to support the great potential that already exists. According to the FAO (2020), sustainable livestock farming contributes to food security and increased farmer income.

In Cikedung Subdistrict, Indramayu Regency, especially around the Situ Bolang area, individual farmers continue to face various challenges despite the great potential of the livestock sector. These challenges include limited access to technology, inadequate feed sources, business instability, and low human resource capacity. Many farmers also find it difficult to adapt to modern practices, whereas previous studies have shown that this system can be overcome through communal or group livestock farming. This statement is also reinforced by Sutrisno (2022), who found that group farmers in the Situ Bolang area have a sustainability rating of "moderately sustainable." The concept of sustainability is complex due to its dynamic and multi-interpretative nature (Fauzi and Oxtavianus 2014). Therefore, analyzing the sustainability of individual livestock systems in this region is very important and necessary to identify the factors that influence various dimensions. Based on this sustainability analysis, effective strategies can be developed to optimize individual farming systems as well as group farming systems and enhance long-term sustainability.

MATERIALS AND METHODS

This research was conducted over two months, from April to May 2025, targeting individual farmers around the Situ Bolang area, Cikedung District, Indramayu Regency, West Java. Data collection began in March through site surveys and direct observations, followed by primary data collection using questionnaires and secondary data from relevant institutions and literature. Mapping of farming areas was done simultaneously with questionnaire distribution. A sample of 15 respondents was selected using purposive sampling, referring to Rahmadi (2011) the number of purposive sampling respondents was determined based on the criteria or considerations of the subject under study. Meanwhile, Gay et al. (2009) suggest a minimum of 10-20% for small descriptive populations and 30 respondents for correlational studies. The analysis applied Multi Dimensional Scaling (MDS) using the Rap-UPTS (Rapid Appraisal of Cattle Breeding Business) approach, a modified version of the Rapfish method. Sustainability was assessed across five key indicators: economic, socio-cultural, ecological, technological-infrastructure, and legal-institutional. Each attribute was rated on a 0–3 ordinal scale, with 0 indicating poor and 3 indicating good conditions. Higher scores reflect better sustainability potential. Leverage and Monte Carlo analyses were used to identify sensitive attributes and calculate error index values, forming an X matrix (n × p), where n is the number of regions and p the number of attributes. The score value is then standardized for each attribute score value with the formula:

$$X_{ik}sd = \frac{X_{ik} - X_k}{s_k} \quad (1)$$

Xik sd is standard score value of the region (including X as its reference point) for i 1,2,... n, on each Attribute for k = 1,2,... p; Xik is standard score value of the region (including X as the reference point) for i = 1,2,... n, at each k-th Attribute = 1,2,... p; Xk is center score value on each k-th Attribute = 1,2,...p; Sk is Standard deviation of scores at each k-th Attribute,... p.

Differences between measurement scales can be eliminated, as score values have uniform weights. To calculate the closest distance from the Euclidean distance using the following equation:

$$d_{12} = \sqrt{(X_1 - X_2)^2 + (Y_1 - Y_2)^2 + \cdots} \quad (2)$$

d12 is geometric distance (Euclidean distance); xi is i-th x coordinate; yi is i-th y-coordinate.

The Euclidean distance between the two previous points is then projected into a two-dimensional Euclidean distance. In Rapfish, this regression process uses the ALSCAL algorithm, which applies the principle of repetition to minimize the resulting error value. When the stress value is smaller than 0.25 or 25%, the repetition process stops. The stress value is obtained based on the following equation:

$$\text{Stress} = \frac{1}{m}\sum_{k=1}^{m}\sqrt{\frac{\sum_i\sum_i(D_{ijk}-d_{ijk})^2}{\sum_i\sum_i d_{ijk}^2}} \quad (3)$$

Dijk is distance between the j-th object and k-th object; dijk is disparities between object j and object k.

MDS analysis was used to find the sustainability index value of individual livestock rearing systems around the Situ Bolang area. If the sustainability index value is at 00.00-25.00, it can be said that it is not sustainable. If the index value is 25.01-50.00, it can be said that the livestock system is considered sustainable. Meanwhile, if the sustainability index value is at 50.01-75.00, it can be said to be quite sustainable, and if the sustainability index value is 75.01-100, it can be said that the livestock system is considered sustainable (Saragih *et al.* 2019).

Table 1. Index categories and sustainability status

Index Value	Status Category
0.00 – 25.00	Un-sustainable (low sustainability)
25.01 – 50.00	Less sustainable (fair sustainabiliy)
50.01 – 75.00	Sufficent sustainable (moderately sustainability)
75.01 – 100.00	Sustainable (sustainability potential)

Source : Kavanagh and Pitcher (2004); Dzikrillah *et al.* (2017); Puspitasari *et al.* (2019)

RESULTS AND DISCUSSION

Indramayu Regency is one of the regencies located in West Java Province with is characterized by a diverse array of natural resource potentials such as agriculture and animal husbandry. Indramayu Regency is located on the north coast of Java Island at coordinates 107°52′-108°36′ East and 6°15′-6°40′ LS. It borders Subang Regency to the west, the Java Sea and Cirebon Regency to the east, Majalengka and Sumedang Regencies to the south, and the Java Sea to the north. The area reaches 204.011 hectares with 147 km of coastline, covering 36 coastal villages in 11 sub-districts. Indramayu Regency is one of the strategic areas, because it is included in the pantura route (national route) as access to transportation and a large land economy. The climate in Indramayu Regency falls into the tropical category with temperatures between 22 °C-32 °C and air humidity between 70-80%. Indramayu Regency is mostly in the form of plains with a slope between 0-2% covering 201.285 ha (96.03%) of the total area of Indramayu (BPS Indramayu Regency 2023).

The Regency of Indramayu has great potential for developing the agricultural, horticultural, and livestock sectors, which can stimulate economic growth in the surrounding area. This potential is supported by the majority of Indramayu people who work in these sectors. The agricultural sector includes rice and livestock includes cattle, goats, sheep, and layer ducks. One area that stands out in the livestock sector is the Situ Bolang area in Cikedung District, which has the largest population of cattle in Indramayu, with more than 1,500 head of cattle out of a total of 6,507 in the county (BPS 2024). These figures demonstrate the area's significant potential for developing livestock, particularly beef cattle. However, this potential remains underutilized as most people in the area only engage in peternakan as a secondary occupation on a small scale. Therefore, active community involvement and structured support systems are necessary to develop this sector optimally. The results of the Rap-UPTS and Leverage analyses for each sustainability indicator are discussed in the following sections:

1) Economic Dimension Sustainability Status

The results of the Rap-UPTS analysis on the sustainability index of cattle rearing around the Situ Bolang area can be seen in the ordination graph in Figure 1. The graph shows that the more to the right, the better and the higher the better. On the graph, it can be seen that the graph shows a value of 43.94 from an index value of 1-100, which means that the economic dimensions and indicators show the sustainability of individual farmers is less sustainable and falls into the range of 25.00-50.00. This shows that from the economic dimensions and indicators, business sustainability still has great potential and does not fall into the unsustainable range. Various indicators and factors influence the results of this sustainability analysis. It is still very possible to make improvements to various sensitive aspects as the key point at a fairly sustainable level, or even become sustainable. This value of 43.94 indicates that various economic indicators such as farmer income, production efficiency, access to markets, stability of selling prices, and the ability to manage operational costs are not at an optimal level.

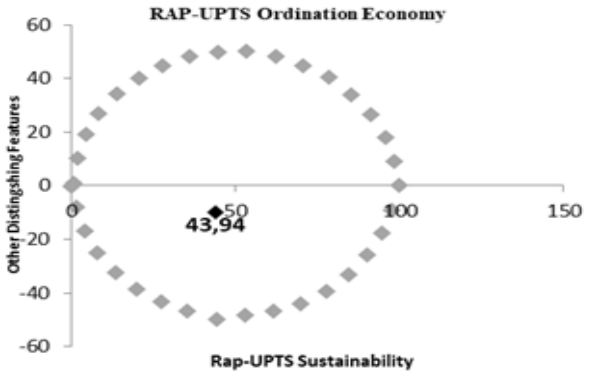

Figure 1. Sustainability index of economic indicators

Based on the graph of Leverage data on individual farmers around the Situ Bolang area, 5 aspects out of a total of 17 aspects affect the sensitivity value of the sustainability index of the economic dimension. Technical problems and supporting facilities are the main factors in increasing the economic value capacity of individual farmers. Employee income is the most influential indicator, particularly for livestock caretakers, with an index score of 2.80. This reflects the high cost of labor, equivalent to the regional minimum wage in Indramayu Regency (IDR 2,500,000 per month). This amount is substantial compared to farmers' net income. Furthermore, the number of livestock being raised influences this indicator, 311 animals are managed by only 15 respondents, indicating a high labor demand under traditional and simple management systems. This issue can be addressed by optimizing and enhancing existing resources, such as improving feeding practices, barn hygiene, and waste management. A more efficient system is expected to increase livestock productivity and farmer income. Proper management of livestock waste, such as converting it into organic fertilizer, could also provide an additional source of income. Cattle farming can be considered successful if it contributes to income and meets the daily needs of farmers, as evidenced by an increase in livestock ownership, livestock weight gain, and additional household income (Maryam *et al*. 2016).

Other significant indicators include the government's involvement in setting livestock selling prices and the contribution of livestock to regional revenue (PAD), which

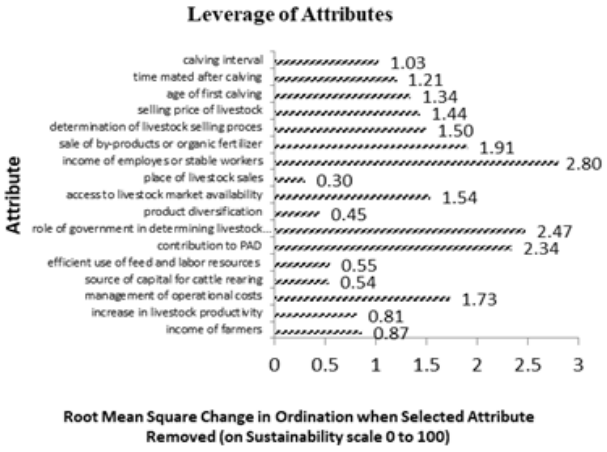

Figure 2. Leverage analysis of economy sustainability indicators

have index scores of 2.47 and 2.34, respectively. These low scores suggest limited government engagement, which results in unstable farmgate prices and weakens farmers' bargaining power. Inadequate regulation and tax policies further hinder the sector's contribution to local revenues. The lowest-ranked economic indicators were the sale of by-products (organic fertilizer) and operational cost management, with scores of 1.91 and 1.73, respectively. These are closely related to waste utilization and production efficiency. However, the low values suggest limited access to waste processing technology and market opportunities. Strategic interventions, such as technical training, managerial support, market access, and technology facilitation, are necessary. Training is closely related to improving the acceptance of information to broaden knowledge and skills about the farming practices they carry out (Manyamsari and Mujiburrahmad 2014). These efforts would be more effective with the support of farmer institutions, such as cooperatives.

2) Socio-Cultural Dimension Sustainability Status

The results of the sustainability index analysis using Rap-UPTS on socio-cultural indicators show a value of 45.94 better than the previous economic dimension, however, this value is still included in the less sustainable category because the value obtained is still in the range of 25.00-50.00 in accordance with the classification of the level of sustainability used in this analysis method. Based on this, the social-cultural dimension is still very possible to be developed for the better, various supporting aspects can be optimized and maximized to increase the sustainability index value. Various supporting aspects can be optimized and maximized to increase the sustainability index value. These improvement efforts require cross-sectoral commitment from the government, community, and private sector through a collaborative and participatory approach that considers local social and cultural characteristics. One way to increase this index value is by strengthening institutional and collective capacity, expanding access to inclusive information and education, and providing guidance to farmers based on their existing experience. This is reinforced by Ahmad and Sugiarto (2014). The potential for beef cattle development based on human resources can be seen from the length of time or experience in farming and the level of education, as both are positively related to the potential for livestock development.

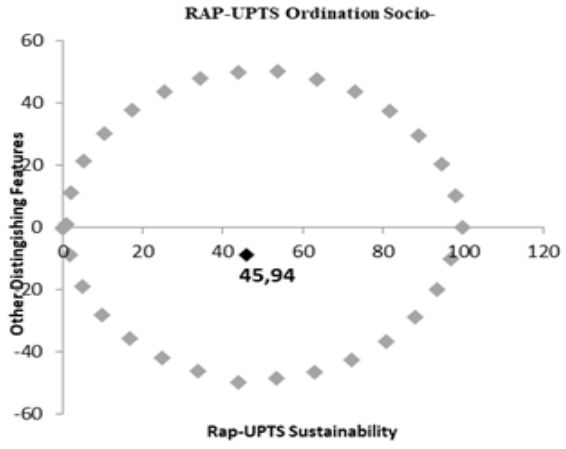

Figure 3. Sustainability index of socio-cultural indicators

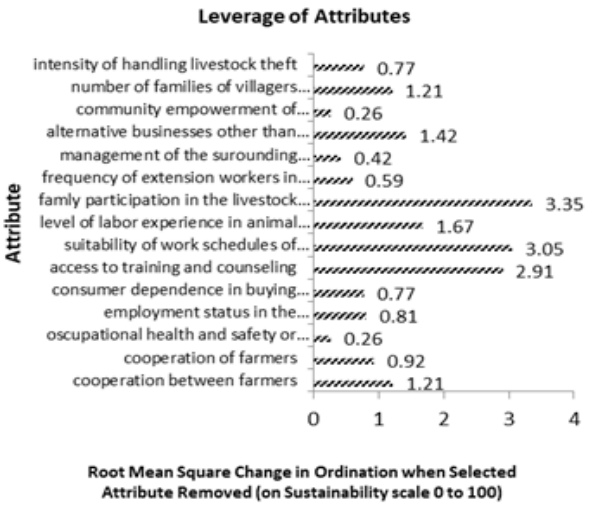

Figure 4. Leverage analysis of socio-cultural sustainability indicators

Based on the results of the Leverage analysis, it is known that the number of influential indicators in the socio-cultural dimension is not as many as in the economic dimension. The three most influential indicators are the role of the family in the cattle business (3.35), the suitability of the official schedule (3.05), and access to training and extension (2.91). The role of the family proved to be a key factor in the success of the business Meanwhile, schedule mismatches between dinas officers and farmers caused obstacles in the implementation of extension services and animal health services, which had an impact on farm productivity. Access to training and extension services is also still limited due to the lack of local government attention to empowering farmers through livestock extension workers. This suggests the need for schedule adjustments, innovations in extension

methods, and strengthening the role of local governments to optimize and sustain capacity development of farmers.

3) Ecology Dimension Sustainability Status

The results of the sustainability index analysis using Rap-UPTS on ecological indicators show a value of 49.80, better than the economic and socio-cultural indicators, although still in the "less sustainable" category (25.00-50.00). This value reflects the potential for improvement although the management of ecological aspects by farmers in the Situ Bolang area is not yet optimal. Factors causing this low score include the limited application of environmentally friendly animal husbandry principles, waste management that is not up to standard, inefficient land use, and low awareness of environmental conservation.

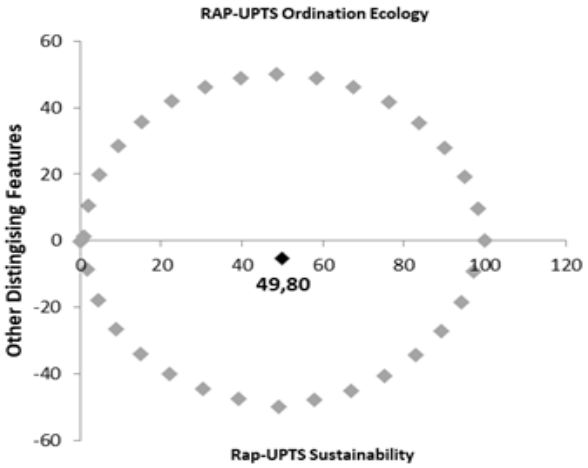

Figure 5. Sustainability index of ecology indicators

In addition, climate change, degradation of water and soil quality, and limited access to green technology also worsen the condition. However, index values close to the "moderately sustainable" threshold indicate opportunities for improvement through ongoing training, provision of waste treatment technologies and strengthening of local institutions. With collaboration between farmers, local government and other stakeholders, it is hoped that improvements in ecological sustainability can be achieved in real terms and have a positive impact on the environment and local food security.

Based on the results of the leverage analysis, three main aspects were identified that significantly influenced the sensitivity of the sustainability index in the ecological dimension, namely ownership of cage land (2.61), distance between cages and settlements (2.18), and reduction of emissions from livestock (1.82). Ownership of paddocks is a crucial factor because it affects waste management, the ideal distance from settlements, and the implementation of environmental standards.

With a high livestock population, the need for adequate cage land is urgent. Therefore, land access policies, technical training, and institutional strengthening such as farmer cooperatives are needed. Meanwhile, the proximity of cages to settlements can cause pollution and

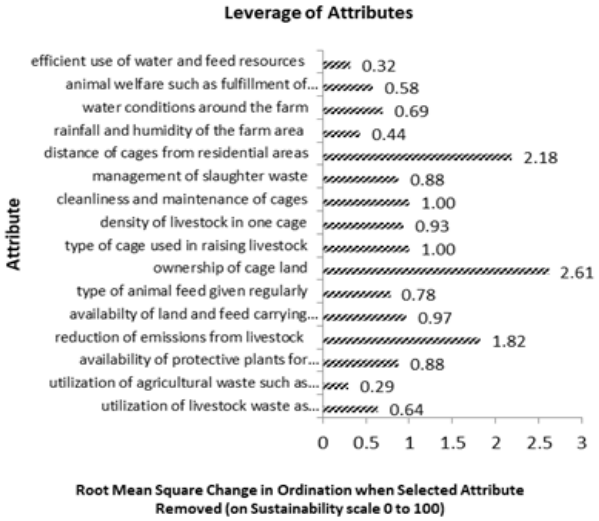

Figure 6. Leverage analysis of ecology sustainability indicators

health problems, so it is important to implement livestock zoning in accordance with applicable regulations. Reducing emissions from livestock waste also needs attention, given its contribution to air pollution and climate change. The use of environmentally friendly technologies such as biodigesters or organic fertilizers can be an effective solution. To overcome these problems as a whole, collaboration between farmers, government, academics and the community is needed through mentoring, applied research and capacity building so that smallholder farming practices can run more efficiently, environmentally friendly and sustainable.

4) Legal-Institutional Dimension Sustainability Status

The legal-institutional dimension shows an index of sustainability value of 37.61 based on the Rap-UPTS analysis, which is categorized as non-sustainable and the lowest compared to the other dimensions. The low value reflects various structural issues, such as the weak function of local livestock institutions, the lack of supporting regulations, insufficient supervision, low participation of livestock farmers in organizations, and poor coordination among stakeholders. To increase the index to a level of moderate or sustainable development, significant efforts are needed through institutional strengthening, the formation of legal and active cooperatives or groups of farmers, and increased capacity in governance. The local government also needs to establish regulations that promote sustainability, strengthen oversight, provide incentives, and increase dissemination of legal information so that farmers understand their rights and obligations. This approach, if implemented in a systematic and integrated manner, will support the increase in the index value and strengthen the resilience of the livestock sector in the Situ Bolang area.

Based on the leverage analysis of the legal and institutional dimensions, the attribute with the greatest influence on sustainability is leadership and decision-making, with an RMS value of 2.54. Index is leadership and decision-making. With an RMS value of 2.54, this indicates that strong leadership is crucial for the success of livestock

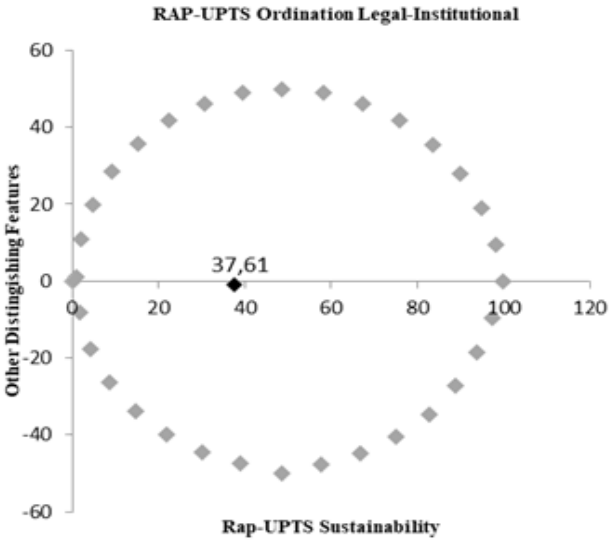

Figure 7. Sustainability index of legal-institutional indicators

institutions. Other important attributes include the role of government institutions (2.26), microfinance institutions (2.18), and policy synchronization across levels of government (2.04). These attributes play a vital role in empowering farmers by providing regulatory support, training, and access to financing. The marketing network attribute (1.70) and the discussion or training venue attribute (1.58) also significantly contribute to strengthening farmers' capacity and collaboration. Marketing at the farm-livestock level still involves a lengthy process. The transfer of cattle at the farmer-livestock level must go through institutions that are directly or indirectly involved in marketing activities (Lasaharu et al. 2020). Conversely, attributes such as research centers (0.22), interregional collaboration (0.27), and community leaders' roles (0.36) have low leverage, indicating the need to optimize these roles. To enhance institutional sustainability, recommended strategies include leadership training, strengthening communication forums, reinforcing

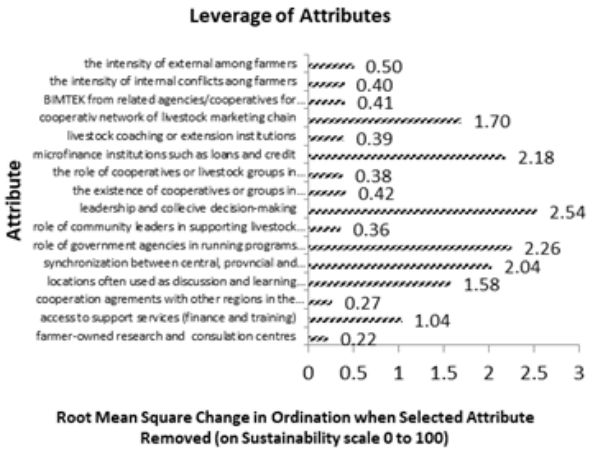

Figure 8. Leverage analysis of legal-institutional sustainability indicators

the role of microfinance institutions, clarifying marketing systems and price standardization, and harmonizing central and local policies. With targeted intervention on these strategic attributes, the livestock institutions in Situ Bolang can become more adaptive, inclusive, and sustainable.

5) Technology-Infrastructure Dimension Sustainability Status

The results of the analysis of the sustainability index of the technology and infrastructure dimensions using the Rap-UPTS method showed a value of 38.60, indicating "insufficient sustainability," due to limited access to technology and agricultural infrastructure, and low digital literacy among farmers in the Situ Bolang area. The attributes most influential to sustainability are the adoption of environmentally friendly technology (RMS 2.84), technological proficiency (2.78), technological use in production (2.52), and animal feed innovation (2.63). The low utilization of information technology and innovation (RMS <0.5) indicates the ineffectiveness of digitalization in livestock practices. To improve sustainability, an integrated intervention is needed in the form of training, technology assistance, and basic infrastructure development. The focus should be on implementing environmentally friendly technology, increasing the capacity of farmers, and utilizing local resources to make individual farming more efficient, independent, and competitive.

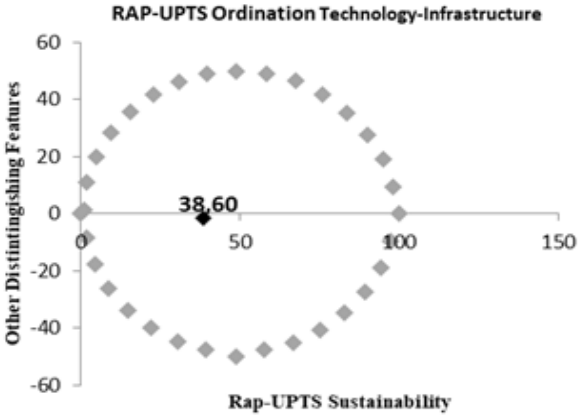

Figure 9. Sustainability index of technology-infrastructure indicators

6) Kite diagram of farmer sustainability

The results of the Multidimensional Scaling (MDS) analysis show that individual livestock businesses around the Situ Bolang area are "less sustainable" with an average value of 43.18 (range 25.00-50.00). However, the stress value <0.25 and the coefficient of determination (R^2) of 0.955 indicate a good model that fits the data. Monte Carlo results also support the validity of the analysis with a difference in index values of 0.07-0.86 at the 95% confidence level, indicating high accuracy. The sustainability of this business is influenced by various indicators and dimensions, so optimizing aspects of policy, institutions and cooperation between farmers is key in increasing efficiency and improving weak indicators to support dynamic, integrative and sustainable livestock farming.

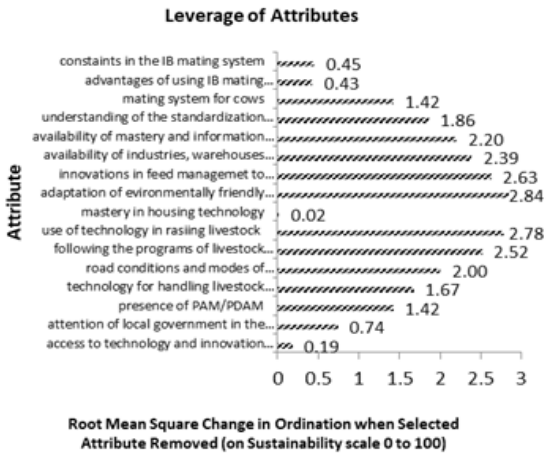

Figure 10. Leverage analysis of technology-infrastructure sustainability indicators

The average sustainability index of individual farmer businesses in the Situ Bolang area of 43.18 is categorized as "less sustainable", with variations in values across five main dimensions: economic, socio-cultural, ecological, legal-institutional, and infrastructure-technology. Analysis of 80 attributes shows that the legal-institutional dimension has the lowest index (37.61), indicating weak governance, regulation and institutional support. Other dimensions such as ecology (49.8), socio-culture (45.94), economy (43.94) and technology-infrastructure (38.6) also need to be improved. According to Sutrisno (2022), livestock groups in the Situ Bolang area have a value of "sufficent sustainable" from the average value of indicators. This statement reinforces the opinion that by grouping the sustainability value is better than raising livestock individually and is related to the legal-institutional indicator with the lowest sustainability value. Therefore, strategic interventions are needed in strengthening institutions and enforcing regulations, as well as optimizing the potential of each dimension to encourage the sustainability of individual farming systems towards a better category.

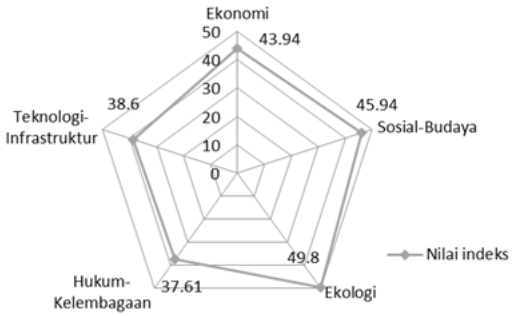

Figure 11. Multindicator Kite Diagram of Individual Ranch Sustainability

CONCLUSION

Individual livestock rearing systems in Cikedung are classified as less sustainable, with the legal-institutional dimension being the weakest. Strategic interventions focusing on institutional development, cooperative establishment, and capacity building are essential to transition toward more resilient and sustainable livestock production.

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Table 2. Index value of sustainability of individual farmers, 95% monte carlo, difference, stress and determination value R^2

Indicator	Index Sustainability		Difference	Stress	R^2
	MDS	*Monte Carlo*			
Economy	43.94	44.02	0.07	0.133	0.955
Socio-cultural	45.94	46.13	0.19	0.132	0.955
Ecology	49.8	48.94	0.86	0.133	0.955
Legal-institutional	37.61	38.42	0.8	0.133	0.955
Technology-infrastructure	38.6	38.53	0.07	0.131	0.955
Average	43.18	43.21	0.39	0.132	0.955

Note: Coefficient of determination (R^2) are used to assess the accuracy and scientific feasibility of the analyzed attributes, with a conficedence level of (95%).

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