ABSTRACT

Objective: The research aims to analyze the sustainability status of the Bali cattle breeding area based on smallholder farms in South Konawe Regency. The research variable is the breeding dimension with 19 attributes in the Bali cattle breeding center area.

Methods: The location of this research is Tinanggea, Buke, Palangga, and Baito sub-districts using sustainability analysis with multidimensional scaling (MDS) approach or Rapid Appraisal Sustainability Index for Breeding in central breeding areas (Rap-BREEDKASEBIT).

Results: The analysis showed that the Tinanggea sub-district was 51.30%, Buke was 60.93%, Palangga was 62.05%, and the Baito sub-district was 51.46%, fairly sustainable. Leverage was at the root mean square value above the median value (>1.5), namely the rearing system, percentage of female calves, percentage of male calves, percentage of mature females, calving interval (CI), service preconception (S/C), percentage of pregnancy rate, percentage of mortality rate, and animal health service posts.

Conclusion: The breeding dimension needs to receive optimal attention so that all attributes can become a leverage factor for the sustainability of the area in increasing the production of seeds and feeders to meet the needs of farmers adequately and sustainably.

Keywords: breeding, area, smallholder farms, bali cattle.

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RESUMO

Objetivo: A pesquisa visa analisar o status de sustentabilidade da área de criação de gado de Bali baseada em pequenas fazendas na Regência de South Konawe. A variável de pesquisa é a dimensão pecuária com 19 atributos na área do centro pecuário de Bali.

Métodos: O local desta pesquisa são os subdistritos de Tinanggea, Buke, Palangga e Baito, usando análise de sustentabilidade com abordagem de escala multidimensional (MDS) ou Índice de Sustentabilidade de Avaliação Rápida para Reprodução em áreas de reprodução centrais (Rap-BREEDKASEBIT).

Resultados: A análise mostrou que o subdistrito de Tinanggea era de 51,30%, Buke era de 60,93%, Palangga era de 62,05% e o subdistrito de Baito era de 51,46%, bastante sustentável. A alavancagem estava no valor da raiz quadrada média acima do valor mediano (> 1,5), nomeadamente o sistema de criação, percentagem de bezerros fêmeas, percentagem de bezerros machos, percentagem de fêmeas maduras, intervalo entre partos (CI), preconceito de serviço (S/C) , percentual de taxa de prenhez, percentual de taxa de mortalidade e postos de serviços de saúde animal.

Conclusão: A dimensão do melhoramento precisa receber a máxima atenção para que todos os atributos possam se tornar um fator de alavanca para a sustentabilidade da área no aumento da produção de sementes e rações para atender às necessidades dos agricultores de forma adequada e sustentável.

Palavras-chave: criação, área, fazendas familiares, gado bali.

1 INTRODUCTION

Bali cattle are a potential livestock commodity (Nurdiyansah et al. 2020) and are a farmer's business and household income (Aka et al. 2018; Ashley et al. 2018; Mukson et al. 2020). Bali cattle raise public awareness and fulfill nutritional needs, especially meat and dairy products (Afriani et al. 2019; Hajirin et al. 2020). The increase in population is not accompanied by increased cattle productivity, forcing the government to continue to work in various ways. One is a sustainable area-based Bali cattle breeding business (Mukson et al. 2020; Nugroho et al. 2022). This is because breeding is an important production factor in the cultivation of Bali cattle. After all, quality seedlings can influence beef production (Sousa et al. 2017; Ananda et al. 2020).

Beef production in Indonesia has been unable to meet domestic beef demand due to increasing demand and decreasing beef availability. Beef production in Indonesia in 2022 amounted to 498,923.14 tons of the total projected national meat demand in 2022 of 711,885 tons. (BPS Indonesia, 2020). The low beef production is due to the declining
productivity of beef cattle business in smallholder farms, so the government needs to make efforts to provide beef cattle sustainably through the support of the availability of quality seeds and feeders on an ongoing basis because seeds and feeders are one of the factors that determine the development of Bali cattle as beef cattle (Mishra, 2021).

The beef cattle population in Indonesia was recorded in 2022 at 18,610,100 heads, up 3.08% from 2021 at 18,053,710 heads (Central of Statistics, 2020). One of them is Southeast Sulawesi which is a beef-producing area. A source of seeds totaling 390,903 heads, one of the seed-producing districts in South Konawe, with a population of 69,274 heads (Central of Statistics, 2020). Most of them are developed by communities in rural areas, which reach 95% (Nafiu, 2018).

Increasing the productivity of the Bali cattle breeding business in rural areas certainly requires an area as a source of seeds that can produce and developed in other villages. (Raufet et al. 2015). The seedling source area can be realized if the nursery is managed by applying directed and sustainable breeding patterns in an area and maintained as a seedling source area (Suwiti, 2016; Director General of PKH, 2014; Minister of Agriculture, 2016). The Bali cattle development area in South Konawe Regency can potentially increase the number of cattle in the region. (Abadi et al. 2020; Abadi et al. 2022) A regionally promoted commodity (Demas et al., 2023) can be used as a national priority program (Nafiu, 2018). Therefore, it can be used as one of the source areas for Bali cattle breeding in Indonesia (Kepmentan, 2010). South Konawe District has four sub-districts that have been designated as Bali cattle breeding areas, including Tinanggea, Buke, Palangga and Baito sub-districts because the four sub-districts are supported by sufficiently available forage resources as a major factor in the development of Bali cattle (Nafiu, 2018; Abadi et al. 2019; Budiari and Suyasa, 2019; Mauludin et al. 2012), so the development and management of the Bali cattle breeding system needs more attention to produce adequate and sustainable seedlings.

Bali cattle breeding is an effort to provide seeds and feeders sustainably (Mashur, 2014; Afriani et al., 2019); however, currently, the Bali cattle breeding business is still carried out by smallholder farms (Soeharsono et al., 2017; Sayaka, (2016) this is also done by farmers in South Konawe District, especially in the Bali cattle breeding source area with a simple breeding system that is maintained extensively and semi-intensively (Nafiu, 2018) with an average ownership scale of 1-5 heads per farmer (Sari et al. 2020; Mustofa, 2020) and the use of technology and innovation is still limited (Mauludin et al.
Ensuring the sustainability of the breeding system in the Bali cattle breeding center area, especially in the South Konawe District, optimally according to its characteristics, it is necessary to harmonize the interests of the region through the development of a sustainable Bali cattle breeding production system (Hakim et al. 2017). By assessing various criteria, namely the percentage of productive males, percentage of productive females, percentage of young males, percentage of young females, percentage of male calves, percentage of female calves, birth rate, mortality rate, availability of superior male and female seedlings, selection, recording, mating techniques, maintenance system, calving interval (CI), service per conception (S/C), pregnancy rate, animal health service posts, IB service posts, and availability of public infrastructure in the area.

The sustainability of the breeding system in the breeding center area requires appropriate measures as an alternative and optimization of the role of the Bali cattle breeding center area in spurring population increase, contributing to increasing income and farmer welfare while encouraging regional economic growth in South Konawe District. Therefore, the sustainability of the Bali cattle breeding system needs to be built with a multidimensional scaling (MDS) approach with a modified Rapid Appraisal Sustainability Index for Breeding in the Bali Cattle Breeding Center (Rap-BREEDKASEBIT) approach to determine the sustainability index of the breeding system in the Bali cattle breeding center area based on smallholder farming in South Konawe Regency.

2 METHODS

This research was conducted in September-December 2022. This research was located in the People's Farm-based Bali Cattle Breeding Center Area of South Konawe District. The data analysis used was multidimensional scaling (MDS) sustainability analysis with the Rapid Appraisal Sustainability Index for the Breeding approach in the Bali cattle breeding center area (Rap-BREEDKASEBIT). This method is a way of statistical analysis by transforming various dimensions and multidimensions of sustainability (Prasodjo et al. 2015).

The use of MDS as an analytical tool has various advantages in that its use is simple, fairly easy, the values are quickly obtained, and the cost is relatively cheap. The Rap-BREEDKASEBIT Bali Cattle ordination technique has been modified through the
MDS method with several stages (Pitcher, 2004):

1. There are 19 attributes of sustainability in the breeding dimension. The determination of attributes is based on literature studies and previous studies (Suyitman, 2010; MOA No. 48 of 2011; Decree of the Minister of Agriculture No. 325/Kpts/OT.140/1/2010; MOA No. 101/Permentan/OT.140/7/2014; Subandrio, 2004; Ananda et al. 2020) and adjusted based on the commodity and conditions of the research site.

2. MDS ordination analysis is used to determine where the sustainability status of the breeding dimension is according to the sustainability index value.

3. Assessing the index and status of sustainability in the breeding dimension with sustainability score values: poor (0-25), less (26-50), fair (51-75), and good (76-100).

Furthermore, the sustainability index value of the Bali cattle breeding system in the breeding dimension is visualized on a scatter diagram. Distance determination or ordination technique in MDS is based on Euclidian Distances in dimensionless space, which can be written as follows:

\[ d_{12} = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + \ldots} \]  

\[ \text{Stress} = \sqrt{\frac{1}{m} \sum_{k=1}^{m} \left( \frac{\sum_i \sum_j (D_{ijk} - d_{ijk})^2}{\sum_i \sum_j d_{ijk}} \right)} \]  

The squared distance is the weighted Euclidian distance or written as follows:

\[ d_{12} = a + bD_{12} + \text{error} \]  

5. Assessment of the accuracy of a good model (goodness of fit) in MDS can be seen from the magnitude of the S-Stress and R2 values. In Rapfish, a good
model can be seen in the S- stress value, which is smaller than 0.25 (S<0.25), while the R2 value is close to 1 (Malhotra, 2006).

3 RESULTS AND DISCUSSION

The development of a sustainable Bali cattle breeding system in the breeding dimension in the People's Farm-based Bali Cattle Breeding Center Area of South Konawe District is carried out by paying attention to attributes that become leverage factors for the efficiency and effectiveness of Bali cattle breeding development in the area. There are 19 (nineteen) attributes that determine the sustainability of the breeding dimension in the research location, consisting of (1) percentage of productive males, (2) percentage of productive females, (3) percentage of young males, (4) a percentage of young females, (5) percentage of male calves, (6) percentage of female calves, (7) birth rate, (8) mortality rate, (9) availability of superior male and female breeds, (10) selection activities, (11) recording activities, (12) mating techniques, (13) maintenance systems, (14) calving interval (CI), (15) service per conception (S/C), (16) pregnancy rates, (17) animal health service posts, (18) IB service posts, and (19) availability of regional public infrastructure. The results of the MDS analysis on the breeding dimension show different values in each research location, which are presented in Figure 1 and Table 1.

Figure 1. Results of the Rap-BREEDKASEBIT Index Ordination on the Breeding
Dimension The value and category obtained in the breeding dimension for the highest value is in Palangga District (62.05), then Buke District (60.93), Baito (51.46), and Tinaggea District (51.30) with the same category index (quite sustainable). The difference in values in each sub-district is inseparable from differences in the assessment of each attribute in the same dimension. In other words, each sub-district has its advantages and disadvantages, so the scoring by experts for each of the same questions in each sub-district must be different. More details it is presented in Table 1.

Table 1. Results of Rap-BREEDKASEBIT MDS Analysis and Assessment Categories of Breeding Dimensions at Research Sites

<table>
<thead>
<tr>
<th>No.</th>
<th>District</th>
<th>MDS</th>
<th>Monte Carlo</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tinanggea</td>
<td>51.30</td>
<td>51.17</td>
<td>Sustainable Enough</td>
</tr>
<tr>
<td>2</td>
<td>Buke</td>
<td>60.93</td>
<td>60.32</td>
<td>Sustainable Enough</td>
</tr>
<tr>
<td>3</td>
<td>Palangga</td>
<td>62.05</td>
<td>60.80</td>
<td>Sustainable Enough</td>
</tr>
<tr>
<td>4</td>
<td>Baito</td>
<td>51.46</td>
<td>51.35</td>
<td>Sustainable Enough</td>
</tr>
</tbody>
</table>

Source: Data processed, 2022

Table 1 shows that the sustainability index in the breeding dimension at the research location analyzed using the Rap-BREEDKASEBIT MDS analysis is fairly sustainable, influenced by various attributes as leverage factors. The attributes that become leverage factors in the breeding dimension are presented in Figure 2.
The results of the analysis of leverage factors in the breeding dimension with the acquisition of RMS (root mean square), which is a value above the median value (> 1.5), there are 8 (eight) attributes in the breeding dimension which are leverage factors, including:

3.1 MAINTENANCE SYSTEM

The maintenance system applied by farmers in the Bali cattle breeding business in the research location is dominated by a semi-intensive maintenance system of 2,105 people (80.74%) of the total farmer households (RTP) of 2,607 people. This maintenance system illustrates that the Bali cattle breeding business developed by farmers for generations has led to a relatively good maintenance system. This condition is due to the relatively high experience of farmers who have run their Bali cattle breeding business for an average of ≥10 years. The semi-intensive rearing system is generally practiced in Bali cattle breeding businesses developed by smallholder farmers. It usually operates with its farms (paddy fields and mixed gardens), with a relatively simple housing system. The semi-intensive rearing system has become the choice of Bali cattle farmers in the research location because it is considered to minimize feed costs due to the additional source of feed from grazing Bali cattle in the plantation area of 1,247 people (47.83%) and the rice field area of 1,203 people (46.14%).

3.2 PERCENTAGE OF FEMALE CALVES AND MALE CALVES

The percentage of female and male calves is one of the criteria for determining the sustainability of Bali cattle breeding in ruminant breeding centers. The standard percentage of female calves in the Bali cattle breeding center area population must reach >5%, while for male calves, it must be <5%. (Regulation of the Minister of Agriculture, 2016; Directorate of Livestock Breeding, 2007). The percentage of female and male calves in the Bali Cattle Breeding Center Based on Smallholder Farming in the South Konawe District is presented in Table 2.

Table 2. Percentage Structure of Bali Cattle Population in the Study Area

<table>
<thead>
<tr>
<th>No</th>
<th>District</th>
<th>Population (Tail)</th>
<th>Male Calf</th>
<th>% Male Calves</th>
<th>Female Calves</th>
<th>% Female Calves</th>
<th>Total (Tail)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tinanggea</td>
<td>3.139</td>
<td>348</td>
<td>11.09</td>
<td>490</td>
<td>15.61</td>
<td>838</td>
</tr>
<tr>
<td>2</td>
<td>Buke</td>
<td>2.124</td>
<td>241</td>
<td>11.35</td>
<td>232</td>
<td>10.92</td>
<td>473</td>
</tr>
</tbody>
</table>
Table 2 shows that the results of data analysis of the Bali cattle population in the research location related to female calves and male calves obtained an average percentage of female calves of 14.48% (>5%) which means that the percentage of female calves is quite high with the highest score (score 4), while the average percentage of male calves is 11.47% (<8%) which means that the percentage of male calves is too high with the lowest score (score 1). (Regulation of the Minister of Agriculture, 2016). While the results of the Rap-BREEDKASEBIT MDS analysis show that the percentage of female calves and male calves is an attribute in the breeding dimension that is a leverage factor so that the South Konawe Regency People's Farm-based Bali Cattle Breeding Center is in the moderately sustainable category. The percentage of female calves and male calves illustrates that the availability of calves as a source of Bali cattle seedlings will be able to meet the needs of prospective mothers and prospective males as replacement/replacement Bali cattle in the Bali cattle breeding area of South Konawe District.

3.3 PERCENTAGE OF PRODUCTIVE FEMALES/MATURE

The percentage of mature females is the population structure that needs to be considered in a Bali cattle breeding area. Mature cows are productive females with age > 24 months and have given birth less than 5 (five) times or under 8 (eight) years old. The number of mature females in the research location is 46.67%, which is higher than the applicable standard, which is the number of mature females >42% of the total population based on the Technical Guidelines for Determining and Managing Seedling Source Areas (Director General of PKH, 2015), while the results of the Rap-BREEDKASEBIT MDS analysis show that the percentage of mature females is an attribute in the breeding dimension that is a leverage factor so that the South Konawe District People's Farm-based Bali Cattle Seedling Center is in the moderately sustainable category. The high number of productive females of Bali cattle in the research location indicates that it is feasible to become an area based on the percentage of productive females available. It is further stated in the Animal Husbandry and Animal Health Law No. 41 of 2014 that to meet the
availability of breeding stock, productive female ruminants (Bali cattle) are selected for breeding purposes, while unproductive female ruminants (Bali cattle) are removed/culled to be used as slaughter livestock.

3.4 CALVING INTERVAL (CI)

The calving interval is the time between one birth and the next birth, where the optimal calving interval of Bali cows is around 12 months or 1 year. (Ananda et al., 2020). The results of the Rap-BREEDKASEBIT MDS analysis show that the calving interval is an attribute in the breeding dimension that is a leverage factor.

The calving interval of female Bali cows in the study area was dominated by internal calving of 365-420 days (12-14 months) for as many as 4,437 cows (96.69%) from 4,589 productive female Bali cows. The short calving interval value indicates that the reproductive performance of female Bali cows kept by farmers is relatively good and can be a potential development of Bali cattle breeding in the People's Farm-based Bali Cattle Breeding Center Area of South Konawe District.

Calving intervals, short and long, can be influenced by several factors, namely the length of weaning age, the length of pregnancy, and the distance of remating after giving birth and maintenance management. The length of pregnancy in Bali cattle can affect the calving interval. While the age of weaning can also affect the delay of estrus in Bali cows due to calves still breastfeeding, this condition will also affect the distance of remating after giving birth is longer and will ultimately affect the length of the calving interval in Bali cows.

3.5 SERVICE PER CONCEPTION (S/C)

Service per conception (S/C) is the number of matings by a female cow until the cow becomes pregnant or conception. S/C illustrates Bali cattle's fertility level in a region or development area. A low S/C value can be an economically favorable indicator of natural mating or Artificial Insemination (AI) in a Bali cattle breeding business.

The S/C value of female Bali cows in the research location is at S/C 1-2 times as many as 3,814 cows (83.11%) from 4,589 productive female Bali cows. The S/C value of 1-2 times illustrates that female Bali cows in the research location have good reproductive potential for developing Bali cattle breeding in South Konawe Regency. However, female Bali cows still ask to mate again >3 times, or the S/C value is >3 times until the female
cows become pregnant. This is more due to the accuracy of the inseminator in conducting insemination and the farmer's knowledge of the symptoms of lambing and due to the lack of attention of the farmer to his Bali cattle. The S/C value explains that the lower the S/C value of an animal, the higher its fertility. Otherwise, the higher the S/C value, the lower the fertility level (Saputra et al., 2022).

3.6 PREGNANCY RATE (%)

The pregnancy rate in this study was calculated based on the data of Bali cows born at the time of the study divided by the number of productive adult mothers/females in the study location within one year. The average pregnancy rate obtained was 55.61%, but when viewed at the sub-district level, the pregnancy rate in Tinanggea sub-district was 58.40%, Buke was 46.37%, Palangga was 56.86%, and Baito sub-district was 60.99%. Although the pregnancy rate of female Bali cattle in the research location is still relatively low, according to the Rap-BREEDKASEBIT MDS analysis, the pregnancy rate is one of the attributes in the breeding dimension that is a leverage factor.

The pregnant rate of female Bali cattle in the research location is still relatively low, so it is necessary to improve the mating system and reproductive management in the Bali cattle breeding business so that the pregnant rate of female Bali cattle raised by farmers in the People's Farm-based Bali Cattle Breeding Center Area of South Konawe District reaches the ideal number, according to the opinion of (Febrianthoro et al. 2015). The ideal pregnancy rate is ideal.) The ideal pregnancy rate in a Bali cattle population is > 60-75%, where the higher the pregnancy rate, the more fertile the cattle are, and vice versa. Low values pregnancy rates can be a cause of economic losses to farmers. She further stated (Romjali, 2019) that the pregnancy rate can reach 80%.

3.7 MORTALITY RATE (%)

The mortality rate is calculated based on the number of animals that die in percentage units in a certain period. According to (Mullik and Jelantik, 2009), the range of livestock mortality is very wide, between 6.12%-65.5%. The mortality rate of Bali cattle in the research location is presented in Table 3.
Table 3. Mortality Rate of Bali Cattle in the Study Sites

<table>
<thead>
<tr>
<th>No.</th>
<th>District</th>
<th>Population* (tail)</th>
<th>Mortality** (head)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tinanggea</td>
<td>3.139</td>
<td>184</td>
<td>5.86</td>
</tr>
<tr>
<td>2</td>
<td>Buke</td>
<td>2.124</td>
<td>167</td>
<td>7.86</td>
</tr>
<tr>
<td>3</td>
<td>Palangga</td>
<td>3.148</td>
<td>256</td>
<td>8.13</td>
</tr>
<tr>
<td>4</td>
<td>Baito</td>
<td>1.421</td>
<td>144</td>
<td>10.13</td>
</tr>
<tr>
<td></td>
<td>Region</td>
<td>9.832</td>
<td>751</td>
<td>7.64</td>
</tr>
</tbody>
</table>

Source: *Primary data, 2022; **Kecel PKH Office, 2022

Table 3 shows that the percentage of Bali cattle mortality in the study location is still relatively low, with an average mortality rate of 7.64% compared to the average birth rate of 55.61%. Therefore, the mortality rate does not significantly impact the decline in the Bali cattle population. At the same time, the results of the Rap-BREEDKASEBIT MDS analysis show that the mortality rate is one of the attributes in the breeding dimension that is a leverage factor. There is no definitive report on the category of mortality lift declared low or high mortality rate. The incidence of Bali cattle mortality in the People's Farm-based Bali Cattle Breeding Center Area in South Konawe District is more prevalent in the mortality of Bali cattle aged <6 months. This mortality rate is consistent with research conducted by (Mullik and Jelantik, 2009), which states that mortality rates are as follows: (1) mortality in calves (<6-12 months) 12-33%; (2) mortality in juvenile Bali cattle (>12-2 years) 7-12%; and (3) mortality in adult Bali cattle (>2 years) 5-8%.

3.8 ANIMAL HEALTH SERVICE POST

Poskeswan is an animal health service unit for the community which is the spearhead of the animal health sector located in sub-districts in livestock-intensive locations. The main task of Poskeswan is to provide livestock health services according to the designated working area. Therefore, both the Head of Poskeswan and the health officer, in carrying out their duties, need to coordinate with agricultural extension workers as partners of the main actors (farmers, planters, breeders) and other related officers so that everything goes as expected (Directorate General of Livestock Production Development, 2009).

The availability of health service posts in the research location is in the sufficient category because only 3 units are available, namely Tinanggea District, as much as 1 unit, Buke as much as 1 unit, and Palangga District, as much as 1 unit. At the same time, in Baito District, there is no permanent health service post. At the same time, the facilities
and infrastructure are not yet fully available, but health service activities continue to run thoroughly to breeders individually and in mass.

24 health workers carry out health services for Bali cattle spread across Tinanggea sub-district with 12 people, Buke with 4 people, Palangga with 6 people, and Baito sub-district with 4 people. Reinforced by (Iqbal, 2011) that three main problems are often faced by poskeswan, namely the availability of inadequate infrastructure and facilities, the capacity of human resources is not optimal, and the management aspect has not been running according to organizational rules. Optimization of health services can also be seen from the frequency of health services carried out in the research location. The study results show that the frequency of health services has been classified as relatively good because farmers responded that health services had been carried out at any timeso far as 2,016 (77.33%). Hence, this condition needs to be maintained, and the frequency of health services to Bali cattle in the study location needs to be increased. In the opinion of Khan et al. (2020) that health is a factor that greatly affects the condition of Bali cattle that must always be maintained to prevent losses. Aspects of prevention, handling, and overcoming diseases in livestock through routine health checks so livestock remains healthy and productive.

4 CONCLUSIONS

The sustainability of the breeding dimension using Rap-BREEDKASEBIT obtained a sustainability index value in Tinanggea District of 51.30%, Buke at 60.93%, Palangga at 62.05%, and Baito District at 51.46% with each status being quite sustainable. The attributes that become a leverage factor and are at the RMS (root mean square) value above the median value (>1.5), namely the rearing system, percentage of female calves, percentage of male calves, percentage of mature females, calving interval (CI), service per conception (S/C), percentage of pregnancy rates, percentage of mortality rates, and animal health service posts.
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