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Distribution of Bali Cattle Farmers and Break-Even Analysis: Case in Barru Regency South Sulawesi

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Abstract. Barru Regency has a high Bali cattle population in South Sulawesi. This study aimed to analyze the distribution of farmers of Bali cattle and the break-even point of the small-scale Bali cattle business. The research location is Tanete Riaja District, Barru Regency, South Sulawesi. The respondents are smallholder farmers who run the breeding and fattening Bali cattle systems. There were 121 farmers as respondents, consisting of 75 breeding system respondents and 46 fattening system respondents. The respondents were selected through purposive sampling. Data was collected through interviews based on a structured questionnaire. Along with the interview, the location of the farmers was recorded using a GPS receiver. The overlay method on ArcGIS is used to map the farmers' locations. Data were analyzed using break-even price and yield analysis. The farmers' location maps showed they were located on low-elevation land, which is considered more suitable for Bali cattle farming because of good land fertility, suitable forage areas, and an abundant supply of food crop waste to reduce feed costs. Break-even analysis of the Bali cattle breeding business shows that farmers can break even and profit when rearing Bali cows with more than four heads. The Bali cattle fattening business is above the break-even point. This study recommends improving farmers' skills related to the reproductive aspects of Bali cows to shorten calving intervals. Also, providing loans to farmers is essential to increasing the business scale.

Keywords: Bali cattle, break-even analysis, breeding systems, fattening systems, mapping location

Abstrak. Kabupaten Barru merupakan daerah dengan populasi sapi Bali yang tinggi di Sulawesi Selatan. Penelitian ini bertujuan untuk menganalisis sebaran peternak sapi bali dan titik impas usaha ternak sapi bali skala kecil. Lokasi penelitian adalah Kecamatan Tanete Riaja, Kabupaten Barru, Sulawesi Selatan. Responden penelitian adalah peternak rakyat yang menjalankan usaha pembibitan dan penggemukan sapi Bali. Jumlah responden sebanyak 121 peternak yang terdiri dari 75 responden sistem pembibitan dan 46 responden sistem penggemukan. Responden dipilih secara purposive sampling. Data dikumpulkan melalui wawancara dengan menggunakan kuesioner terstruktur. Selaian melalui wawancara, lokasi peternak dicatat dengan menggunakan GPS. Metode overlay pada ArcGIS digunakan untuk memetakan lokasi peternak. Data dianalisis dengan break-even point (BEP) berdasar harga dan unit. Peta lokasi menunjukkan bahwa peternak berada di dataran rendah, yang dianggap lebih cocok untuk peternakan sapi Bali karena kesuburan tanah yang baik, area hijauan yang cocok, dan pasokan limbah tanaman pangan yang melimpah untuk mengurangi biaya pakan. Analisis BEP usaha pembibitan sapi Bali menunjukkan bahwa peternak dapat mencapai titik impas dan mendapatkan keuntungan jika memelihara sapi Bali induk lebih dari empat ekor. Usaha penggemukan sapi Bali berada di atas titik impas. Studi ini merekomendasikan untuk meningkatkan keterampilan peternak terkait aspek reproduksi sapi Bali induk untuk memperpendek jarak beranak. Selain itu, pemberian pinjaman kepada peternak sangat penting untuk meningkatkan skala usaha.

Kata kunci: Sapi Bali, sistem pembibitan, sistem penggemukan, kelayakan, pemetaan lokasi

Introduction

Bali cattle are indigenous Indonesian cattle. Although it is difficult to trace their history and origin (Praharani, 2004; Martojo, 2012), genetic studies and analysis of their phenotypes have shown that Bali cattle are relatively similar to the Banteng breed (Groeneveld et al., 2010; Martojo, 2012; Agung et al., 2019). Mohamad et al. (2009) showed that various beef cattle breeds in Indonesia are the result of crossbreeding between the Zebu and Banteng breeds. The difference between other beef cattle breeds and Bali cattle in Indonesia is that only Bali cattle have spread to almost all regions of Indonesia.

The beef cattle population in Indonesia is 17.4 million heads, with South Sulawesi Province ranking third at 1.41 million heads (Statistics Indonesia, 2021). According to Malindo et al. (2023), the Bali cattle breed population

proportionally dominates with the highest percentage, reaching 34.9% of the overall beef cattle population. Bali cattle distribution started in the late 18th and early 19th centuries through the transmigration program (Purwantara et al., 2012). Currently, the largest population of Bali cattle in Indonesia is in South Sulawesi. The wide distribution and high population make Bali cattle contribute significantly to the national beef cattle industry (Rachma et al., 2011). One of the essential factors that causes it is the high reproductive and production performance of Bali cattle.

Bali cattle have good production and reproduction performance, making them suitable for breeding and fattening. Bali cattle are more effective at utilizing low-quality feed, have high fertility, a high rate of service per conception (S/C), and have more calving abilities than other beef cattle breeds (Bamualim and Wirdahayati, 2003; Siswanto et al., 2013; Susilawati, 2017; Habaora et al., 2020). Even though Bali cattle are small in size and weight, they are suitable for smallholders. The production and reproduction performance of Bali cattle is a significant factor in the income of smallholder farmers.

Barru Regency, South Sulawesi Province, is a region that has been legalized as a center of breeding for Bali cattle. It means that other beef cattle breeds are restricted to being raised and need to also pay attention to the sustainability and development of Bali cattle farming. Bali cattle are the leading local beef production option because they are ideal for the climate of Indonesia (Bozkurt, 2012; Suprun et al., 2016). Although there is no official data, it is reported that around 90–95% of beef cattle production is produced by smallholders, with the amount of beef cattle ownership being less than five heads per farmer (Priyanti et al., 2012; Widi, 2015). Smallholder farmers run two types of beef farming systems, namely breeding and fattening Bali cattle systems. The Bali cattle industry serves multifaceted roles, functioning as a source of income, an avenue for investment, a progeny source, a financial resource in emergencies, and a provider of employment opportunities for individuals in rural areas (Lisson et al., 2010; Martojo, 2012). In contrast, the growth of Bali's cattle population in this area is 2.31% per year, lower than the national percentage, which is 2.5% per year.

Some strategies for increasing the population growth of Bali cattle are not solely dependent on reproductive and production performances or government regulations but also rely on assessing financial and geographical aspects, as emphasized in this paper. A map of farmers' locations can be produced using the Geographical Information System (GIS) software. Land elevation is one of the essential geographical characteristics of the beef cattle system. Only a few studies have analyzed smallholder beef cattle in a spatial context. Widiati et al. (2017) analyzed the land capability for developing cattle farming at Merapi Volcanic Slope, Yogyakarta. They show how GIS creates a land capability class map for food crops and forage analysis.

Furthermore, there needs to be available data or an assessment of the potential benefits of long-term investment in breeding and fattening Bali cattle. Bali cattle economic assessment in previous research only concerned smallholder business economic models (Lisson et al., 2010) and the willingness of farmers to pay for artificial insemination (Bahar et al., 2017). It, therefore, requires an investment assessment of the Bali cattle system. Against this background, this study was conducted to analyze the distribution of farmers of Bali cattle and the break-even point of small-scale Bali cattle farming in South Sulawesi. An economic evaluation of smallholder Bali cattle farming could provide farmers with indicators to improve Bali cattle farms. The correlations observed between Bali cattle farming, encompassing both breeding and fattening systems, and the spatial distribution of farmers can furnish valuable

insights for strategic planning in the development of Bali cattle. This information is pivotal for the implementation of clustered and sustainable agricultural practices.

Materials and Methods

The research location is located in Tanete Riaja District, Barru Regency, South Sulawesi. The research was conducted from June to September 2019. The number of beef cattle was approximately 72,198 heads in 2018, and the population grew by 2.31 percent in five years. Consideration of the Tanete Riaja District as a study area is not only based on the Barru Regency Agriculture Office's recommendation but also on the fact that it is the center of smallholder Bali cattle farmers and has lowland and fertile highland for feeding resources. Thus, local government policies and the geographic conditions of the Tanete Riaja District support developing Bali cattle. Quantitative data is analyzed descriptively.

The respondents are smallholder farmers who run the breeding and fattening Bali cattle systems. There were 121 farmers as respondents, consisting of 75 breeding system respondents and 46 fattening system respondents. The respondents were selected through purposive sampling. Breeding cattle system respondents were selected with the consideration of having at least three Bali cattle cows in their household. Respondents to the cattle fattening system are farmers who fatten at least two Bali bulls per period.

Data was collected using a survey method that involves observation and structured interviews. During the interviews, the respondents were asked questions using a structured questionnaire. Primary data is grouped as follows: (1) Profile: age, formal education, family size, Bali cattle farming experience, job, and area of forage land; (2) Bali cattle productivity: Service per conception (S/C), Calving Interval (CI), calf mortality, age of bull, bull selling period, and average daily weight gain (ADG); (3) Economical variables: input and output costs.

Along with the survey data, each location of the farmer was taken and recorded using a GPS (global positioning system) receiver. The recorded farm locations were converted to points, while types of businesses (Bali cattle breeding or fattening) were converted into attribute data. It was analyzed using the overlay method. The overlay method on ArcGIS (the geographical information system software) was used to determine the distribution map of Bali cattle farmers based on land typology (elevation). It divided the land elevation into three categories: low elevation (less than 100 m above Mean Sea Level/MSL), medium elevation (100–500 m MSL), and high elevation (greater than 500 m MSL).

Break-even analysis is used to estimate the break-even point of the output of the Bali cattle business. The formula to calculate the break-even point, according to Sigit (2002), is as follows:

$$\text{Break-even price} = \frac{fixed\ cost}{\left(1-\frac{variable\ cost}{revenue}\right)}$$

$$\text{Break-even (in head)} = \frac{break-even\ price}{selling\ price}$$

Results and Discussion

Characteristics of Respondents

The average age of the respondents falls within a productive period, rendering them capable of active participation in cattle rearing. Smallholder farmers, by and large, exhibit considerable experience. The confluence of a productive age facilitates ease in business expansion for farmers, owing to their inherent flexibility, innovation, and enthusiasm (Sugiarto et al., 2019).

Table 1. The Characteristics of Respondents

Characteristics	Breeding (n=75)		Fattening (n=46)	
	Average	%	Average	%
Age (years)	45.29		46.54	
Degree of education				
No school		4.00		4.35
Primary school		46.67		30.43
Middle school		16.00		17.39
High school		24.00		39.13
University		6.67		4.35
Family size (people)	4.24		4.00	
Breeding/fattening experience (years)	11.97		12.57	
Main occupation				
Farmer		94.67		91.30
Teacher		1.33		4.35
Entrepreneur		4.00		4.35
Forage land size (m^2)	3,269		10,152	

The level of education of respondents in Bali cattle fattening is higher than that of the breeding systems. Table 1 shows that the education level of respondents in the Bali cattle breeding system was predominantly at the primary school level (46.67%), while the fattening system was predominantly at the high school level (39.13%). This condition proves that more knowledge and higher education are requirements for the fattening system. The Bali cattle fattening business has more complex management than breeding because it requires more high-quality feed, more intensive care, and monitoring of body weight gain, hence the need to be supported by a high level of education. According to Kusuma et al. (2017), the low level of knowledge in the breeding systems affects how beef cattle are raised and handled. A low level of education makes it difficult for farmers to adopt new technology.

The family size of the respondent is between 3 and 5 people. Family members participate in the raising of Bali cattle, for example, by feeding cattle. According to the findings of Nalle et al. (2017) in East Nusa Tenggara, family size influences the preference of whether to implement a grazing or tethering system in raising beef cattle. Smallholder farmers choose to tether their cattle when they have many family members to assist the Bali cattle business. These family members feed and give drinking water to the Bali cattle and clean the pens. On the other hand, if there are just a few family members, the farmer prefer to open-grazing.

Average cattle breeding or fattening experience of smallholder farmers is over ten years. Farmers' long experience in beef farming has made it easier for them to make business decisions, handle & raise Bali cattle. Arifin & Riszqina (2016) argue they have been doing this business since they were children/ have assisted their parents. The long experience accumulated by these farmers has refined their expertise in all facets of Bali cattle rearing & management.

Barru Regency is an agricultural area with food crop producers and beef cattle, and most of the population is employed in this sector. The agricultural land area is dominated by 62.2% rainfed rice fields (Statistics Indonesia, 2018). Although the number of beef cattle in the breeding systems is higher than in Bali cattle fattening, the feed area is narrower. This difference is due to variations in the preferences of production systems & economic capital. Bali cattle breeding is semi-intensive, while the fattening systems are intensive. Bali cattle

fattening expenditure is more significant, including expense of each shed, procurement of young bulls for each cycle & the feed.

In Bali's cattle breeding systems, there is a growing trend among farmers to utilize food crop residues as feed for their cattle. Apart from the narrow feed area, farmers do not have a daily weight gain target for calves and Bali cattle cows. Farmers gather rice straw on agricultural land, as is the farmers' situation in Yogyakarta (Widiati & Widi, 2016). On the other hand, farmers use food crop residues since pasture has been turned into housing or planting land (Syamsu et al., 2013). By using food crop residues, farmers who run Bali cattle breeding can reduce the feed cost to less than fatten the Bali cattle systems. This condition aligns with the study's finding in Table 1 that the extent of forage land within the Bali cattle breeding system is comparatively narrower than that within the Bali cattle fattening system.

Reproduction and Production Performance of Bali Cattle

In the research area, the (S/C) is lower than the figure reported by Bamualim & Wirdahayati (2003) in Nusa Tenggara, indicating ratio 1.49 times less, as presented in Table 2. Massive artificial insemination activity in Barru Regency (Sirajuddin et al., 2018) is one reason for low number of S/C of Bali cattle cows. Mean calving interval was 16.31 months, higher than findings of Martojo (2003), who recorded the fastest CI for Bali cattle in Bali Province at 14 months.

The Calving Interval (CI) of Bali cattle is longer than the optimal CI (14 months). The long CI of Bali cattle is caused by long weaning ages and post-partum mating. Dahlanuddin et al. (2016) suggested improving the management of mating and cows' nutrition so Bali cattle can mate within two months. On the other hand, calf mortality in this study is lower than the 9.00% reported by Baco et al. (2019) in South Sulawesi. Long CI and calf mortality not only inflicted a financial loss on smallholder farmers' investments in Bali cattle breeding but also increased labor costs.

Smallholder farmers in the fattening business buy young bulls on the basis of age and external performance. The average age of young bulls is 1.57 years (Table 2). When smallholder farmers buy young bulls, they do not use weight scales but use an estimation approach. Even if they have not reached the optimum age, i.e., 2.5 years (Guntoro (2002), smallholder farmers adjust to consumer criteria and preferences. Consumers exhibit a preference for bulls of moderate weight that are sufficiently mature for Eid al-Adha. Smallholder farmers receive this supply of young bulls from other breeders who focus on raising Bali cattle (Pasambe, 2017).

The type of feed will increase the average daily gain (ADG) of Bali bulls. The ADG of Bali cattle is 0.41 kg/day, or according to Suhubdy et al. (2017), the ADG of Bali cattle is 0.30 - 0.40 kg/day. Smallholder farmers feed with forage, crop residues & rice bran. They refrain from providing high-nutrition feed, such as concentrates and supplements, due to both the elevated cost and the associated difficulty in procurement. The ADG of Bali cattle is maximized when farmers feed high-quality, nutrient-dense feed

Table 2. Reproductive and Production Performance of Bali Cattle Systems

Parameters	Breeding	Fattening	Optimum
Service per Conception (time)	1.39		1.49
Calving Interval (month)	16.31		14.00
Calf mortality (percentage)	5.14		9.00
Age of young bulls (years)		1.57	2.00
Selling age of bulls (years)		2.32	3.00
Average daily weight gain (kg/day)		0.56	0.69

Table 3. Population and Bali Cattle Herd Structure

Bali cattle herd structure	Breeding		Fattening	
	Head	AU	Head	AU
Mature				
- Cow	2.75	2.75	-	-
Young				
- Bull	-	-	4.13	2.48
Calves				
- Male	1.11	0.21	-	-
- Female	1.45	0.31	-	-
Bali cattle ownership/farmer	4.57	3.20	4.13	2.48
Total population	343.00	240.25	190.00	95.00

Bali Cattle Herd Structure

Bali cattle herd structure illustrates business goals & preferences of farmers (Table 3). Smallholder farmers in breeding systems are raising Bali cows. Although fattening systems rear Bali cattle at 4.13 heads/equivalent to 2.48 animal units, less than breeding systems, Bali bulls need more feed input. Based on average number of Bali cattle owners, respondents have fewer Bali cattle than owners of Bali cattle farmers on Timor Island, which reached 13.20 heads/farmer (Habaora et al., 2019).

Limiting the number of ownerships carried out minimizes the costs & time for Bali cattle handling. If calves selling occurs almost every year, number of cattle remains constant (Rohaeni et al., 2014). Lack of capital ensures that farmers raise only 3 to 6 heads. Female calves have a higher sex ratio than male calves. Although female price is lower than male calves, female calves are replacement stock of cows.

Mapping Location

The location of each Bali cattle farmer was geo-referenced using a GPS. The coordinates of the farmer's location are plotted on the base map, resulting in a map of the farmer's location. Land elevation data is overlaid with a map of the farmer's location. It showed the result in Figure 1. The locations of one farmer and other farmers are clustered, so the points appear as groups on the map. The location of farmers who are clustered makes it easy for agricultural extension activities & is suitable for the development of village breeding centers. Agricultural extension agents can easily reach them to provide training, guidance & information on improved breeding practices. The presence of farmers in one area allows for collaboration in Bali cattle breeding programs & efficient use of farm resources to increase business productivity.

The mapping results of farmers' location and land elevation show that both breeding and fattening Bali cattle farming are on low-elevation land (< 100 MSAL). Although Statistics Indonesia (2018) data showed that middle-elevation land (100–500 MSAL) dominates the land in Barru Regency, low-elevation land has a good fertility level, is suitable for forage areas, and farmers can easily use food crop waste. Research by Priyanti et al. (2015) on small-scale beef cattle in East Java shows lowland farmers using more rice straw feed compared to farmers in the highlands. This tendency is attributed to improved access to rice straw feed, facilitated by the expansive rice fields situated in low elevation areas. The research findings suggest that utilizing food crop waste can effectively minimize feed costs in small-scale Bali cattle farming, particularly in lowland areas where farmers have easier access to abundant food crop waste resources. In a cost of production analysis, efficient use of available resources is essential to optimize profits and break even. It highlights the importance of considering geographic factors & resource availability when implementing sustainable feeding strategies in beef cattle production systems.

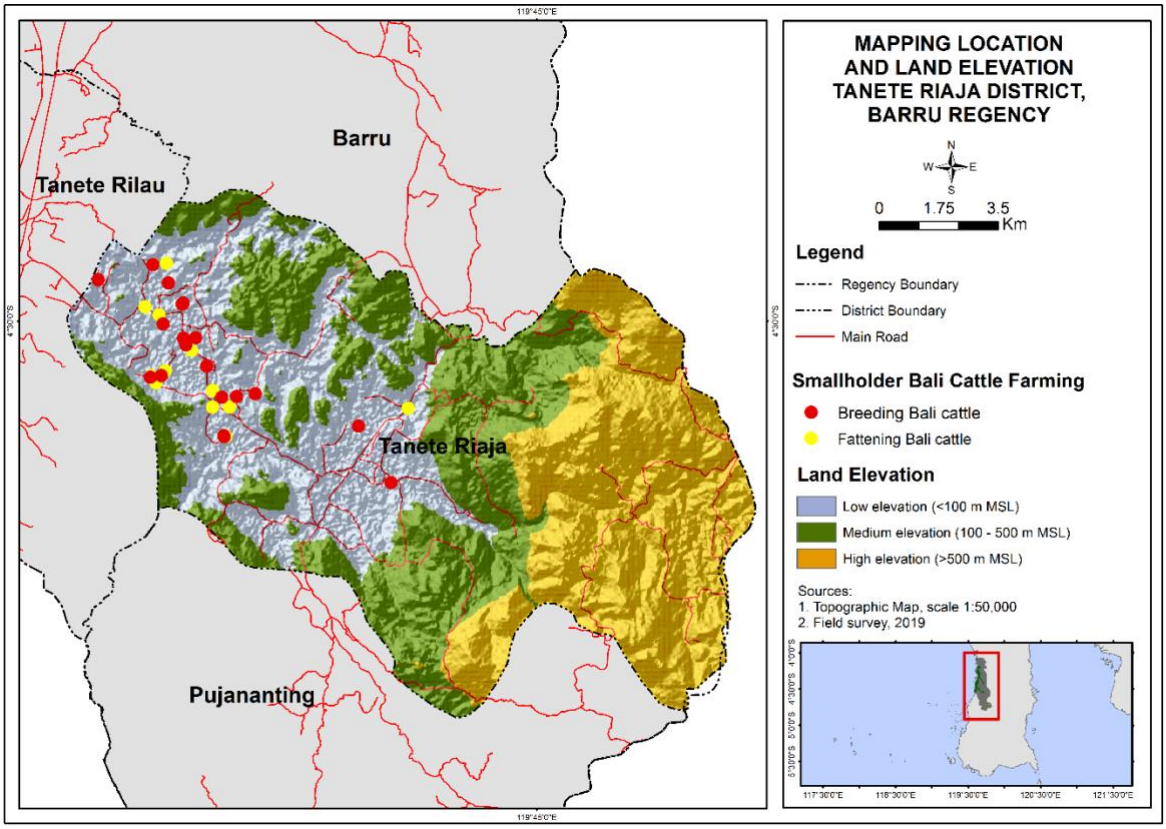

Figure 1. Location Map for Bali Cattle Farmers and Land Elevation

Total Cost and Revenue of Bali Cattle Breeding and Fattening Systems

The study findings reveal that the cost structure of Bali cattle breeding primarily consists of fixed costs such as land rent, labor, equipment depreciation, and pen depreciation, with the purchase of Bali cows being the most significant expenditure, accounting for 76.15% of the total costs (Table 4.). Additionally, the business's variable costs encompass feed and veterinary expenses, while revenue generation solely relies on selling three Bali calves. Bali cattle breeding business relies heavily on substantial fixed costs, particularly the expenditure of acquiring Bali cows. Consequently, managing and optimizing these reproductive performances of Bali cows becomes crucial for profitability. One effective strategy to increase the profit of breeding beef cattle is by shortening the calving interval (Widiati & Kusumastuti, 2022). Shortening the calving interval requires careful management practices such as timely insemination, proper nutrition, and regular health monitoring. In addition, it is necessary to diversify the sources of revenue beyond calf sales alone, such as by utilizing the sale of manure.

Results highlight that in the Bali cattle fattening business, fixed costs encompass various items such as land rent, labor, equipment depreciation, pen depreciation, and bank loans, with bank loans being the highest component, accounting for 10.19%. On the other hand, the study reveals that the primary variable cost in this business is attributed to the purchase of young bulls, constituting a substantial percentage of 66.55%. Bank loans in the Bali cattle-fattening business indicate dependence on external financial support. Banks play a crucial role in this industry by offering subsidized and non-subsidized interest rates, empowering farmers, and enhancing their involvement in farmer groups (Asnawi and Amrawaty, 2019; Mahendri et al., 2023).

Table 4. Total cost and revenue of Bali Cattle Breeding and Fattening Systems (farmer/year)

No.	Items	Breeding		Fattening	
		Amount (IDR)	Percentage (%)	Amount (IDR)	Percentage (%)
	Fixed Cost				
1	Land rent	130,667	0.62	179,348	0,46
2	Labor	2,344,320	11.11	2,664,100	6,84
3	Equipments depreciation	234,118	1.11	381,109	0.98
4	Pens depreciation	465,570	2.21	445,080	1.14
5	Cows (3 heads)	16,071,428	76.15	0	0.00
6	Credit	0	0.00	4,235,290	10.19
	Sub-total	19,246,102	91.19	7,904,927	20.28
	Variable Cost				
1	Young bulls (4 heads)	0	0.00	25,937,354	66.55
2	Feed	1,814,929	8.60	5,070,772	13.01
3	Veterinary	44,227	0.21	61,775	0.16
	Sub-total	1,859,156	8.81	31,069,901	79.72
	Total cost	21,105,258	100	38,974,828	100
	Revenue	14,010,000		49,281,250	

The research underscores that the purchase of young bulls constitutes a substantial proportion of variable costs, so it is vital to maintain the supply and acquisition of young bulls for optimal economic outcomes. Young bulls can be supplied from Bali cattle breeding businesses

Break-Even Analysis of Bali Cattle Breeding and Fattening Systems

Break-Even Point (BEP) is the point at which costs and revenues are equal: the Bali cattle farmers get no profit or loss from their operations (Habaora et al., 2019; Tyapradana & Azizah, 2022). Table 5 shows the BEP calculations for Bali cattle breeding and fattening businesses. Breeding of Bali cattle generates revenue from selling two calves, while the fattening of Bali cattle generates revenue from selling four bulls.

The Bali cattle breeding business calculated to get a break-even price of IDR 22,190,878 from selling three calves, or IDR 7,396,959 per calf. By dividing the BEP of calves sales by the selling price, the BEP in units is five calves. Compared with the selling price of calves, the calculated break-even price of the Bali cattle breeding business is still higher. The Bali cattle breeding business means that to make a profit, the selling price of calves must be higher than the break-even price. Furthermore, the break-even yield shows that the number of calves that farmers must sell to make a profit is five heads. Farmers engaged in the Bali cattle breeding business ought to augment the population of Bali cows to enhance farmers' revenue. To get sales of five calves, the Bali cattle breeding business must raise at least six Bali cows. Expanding the Bali cow population remains attainable, as these farmers inhabit low-lying areas with fertile arable land. This circumstance allows farmers to harness food crop waste, such as straw.

Table 5. BEP Calculation of Bali Cattle Breeding and Fattening Systems

Items	Breeding	Fattening
Fixed cost (IDR)	19,246,102	7,904,927
Variable cost (IDR)	1,859,156	31,069,901
Revenue (IDR)	14,010,000	49,281,250
Break-even price (in IDR)	22,190,878	21,391,314
Break-even yield (in head)	4.75	1.74

The findings of Nono et al. (2018) on beef cattle breeding performance in Kupang District, East Nusa Tenggara Province, also confirm that farmers can optimize their income by increasing their beef cattle population. Meanwhile, the Bali cattle fattening business recorded a break-even price of IDR 21,391,314 and a BEP in units of two bulls. The number of bulls sold by farmers was above the break-even price and units, meaning that farmers profited from fattening four bulls. These results highlight the potential economic benefits for farmers from engaging in the Bali cattle fattening business.

Conclusions

Mapping the location of Bali cattle farming shows all farmers are at low elevation (0–100 m MSL) and clustered. Low elevation has feed resources from food crop residues to provide a sustainable feed source and minimize feed costs, so the Bali cattle business can optimize profits and break even. Break-even analysis of the Bali cattle breeding business shows that farmers can break even and profit when rearing Bali cows with more than four heads. Meanwhile, the Bali cattle-fattening business is above the break-even point. Even though the Bali cattle breeding business has yet to reach break-even prices and yields, this breeding system is essential because many farmers run it in rural areas, and the sustainability of Bali cattle fattening depends on the production of young bulls of Bali cattle on breeding systems. This research recommends that the government and other stakeholders improve farmers' skills regarding the reproductive aspects of Bali cows through agricultural extension and training for shortening calving intervals. Also, providing loans to farmers is essential to increasing the business scale.

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