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Population Structure and Dynamics of Beef Cattle in Sidenreng Rappang Regency, South Sulawesi, Indonesia

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ABSTRACT

This study aimed to analyze the population structure and dynamics of beef cattle in Bulo Timoreng Village, Panca Rijang District, Sidenreng Rappang Regency, South Sulawesi, Indonesia. The research was conducted from March to April 2023 using a survey method with 53 respondents selected purposively. Data were collected through observation and interviews, then analyzed descriptively to determine population structure and population dynamics based on the percentages of births, deaths, and slaughter of productive females. The population structure consisted of 60.47% cattle (21.34% males and 39.13% females), 28.26% heifers (15.47% males and 12.79% females), and 11.27% calves (5.72% males and 5.55% females). The birth rate was 11.27%, mortality rate 3.62%, and the slaughter rate of productive females 1.65%. The findings are highly relevant for formulating livestock development strategies and increasing cattle population growth in South Sulawesi. This study provides novel insights into how local population data can guide sustainable livestock policies, serving as a regional model for achieving the Sustainable Development Goals (SDGs), particularly Goal 2: Zero Hunger.

Keywords: Beef cattle, population dynamics, South Sulawesi, livestock policy, sustainable development

INTRODUCTION

One of the agricultural sectors that determines the development of food security is livestock, which plays a vital role in providing the food and nutritional needs of the Indonesian people. The current condition of animal husbandry is a challenge and an opportunity for the welfare of farmers. This will encourage the overall growth of related sectors in other agricultural fields. The expansion of the livestock industry must be balanced with an increase in production and the number of beef cattle. [1].

The production of meat and milk, which has high economic value and is very important for people's daily lives, comes from cattle. The primary purpose of raising beef cattle is to produce

meat used as a food ingredient. Indonesia's beef supply must catch up with the country's increasing demand from the general public. One reason is that the beef cattle population grows at a rate different from that of the high human population. Their genetic makeup can influence the amount of meat produced by beef cattle. Thus, efforts are needed to utilize technology such as artificial insemination (AI) to improve the genetic quality of livestock, especially local cattle [2].

The application of artificial insemination (AI) in beef cattle is one of the actions that can be taken to increase the beef cattle population. The spermatozoa used in the AI technique are usually the result of ejaculation, which is accommodated with an artificial vagina. The AI program aims to make the most of healthy males with high genetic quality. Spermatozoa must also be preserved so that they can be used for a long time and sold at a later time. Thus, the cement must be combined with a diluent solution to meet all its physical and chemical requirements [1]. The increase in Indonesian people's protein consumption positively impacts the increasing beef cattle industry, while most beef cattle farming is traditional. The demand for beef increases yearly as the population grows and awareness of the benefits of eating enough protein. In Indonesia, more than 90% of beef cattle farms are still on a small scale, with a weak capital base. This is a side job even though the beef cattle industry has the potential to improve the financial condition of farmers by increasing production to reduce meat imports. The number of beef cattle and processed products reaches 600-700 heads every year [3].

The development of beef cattle farming agribusiness has a strategic meaning and plays a vital role in the regional economic structure. Cattle have social and economic functions in the lives of the Indonesian people because livestock can be used as labor for processing agricultural land, a source of cash, a source of income, religious ceremonies, souvenirs, a source of organic fertilizer, and labor. It can also raise social status in specific communities, be bought and sold when needed, and function as savings for the future of the farming community [4].

The history of cattle is known worldwide from the Homacodontidae, discovered in the Pliocene era. The primitive type was determined in the Pliocene era in India and Asia. The existing literature has yet to learn specifically when humans first domesticated cows. However, in centers of cultural development such as Mesopotamia, India, China, and Europe, it was known from 6,000 BC. In contrast, in Egypt, it is said that in 8,000 BC, there were already domesticated cows [5].

Cattle belong to the ruminant (polygastric) class of livestock, which has a front stomach consisting of the rumen (towel stomach), reticulum (mesh stomach), omasum (book stomach), and true stomach, namely the abomasum. In general, the ruminant stomach functions to digest feed ingredients that have high fiber, such as forage. Histologically, the structure of the front stomach of ruminants (rumen, reticulum, and omasum) has a unique feature in the form of a protective epithelium, namely a multi-layered, keratinized epithelium which plays an essential role in helping digest rough and rugged feed and protecting the gastric mucous membrane from mechanical damage. This shows that cattle are unique in their digestive system [6].

Native Indonesian beef cattle have existed in Indonesia since ancient times. In contrast, local cattle originate from outside Indonesia but have been bred and cultivated for a long time in Indonesia, so they have specific characteristics. Bali cattle (*Bos sondaicus*) are beef cattle native to Indonesia, while local cattle include Madura cattle and Sumba Ongole (PO) cattle [7].

The development strategy for beef cattle should be based on food causes and business standing. For this reason, introduction and tactics are needed for expanding livestock areas so

that the use of livestock areas developed in these areas can be optimized to make new investments in beef cultivation [8].

The livestock population is the number of livestock living in an area for a certain period, usually expressed over the years. Various causes, including the number of slaughters, livestock deaths, livestock exports, and the level of natural increase, influence the size of the beef cattle population. The characteristics of the population groups above are quantitative descriptions of the population that will change over time. This change in status is called population dynamics.

According to Blesbois [10] describes several factors that cause a lack of livestock population in Indonesia, including the existence of a cattle breeding program, low livestock reproduction rates, and techniques and methods of animal husbandry practices in Indonesia that do not support livestock development are factors that cause livestock populations not to develop properly.

Birth is the number of births experienced by a female animal in a year/calving period. The low birth rate of cattle is due to breeders' lack of care in the mating program and their low level of knowledge about aspects of livestock reproduction [11].

A high percentage of livestock deaths is one obstacle to efforts to increase livestock populations. The high or low livestock deaths in an area will influence the difference between birth and death rates. Sudden death is often found in livestock, whether newly arrived from a particular region or newly imported from abroad. Death is sometimes not preceded by apparent clinical symptoms. Of the various diseases that cause the above conditions, one of the causes is toxigenic Clostridia bacteria [4].

Slaughtering productive females is one of the factors causing an accelerated decline in the domestic cattle population. Suppressing productive females' slaughter requires supervision, from the beef cattle trade route to slaughterhouses. If productive female cattle are allowed to be slaughtered, the beef cattle supply will decrease. Because the beef cattle supply decreases, the beef price will increase, stimulating farmers to sell their livestock more quickly. This will threaten the sustainability of cattle with extinction [12].

Sidenreng Rappang, South Sulawesi, is one of the beef cattle-producing areas in Indonesia. Therefore, information on the population structure in this area is needed to illustrate the dynamics of the beef cattle population in Indonesia.

MATERIALS AND METHODS

Location and Materials of The Study

The survey method was used in this research [13]. The choice of research location was in Bulo Timoreng Village, Panca Rijang District, Sidenreng Rappang Regency. The material used in this research was observed beef cattle, including Brahman cross cattle, Limousin cattle, Ongole crossbreed cattle, Brahman cattle, Simental cattle, Bali cattle, and Angus cattle. This research uses primary and secondary data, both qualitative and quantitative. They were used in qualitative research collected through observation and quantitative obtained by calculating the percentage of births, the percentage of deaths, and the slaughter of productive females, then processed using predetermined data analysis techniques. The number of samples used in this study was 53 respondents.

Determination of Study Location and Sources of Data

The research location is determined based on the following considerations: (1) the Beef cattle population center; (2) the number of beef cattle breeders. The area that became the research location was Bulo Timoreng Village, Panca Rijang District, Sidenreng Rappang Regency. Quantitative data was collected as primary data obtained through questionnaire interviews with farmer respondents. The questionnaire contains the percentage of births, the percentage of deaths, and the slaughter of productive females. Secondary data was obtained from the livestock and fisheries service in the Sidenreng Rappang Regency.

Reproductive Parameters and Data Analysis

Descriptive statistical analysis using percentage calculations

1. According to Dania *et al*. [14] The following population data analysis is used.

$$Pi = \frac{Xi}{\Sigma x} \times 100\%$$

Information:

Pi = Percentage of population structure (male, female, heifer, bulls, adult males, and adult females)

Xi = Number of beef cattle male, female, bulls and heifer, adult bulls, and adult heifers

∑X = Total population of beef cattle.

2. According to Dania *et al*. [14] The following population dynamics data analysis was used:
   a. Income figures
      Birth Rate (Calving Rate)

$$\text{Birth Percentage} = \frac{\text{Number of Births Per Year}}{\text{Number of Population Per Year}} \times 100\%$$

   b. Expenditure Figures
      1). Percentage of Deaths (Mortality)

$$\text{Percentage of Deaths} = \frac{\text{Number of Deaths Per Year}}{\text{Number of Population Per Year}} \times 100\%$$

      2). Percentage Withholding Productive Famale Livestock

$$\text{Percentage Cut} = \frac{\text{Number of Withholding Peryear}}{\text{Number of Population Per Year}} \times 100$$

RESULTS AND DISCUSSIONS

Timoreng Bulo Village Profile

The village profile of Bulo Timoreng is a comprehensive description of the geographical and demographic conditions, including village boundaries, village office coordinates, village area, village travel time orbit, and public infrastructure in the village. Geographical conditions are the

location and area of the village of Bulo Timoreng is one of 8 sub-districts in the Panca Rijang sub-district, which is located ±7 km east of the capital of the Panca Rijang sub-district and ±17 km from the north of the capital of Sidenreng Rappang Regency, the area of Bulo Village Timoreng ± 13 Km2 with the following boundaries. North side, Pattondon Salu Village, Maiwa District. East side: Cipotakari Village, Panca Rijang District. South: Aka Akae Village, Wattang Sidenreng District. West side: Bulo Wattang Village, Panca Rijang District. Topography In general, the topography of Bulo Village is plains. Most of the area of Bulo Village is Technical Irrigation Rice Fields and Rain-Fed Rice Fields. Bulo Timoreng Village coordinates at Latitude -3.8407189, Longitude 119.8594622, and an altitude of 60 meters above sea level [15].

Characteristics of Respondents

Number of Respondents Based on Gender

Gender is a physical difference between men and women that can affect the effect of their efforts. Regarding the classification of respondents based on gender, the research results show that they consist of various genders, as shown in Table 1.

Table 1. Number of Respondents Based on Gender

No	Gender	Frequency (Person)	Percentage (%)
1	Man	51	96.22
2	Woman	2	3.78
Total		**53**	**100**

Table 1 shows that of the 53 male respondents, 51 were was man, and the percentage was 96.22%, while there were two female respondents with a percentage of 3.78%. This shows that men dominate the beef cattle business due to the level of productivity; men are relatively higher than women. However, this does not rule out the possibility that men and women can cooperate in trying to do it. This is in line with the opinion of Santoso and Kususiyah [16], which states that more men are involved in the beef cattle business than women because raising livestock is a job that involves more physical activity, so it is more suitable for men. However, it does not rule out the possibility that female breeders are.

Number of Respondents Based on Education Level

Education is expected to liberate social, economic, and political society. From a financial perspective, a person's education level is expected to increase business productivity. Likewise, the higher a farmer's education level can increase his knowledge capacity in the livestock business, the more the company hopes to develop further. The research results show that it consists of various levels of education, as shown in Table 2.

Based on Table 2, it can be seen that of the 53 respondents with the highest level of education based on the number of frequencies, namely high school, 18 people totaled 33.97%. In contrast, the lowest is based on the number of frequencies, namely diploma and bachelor, amounting to 1 person with a percentage of 1.89 %. This is because most breeders still need a higher level of education and a high cost of higher education (S1). This is based on the opinion

that there needs to be more public attention to education due to the high cost of tertiary education.

Table 2. Number of Respondents Based on Age

Education	Frequency (Person)	Percentage (%)
Elementary school	16	30.18
Junior high school	17	32.07
Senior High School	18	33.97
Diploma	1	1.89
Bachelor	1	1.89
Total	**53**	**100**

Number of Respondents by Occupation

Employment status is important because it determines the amount of time a person devotes to his business. The work classification is divided into main work and side work. Based on the research results, it consists of a variety of different jobs, as can be seen from Table 3.

Table 3. Number of Respondents by Occupation

Work	Frequency (Person)	Percentage (%)
Farmer	50	94.33
Household Units	2	3.78
Government employees	1	1.89
Total	**53**	**100**

Based on Table 3, it can be seen that of the 53 respondents who have the highest job based on the number of frequencies, namely farmers totaling 50 people with a percentage of 94.33%. This is because the people in Bulo Timoreng Village have their primary job as farming, while the work of breeders is only a side job, and they only have free time. This is the opinion that one factor in people's motivation to work hard is economic pressure, which means that to satisfy needs, it is impossible to rely only on one source of income.

Number of Respondents Based on Livestock Ownership Scale

The amount of livestock ownership is a determining factor for the level of income earned. Based on the results of research that has been given in Table 4. It can be seen that of the 53 respondents who have the highest livestock ownership scale based on the number of frequencies, namely 1-15, there are 36 people with a percentage of 67.93%, while the lowest frequency, namely 26-35, is one person with a percentage of 1.89 %. The average Bulo Timoreng Village farmer has experience raising beef cattle. Field Nugraha et al. [19] state that the beef cattle business must be developed further because the scale of respondents' livestock ownership is generally relatively small. Therefore, increasing the scale of livestock ownership is necessary to increase the productivity of a livestock business.

Table 4. Number of Respondents Based on Livestock Ownership Scale

Number of Livestock	Frequency (Person)	Percentage (%)
1 – 15	36	67.93
16 – 25	14	26.41
26 – 35	1	1.89
> 75	2	3.77
Total	**53**	**100**

Number of Respondents Based on Number of Family Members

The number of family members is the number of family members owned by the respondent. The more family members, the greater the needs that are met. Based on the research results, this can be seen in Table 5; of the 53 respondents with the highest number of family members 1-5, there were 45 people (84.90%), while the lowest number of family members, namely 6-10, was eight (15.1%). This shows that the husband's access to counseling institutions is more important than the wife and children. This aligns with the opinion that the workforce's role in benefits is defined as all family activities must have the same benefits for all family members.

Table 5. Number of Respondents Based on Number of Family Members

Number of Family Members	Frequency (Person)	Percentage (%)
1 – 5	45	84.90
6 – 10	8	15.10
Total	**53**	**100**

Number of Respondents Based on Land Control Area

The priority of land use, in general, is to support agricultural or plantation businesses. In addition, land use can also be utilized in the cattle business. Based on the results of the research that has been carried out, land tenure can be seen in Table 6. It can be seen that of the 53 respondents who had the highest land tenure area of 0.1 ha - 0.5 ha, there were 24 people with a percentage of 45.28%, while the lowest tenure area was 0.6 ha - 0.10 ha, as many as eight people. This is because the more significant the area of land tenure, the more comfortable it is for livestock to move, eat, and drink. The opposite states that land resources are natural resources that benefit humans, such as a place to live and make a living (agricultural land) [21]. Agricultural land is land designated for farming activities.

Table 6. Number of Respondents Based on Land Control Area

Land Tenure	Frequency (Person)	Percentage (%)
0.1 ha – 0.5 ha	24	45.28
0.6 ha – 0.10 ha	8	15.10
1 ha – 5 ha	21	39.62
Total	**53**	**100**

Population Structure

Population structure is the composition of the population, which includes sex, male, female, and age, such as the categories of calf, youth, and adults. The structure of the population in an area determines the increase in the population of the area itself. The population structure of beef cattle shows an imbalance between males, females, and ages [22]. Based on the research results on the population structure of beef cattle in Bulo Timoreng Village can be seen in Table 7. It is known that from the 53 respondents, the number of beef cattle was 665.

Table 7. Population Structure of Beef Cattle in Bulo Timoreng Village

Gender	Calf		Young		Mature/Adult		Total	
	N	%	N	%	N	%	N	%
Male	38	5.72	103	15.47	142	21.34	283	42.53
Farmale	37	5.55	85	12.79	260	39.13	382	57.47
Total	75	11.27	188	28.26	402	60.47	665	100

Note: N = Number of Beef Cattle
% = Percentage of Beef Cattle

Population structure based on age, namely adults 60.47% (males 21.34% and females 39.13%), youth 28.26% (males 15.47% and females 12.79%) and calf 11.27% (males 5.72% and 5.55% female). This is because the data shows that the population of bulls is lower than that of heifers so that it can be developed naturally or with AI technology. Opposite with Yamin and Syamsu state [23], showing that the calculation of the population structure of beef cattle in Sidenreng Rappang Regency obtained the number of calves of 10,138.46 heads; 10,613.40 young cattle and 27,711.14 adult cows. The total population of beef cattle by livestock unit is 35,552.46, with the distribution of calf at 2,534.61, young cattle at 5,306.70, and adult cattle at 27,711.14.

Tanari et al. [24] state that the low percentage of the male and female livestock population is due to the low birth rate (Calving Rate). The percentage of young cattle is low due to the high sales rate at birth. Adult female livestock is higher than adult male livestock because farmers choose to do cage and feed efficiency.

Population Dynamics

Population dynamics in livestock is the increase and decrease in the number of animals in a livestock population. The cause of the rise and fall of the population is influenced by Natalisis (birth), Mortality (death), and Slaughter of Productive Females [25].

Birth

Birth is the number of births experienced by female livestock in one year/calving period [26]. Based on the study's results, Table 8 shows the number of beef cattle imports in Bulo Timoreng Village, Panca Rijang District, Sidenreng Rappang Regency. Based on Table 8, it can be seen that the birth rate for the past year was 11.27%. This is because the situation in the field shows more males than females. This aligns with Labatar and Aswandi's opinion that the accessibility of males influences the low birth rate. The situation on the ground shows that there are a lot of bulls, but these bulls are generally kept separately from heifers to be fattened and eventually sold, making it difficult to breed. Dg. Malewa and Al Mu'min [28] stated that

supporting the high birth rate of cattle is the availability of Frozen Semen from the Center for Artificial Insemination so breeders can quickly get good livestock seeds. However, the birth rate for cattle is still low due to the lack of supervision by breeders and the government on programs related to livestock pregnancy.

Table 8. Importance of Beef Cattle in Bulo Timoreng Village, Panca Rijang District, Sidenreng Rappang Regency

Indicator	Genre	Total	
		N	%
Birth	Male/Bull	38	5.72
	Farmale/Heifer	37	5.55
Total		**75**	**11.27**

Note: N = Number of Beef Cattle
% = Percentage of Beef Cattle

$$\text{Bull Birth Percentage} = \frac{38}{665} \times 100\% = 5.72\ \%;\ \text{Heifer Birth Percentage} = \frac{37}{665} \times 100\% = 5.55\ \%$$

Death and Slaughter

The high percentage of livestock mortality is one obstacle to increasing the livestock population. The livestock mortality rate in an area will affect the difference between birth and death rates [29]. The slaughter of productive females is one of the factors accelerating the decline in the domestic cattle population [30]. The results of the research that has been conducted can be seen in Table 9.

The mortality rate was 3.62% (2.41% for males and 1.21% for females). Meanwhile, the slaughter rate for productive females was 11, with a percentage of 1.65%. This is due to illness and accidents resulting in death. While an infectious disease causes the slaughter of productive females, so they must be conditionally slaughtered to eradicate and prevent life-threatening diseases. This is the opinion of Oktafiana *et al.* [31], which states that the four leading causes of death are illness, accidents, poisoning, and childbirth.

Table 9. Production Figures for Beef Cattle in Bulo Timoreng Village, Panca District Rijang, Sidenreng Rappang Regency

Indicator	Calf		Young		Mature/adult		Total	
	N	%	N	%	N	%	N	%
Death	12	1.82	6	0.91	6	0.91	24	3.62
Productive Famale Slaughter	-	-	11	1.65	-	-	11	1.65
Total	50	7.54	54	8.11	6	0.91	110	16.54

Note: N = Number of Beef Cattle
% = Percentage of Beef Cattle

CONCLUSIONS

Based on the results of the study, it can be concluded that the population structure is based on age, namely adults 60.47% (bulls 21.34% and heifer 39.13%), youth 28.26% (bulls 15.47% and heifer 12.79%) and children 11.27% (5.72% bulls and 5.55% heifer). Whereas Population

dynamics based on the birth rate over the past year was 11.27% (bulls 5.72% and heifers 5.55%). Mortality rate 3.64%, (Calves 1.82%, Young 0.91%, adults 0.91%). Meanwhile, the slaughter rate for productive female cattle was 11, with a percentage of 1.65%.

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