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Performance and breeding value of male buffalo production traits as a basis for selection in Jembrana Regency, Bali Province, Indonesia

Dewi Ayu Warmadewi *, I Gusti Nyoman Gde Bidura, I Nyoman Ardika and I Made Suasta

Faculty of Animal Husbandry, Udayana University, Denpasar-Bali, Indonesia.

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Abstract

Efforts to increase the buffalo population must also be balanced with efforts to improve their genetic quality, so that there are many superior breeds available as a substitute for livestock that are no longer productive. The aims of this study were to determine the performance of the production traits of the young bull population and to determine the breeding value of the production traits of the young bull in Jembrana District, Bali Province, Indonesia. The data were analyzed descriptively to obtain the average production traits of young bull, and to calculate the breeding value of the measured production traits. The results showed that the average production characteristics obtained in this study were higher than the standards set by SNI 7706.1:2011, regarding young bull of mud buffalo breeds, for the minimum requirements for quantitative body dimensions (chest girth, shoulder height and body length), as a candidate for sire, especially for age group I-1. The highest breeding value was owned by young bull with code 12 and code 9.The conclusions of the study were: (i) the performance of young bull in Jembrana Regency, Bali Province was very good, because it was higher than the quantitative minimum requirements stipulated by SNI 7706.1: 2011, concerning young bull buffalo breeds and (ii) the highest breeding values are owned by young bulls with code 12 and code 9, so that these two young bull are the best candidate as a sire.

Keywords: Breeding; Selection; Sire; Young bull

1 Introduction

Buffalo (*bubalus bubalis*) is one of the potential livestock to be developed. Buffaloes for the community are used as a source of meat, land processing, transportation of agricultural products, for the purposes of religious ceremonies or "yadnya" livestock (especially Hinduism) and also for recreation/entertainment/cultural attractions for buffalo racing with different names for each region. In the Province of Bali, precisely in Jembrana Regency, it is known as "Makepung" which has an attraction for tourists and is also an icon of Jembrana Regency, Bali Province. The largest population of buffalo in the Province of Bali is in Jembrana Regency, namely 1155 heads or 83.09% of the buffalo population in the Province of Bali with a ratio of the number of males and females of 817 heads: 338 heads [1].

However, in reality the buffalo livestock population tends to decrease. Based on data from the[1] shows that the buffalo population in the Province of Bali over the past 5 years (2016-2020) has been 1,865; 1598; 1178; 2492 and 1390 heads, respectively. In addition, it is suspected that there is a decline in the quality of buffalo in Indonesia, due to a decrease in genetic quality and other factors, such as improper maintenance management. If this continues, it is feared that its sustainability will not be maintained [2].

Steps for protection and preservation for the survival of buffalo livestock need to be done. The Jembrana Regency Government has issued Jembrana Regency Regional Regulation Number: 4/2020 [3], concerning the Protection and

*Corresponding author: Dewi Ayu Warmadewi

Preservation of Buffalo Livestock. With this regulation, it is hoped that the buffalo population can be maintained and increased.

Efforts to increase the buffalo population must also be balanced with efforts to improve their genetic quality so that there are many superior breeds available as a substitute for livestock that are no longer productive. Breeders have made efforts to select superior breeds, especially those used for racing or "mekepung", but due to limited resources they have, breeders cannot carry out breeding operations properly. This effort needs to be strengthened scientifically, so that the breed selection is really valid.

The selection program is one of the efforts that can be made to select livestock as a breed. Furthermore, a mating program is carried out with selected fellow livestock, so that offspring with superior genetic quality are produced [4,5]. This program must be carried out in a directed, continuous and continuous manner. In addition, this program can be used as an effort to preserve and develop livestock populations. The selection program can be carried out by looking at its production performance by measuring several production characteristics that have economic value, such as chest girth, chest width, chest depth, shoulder height and body length, then selecting livestock that have good performance [6].

Besides that, the selection program can be carried out by calculating the breeding value of traits that have economic value from each individual for further ranking. The magnitude of the breeding value of an animal shows the superior genetic potential possessed by the livestock compared to the average population. Johansson and Rendell [7] stated that livestock with higher breeding values would be better used as replacement stock or livestock compared to livestock with lower breeding values. Furthermore, the selected livestock are livestock that have high breeding value. In addition, it depends on how many livestock will be needed as a breed or replacement livestock.

The calculation of breeding values for production traits that have economic value in buffalo in Jembrana district, Bali Province, Indonesia has never been carried out, therefore this research was conducted as a basis for carrying out a selection program to improve the genetic quality and population of buffalo in Bali Province.

2 Material and methods

2.1 Place and Length of Research

The research was conducted in Jembrana District, Bali Province, Indonesia. The research lasted for 8 months starting from research preparation to the end of research implementation. Determining the research location by means of purposive sampling, where Jembrana Regency is the district with the largest population of buffalo in the Province of Bali. Sampling was determined by purposive sampling [8]. The study was conducted by direct measurement of production characteristics, namely chest circumference, chest width, chest depth, shoulder height and body length, then grouped by teeth (tooth-0 and tooth-1) of buffalo in Jembrana Regency, Bali Province.

2.2 Measurement method

The independent variable used in this study was the teeth (tooth-0 and tooth-1). The dependent variable was production characteristics, namely chest girth, chest width, chest depth, shoulder height and body length of the young bull, while the control variable was livestock rearing management (assumed to be the same feed). The measured buffalo was put into a fixation cage to facilitate measurement. Furthermore, the measurement of the characteristics of production on buffaloes was carried out.All data obtained was recorded. Furthermore, grouping data based on teeth. Then the performance and breeding values for production traits were calculated for each age group. Based on these calculations were used for selection. The study used 150 young bulls teeth-0 (I0) and 125 young bulls teeth-1 (I1) in Jembrana Regency, Bali Province, Indonesia. The research flowchart is presented in Fig. 1.

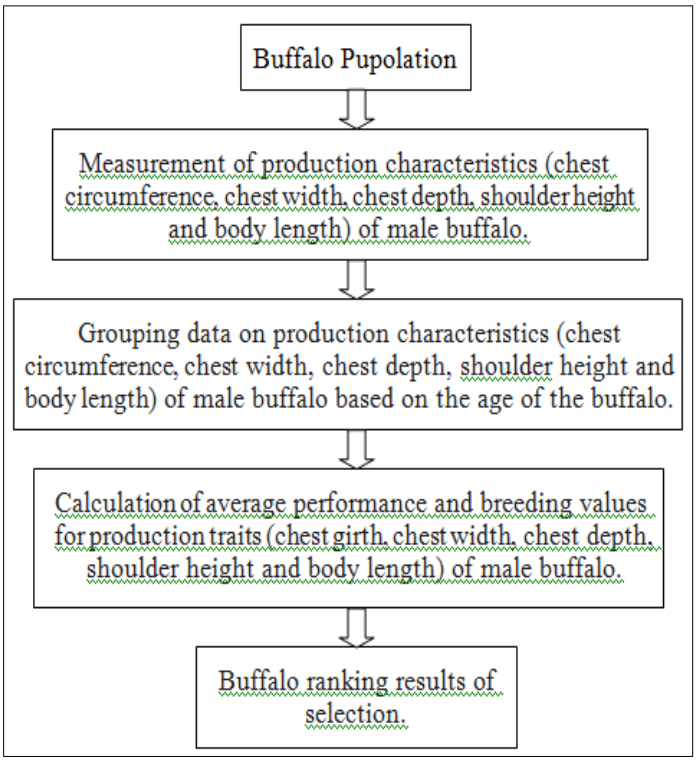

Figure 1 Research flowchart

2.3 Data analysis

The data obtained were analyzed descriptively. Performance of production traits, namely chest girth, chest width, chest depth, shoulder height and body length of young bulls, was calculated by finding the average of each production trait, namely by adding up the total value obtained divided by the total number of livestock measured, or with the formula:

$$\bar{X} = \frac{\sum x}{n}$$

Notes:

$\bar{X}$ = avarage;
$\sum x$ = the total value obtained.
n = the number of animals measured.

The standard deviation (sd) is obtained by the formula:

$$\sqrt{\frac{\sum x^2 - (\frac{\sum x}{n})^2}{n-1}}$$

Estimation of the breeding value of production traits (chest girth, chest width, chest depth, shoulder height and body length) of young bulls was calculated using the individual selection method (performance test) with the formula [9].

$$NP = h^2(Pi - \overline{P})$$

Notes:

NP = breeding value.
h2 = heritability.
Pi = individual body dimensions.
$\overline{P}$ = the average body dimension of the population

3 Results

The average body dimensions (chest girth, chest width, chest depth, and shoulder height and body length) of young bulls I0 and I1 are presented in Table 1.

Table 1 Average body dimensions of young bull in age groups I0 and I1

Traits (cm)	Age group			
	I0		I1	
	n	X	n	X
Chest circumference	155	141.05±17.35	125	181.44±17.54
Chest width		40.24±16.84		47.88±7.65
Chest depth		56.31±8.23		73.28±6.45
Shoulder height		104.93±11.84		125.36±6.52
Body length		101.22± 12.14		123.88±5.58

Notes: n =number (head); X = average; ± = standard deviation

The results showed that the average chest girth of young bull aged I0 and I1 was 141.05±17.35cm and 181.44±17.54cm, respectively. The average chest width of young bull aged I0 and I1 obtained in this study were 40.24±16.84 cm and 47.88±7.65 cm, respectively.

The results showed that the chest depth of young bull aged I0 and I1 were 56.31±8.23 cm and 73.28±6.45 cm, respectively. The average shoulder height of male buffalo aged I0 and I1 in this study were 104.93±11.84 cm and 125.36±6.52 cm, respectively.

The results also showed that the body length of young bull aged I0 and I1 obtained in this study were 101.22±12.14 cm and 123.88±5.58 cm. The results of the analysis of data on the estimated breeding value of young bull chest girth in age group I1 are presented in Table 2.

Table 2 Estimation of breeding values for young bull chest girth in age group I1

No.	Code	Chest girth (cm)	Breeding value (cm)
1.	12	234	35.74
2.	15	227	30.98
3.	11	203	14.66
4.	1	188	4.46

Table 2 above shows the ranking of buffalo livestock based on the results of calculating the breeding value of young bull chest girth of the 125 male buffaloes young bulls measured, 15% or 4 were taken as prospective of sires. The results of the calculation show that the young bull with code 12 is ranked 1st, followed in succession by the young bull with code 15; 11 and 1.

The results of the analysis of the estimation of the breeding value of the young bull's chest width in the age group I1 are presented in Table 3.

Table 3 shows the ranking of livestock based on the calculation of breeding values for chest width. Based on the table above, young bulls with code 6 rank 1st, followed by young bulls with code 9; 2; and 5. The breeding values obtained were 1.57; 1.45; 1.21; and 0.85, respectively.

Table 4, shows the results of the analysis of breeding values in the chest depth of young bull in age group I1.

Table 3 Estimation of the breeding value of young bull chest width in age group I1

No.	Code	Chest width (cm)	Breeding value (cm)
1.	6	61	1.57
2.	9	60	1.45
3.	2	58	1.21
4.	5	55	0.85

Table 4 Estimation of chest depth breeding value for male buffalo in age group I1

No.	Code	Chest depth (cm)	Breeding value (cm)
1.	12	87	10.56
2.	6	85	9.02
3.	2	83	7.48
4.	9	82	6.71

Based on Table 4, young bulls with code 12 occupy the highest rank, followed by young bulls with code 6; 2; and 9, with successive breeding values of 10.56; 9.02; 7.48 and 6.71, respectively.Table 5, shows the magnitude of the shoulder height breeding values for each individual.

Table 5 Estimation of the breeding value of young bull shoulder height in age group I1

No.	Code	Shoulder height (cm)	Breeding value (cm)
1.	9	136	5,00
2.	5	134	4,06
3.	4	133	3,59
4.	6	132	3,12

According to Table 5, young bulls with rank number 9 are ranked first, because they have the highest shoulder height breeding value, followed by young bulls with code 5; 4; and 6, with successive breeding values of 5; 4; 3.59; and 3.12, respectively. The breeding values for male buffalo are presented in Table 6.

Table 6 Estimation of the body length breeding value of young bull in age group I1

No.	Code	Body length (cm)	Breeding value (cm)
1.	9	139	1.61
2.	2	137	1.51
3.	4	136	1.46
4.	5	136	1.46

Based on Table 6, the young bull with code 9 occupies the highest rank, followed by the young bulls with code 2; 4; and 5, with consecutive breeding values: 1.61; 1.51; 1.46; and 1.46, respectively.

4 Discussion

4.1 Average body dimensions of young bull.

The average body dimensions (chest girth, shoulder height and body length) obtained in this study were higher than the standards set by[10], regarding young bull mud buffalo breeds, for the minimum quantitative requirements of body dimensions (chest girth, shoulder height) and body length) for prospective as a sires, especially for age group I1 (Table 1).

Based on [10], the minimum requirements for quantitative body dimensions (chest girth, shoulder height and body length), young bull mud buffalo breeds at the age of 30-<36 months (I1) respectively are: 180cm; 110cm; and 110cm. This proves that young bulls in Jembrana Regency, Bali Province, can be used as superior sires. This young bull, when mated with superior females through natural mating or artificial insemination is expected to improve the genetic quality of the young bull in Jembrana Regency, Bali Province. The higher the body dimensions, especially the chest girth, indicates that the livestock has good and fast growth, because the chest girth has a very close relationship with body weight. This statement is in accordance with the results obtained by [11,6]. When compared with the research by [12] who reported that the average body length of the Nili Ravi buffalo in Pakistan is: 139.56±6.29 cm. So the body length of the young bull in Jembrana Regency is still shorter. One of the reasons for this difference is the difference in breeds, in addition to the method of measuring body length.

Measurement of chest girth was carried out, because it was based on the results of a study conducted by[11] found that chest girth has a closer relationship with body weight than body length and shoulder height. This statement is supported by research by [6] who found that chest girth has a close relationship with body weight compared to body length and shoulder height. Therefore, selection to improve the genetic quality of young bull is more effective on chest girth than selection on body length and shoulder height.

The body dimensions (chest girth, shoulder height and body length) in the I-0 age group obtained in this study cannot be compared with SNI 7706.1: 2011, because the body dimensions at the I-0 age group are not listed in the minimum requirements for young bull body dimensions in SNI 7706.1: 2011. This is due to the appearance of individuals in the I-0 age group which cannot be used as a reference for selection. Parental influence is still visible in individuals in the I-0 age group. Meanwhile, at the age of I-1, large livestock, especially buffalo, are able to meet their own nutritional needs and can adapt to their own environment without any influence from their parents.

4.2 Breeding value of young bull.

The breeding value is the superior value of individual livestock, as a contributor to superior genes for future generations. The breeding value of a trait is obtained from calculating the heritability value of a trait multiplied by the difference between the individual values and the population mean value. According to[13], the high and low heritability values for all production and reproductive traits indicated that most of the observed variation in these traits was due to environmental conditions or non-additive genetic effects. Increasing these characteristics can be pursued by providing better environmental conditions, namely better feeding, better management, and so on. Most body size is affected by the herd and age factors, but the effects of parity, stage of lactation, and season of judgment, vary for different traits and show less clear trends. Most body measurements have been found to be low for heritability in this study[12].

The estimation of breeding values obtained in this study can be used as a basis for selection in choosing superior mud sire. The estimated breeding value for each livestock is calculated by calculating the population average minus the individual average multiplied by the heritability value of a trait.

The heritability value used in this study is based on the results of [11] who obtained the heritability values for body length, shoulder height, and chest girth: 0.85; 0.56; and 0.44, respectively. Next, the average chest girth, shoulder height and body length of each individual animal were calculated.

The results of the calculation of the estimated breeding values for chest girth, shoulder height and body length were then ranked and taken only 15% of the total number of animals measured. Livestock that occupy the top rank are superior livestock, so they can be used as sires to help improve the genetic quality of sire in Jembrana Regency.

Table 2 shows the estimated breeding value of chest girth owned by young bulls. Based on this table it can be seen that the young bull with code 12 occupies the highest rank after selecting the best 15% of the population. This indicates that the buffalo with code 12 is the best, so it can be used as a sire candidate. Reported by[14] that selection based on chest

girth is effective, because it has a high and positive genetic correlation with body weight, so an increase in chest girth size will also increase body weight. Chest girth is a trait that has the closest relationship with body weight compared to body length and shoulder height. Therefore, when carrying out a selection program based on body dimensions, selection based on chest girth breeding values will get more effective results compared to selection based on body length and shoulder height.

Shoulder height is a trait that can be calculated economically besides chest girth. Therefore, the selection program also takes this trait into account. Table 5 shows that the young bull with code 9 ranks highest in the calculation of the estimated breeding value at shoulder height, which is equal to 5.0. According to[15] that individuals with high breeding values will show their ability to pass on genetic potential to their offspring and the appearance potential of their parents will appear to their offspring. The higher the breeding value, the superior the characteristics possessed by the livestock and their offspring. The highest estimated breeding value for height at shoulder height indicates that the young bull will inherit the genetic potential for the trait of shoulder height being the highest among other young bulls.

Body length is a trait that has economic value, so it is taken into account in selecting buffalo livestock. It is hoped that buffaloes that have a body length above the average population will also pass this superior trait on to their offspring. Based on the results of the calculation of the estimation of body length breeding values in buffaloes in age group I1, it was found that the young bull which had the highest superiority value, which was 1.61 cm, belonged to the young bull with code 9. However, in the population where these cattle exist, the superiority displayed by the young bull is highly dependent on the superiority possessed by the dam that gave birth to it. Because one sire can mate with many cows. Especially with the IB mating method, superior sire semen in one ejaculation can marry dozens of cows. Meanwhile, cows have a limited number of offspring, because cows can only mate with one sire per cycle of heat. This is in accordance with [9] which states that if bulls whose breeding values are known are mated with cows randomly in the normal population, the average performance of the offspring will show an advantage of half of the bull's breeding value on performance.

The high value of breeding can also be affected by the high value of heritability. Heritability greatly influences the value of breeding, because heritability is a genetic parameter that is used as the basis for calculating breeding value. The heritability value used in this study is in the high category. This is in accordance with the opinion of [16] which states that the heritability value is said to be high if the value is above 0.30. A high heritability value indicates a high ability to pass on a trait from a cow to its offspring. This trait with a high heritability value can be used as a selection criterion, whereby cows that have traits above the population average, it is expected that their offspring will also have sizes above the population average. The body length heritability value is 0.85, meaning that 85% of the genetic diversity in the population is caused by genetic factors and the rest is influenced by environmental factors.

Mirza et al.[12] stated that the univariate analysis of the nature of body measurements showed that most bodies had low to moderate heritability measurements. The overall range of heritability estimates for body measurements was found to be 0.03±0.06 for neck circumference to 0.41±0.09 for tail length. Head length, tail length, tail diameter at the base and ear length, indicate a fairly high estimate of heritability. Farmer preference for relatively head-smart, slender-tailed and longer-tailed buffalo is supported through the current study, and these traits can be incorporated into selection decisions for replacement stock production.

Breeding value prediction is an integral part of most breeding programs for sire genetic improvement for different economic traits. The accuracy of estimating the breeding value of animals is a major factor affecting genetic progress due to selection. Sire evaluation based on milk, the most widely used outcome criterion. In order to make rapid genetic progress in performance through selection for traits of economic importance, buffalo herds must be selected accurately for their superior breeding values [17].

5 Conclusion

Based on the research results, it can be concluded that the performance of young bulls in Jembrana Regency, Bali Province is very good and the highest breeding values are owned by young bulls with code 12 and code 9, so that the two young bulls are the best male candidates.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest regarding the publication of this manuscript.

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