Research Article

Identifying Potential Breeding Candidates in Etawah Crossbred (EC) Goats in Jembrana, Indonesia

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Abstract | Etawah Crossbred (EC) goats represent an important local genetic resource in Indonesia. However, the EC goat population in Bali Province has declined by approximately 50% over the past five years, raising concerns regarding the sustainability of production systems and the availability of quality breeding stock. Identifying phenotypically superior animals is a critical first step in supporting practical breeding programs at the smallholder level. This study aimed to characterize body measurements of EC goats in Jembrana Regency and to identify potential breeding candidates based on phenotypic performance. Direct measurements were conducted on 209 EC goats (does and bucks) from farmer groups in Jembrana Regency, Bali, Indonesia. Recorded traits included shoulder height, body length, chest circumference, ear length, and body weight for both sexes, as well as scrotal circumference for bucks. Animals were grouped by sex and age class based on incisor eruption (I0–I3). The data was analyzed descriptively using mean values, standard deviations, and coefficients of variation. Phenotypic performance was evaluated through descriptive comparison with the minimum quantitative requirements of the Indonesian National Standard (INS 7352.1:2015). The results showed that average body measurements of both does and bucks generally exceeded the minimum INS standards across most age groups. Coefficients of variation were highest in younger age classes, particularly for body weight, indicating greater phenotypic diversity at early ages. These findings suggest that several individuals in the studied population exhibit favorable phenotypic characteristics relevant for breeding purposes. In conclusion, EC goats in Jembrana Regency demonstrate body measurement profiles that meet or exceed national breeding standards, indicating their potential as breeding candidates based on phenotypic traits. This study provides baseline information to support phenotypic-based selection under smallholder conditions, while emphasizing the need for future studies incorporating reproductive and genetic data to strengthen breeding program development.

Keywords | Phenotypic selection, Body measurements, Breeding candidates, Etawah crossbred goats, Jembrana

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INTRODUCTION

Etawah Crossbred (EC) goat is one of the local Indonesian goat strains resulting from the cross-breeding between Etawah (Jamnapari) goats from India and native Indonesian Kacang goats (Budisatria *et al*., 2018). As an initial step in genetic improvement programs, morphometric characterization of goats is crucial for identifying local breed characteristics and supporting breeding objectives (Adamu *et al*., 2020; Akounda *et al*., 2023). According to the Indonesian National Standard (INS) 7352.1:2015 concerning Etawah Grade Goats, the distinctive features of EC goats include long, drooping, and pendulous ears; long, shaggy hair on both hind legs;

and long, thick hair growing on the thigh area of the hind legs. EC goats possess several significant advantages that make them potential for development, including early sexual maturity, a relatively small body size allowing for efficient land use, more affordable capital compared to large ruminants, and ease of marketing (Untung, 2016). Furthermore, EC goats are known for their short kidding interval, prolificacy with frequent twin or even triplet births (Devendra and McLeroy, 1994; Sutama, 2011), agility, easy adaptation to local environments (Santoso, 2010), enabling them to perform well under the challenging conditions commonly encountered in traditional grazing systems (Kustanti, 2016). Based on these advantages, EC goats are strategically important for development to meet the community's demand for animal protein and improve farmers' welfare.

Data from the Bali Province Agriculture and Food Security Agency in 2022 indicate that the EC goat population in the province is 28,550 heads. The three regencies with the largest EC goat populations are Buleleng (9,541 heads or 33.42%), Karangasem (7,937 heads or 27.80%), and Jembrana (5,076 heads or 17.78%). Alarmingly, data from the last five years (2018-2022) show a significant population decline of 50%, from 57,908 heads in 2018 to 28,550 heads in 2022.

A decline in livestock population may raise concerns regarding the sustainability of production systems and the availability of quality breeding stock. In small ruminant populations, prolonged population reduction can potentially increase the risk of reduced genetic diversity and limit future breeding options (Frankham, 1995; Falconer and Mackay, 1996). However, in the present study, genetic parameters such as inbreeding coefficients or effective population size were not estimated. Therefore, interpretations related to genetic diversity are limited to observable phenotypic variation. The relatively high coefficients of variation observed in several body measurements, particularly in younger age groups, indicate the presence of phenotypic diversity that can be utilized for preliminary phenotypic-based selection under field conditions.

Selection is commonly used in livestock improvement programs to support breeding decisions based on observable performance traits. Selection programs must be conducted in a directed, continuous, and uninterrupted manner across generations. The implementation of selection can be based on the body measurements of individual animals, considering that linear body measurements such as chest girth and body length have been proven to be strong predictors of body weight in various goat breeds, including EC goats (Dakhlan *et al*., 2021; Dakhlan *et al*., 2021; Mokoena *et al*., 2022). The results are then compared against the quantitative requirements for EC goats according to Indonesian National Standard (INS) 7352.1:2015 and by defining appropriate breeding objectives based on local characteristics (Ramzan *et al*., 2020). This INS specifies quantitative trait requirements for EC goat breeding stock, including wither height, body length, chest girth, and ear length. Subsequently, animals with quantitative traits above the population average or meeting INS standards can be selected as breeding stock, which are then mated to produce improved offspring.

In smallholder production systems where pedigree and genetic records are limited, selection decisions are often based on observable phenotypic characteristics. Therefore, the use of body measurements and national breeding standards such as INS 7352.1:2015 serves as a practical approach for preliminary identification of potential breeding candidates, rather than as a basis for estimating genetic improvement.

The selection program will achieve maximum effectiveness if the selected livestock population exhibits high trait variability. In this study, trait variability is evaluated using coefficients of variation as indicators of phenotypic diversity. However, estimation of genetic parameters such as heritability and selection response requires pedigree or genomic information, which was not available in the present study. Therefore, discussion of selection effectiveness in this study is limited to phenotypic variation rather than predicted genetic gain.

This study was conducted to obtain body measurement data for does (including wither height, body length, chest girth, ear length, and body weight) and scrotal circumference measurements for male EC goats. Furthermore, this study focuses on identifying potential breeding candidates based on phenotypic body measurements relative to INS 7352.1:2015, without estimating genetic parameters or selection response.

MATERIALS AND METHODS

Study location and period

We conducted this study in Etawah Crossbred (EC) goat farming groups in Jembrana Regency, Bali Province, Indonesia. The research was carried out over three months, from June to August 2024.

Study materials and equipment

The study utilized 209 EC goats sourced from farming groups in Jembrana Regency. Equipment included a weighing scale for body weight measurement, a measuring stick and measuring tape for body dimension measurements, and notebooks and pencils for data recording.

Sampling method

The selection of the study location was performed purposively, as Jembrana Regency is one of the three regencies with the largest EC goat populations in Bali. Purposive sampling was used because EC goats in Jembrana are organized into farmer groups with unequal flock sizes, making simple random sampling impractical. To minimize selection bias and ensure representativeness, sampling followed three steps: (1) selecting farmer groups with different management intensities (well-managed and less-managed); (2) measuring all animals present in each group on the sampling day (no animals were excluded based on appearance or size); and (3) ensuring proportional representation of age classes based on incisor eruption (I0–I3). Sampling was conducted in five farmer groups representing different management and production conditions within Jembrana Regency: three farmer groups located in Mendoyo District (Amerta Pala, Anggrek Mekar, and Santi Sejahtera) and two farmer groups located in Negara District (Taman Sato and Menda Jaya Lestari). Differences in flock size, feeding system, housing, and overall management practices among the groups provided sufficient variation to capture phenotypic diversity within the local EC goat population. All animals present in these farmer groups on the measurement day were included, resulting in a total sample of 209 goats.

Measurement of variables

This research involved direct measurements of EC goat body dimensions. The independent variable in this study was the age of the animals. Dependent variables included body measurements: Shoulder height, body length, chest circumference, ear length, and body weight for both does and bucks, as well as scrotal circumference specifically for male goats. Livestock management practices, particularly feed provided, were assumed to be uniform and served as a control variable. EC goat body weight was measured using a weighing scale. Shoulder height, body length, chest circumference, ear length, and scrotal circumference were measured directly using a measuring stick and measuring tape. Animal age was determined based on the number of erupted incisors (teeth 0, 1, 2, and 3). All collected data were meticulously recorded.

Data analysis and selection

Body measurement data (shoulder height, body length, chest circumference, ear length, body weight, and scrotal circumference for males) were grouped based on tooth eruption age (teeth 0, 1, 2, and 3) and sex. Subsequently, selection was performed based on criteria for animals that exhibited measurements above the population mean and met the Indonesian National Standard (INS) 7352.1:2015 for EC goats. Data were analyzed descriptively using mean values, standard deviations, and coefficients of variation. Comparisons between observed body measurements and INS 7352.1:2015 standards were conducted descriptively, without inferential statistical testing. Accordingly, one-sample t-tests, significance testing, and assumptions of normality were not applied. Genetic parameter estimation, including heritability and selection response, was not performed due to the absence of pedigree or genomic information. The overall study design and analytical workflow are summarized in Figure 1.

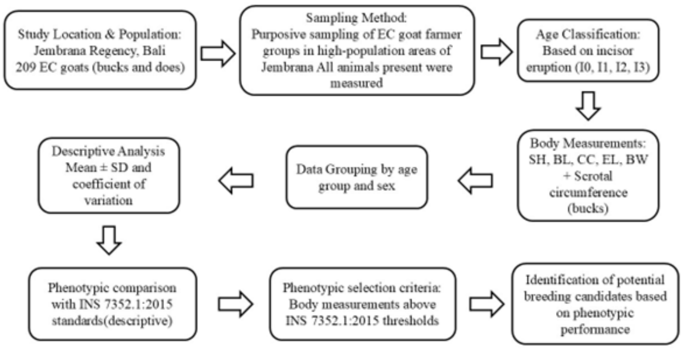

Figure 1: Workflow of phenotypic data collection and selection of Etawah Crossbred (EC) goats based on INS 7352.1:2015.

RESULTS AND DISCUSSION

Body measurements of EC does

The results of body measurements (shoulder height, body length, chest circumference, ear length, and body weight) for each age group of doe are presented in Table 1.

Based on Table 1, the average shoulder height of doe in age groups Incisor 0 (I0), Incisor 1 (I1), Incisor 2 (I2), and Incisor 3 (I3) were 54.70±10.91 cm, 74.25±4.38 cm, 73.88±5.40 cm, and 75.22±2.59 cm, respectively. Compared to the minimum quantitative requirements for doe breeding stock according to INS 7352.1:2015 (56 cm, 65 cm, and 69 cm for I1, I2, and I3, respectively), the average shoulder height of EC goats in this study exceeded the INS minimum requirements. Specifically, shoulder height in age group I1 was 32.59% higher, I2 was 13.67% higher, and I3 was 9.02% higher than the INS standard. These results indicate that shoulder height values in the studied population were generally above the national breeding standard across age groups. Sarina *et al.* (2021) reported an average shoulder height of 71.69±5.97 cm for doe aged 12-24 months.

The average body length of doe in age groups I0, I1, I2, and I3 were 52.65±11.88 cm, 76.42±7.22 cm, 75.45±7.64 cm, and 74.33±7.57 cm, respectively (Table 1). The minimum INS 7352.1:2015 requirements for body length in age groups I1, I2, and I3 were 51 cm, 62 cm, and 65

Table 1: Average body measurements (mean ± SD) of EC does by age group (units: cm for linear traits, kg for body weight).

Body measurement	Age group (teeth)			
	I0	I1	I2	I3
Shoulder Height (cm)	54.70±10.91	74.25±4.38	73.88±5.40	75.22±2.59
Body Length (cm)	52.65±11.88	76.42±7.22	75.45±7.64	74.33±7.57
Chest Circumference (cm)	57.35±13.80	79.10±6.67	77.94±6.91	81.33±6.91
Ear Length (cm)	25.95±4.06	27.50±2.92	27.80±3.78	27.00±3.35
Body Weight (kg)	20.35±11.31	39.99±10.44	41.11±10.22	42.79±11.60

Note: I0= <8 months; I1 = 8-12 months; I2 = >12-18 months; I3 = >18-24 months. INS 7352.1:2015 minimum standards are provided in the Results section for descriptive comparison.

Table 2: Average body measurements (mean ± SD) of EC bucks by age group (units: cm for linear traits and scrotal circumference, kg for body weight).

Body measurement	Age group (teeth)			
	I0	I1	I2	I3
Shoulder Height (cm)	46.20±7.30	81.00±11.58	84.81±7.87	92.00±1.15
Body Length (cm)	42.70±9.53	77.57±12.53	83.13±4.16	84.00±3.46
Chest Circumference (cm)	44.90±11.86	84.86±8.72	77.38±7.81	93.50±1.73
Ear Length (cm)	25.80±4.16	30.00±6.35	31.38±2.13	21.50±2.89
Body Weight (kg)	13.73±10.00	48.46±12.35	47.19±7.62	60.45±2.25
Scrotal Circumference (cm)	22.50±1.58	31.57±4.65	27.56±3.08	24.00±0.00

Note: I0 = <8 months; I1 = 8-12 months; I2 = >12-18 months; I3 = >18-24 months. INS 7352.1:2015 minimum standards are provided in the Results section for descriptive comparison.

cm, respectively. The observed average body length values for doe exceeded the INS minimum requirements in age groups I1, I2, and I3. Specifically, age group I1 was 49.84% higher, I2 was 21.70% higher, and I3 was 14.36% higher than the INS standards. Sarina et al. (2021) reported an average body length of 69.63±7.01 cm for doe aged 12-24 months.

The average chest circumference of doe in age groups I0, I1, I2, and I3 were 57.35±13.80 cm, 79.10±6.67 cm, 77.94±6.91 cm, and 81.33±6.91 cm, respectively (Table 1). The minimum INS 7352.1:2015 requirements for chest circumference in age groups I1, I2, and I3 were 52 cm, 66 cm, and 72 cm, respectively. Chest circumference values of doe in this study were higher than the INS minimum requirements for all evaluated age groups. Specifically, age group I1 exceeded the INS standard by 52.12%, I2 by 18.09%, and I3 by 12.96%. Sarina *et al*. (2021) reported an average chest circumference of 75.16±6.74 cm for doe aged 12-24 months.

The average ear length of doe in age groups I0, I1, I2, and I3 were 25.95±4.06 cm, 27.50±2.92 cm, 27.80±3.78 cm, and 27.00±3.35 cm, respectively (Table 1). The minimum INS 7352.1:2015 requirements for ear length in age groups I1, I2, and I3 were 22 cm, 26 cm, and 26 cm, respectively. Ear length measurements of doe in the present study exceeded the INS minimum requirements across the evaluated age groups. Specifically, age group I1 was 25% higher, I2 was 6.92% higher, and I3 was 3.85% higher than the INS standard.

The average body weight of doe in age groups I0, I1, I2, and I3 were 20.35±11.31 kg, 39.99±10.44 kg, 41.11±10.22 kg, and 42.79±11.60 kg, respectively (Table 1). The minimum INS 7352.1:2015 requirements for body weight in age groups I1, I2, and I3 were 19 kg, 26 kg, and 34 kg, respectively. The average body weight of doe in this study was higher than the INS minimum requirements in all evaluated age groups. Specifically, age group I1 exceeded the INS standard by 110.47%, I2 by 58.11%, and I3 by 25.86%.

Body measurements of EC bucks

Body measurements (shoulder height, body length, chest circumference, ear length, body weight, and scrotal circumference) for each age group of EC bucks are presented in Table 2.

Based on Table 2, the average shoulder height of EC bucks in age groups I0, I1, I2, and I3 were 46.20±7.93 cm, 81.00±11.58 cm, 84.81±7.87 cm, and 92.00±1.15 cm, respectively. Compared to the minimum quantitative requirements EC bucks breeding stock according to INS 7352.1:2015 (60 cm, 73 cm, and 78 cm for I1, I2, and I3, respectively), the average shoulder height values exceeded the INS minimum requirements in age groups I1–I3. Specifically, shoulder height in age group I1 was 33.57% higher, I2 was 16.18% higher, and I3 was 17.95% higher than the INS standard.

The average body length of EC bucks in age groups I0, I1, I2, and I3 were 42.70±9.53 cm, 77.57±12.53 cm, 83.13±4.16 cm, and 84.00±3.46 cm, respectively (Table 2). The minimum INS 7352.1:2015 requirements for body length in age groups I1, I2, and I3 were 54 cm, 66 cm, and 74 cm, respectively. Observed body length values of EC bucks exceeded the INS minimum requirements in age groups I1–I3.

The average chest circumference of EC bucks in age groups I0, I1, I2, and I3 were 44.90±11.86 cm, 84.86±8.72 cm, 77.38±7.81 cm, and 93.50±1.73 cm, respectively (Table 2). The minimum INS 7352.1:2015 requirements for chest circumference in age groups I1, I2, and I3 were 60 cm, 71 cm, and 78 cm, respectively. Chest circumference values of EC bucks in this study exceeded the INS minimum requirements across evaluated age groups.

The average ear length of EC bucks in age groups I0, I1, I2, and I3 were 25.80±4.16 cm, 30.00±6.35 cm, 31.38±2.13 cm, and 21.50±2.89 cm, respectively (Table 2). Compared to the INS 7352.1:2015 standards, ear length measurements in age groups I1 and I2 exceeded the minimum requirements, whereas ear length in the I3 age group was lower than the INS standard. This deviation does not indicate a biological reduction in ear size but may reflect the small sample size in the I3 buck group (n= 4), differences in parental genetic background, and variability in management practices among farmer groups. Ear length is a breed-specific morphological trait that does not increase linearly with age and can show considerable individual variation, making deviations across age classes biologically plausible (Sulastri *et al*., 2012; Nafiu *et al*., 2020).

The average body weight of EC bucks in age groups I0, I1, I2, and I3 were 13.73±10.00 kg, 48.46±12.35 kg, 47.19±7.62 kg, and 60.45±2.25 kg, respectively (Table 2). The minimum INS 7352.1:2015 requirements for body weight in age groups I1, I2, and I3 were 20 kg, 34 kg, and 42 kg, respectively. The average body weight of EC bucks exceeded the INS minimum requirements in all evaluated age groups.

Coefficient of variation of doe body measurements

Table 3 shows the coefficient of variation (CV) for body measurements (shoulder height, body length, chest circumference, ear length, and body weight) in each age group of EC does.

Table 3: Coefficient of variation (%) of EC does body measurements by age group (teeth).

Trait	I0	I1	I2	I3
n	20	48	95	9
Shoulder Height (%)	19.94	5.90	7.31	3.44
Body Length (%)	22.56	9.45	10.13	10.18
Chest Circumference (%)	24.06	8.43	8.87	8.50
Ear Length (%)	15.64	10.63	13.60	12.42
Body Weight (%)	55.58	26.11	24.85	27.11

Note: n = number of animals; I0 = <8 months; I1 = 8-12 months; I2 = >12-18 months; I3 = >18-24 months.

The coefficient of variation for shoulder height in doe in age groups I0, I1, I2, and I3 were 19.94%, 5.90%, 7.31%, and 3.44%, respectively. For body length, the CVs were 22.56% (I0), 9.45% (I1), 10.13% (I2), and 10.18% (I3). Chest circumference had CVs of 24.06% (I0), 8.43% (I1), 8.87% (I2), and 8.50% (I3). Ear length showed CVs of 15.64% (I0), 10.63% (I1), 13.60% (I2), and 12.42% (I3). Meanwhile, the CV for body weight in doe in age groups I0, I1, I2, and I3 were 55.58%, 26.11%, 24.85%, and 27.11%, respectively.

These results indicate greater phenotypic variation in body measurements among younger does (I0), particularly for body weight, compared to older age groups. The higher CV values observed in early age classes reflect wider observable differences in growth-related traits at younger ages. These results differ from Sarina *et al*. (2021), who reported higher CV values for shoulder height (71%), body length (78%), and chest circumference (79%), likely due to differences in population and study location.

Coefficient of variation of buck body measurements

Table 4 shows the coefficient of variation (CV) for body measurements (shoulder height, body length, chest circumference, ear length, body weight, and scrotal circumference) in each age group of bucks.

The coefficient of variation for shoulder height in buck in age groups I0, I1, I2, and I3 were 17.16%, 14.29%, 9.28%, and 1.26%, respectively. For body length, the CVs were 22.33% (I0), 16.15% (I1), 5.01% (I2), and 4.12% (I3). Chest circumference had CVs of 26.40% (I0), 12.33% (I1), 10.10% (I2), and 1.85% (I3). Ear length showed CVs of 16.12% (I0), 21.17% (I1), 6.77% (I2), and 13.43% (I3). Body weight had CVs of 72.80% (I0), 25.48% (I1), 16.14% (I2), and 3.72% (I3). The coefficient of variation for scrotal circumference in buck in age groups I0, I1, I2, and I3 were 7.03%, 14.73%, 11.16%, and 0.00%, respectively.

The CV values indicate higher phenotypic variation in several body measurements of bucks at younger ages (I0 and I1), particularly for body weight. In contrast, lower CV values in older age groups suggest more uniform body dimensions as animals approach maturity.

Table 4: Coefficient of variation (%) of EC bucks body measurements by age gr0up (teeth).

Trait	I0	I1	I2	I3
n	10	7	16	4
Shoulder Height (%)	17.16	14.29	9.28	1.26
Body Length (%)	22.33	16.15	5.01	4.12
Chest Circumference (%)	26.40	12.33	10.10	1.85
Ear Length (%)	16.12	21.17	6.77	13.43
Body Weight (%)	72.80	25.48	16.14	3.72
Scrotal Circumference (%)	7.03	14.73	11.16	0.00

Note: n = number of animals; I0 = <8 months; I1 = 8-12 months; I2 = >12-18 months; I3 = >18-24 months.

The zero CV value for scrotal circumference in the I3 buck group is likely attributable to the very small sample size (n= 4), which limits observable variation and should be interpreted cautiously.

DISCUSSION

Livestock body size is a quantitative value that reflects growth from birth to maturity, thus it is closely related to age. Differences in body size among individual goats can occur due to genetic and environmental factors, including feed and management systems (Nafiu *et al*., 2020).

Shoulder height is closely related to the development of the forelegs, where the bones forming the forelegs grow earlier to support the body. Body length is influenced by the continuous growth of the vertebral column, which includes the thoracic, lumbar, and sacral vertebrae (Setiono *et al*., 2020).

Chest girth has the highest correlation with body weight, making it an effective trait for selection in estimating livestock body weight (Warmadewi *et al*., 2017). Other studies also confirm that linear body measurements such as chest girth and body length are strong predictors for body weight in various goat breeds, demonstrating their relevance in breeding programs (Dakhlan et al., 2020, 2021; Mokoena *et al*., 2022). The larger the chest girth, the higher the body weight. Body weight itself is influenced by breed, age, sex, environment, management system, and feed quality. Chest girth reflects the growth of the ribs and surrounding muscle tissue (Setiawati *et al*., 2013). Larger rib length correlates with more muscle, thereby increasing chest girth. Victori *et al*. (2016) also stated that chest girth significantly influences livestock body weight, where its development is affected by the muscles in the chest area, and an increase in chest girth will increase body weight. Soenarjo (1988) suggested that wide ribs provide ample space for twin or multiple fetuses. Hamdani (2015) added that goat productivity is determined by the birth of their offspring; twin births can increase the dam's productivity index. Etawah Grade (EC) goats are known to be prolific, with the ability to give birth to 2-3 kids per kidding (Santoso, 2010). Ear length is also a selection trait because it is a characteristic of the goat breed, and its size can be influenced by parental genetics (Sulastri *et al*., 2012; Nafiu *et al*., 2020).

Based on the results of this study, it can be concluded that EC goats in Jembrana Regency show favorable growth traits for consideration as breeding candidates because their average body measurements exceed the minimum quantitative requirements for EC bucks and does breeding stock according to INS 7352.1:2015. However, this conclusion is based on phenotypic performance only and does not involve estimation of genetic parameters or predicted genetic gain.

According to Hanafiah (1991), a population is considered diverse if its coefficient of variation (CV) is greater than 15%, and uniform if the CV is less than 15%. Selection will be more effective in diverse populations. Based on Table 3, the body measurements of does in age group I0 (shoulder height, body length, chest girth, ear length, and body weight) show a CV >15%, indicating a highly diverse population at a young age. This variation may reflect differences in growth expression influenced by maternal factors (prenatal maternal environment) and post-birth environmental factors (milk production and dam's nursing behavior) rather than genetic differences alone (Zulchaidi *et al*., 2021). Adequate nutrition from the dam significantly affects offspring growth, which is then reflected in the animal's body size.

Table 3 also shows that body weight has the highest coefficient of variation among all body measurements in all age groups of does, indicating significant variation in this trait. This suggests that body weight is a useful phenotypic indicator for preliminary screening of potential breeding candidates under field conditions (Nafiu *et al*., 2020).

Similarly, from Table 4, shoulder height, body length, chest girth, ear length, and body weight of buck in age groups I0 and I1 also show a CV >15%, indicating high population diversity at these ages. This supports the selection of male breeding stock at ages I0 and I1, although it should be considered that at I0, performance is still highly dependent on the dam. Conversely, the coefficient of variation for scrotal circumference in buck across all age groups (<15%) shows a uniform trait. This means there is no significant difference in scrotal circumference variation among age groups. Body weight also shows the highest variation in buck in all age groups, indicating that body weight is a practical phenotypic trait for preliminary screening of male breeding candidates.

Although body measurements generally increase with age, non-linear growth patterns may occur in bucks and have been reported in several goat studies. Such patterns can be influenced by environmental and management differences among farmer groups, which may result in intermediate age classes showing lower mean values than younger or older groups (Makgopa *et al.*, 2023; Wiradarya *et al.*, 2020). In addition, unbalanced sample sizes across age groups can affect mean estimates, particularly when the number of animals is limited (Mavule *et al.*, 2013). Therefore, the observed variations in body measurements among buck age groups reflect natural phenotypic variation rather than biologically implausible growth patterns. A major limitation of this study is the small sample size in the I3 buck age group (n= 4), which may restrict the reliability of variability estimates for certain traits and should be interpreted with caution.

CONCLUSION

This study demonstrated that EC goats in Jembrana Regency exhibit body measurements that exceed the minimum quantitative requirements of INS 7352.1:2015. These results indicate that many individuals possess favorable growth-related characteristics and therefore show potential to be considered as candidates for breeding selection. However, because this study evaluated only morphological and growth traits, the classification of animals as breeding candidates is based on phenotypic performance and must be interpreted cautiously. Other important criteria such as reproductive performance, kid survival, disease resistance, and adaptation to local management systems were not measured and should be included in future evaluations.

Overall, the findings support the use of phenotypic-based screening to assist practical breeding decision-making under smallholder conditions. Future breeding efforts should adopt a more comprehensive evaluation approach by incorporating additional performance and reproductive traits, as well as resilience to local environmental stressors such as feed availability fluctuations, climatic variability, and management-related challenges, to support sustainable breeding program development in the EC goat population.

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NOVELTY STATEMENT

This study provides novel empirical evidence through comprehensive phenotypic characterization of Etawah Crossbred (EC) goats managed under smallholder farming systems in Jembrana Regency, Indonesia. Unlike previous studies that primarily describe breed characteristics, this research systematically evaluates body measurements across age and sex groups and applies national breeding standards (INS 7352.1:2015) as practical reference criteria for identifying potential breeding candidates. The novelty of this study lies in its field-based, phenotypic approach to supporting breeding decision-making in data-limited production systems, where pedigree and genetic information are not readily available. By highlighting patterns of phenotypic variation across age classes, particularly at younger ages, this study offers a practical foundation for preliminary screening of breeding candidates while explicitly acknowledging the limitations of phenotypic selection without genetic evaluation.

AUTHOR'S CONTRIBUTION

DAW, INA, NPYM, IGNGB, and INAA, conceptualized the study, developed the methodology, provided resources, and supervised the study. DAW, INA, and NPYM, conducted the investigation and data collection. DAW and IGNGB performed the data analysis. DAW, NPYM, and INA wrote the original manuscript. IGNGB, INAA, and ILM revised the manuscript. All authors agreed to the final version of the manuscript.

Generative AI and AI-assisted technology statement

The authors declare that no Gen AI/DeepSeek was used in the writing/creation of this manuscript.

Conflict of interest

The authors have declared no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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