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SUSTAINABILITY STRATEGY AND DEVELOPMENT OF VILLAGE BREEDING CENTER: EVALUATION OF MORPHOMETRIC CHARACTERISTICS OF FEMALE PERANAKAN ONGOLE CATTLE IN NAPIS VILLAGE

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ABSTRACT

This study evaluates the morphometric characteristics of female Peranakan Ongole (PO) cattle in Napis Village, Bojonegoro Regency, East Java, as part of a strategy for developing sustainable village breeding centers. The selection of the research location was conducted through purposive sampling, and the material in this study consists of female Peranakan Ongole cattle with age criteria (PI) based on the SNI for Peranakan Ongole cattle, namely PI_0 (aged <1 year), PI_2 (1 – 1.5 years), PI_4 (1.5 - 2 years), PI_6 (2 – 3 years), PI_8 (aged > 3.5 years). Measurements include body height, body length, hip height, chest depth, chest circumference, ossa cervical vertebrae, ossa thoracic vertebrae, ossa vertebrae lumbar, ossa scapula, hip width, head length, head width and body weight, as well as morphometric indices such as head index, height slope, body index, index of compression, conformation index, length index, body ratio, proportionality and thoracic development on 206 female cattle grouped by age (PI_0-PI_8). Data were analyzed using multivariate analysis of variance (MANOVA) and post hoc tests, as well as key indices to identify growth patterns and body size stability. The research results show a significant increase in body size in the young-to-adult age group, where adult cows reach size stability. The morphometric index reveals consistent proportional development in the body of cattle as they age, reflecting structural maturity. Evaluation based on the Indonesian National Standard (SNI) shows that most cattle are in Class II and III, indicating excellent body quality in the productive age group. This research emphasizes that morphometric characteristics are important indicators in determining optimal management strategies to support the sustainability of local PO cattle development. These findings provide a foundation for the maintenance and development programs of the PO cattle population by prioritizing quality livestock management, supporting the conservation of local genetic resources, and enhancing cattle productivity in Indonesia.

Keywords: *Peranakan Ongole; morphometric; cattle; local breed*

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INTRODUCTION

Indonesia has a wealth of native livestock genetic resources, including the Peranakan Ongole (PO) cattle. Indigenous genetic resources like Bali cattle, Madura cattle, Brahman cattle, Sumba Ongole cattle, Pesisir cattle, Aceh cattle, and Galekan cattle exhibit remarkable adaptability to tropical climates and demonstrate resilience in conditions with subpar feed quality (Susilawati, 2017). A significant challenge in safeguarding this local cattle breed is the rising trend of crossbreeding with exotic cattle (Bos taurus), which poses a potential risk to the local livestock population. PO cattle, resulting from the crossbreeding of Javanese cattle and Ongole cattle from India, have been cultivated in Indonesia since 1930.

They are legally recognized under the Minister of Agriculture's Decree Number 2841/Kpts/LB.430/8/2012, which designates Ongole Crossbred cattle as a local genetic resource that requires preservation. Phenotypic characterization serves to identify and document the diversity among various breeds of cattle, focusing on traits that are directly observable in their phenotypes (FAO, 2012). In this context, a significant parameter that can be utilized to assess the characteristics of cattle breeds is morphometric observation. This observation encompasses a range of physical measurements that yield quantitative insights into cattle, highlighting phylogenetic relationships and distinctions among cattle groups via discriminant analysis and principal component analysis (Utomo et al., 2010).

The report by Jourshari et al., (2022) outlines the morphometric characteristics of cattle, detailing various body parameters including horn length and diameter, head length and width, height at withers, chest girth, body length, hip height, body weight, and additional dimensions that serve to estimate growth patterns relative to the age of the cattle. The Ongole Crossbred Cattle exhibit distinct physical characteristics, including a body color that varies from white to gray, a prominent hump in males, and elongated wattles. Furthermore, PO cattle exhibit remarkable resilience to subpar feed and demonstrate a strong capacity to adapt to tropical environmental conditions.

Genetic research suggests that Ongole cattle in Indonesia have probably experienced crossbreeding with indigenous cattle like Banteng, leading to distinct traits that set them apart from the original Ongole breed (Mohamad et al., 2009). Consequently, information regarding phenotypic and genotypic traits, along with population structure, is crucial for evaluating, monitoring, and advancing local cattle. Napis village, situated in the Tambakrejo District of Bojonegoro Regency in East Java, represents a region with significant potential for advancing the development of PO cattle breeding resources. Susilawati et al. (2019) indicate that Napis Village is characterized by nearly every household raising 1-3 cattle, particularly female cattle, with the surrounding forests providing a resource for fodder land. Nonetheless, the advancement of PO cattle breeding resources in this village remains suboptimal. According to information from the Bojonegoro District Livestock Service in 2022, the cattle population in Bojonegoro District was recorded at 258,563 head, with 25,125 head situated in Tambakrejo District, encompassing

Napis Village as part of its development area. A thorough assessment of the morphometric traits of female PO cattle in Napis Village is essential for the sustainability and advancement of PO cattle in this area. This assessment is crucial for evaluating the productivity potential of female cattle as a breeding resource and for identifying suitable management strategies influenced by both internal and external factors impacting the area's development. By employing a SWOT analysis, the strategy for developing the PO cattle breeding source area can be enhanced to better support the preservation of local

genetic diversity and to elevate both the quality and quantity of the PO cattle population in Indonesia (Ali et al., 2023). This assessment aims to generate approaches that can enhance the sustainability of PO cattle development in Napis Village, considering all local ecological, social, and economic factors, while also safeguarding the biodiversity of local Indonesian cattle. Utilizing precise morphometric data, the opportunity to enhance the breeding source area for PO cattle can be further refined, thereby bolstering national initiatives aimed at the conservation and advancement of indigenous livestock.

MATERIALS AND METHODS

This research was conducted in Napis Village, Tambakrejo District, Bojonegoro Regency, East Java Province, and the Technical Service Unit for Livestock Breeding from January to May 2023. The selection of the research location was conducted through purposive sampling, and the material in this study consists of female Peranakan Ongole cattle with age criteria (PI) based on the SNI for Peranakan Ongole cattle, namely PI_0 (aged <1 year), PI_2 (1 – 1.5 years), PI_4 (1.5 - 2 years), PI_6 (2 – 3 years), PI_8 (aged > 3.5 years).

The total number of cattle used was 206 head. The initial stage of the research includes interviews with parties involved in the development of the Ongole Crossbred Cattle breeding area, including farmers and livestock groups. Napis Village, located in the Tambakrejo District of the Bojonegoro Regency, is the location where this research is conducted using a case study technique, which involves observation and direct measurement. Following the SNI 2015 requirements for PO cattle, the location of the research samples and the research samples themselves were established via the use of purposive sampling, with consideration given to the characteristics of the cattle.

Table 1. Classification of Female PO Cattle by Age

Location	Number of Cattle	Age of Peranakan Ongole Cattle				
		PI_0	PI_2	PI_4	PI_6	PI_8
	206					
Napis Village		28	30	38	49	61

Information: PI_0 (aged <1 year), PI_2 (1 – 1.5 years), PI_4 (1.5 - 2 years), PI_6 (2 – 3 years), PI_8 (aged > 3.5 years)

The instruments used in this research included a Canon 100D camera with an 18-megapixel CMOS sensor, an SD card, a measuring stick with a precision of 0.01 centimeter, a cattle scale with a capacity of 1500 kilograms, a measuring tape with a precision of 0.01 centimeter, a caliper with a precision of 1 centimeter, a laptop, and apps for data analysis like Excel and R version 4.4. Sudarwati, et al. (2018) provide a descriptive interpretation of body size by using the mean and standard deviation data. The researchers use a one-way multivariate analysis of variance (MANOVA) statistical test to investigate the differences in mean values of the cattle group variables that depend on the ages of the cattle. In the event that the findings of the MANOVA are found to be statistically significant, post hoc testing and clustering of the cattle population using principal component analysis (PCA) are carried out (Gazpers, 1995).

Table 2. Morphometric Characteristics of Female Peranakan Ongole Cattle

No.	Morphometric	Symbol	Information
1.	Body Height	BH	The measurement was taken precisely from the dorsal point behind the OS scapula to the floor surface.
2.	Body Length	BL	The assessment ranges from the tuber humerus to the tuber ischium
3.	Hip Height	HH	The assessment proceeds directly from the Os coxae (tuber coxae) to the ground level
4.	Chest Depth	CD	Measured precisely from the dorsal point to the ventral point behind the OS scapula
5.	Chest Circumference	CC	The measurement was taken around the chest using a tape measure positioned behind the front legs.
6.	Ossa Cervical Vertebrae	OVC	The assessment is conducted from the axio-dorsal boundary, or directly anterior to the prominence, down to the base of the head.
7.	Ossa Thoracic Vertebrae	OVT	The assessment was conducted from the lower neck region to the back section of the 13th rib
8.	Ossa Lumbar Vertebrae	OVL	The assessment extends from the dorsal structure's center to the sacral bone's initial spinous projection
9.	Ossa Scapula	OSC	Assessed from the apex of the organism (for humpbacked cattle, evaluated from the base of the hump) to the tuber humerus.
10.	Hip Width	HWi	measured from the left Tuber ischium to the right Tuber ischium
11.	Head Length	HL	The assessment was conducted from the right temporal to the left temporal
12.	Head Width	HW	Calculated from the foundation of the snout to the central point between the right and left antlers
13.	Body Weight	BW	The assessment was conducted using a bovine weighing apparatus with a peak limit of 1,500 kg

Sources: Food and Agriculture Organization (2012), Kuswati et al., (2022) dan Islam et al., (2022)

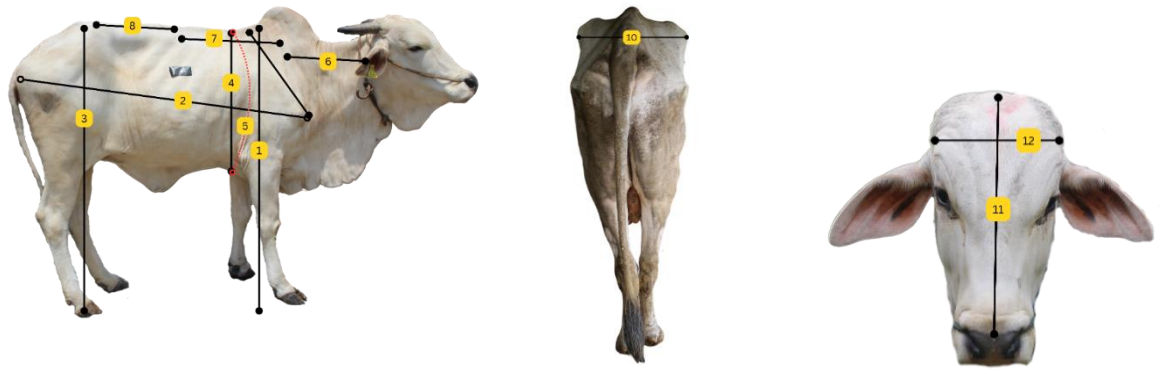

Figure 1. Morphometric Measurements of Female PO Cattle

Table 3. Morphometric Index Formula

Morphometric Index	Symbol	Formula
Head Index	IK	Head Width / Head Length
Height slope	HS	Body Height – Hip Height
Body Index	BI	(Body Length / Chest Circumference) x 100
Index of compression	IC	(Chest Circumference / Body Length) x 100
Conformation Index	CI	Chest Circumference^2 / Body Height
Length Index	LI	Body Length / Body Height
Body Ratio	BR	Body Height / Hip Height
Proportionality	Pr	Body Height / Body Length
Thoracic Development	TD	Chest Circumference / Body Height

Sources: Alderson, (1999); Salako, (2006); Parés-Casanova et al., (2013); Marković et al., (2019); Baye et al., (2022); Warman et al., (2023);

RESULTS AND DISCUSSION

Morphometric Characteristics of Female Peranakan Ongole Cattle

In livestock farming, morphometric analysis is a quantitative statistical method that examines body dimensions, including growth patterns, anatomy, performance, and production. Morphometry quantitatively examines variations and changes in the shape and size of organisms, encompassing length measurements and skeletal analysis. Size serves as a significant indicator of growth, enabling the assessment of growth via body morphometry. Zelditch et al. (2004). Research employing a morphometric approach encompasses the assessment of Sahiwal cattle characteristics through measurements of chest circumference, body length, horn circumference, horn length, and tail length (Kaushik et al., 2020). Researchers have looked at Baoulé and Zebu cattle crossbreeding as a way to protect them (Yougbaré et al., 2020); used principal component analysis to find specific traits in different breeds of cattle (kuswati et al., 2022); used discriminant analysis to see how similar different breeds are to each other (Nasution et al., 2022; Putra, Hilmawan, et al., 2020); found morphometric indices in cattle (Lomillos and Alonso, 2020); looked at body conformation in relation to age, weight, and growth (Vaz et al., 2016); and looked at the effects of heterosis on the growth of crossbred cattle at 365 days of age (Fernandes et al., 2022).

Table 4. Size of Female PO Cattle

	BW	BH	BL	CC	CD	HH	Hwi	OVC	OVT	OVL	OSC	HL	HW
BW	1.00	-	-	-	-	-	-	-	-	-	-	-	-
BH	0.72	1.00	-	-	-	-	-	-	-	-	-	-	-
BL	0.82	0.90	1.00	-	-	-	-	-	-	-	-	-	-
CC	0.84	0.80	0.78	1.00	-	-	-	-	-	-	-	-	-
CD	0.78	0.84	0.84	0.85	1.00	-	-	-	-	-	-	-	-
HH	0.69	0.97	0.87	0.78	0.81	1.00	-	-	-	-	-	-	-
Hwi	0.82	0.76	0.80	0.83	0.80	0.72	1.00	-	-	-	-	-	-
OVC	0.55	0.60	0.61	0.60	0.60	0.61	0.56	1.00	-	-	-	-	-
OVT	0.67	0.75	0.76	0.70	0.70	0.75	0.71	0.70	1.00	-	-	-	-
OVL	0.59	0.68	0.65	0.65	0.70	0.65	0.61	0.52	0.52	1.00	-	-	-
OSC	0.82	0.77	0.76	0.78	0.74	0.74	0.77	0.60	0.70	0.59	1.00	-	-
HL	0.67	0.79	0.75	0.79	0.77	0.75	0.73	0.61	0.65	0.69	0.74	1.00	-
HW	0.43	0.52	0.50	0.49	0.47	0.51	0.45	0.43	0.45	0.43	0.42	0.48	1.00

The correlation matrix analysis concludes a strong relationship between the body weight of cattle and its body height, body length, and chest circumference. These three variables show a significant positive correlation with body weight, indicating that cattle with greater body height, body length, and chest circumference tend to have higher body weight. Additionally, hip height, chest depth, and hip width also have a positive correlation with body weight, although their values are slightly lower compared to the main variables such as body length and chest circumference. Despite their smaller influence, these variables still contribute to a comprehensive understanding of the cattle's body size, which in turn influences its weight. On the other hand, bone size represented by the Ossa vertebrae cervicales, Ossa vertebrae thoracicae, Ossa vertebrae lumbales, and Ossa scapula, although related to the size of the cow's body, shows a weaker correlation with the cattle weight. This indicates that, although bone size contributes to the structure of cattle, factors such as body length, height, and chest circumference have a greater influence on determining overall body size.

Table 5. Size of Female PO Cattle

Variable	PI_0 Mean±SD	PI_2 Mean±SD	PI_4 Mean±SD	PI_6 Mean±SD	PI_8 Mean±SD
Population (n)	28	30	38	49	61
Body Weight (Kg)	147.04 ± 27.49 [a]	202.38 ± 24.50 [b]	253.42 ± 28.93 [c]	284.99 ± 37.21 [d]	318.01 ± 41.01 [e]
Body Height	108.66 ± 5.77 [a]	115.27 ± 5.92 [b]	120.58 ± 5.08 [c]	124.58 ± 6.57 [d]	127.27 ± 6.61 [d]
Body Length	104.68 ± 7.26 [a]	113.27 ± 7.74 [b]	122.76 ± 6.82 [c]	127.69 ± 8.36 [c]	133.90 ± 8.86 [d]
Hip Height	126.61 ± 8.41 [a]	142.60 ± 6.58 [b]	153.03 ± 7.73 [c]	159.27 ± 8.50 [d]	162.66 ± 7.57 [d]
Chest Depth	49.57 ± 4.53 [a]	54.97 ± 4.53 [b]	59.79 ± 4.01 [c]	61.98 ± 3.63 [cd]	64.30 ± 4.75 [d]
Chest Circumference	114.86 ± 6.50 [a]	121.43 ± 6.66 [b]	126.03 ± 5.58 [c]	130.29 ± 7.57 [d]	131.80 ± 6.76 [d]
Ossa Cervical Vertebrae	29.18 ± 2.74 [a]	34.50 ± 3.55 [b]	37.61 ± 2.88 [c]	40.06 ± 3.22 [d]	42.36 ± 3.35 [e]
Ossa Thoracic Vertebrae	37.25 ± 5.39 [a]	39.37 ± 4.21 [ab]	41.61 ± 4.06 [bc]	43.20 ± 4.13 [c]	44.54 ± 6.26 [c]
Ossa Lumbar Vertebrae	38.43 ± 3.56 [a]	42.67 ± 4.33 [b]	46.03 ± 4.55 [c]	47.37 ± 3.86 [c]	48.70 ± 5.12 [c]
Ossa Scapula	28.29 ± 4.20 [a]	29.80 ± 3.47 [ab]	32.00 ± 3.22 [bc]	33.43 ± 2.79 [cd]	34.33 ± 3.86 [d]
Hip Width	35.04 ± 3.51 [a]	39.43 ± 2.73 [b]	42.16 ± 2.83 [c]	43.14 ± 3.71 [cd]	44.85 ± 3.20 [d]
Head Length	37.79 ± 3.02 [a]	41.13 ± 3.08 [b]	43.76 ± 2.50 [c]	44.96 ± 2.71 [cd]	45.90 ± 2.63 [d]
Head Width	17.57 ± 1.50 [a]	18.40 ± 1.07 [a]	19.47 ± 1.37 [b]	20.16 ± 4.39 [b]	20.64 ± 1.60 [c]

[a,b,c,d,e] Different superscripts on the same line indicate significant differences in the age groups of the cattle. ($p < 0.05$); PI = Permanent Incisivi; SD = Standard Deviation

Table 5. presents the mean and standard deviation (SD) of several body size variables for the female PO cattle population in the Napis village area, categorized by age groups: PI_0, PI_2, PI_4, PI_6, and PI_8. The average body weight shows an increase from PI0 (147.04 ± 27.49 kg) to PI8 (318.01 ± 41.01 kg).

There are significant differences ($P<0.05$) in body weight between each age group, indicating that the increase in body weight is in line with the aging of the cattle. This reflects the natural growth process where the weight of the cattle increases over time. Several factors influence differences in body size, including genetics (Anderton et al., 2018; Mohamad et al., 2012), intensive rearing systems (Prasetia et al., 2021), feed management (De Oliveira et al., 2016; Singh et al., 2020), and the environment (Magrin et al., 2019; Widyas et al., 2022).

Body height, body length, and chest circumference of cattle showed significant increases with age. Body height increased from 108.66 ± 5.77 cm at PI_0 age to 127.27 ± 6.61 cm at PI_8 age. The height of PO cattle that have reached adult (PI_6 and PI_8) showed no significant difference ($P<0.05$). Body length also showed a significant increase ($P<0.05$) from 104.68 ± 7.26 cm at age PI0 to 133.90 ± 8.86 cm at age PI_8, indicating a real difference and an increase in body length. The results showed that the chest circumference increased from 126.61 ± 8.41 cm at PI0 to 162.66 ± 7.57 cm at PI_8, but at the age of PI_6 and PI_8 there was no significant difference ($P < 0.05$) indicating that the growth of the chest circumference of female PO cattle has experienced a slowdown in growth.

This increase in chest circumference reflects an increase in the body's capacity to accommodate larger vital organs with age. Misrianti et al., (2018 & 2021) that chest circumference, chest depth and body height can be used as frame characteristics in cattle breeds. The Ossa Vertebrae cervicales, Ossa Vertebrae thoracicae, Ossa Vertebrae lumbales, and Ossa Scapula of cattle showed a significant increase in size with age, as indicated by superscript differences in each age group ($P<0.05$).

Ossa Vertebrae cervicales increased from 37.25 ± 5.39 cm at PI_0 to reach 44.54 ± 6.26 cm at PI_8. Different superscripts in each age group indicated a significant difference between the young age group and the early adult phase, but there was no significant

difference between the cattle at PI_6 and PI_8, indicating stabilization of size in adults. Ossa Vertebrae thoracicae size increased from 38.43 ± 3.56 cm at PI_0 to 48.70 ± 5.12 cm at PI_8. Significant differences ($P<0.05$) in the age groups PI_0 to PI_4 show that bones are growing in the early stages of life. However, there were no significant differences in the sizes of the OS Vertebrae thoracicae in cattle aged PI_4, PI_6, and PI_8. This means that growth has slowed down and is now stable in adults.

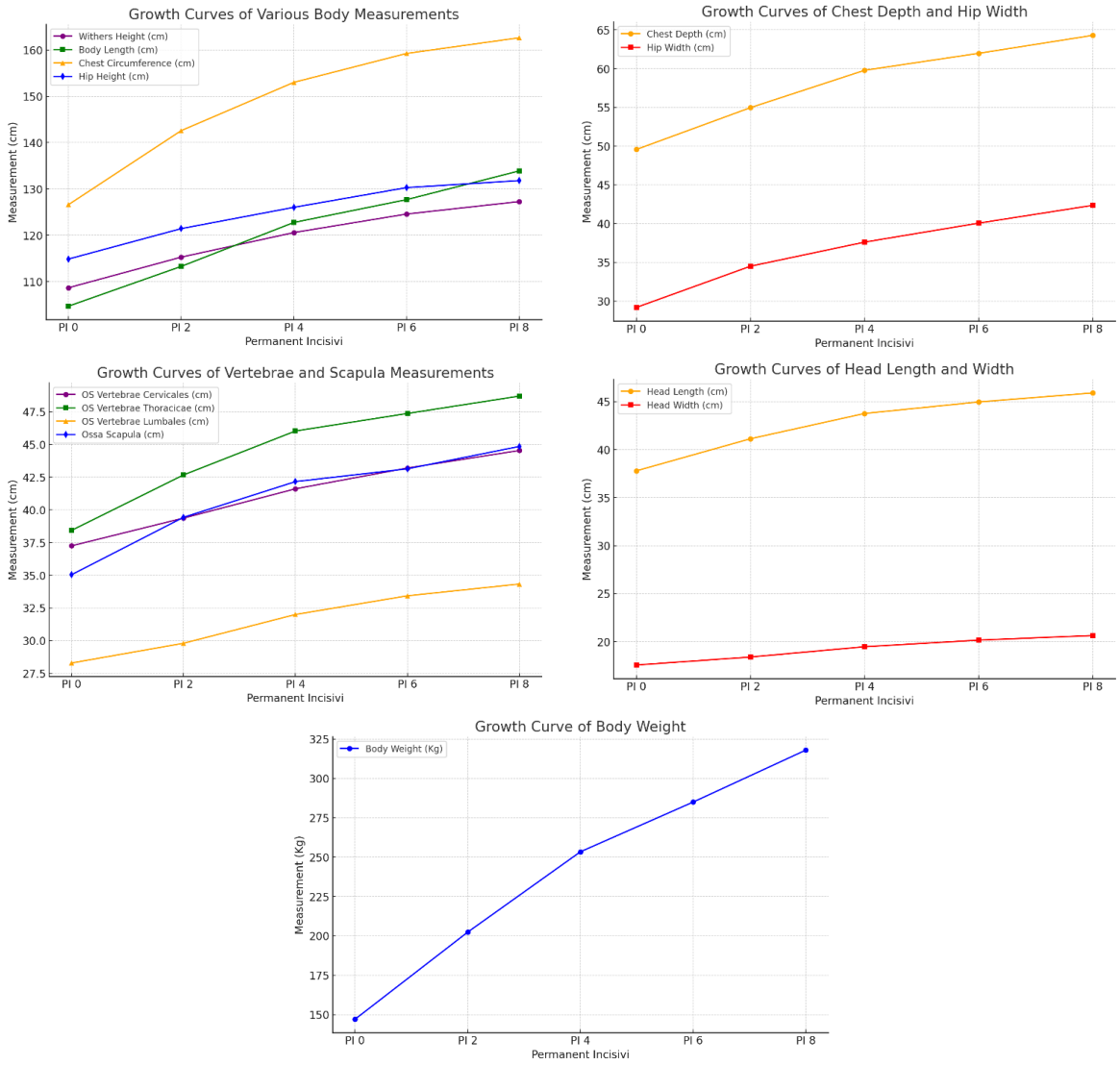

Figure 2. Graph of Body Size Growth of Female PO Cattle

Research results ($P<0.05$) on ossa Vertebrae lumbales show an increase from 28.29 ± 4.20 cm at PI_0 to 34.33 ± 3.86 cm at PI_8. PO cattle in the age group PI_0 showed significant differences compared to the age groups PI_4, PI_6, and PI_8, while cattle in the age group PI_2 showed significant differences compared to the age groups PI_6 and PI_8. Young female PO cattle did not show differences, indicating significant development of the lumbar vertebrae until the cattle reach adult, where the size begins to stabilize at ages PI_6 and PI_8. Ossa Scapula showed an increase from 35.04 ± 3.51 cm at PI_0 to 44.85 ± 3.20 cm at PI_8. In the age groups PI_0 to PI_4, there were moderately significant differences, while PI_4, PI_6, and PI_8 did not show significant size differences ($P<0.05$), indicating that scapula growth stabilizes in adults. Overall, the increase in

size of the cervical, thoracic, lumbar vertebrae, and scapula bones shows significant differences between age groups until the cattle reach adult. Different superscripts on the same line indicate significant growth at a young age and stabilization in the adult phase ($P<0.05$), reflecting the skeletal development process in line with the physical growth of female PO cattle.

In terms of the depth chest, hip height, and hip width of the cattle, there was a significant increase with age, as indicated by the superscript differences in each age group ($P<0.05$). The chest of the cattle increased from 49.57 ± 4.53 cm at PI_0 to 64.30 ± 4.75 cm at PI_8. Female PO cattle at the age of PI_6 did not show significant differences compared to the ages of PI_4 and PI_8, indicating a more complex variation in chest growth at certain ages, where growth began to experience uneven changes. Based on research (Baye et al., 2022), these differences in the chest may reflect structural adaptations to the local environment, allowing cattle to have a larger chest capacity to support respiratory and metabolic efficiency, especially in environments that may require higher physical stamina to graze in challenging terrain.

Hip height also increased from 114.86 ± 6.50 cm at PI_0 to 131.80 ± 6.76 cm at PI_8. PO cattle aged PI_0 to PI_6 showed significant differences ($P<0.05$), while PI_6 and PI_8 did not show significant differences, indicating stability in hip height growth in adulthood. The research results showed that hip width increased from 29.18±2.74 cm at PI_0 to 42.36±3.35 cm at PI_8. Each age group showed significantly different superscripts ($p<0.05$), indicating differences between age groups. This indicates a consistent increase in hip width as cattle age, without any signs of stabilization in adulthood, implying that hip width growth tends to persist longer than other variables. This research demonstrates that factors such as age, agro-ecological zone, and breed type influence variations in size and body shape in local cattle populations (Kabi et al., 2015).

Differences in morphometric size show how these cattle have changed genetically and ecologically to survive in different places. They also show how important agro-ecological suitability is in how the morphometric structure of local cattle populations has changed over time. This adaptation is crucial for the resilience and productivity of cattle in diverse environments, so understanding this variation can aid in programs to improve the quality of local cattle. Figure 3. shows the distribution of body size in the PO cattle population based on principal component analysis. Scatter plot of the principal component analysis (PCA) results; the main axes, PC_1 and PC_2, represent the most significant dimensions in the data variation. PC_1 generally reflects the most dominant principal component in explaining the differences in cattle body size, while PC_2 shows additional variation that, although less dominant, still plays an important role.

Younger cattle, such as those in the PI_0 cluster (age < 1 year) and PI_2 (1–1.5 years), tend to be spread in areas with lower PC_1 values, indicating greater variation in body size and not yet achieving body shape stability. In contrast, older age clusters, such as PI_6 (2–3 years) and PI_8 (age > 3.5 years), appear more separated and distributed in areas with higher PC_1 values, reflecting that older cattle tend to have larger, more stable, and more uniform body sizes. These findings indicate that the principal components generated by PCA are effective in illustrating the differences in cattle body size as they age (Kuswati, et al., 2022).

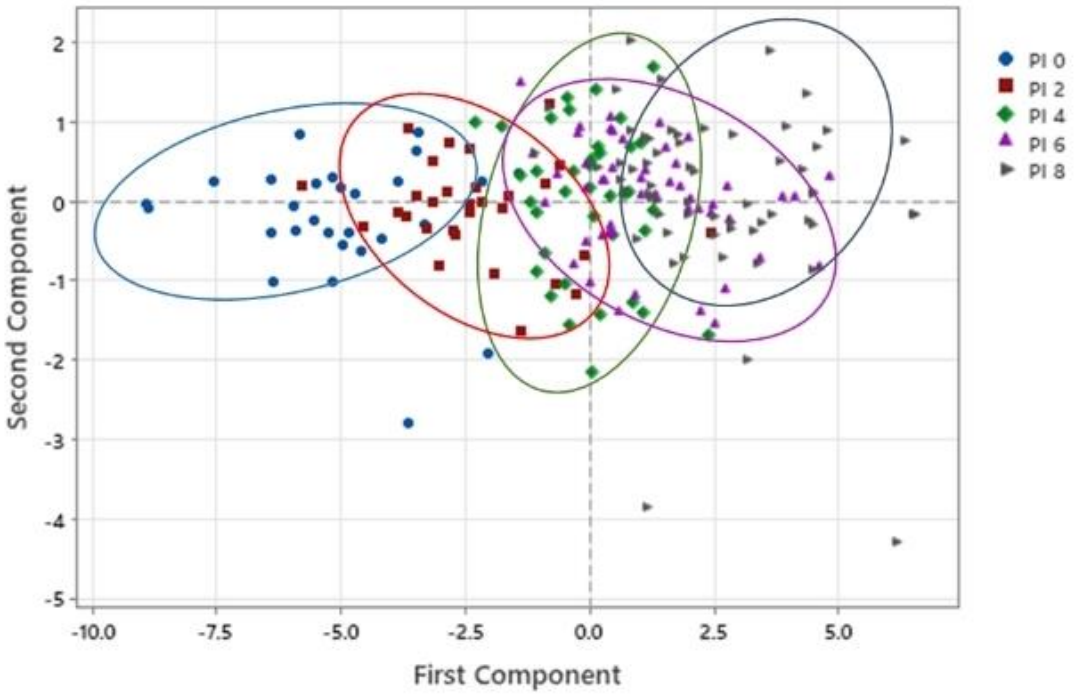

Figure 3. Biplot of the body size of female PO cattle based on age

Morphometric Indices of Female Peranakan Ongole Cattle

Morphometric (zoometric) indices are measurements used to describe the proportions and shapes of living organisms, including animals and plants. An organism's geometric measurements, such as length, width, and thickness, can calculate the morphological index. Some examples of commonly used morphological indices are Height Slope, Body Index, Index of Compression, Conformation Index, Length Index, Body Ratio, Proportionality, and Thoracic Development. Morphometric indices can be used to study changes in the shape and size of organisms and to understand the factors influencing these changes (Dauda et al., 2018; Ilham et al., 2023; Putra et al., 2020). A combination of body size variables, such as chest circumference, head length, shoulder height, body length, horn length, muzzle circumference, chest width, hip height, pelvic length, pelvic width, neck length, chest depth, ear length, tail length, and neck circumference, can calculate morphometric indices. (Gelaye et al., 2022). The research results depict the physical development and body conformation of female PO cattle at various age groups. Head index variable there is a difference in cattle from age PI_0 to PI_8 ($P<0.05$); young PO cattle have a more elongated head shape compared to when they are adults, indicating a slight change in the head-to-body proportion across ages. The variables Height Slope, Body Index, and Index of Compression show consistency without significant changes between age groups of cattle, which means the height relative to body length does not change much despite growth.

A significant increase in the conformation index from PI_0 to PI_8 indicates a more proportional body development, reflecting important structural growth in the maturation process of cattle. Female PO cattle at PI_6 have a conformation index value that is not significantly different ($P<0.05$) from PI_4 and PI_8. In Ethiopia, cattle from different districts show significant differences in body size and structural indices, indicating adaptation to the local environment. (Gelaye et al., 2022). Length Index, which measures the ratio between

body length and height at the withers, shows an increase with age. Female PO cattle at ages PI0 and PI2 did not show significant differences (P<0.05), indicating that body length growth occurs faster than height, in line with the tendency for body length to increase in older cattle. This increase indicates the development of the cow's body, which becomes longer as the maturation process progresses.

Table 5. Morphometric Indices of Female Peranakan Ongole Cattle

Variable	PI_0 Mean±SD	PI_2 Mean±SD	PI_4 Mean±SD	PI_6 Mean±SD	PI_8 Mean±SD
Population (n)	28	30	38	49	61
Head Index	0.47 ± 0.04 [a]	0.45 ± 0.04 [ab]	0.45 ± 0.04 [ab]	0.45 ± 0.12 [ab]	0.45 ± 0.03 [b]
Height Slope	-6.20 ± 2.53 [a]	-6.17 ± 2.77 [a]	-5.45 ± 2.91 [a]	-5.70 ± 3.19 [a]	-4.52 ± 2.99 [a]
Body Index	82.86 ± 5.81 [a]	79.58 ± 6.55 [a]	80.44 ± 6.24 [a]	80.39 ± 6.69 [a]	82.44 ± 5.91 [a]
Index of Compression	121.25 ± 8.54 [a]	126.45 ± 10.04 [a]	125.06 ± 9.86 [a]	125.22 ± 10.27 [a]	121.93 ± 8.99 [a]
Conformation Index	147.98 ± 16.56 [a]	177.04 ± 16.37 [b]	194.96 ± 20.76 [c]	204.62 ± 23.49 [cd]	208.58 ± 19.43 [d]
Length Index	0.96 ± 0.05 [a]	0.98 ± 0.04 [a]	1.02 ± 0.04 [b]	1.03 ± 0.05 [bc]	1.05 ± 0.05 [c]
Body Ratio	0.95 ± 0.02 [a]	0.95 ± 0.02 [a]	0.96 ± 0.02 [ab]	0.96 ± 0.02 [ab]	0.97 ± 0.02 [c]
Proportionality	1.04 ± 0.05 [a]	1.02 ± 0.04 [ab]	0.98 ± 0.04 [b]	0.98 ± 0.04 [c]	0.95 ± 0.05 [c]
Thoracic Development	1.17 ± 0.07 [a]	1.24 ± 0.07 [b]	1.27 ± 0.08 [b]	1.28 ± 0.09 [b]	1.28 ± 0.08 [b]

[a,b,c] Different superscripts on the same line indicate significant differences in the age groups of the cattle. (p< 0.05); PI = Permanent Incisivi; SD = Standard Deviation

Body ratio remains stable with a slight increase, indicating a satisfactory balance between body length and width. Proportionality decreases with age. Based on the research by Lomillos and Alonso (2020), the proportionality index is valuable for assessing the overall body structure of cattle. In the case of Lidia cattle, the lower index in males compared to females reflects the selective breeding practices focused on improving the bulls' conformation. This selection has aimed to enhance the athletic appearance and performance of charging behavior during bullfighting rather than solely focusing on beef production traits. The development of thoracic capacity has significantly increased, which is crucial for supporting respiratory and metabolic functions in cattle and characterizing their type. A study by Lendechy et al. (2023) says that the head index is used to find out how symmetrical an animal's head is. A value below 75.9 means that the head is dolicocephalic, which means it is long and thin, a value above 81 means that the head is brachycephalic, which means it is short and wide, and a value between 76 and 81 means that the head is mesocephalic. The Thoracic Index (TI) reflects variations in chest shape, where higher values indicate a tendency towards meat production, while lower values indicate a tendency towards milk production. The Body Index functions to classify animals based on body biotype, namely brevilineous (≤85), mesolineous (86-88), or longilineous (≥90). The Lateral Body Index shows the proportion of height to body length; a lower value indicates a rectangular shape, which is more common in beef-type cattle. The conformation index, which connects chest circumference with shoulder height, indicates a tendency for meat production if the value is high (4.0–5.0) and a tendency for milk production if the value is low (2,5-3,0).

Evaluation Based on SNI Peranakan Ongole Female Cattle

The population is divided into several age groups, ranging from PI_0 (6–12 months) to PI_6 (24–36 months). At the youngest age (PI 0), there are 26 individuals spread across

Class I, II, and III, with a dominance in Class III. Meanwhile, in PI_2 (12–18 months) and PI_4 (18–24 months), the number of livestock gradually increases, especially in Class III, indicating that these age groups may have higher productivity potential. The highest population is in PI_4, with a total of 36 individuals, almost all of whom are in Classes II and III. In PI_6 (24–36 months), the number of livestock reaches 35, with a significant increase in Class III. Based on SNI, Class III dominates with 33.5% of the total population, followed by Class II with 22.33%, while Class I only comprises 2.43%, indicating that the majority of livestock have higher body quality. Most of the livestock fall into the more productive age and class categories, namely Class II and III, which together account for 58.25% of the total population. This highlights the focus on maintaining livestock with better quality at productive ages. The low percentage of Class I may indicate a high selection or preference for maintaining livestock in higher quality categories within this population.

Table 6. PO female cattle that meet the criteria of the Indonesian National Standard

Age (PI)	Population in Napis (206 head)			Numbers of Cattle
	Class I	Class II	Class III	
PI 0 (6-12 Months)	2	11	13	26
PI 2 (12-18 Months)	1	6	16	23
PI 4 (18-24 Months)	2	18	16	36
PI 6 (24-36 Months)	0	11	24	35
	5	46	69	120
Percentages (%)	2.43%	22.33%	33.50%	58.25%

CONCLUSION

This study found that the morphometric analysis of female Peranakan Ongole (PO) cattle in Napis Village showed significant increases in body size, such as height, length, and chest circumference, according to age, until reaching stability in the adult phase. The morphometric index shows proportional body development over growth, reflecting structural maturity. Based on the Indonesian National Standard (SNI), the majority of cattle are in the productive class, showing excellent body quality in this age group. These results underscore the significance of morphometric assessment as a foundation for management strategies that promote sustainability and productivity growth in female PO cattle, particularly in the face of local tropical environmental challenges.

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