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Morphometric Characteristics of Galekan Cattle Breed Base on Principle Component Analysis (PCA)

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ABSTRACT: This study obtained morphometric information on Galekan cattle and compared phenotypic characteristics of Galekan cattle with local breed based on previous studies. This research was a case study with purposive sampling using the snowball sampling technique. The material used was 60 cattle of Galekan cattle which were kept in the Technical Unit (UPT) at Dongko and Panggul Sub Districts. The variables observed included qualitative characteristics and quantitative characteristics of morphometric components and body weight. T^2-Hotelling test, descriptive statistics, and principal component analysis are used for quantitative data. The results showed that the qualitative characteristics of Galekan cattle were dominated by light brown body color with smear body color border, black backline, black vulva, black tail tip, face color as same as dominant body color, black muzzle, black upper and lower lips, smear white eye area, dark eye circles, black eyelashes, and black ear lines. The characteristics of the body shape of Galekan cattle have upward horns, no hump, and thin dewlap. The results of the T^2-Hotelling analysis in UPT showed a significant difference ($p < 0.05$) compared to other cattle in Dongko and Panggul Sub Districts. Principal component analysis (PCA) of Galekan cattle can be characterized by body weight, chest girth, depth chest, Ossa vertebrae lumbales, Ossa metatarsal, and Ossa vertebrae thoracicae.

Keywords: Extinction; Local breed; Phenotype; Smallholder farmer

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INTRODUCTION

Indonesia has several local genetic resources, such as Bali cattle, Java cattle, Madura cattle, Galekan cattle, and several crossbred cattle; Jabres cattle, Mandras cattle, Rambon cattle, Ongole crossbred (PO). The diversity of cattle breeds can be seen from the visual characteristics expressed in their phenotype (Noor, 2008). Local beef cattle have high adaptability to local environmental conditions, can utilize low-quality feed resources, and have the high reproductive ability. The trend to raise local cattle among smallholder farmers declined due to low growth rates of local cattle, so it will take a longer to raise compared to Limousin and Simmental breeds. Sumadi et al. (2008) declared that the current population of beef cattle in Java consists of PO, Simmental PO (Simpo), Limousin PO crossed (Limpo), and Brangus. However, the total number and population structure of each breed are unknown. The base population data and population structure are critical, and it used as initial data for making policies to increase productivity and developing and preserving local cattle.

Galekan cattle are threatened with extinction. According to the Agriculture Office of Trenggalek District data, the number of Galekan cattle raised in UPT Dongko and Panggul Sub District is only 22. In addition, a small number spreads around Dongko and Panggul Sub District. The population of Galekan cattle is at a critical point, based on the Agriculture Ministry of Indonesia 2006. The population of livestock genetic resources is declared critical if the number of adult females in the population is less than 10,000 heads. The criteria for a critical population of livestock genetic resources are divided into four groups as follows: (1) sparse population if the number of adult females is 5,000 – 10,000 heads; (2) vulnerable population if the number of adult females is 1,000 – 5,000 heads; (3) the population is threatened, if the number of adult females is 100 – 1,000 heads; (4) critical population, if the number of adult females is less than 100 heads. The existence of Galekan cattle as a local breed requires conservation and development efforts to be considered seriously.

The qualitative characteristics of Galekan cattle are similar to Madura cattle; the dominant skin color is brick red, has horns, has thin wattles, the color boundaries are not clear, has a long tail, and has black eye circles. Body sizes of adult female Galekan cattle, young females, and young males in terms of body length 113$\pm$2.06 to 118$\pm$5.21 cm, body weight 217$\pm$3.17 to 250$\pm$28.2 kg, withers height 110 $\pm$3.11 to 118$\pm$6.24 cm, hip height 113$\pm$6.13 to 116$\pm$14.32 cm and chest girth 140$\pm$6.63 to 145$\pm$8.31 cm (Susilawati, 2017). Mohamad et al. (2009) stated that Galekan cattle have a close relationship with Zebu cattle and Bali cattle, which amounted to 22%. It means they have a closer relationship to *Bos indicus* than Aceh, and Pesisir cattle are only 11-16%.

The limited data on these characteristics becomes an obstacle in conservation and development efforts. Other physical characteristics (phenotype) and body size indicate the closeness of characteristics to other cattle breeds. One of the parameters that can be used to see the characteristics of an animal is morphometric analysis. Bovine morphometric diversity will provide information on quantitative characteristics through morphological analysis with a discrimination technique approach and principal component analysis (PCA). PCA can be used to determine phylogenetic relationships and distinguish variables to determine the difference between groups (Utomo et al. 2010). Qualitative data were analyzed descriptively, while quantitative data were analyzed using PCA. PCA was used to determine the differences between the morphometric body sizes of the observed cattle. Exploration of the characteristics of Galekan cattle is very important to determine the genetic and phenotypic

potency qualitatively and quantitatively. Therefore, this study was conducted to obtain information on body measurement characteristics of Galekan cattle through research studies in their distribution area.

MATERIALS AND METHODS

Research Location and Time

This research was conducted at the UPT located in Pogalan Sub District, Panggul Sub District, and Dongko Sub District, Trenggalek District. Data collection was carried out from September to December 2019.

Research Material

The material used in this study is the 22 heads of Java cattle kept in the UPT in Pogalan Sub District. Meanwhile, in Dongko and Panggul Sub Districts, many samples were taken from Galekan cattle. Galekan cattle have black muzzle characteristics, black hairtail, brown color, or a mixture and black vulva (Susilawati, 2017).

The cattle observed were selected according to age based on PI (permanent incisor) PI_0 – PI_8; PI_0 (aged <12 months), PI_2 (aged 12-18 months), PI_4 (aged 18- 24 months), PI_6 (aged 24-30 months) and PI_8 (aged >30 months). The cattle were grouped based on age and sex. Quantitative properties shown in vital body statistics were measured using a measuring tape of 1 cm (used for measuring chest girth and head index). Cattle weighing scales were used to measure body weight in kilograms. At the same time, measuring sticks were used to measure the length of the cervical vertebrae group, the thoracicae vertebrae group length, the lumbar spine group length, scapula, metacarpal, metatarsal, body length, withers height, chest width, hip height with an accuracy of 1 cm (used for morphometric measurement data). The procedure measuring all parameters was carried out according to the Food and Agriculture Organization's (FAO) standard procedure (FAO, 2012; ICVGAN, 2017).

Research Methods

The research was a case study through direct observation and measurement at UPT located in Pogalan Sub District, Panggul Sub District, and Dongko Sub District. The research location was determined by purposive sampling.

Statistic Analysis

Qualitative data were analyzed descriptively, while quantitative data were analyzed by T^2-Hotteling which was used to determine the difference between the body measurement morphometrics of the observed cattle groups. The statistical formula for T2 -Hotelling according to (Pitutch and Stevens, 2016):

$$T^2 = \frac{n_1 n_2}{n_1 + n_2}\left(\overline{X1} - \overline{X2}\right)' S_{G^{-1}}\left(\overline{X1} - \overline{X2}\right)$$

$$F = \frac{n_1 + n_2 - p - 1}{(n_1 + n_2 - 2)p} T^2$$

T^2 = Statistical Value T^2 Hotelling
F = Calculated Value T^2 Hotelling
n_1 = The size of the sample of cattle group 1
n_2 = sample size of the cattle group 2
(X1) = Vector mean value of variables in cattle group 1
(X2) = Vector mean value of variables in cattle group 2
p = Number of variables to be measured
S_G = Inverse of the covariance matrix (SG).

PCA was used to classify the characteristics of the relationship between body sizes. Grouping observations using principal component analysis (PCA) was analyzed by Minitab 19 software. Descriptive statistical analysis was used to analyze the characteristics of body size included the length of the cervical vertebrae

bone group, the thoracicae vertebrae bone group length, the lumbar spine bone group length, the scapula bone length, the metacarpal bone length, the metatarsal bone length, body length, wither height, hip height, head length, head width, head index and body weight.

RESULT AND DISCUSSION

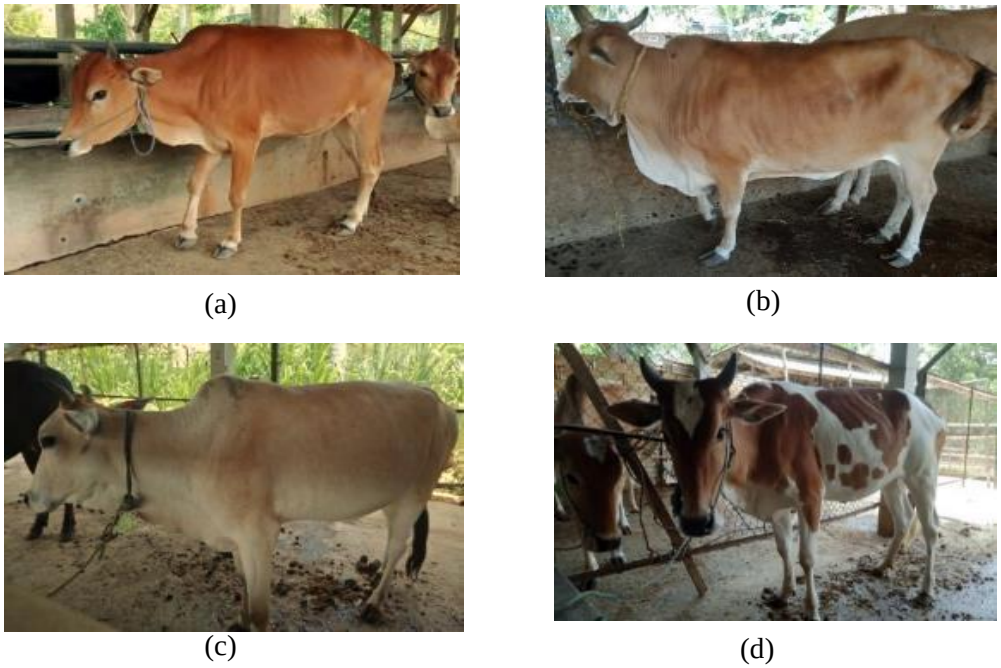
Qualitative Characteristics

The results of the characteristic qualitative research based on observation showed that the composition of Galekan cattle is presented in Table 1.

Table 1. Physical characteristics of Galekan cattle

Qualitative characteristic	UPT	Dongko sub District	Panggul sub District	Total	
				n (60)	%
Dominant body color					
- Brown	12	11	3	26	43,33
- Light brown	5	17	6	28	46,67
- Other	5	1	-	6	10,0
Back dorsal line color					
- Black	13	8	3	24	40,0
- Same as the body color	7	11	3	21	35,0
- Other	2	10	3	15	25,0
Buttocks color					
- *Smear*	19	25	8	52	86,67
- Same as the body color	3	4	1	8	13,33
Vulva color					
- Black	19	22	6	48	80,00
- Pink	-	2	-	2	3,33
- Mix color	3	4	3	10	16,67
Tail tip color					
- Black	21	26	9	56	93,33
- White	1	-	-	1	1,67
- Same as body color	0	3	0	3	5,00
Muzzle color					
- Black	22	29	9	60	100
Characteristics of the body shape of Galekan cattle					
Horn					
- Horn heading Forward	3	8	2	13	21,67 70,0 5,0 3,33
- horns upward	19	17	6	42	
- horns lead to the Side	0	3	0	3	
- No horns	0	1	1	2	
Hump					
- large humped	10	9	1	20	33,33
- No hump	12	20	8	40	66,67
Dewlap at the neck					
- Thin	22	29	9	60	100

The results of the analysis of the characteristics of the Galekan cattle based on the color characteristics of the body parts have similarities with the *Bos javanicus* (Bali cattle) and *Bos indicus* (Madura cattle). However, the dominant body color characteristic of Galekan cattle is different from Susilawati (2017) study, which states that Galekan cattle have a brick red dominant color.



(a) (b)

(c) (d)

Figure 1. Characteristics of Galekan cattle based on dominant color and body color border. (a). brick red; (b) brown; (c). light brown; (a), (b), (c) Smear color border; (d). The body color border is clear

The color composition diversity of Galekan cattle provides specific characteristics to compare with other cattle breeds. Trifena et al. (2011) stated that color differences were caused by genetic differences between cattle breeds controlled by one or more pairs of genes. A comparison of the color characteristics of Galekan cattle with Indonesian local cattle breed based on the National Indonesian Standard (SNI) is presented in Table 1.

Table 2. Color characteristics of female Galekan cattle with Indonesian local female cattle based on SNI

No	Color characteristic	Galekan cattle	Bali cattle[1]	Madura cattle[2]	Aceh cattle[3]	Pesisir cattle[4]
1.	Dominant in body	Brown or light brown	reddy brown	brick red or light brown	brick red, brown to light brown	Light brown to brick red,
2.	Circle around an eye	black	black	black	black	black
3.	Line around an ear	black	black	black	black	black
4.	Metacarpal and Metatarsal area	white smear	white, clear border	white smear	white smear	white smear
5.	Hairtail	black	black	black	black	black
6.	Backline	black	black	black	-	-
7.	Muzzle	black	black	black	black	black

Source: SNI 7651.4 Bali Cattle[1]; SNI 7651.2 Madura Cattle[2]; SNI 7651.3 Aceh Cattle[3]; SNI 7651.6 Pesisir Cattle[4].

Table 1. shows that the characteristics of female Galekan cattle have characteristics color similar to Bali cattle, Madura cattle, Aceh cattle, and Pesisir cattle. The color characteristics are similar to the most Indonesian local breed based on SNI. The eye circumference, hairtail, backline, and muzzle are all black. The dominant body color of female Galekan cattle is similar to Pesisir and Aceh cattle, brown to light brown. The color of the Bali cattle on the legs is visible, while the Galekan cattle have a smear border and the dominant body color is brown or light brown. Bali cattle are thought to result from the domestication of banteng (*Bos javanicus*). According to a previous study by Mahdi et al. (2013), the characteristics of Bali cattle and Baluran bulls have considerable similarities based on craniometric analysis.

Baluran bulls have many characteristics in common with Bali cattle, but there are still differences in cranium size, perhaps due to domestication. Mohamad et al. (2009) stated that Aceh cattle, Pesisir cattle, Madura cattle, and Galekan cattle are the same group as *Bos indicus* (Nellore cattle, Ongole cattle, Sahiwal cattle) based on the phylogenetic tree. Meanwhile, Bali cattle are not, but it still has similarity around 22%. Color characteristics can be used as a marker of a cattle breed. Therefore, it can be used as a fundamental consideration for breeding selection.

Quantitative Characteristic

The Result of the T^2 Hotelling Test of Galekan Cattle Body Size

T^2 Hotelling's test is used to distinguish the mean value of the variables from two different populations or groups of cattle at once. Each group consists of two or more varieties, and statistical analysis will be carried out. The T^2 Hotelling's test results showed differences in body characteristics between the two groups of Galekan cattle based on their sub-populations. The results showed that the Galekan cattle in the UPT and the distribution of Dongko and Panggul Sub Districts had significant differences ($p<0.05$). The research data showed that the real difference was influenced by the variables (X_2) withers height and (X_3) hip height with the correlation values 0.210 and 0.214, respectively, so the higher of withers height (X_2), the greater the size (X_3) hip height of Galekan cattle. The research data had found that Galekan PI_2-PI_8 cattle in the Dongko and Panggul Districts had an average withers height (X_2) and the greater hip height (X_3); 125.95 $\pm$ 6.55 cm and 129.34 $\pm$ 6.82 cm, respectively. Meanwhile, the cattle in UPT had a size of withers height (X_2) and hip height (X_3) of 111.94 $\pm$ 6.43 cm and 114.44 $\pm$ 7.29 cm, respectively. The difference is due to the pattern of rearing and the offspring of Galekan cattle. Galekan cattle found in those Sub District have potentially mixed with other breeds, which have greater body size and bodyweight because of the artificial insemination program's implementation. The results study by Nurgiartiningsih (2010) stated that the crossbred cattle showed higher chest girth and body length for the first offspring and optimum body.

Principal Component Analysis (PCA) of Galekan Cattle Body Size

The use of PCA aims to reduce variables of Galekan cattle, including (X_1) body length, (X_2) withers height, (X_3) hip height, (X_4) head length, (X_5) head width, (X_6) chest girth, (X_7) depth chest, *Ossa vertebrae cervicales*, (X_9) *Ossa vertebrae thoracicae* , (X_{10}) *Ossa vertebrae lumbales*, (X_{11}) *Ossa metacarpal*, (X_{12}) *Ossa Metatarsal*, (X_{13}) *Ossa scapula* and (X_{14}) body weight. The first principal component (PC_1) has an eigenvalue of 8.12 with a cumulative diversity of 58%. Furthermore, PC_2 has an eigenvalue of 1.310, which can explain 9.4% of the total sample variation, PC_3 explains 8% of sample variation with an eigenvalue of 1.12, and PC_4 explains 5.5% of sample variation.

The cumulative value that the first four principal components can explain has explained 80.8%. The use of PC_1 and PC_2 has been able to describe the diversity of the morphometric characteristics of Galekan cattle due to the highest cumulative value. Further explanation by Heryani et al. (2018) is that the first principal component (PC_1)

can be accepted as a vector size and the second principal component (PC_2) as a shape vector. So that PC_1 can show size differences which will explain the different levels of body size variation in a group of animals, while PC_2 will explain the shapes that are not described in PC_1. The results of the principal component analysis obtained the equation (PC_1), the first principal component (Y_1), (PC_2), the second principal component (Y_2), (PC_3), the third principal component (Y_3), (PC_4), the fourth principal component (Y_4). The grouping of variables is taken with the two most significant values , or a value that is more than 0.3. A positive (+) or negative (-) sign indicates the relationship between the principal components and the original variable**.**

$$Y_1 = \mathbf{0,322\ X_1} + 0{,}293\ X_2 + 0{,}302\ X_3 + 0{,}262X_4 + 0{,}261X_5 + \mathbf{0,328\ X_6} + 0{,}168\ X_7 + 0{,}193X_8 + 0{,}220\ X_9 + 0{,}182\ X_{10} + 0{,}267\ X_{11} + 0{,}254\ X_{12} + 0{,}284\ X_{13} + \mathbf{0,333\ X_{14}}$$

The results showed that the morphometric PC_1 value of Galekan cattle was explained dominantly by the variables body length (X_1), chest girth (X_6), and body weight (X_{14}). It can be seen that the coefficient value is more significant compared to other variables. The coefficients on the three variables show a positive sign, which means that PC_1 has a close relationship with the constituent variables. The variables of body weight and chest girth of Galekan cattle can describe the size. Therefore the more excellent value of the determinant coefficient of body weight and chest girth, the larger the body size of the cattle. The previous research of Septayani et al. (2015) declared that body length and chest girth were most effectively used to estimate body weight with a regression equation. In practice, chest girth was the primary variable in estimating body weight. The total diversity value of PC_1 is 58%, with an eigenvector value of 8.12, and the PC_1 equation can be explained by the variables of chest girth and body weight. The body shape characteristics of Galekan cattle will affect the shape and the size, which will become the unique characteristics to distinguish it from other types of cattle.

The study results from Warwick et al. (1987) explained that body size and body components are a biological balance that can be used to predict body shape as a characteristic of a species, phylum, breed, and type of livestock.

$$Y_2 = 0{,}087\ X_1 + 0{,}373\ X_2 + 0{,}307\ X_3 - 0{,}103\ X_4 - 0{,}168\ X_5 + 0{,}129\ X_6 - \mathbf{0,397\ X_7} - 0{,}378\ X_8 - 0{,}358\ X_9 + \mathbf{0,442\ X_{10}} - 0{,}229\ X_{11} - 0{,}115\ X_{12} - 0{,}035\ X_{13} + 0{,}112\ X_{14}$$

The value of PC_2 was explained more by the variables in the depth chest (X_7) and Ossa vertebrae lumbales (X_{10}). The negative value of the variable coefficients in the depth chest indicates a negative relationship, while the vertebral column lumbar spine shows a positive relationship. Variable components in the depth chest and lumbar spine have the highest scores to explain most of the second principal components with eigenvector values of 0.397 and 0.442. The cumulative variability that can be explained is 9.4%.

$$Y_3 = -0{,}063\ X_1 + 0{,}142\ X_2 + 0{,}189\ X_3 - 0{,}197\ X_4 - 0{,}119\ X_5 - 0{,}115\ X_6 - 0{,}330\ X_7 - 0{,}197\ X_8 - 0{,}117\ X_9 - \mathbf{0,457\ X_{10}} + 0{,}447\ X_{11} + \mathbf{0,543\ X_{12}} + 0{,}050\ X_{13} - 0{,}081\ X_{14}$$

The PC_3 value was explained more by the variables Ossa vertebrae lumbales (X_{10}) and Ossa metatarsal (X_{12}). The negative value of the variable coefficients in the chest indicates a negative relationship, while the Ossa metatarsal shows a positive relationship. The variable components of Ossa vertebrae lumbales and Ossa metatarsal have the highest eigenvectors of 0.457 and 0.543. They can explain most of the third component with a cumulative diversity value of 8%.

$$Y_4 = 0{,}171\,X_1 + 0{,}096\,X_2 + 0{,}166\,X_3 + 0{,}406\,X_4 - 0{,}104\,X_5 - 0{,}078\,X_6 + \mathbf{0{,}487\,X_7} - 0{,}020\,X_8 - \mathbf{0{,}607\,X_9} - 0{,}220\,X_{10} + 0{,}020\,X_{11} + 0{,}023\,X_{12} - 0{,}309\,X_{13} - 0{,}046\,X_{14}$$

The value of PC_4 was explained more by the variables in the depth chest (X_7) and vertebrae thoracicae (X_9). The negative value on the variable coefficient of Ossa vertebrae thoracicae ae indicates a negative relationship, while the PC_4 in the chest shows a positive relationship. Variable components in the chest and Ossa vertebrae thoracicae ae have the highest eigenvectors of 0.487 and 0.607. They can explain most of the third component with a cumulative diversity value of 5.5%.

Generally, the variable components of Galekan cattle can be explained by components of body weight, chest girth, chest depth, Ossa vertebrae lumbales, Ossa metatarsal, and Ossa vertebrae thoracicae ae. Characteristics of body weight, chest girth, and the depth of chest can describe the size of Galekan cattle. Morphometric characteristics of Aceh cattle, PO cattle, and Bali cattle, stating that Bali cattle have a chest girth as a feature of depth chest size and become a marker of shape, shoulder height as a size marker, and depth chest as a shape marker in PO cattle as well. Furthermore, body length is a marker of body size and thoracicae

as a shape characterization in Aceh cattle (Mahmudi et al. 2019). The morphometric characteristics of Galekan cattle have similarities with Bali cattle in the pectoral circumference and inner chest variables, PO cattle have similar characteristics in the depth chest and Aceh cattle in the Ossa vertebrae thoracicae ae bone group. The most variables that influenced the body size and body shape of Galekan cattle were body weight and chest girth.

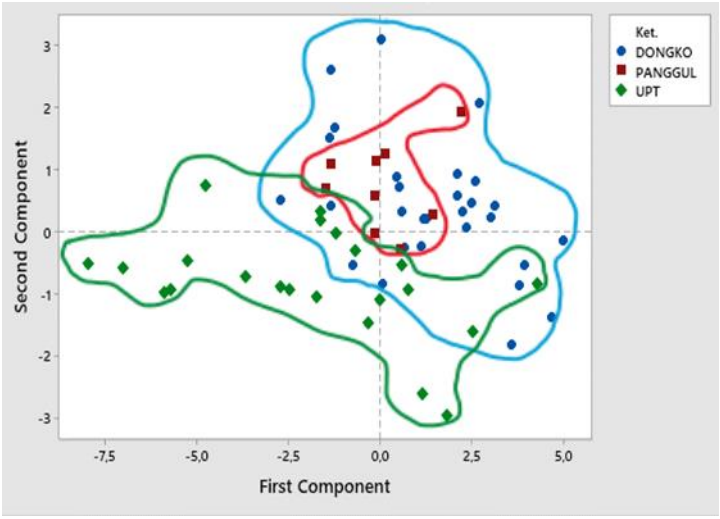


Figure 2. Visualization of the grouping of Galekan cattle by subpopulation

Based on the biplot visualization, it was found that the Galekan cattle in the UPT formed a crowd of PC_1 and PC_2 sizes. Crossbreeding does not occur in Galekan cattle that are kept in UPT. The cattle have natural mating with Galekan bulls.

Meanwhile, Galekan cattle kept by smallholder farmers located in Dongko and Panggul Sub Districts have potentially crossbred with other breeds due to the artificial insemination program by the government. Hartatik et al. (2009) stated that the greater of genotypes number shared between individuals or groups of livestock, the higher the genetic similarity.

In addition, the higher the proportion of distinct genotypes possessed by a group or individual, the higher the degree of genetic differences. Based on the results of PI visualization, it was found that PI_6 and PI_8 formed a crowd in the same quadrant while PI_0, PI_2, and PI_4 were scattered in the other three quadrants. Because of the peak growth, the diversity at the PI_2 and PI_4 levels occurs in this phase. Therefore feed and management will affect to accelerated growth pattern and muscle development of the cattle.

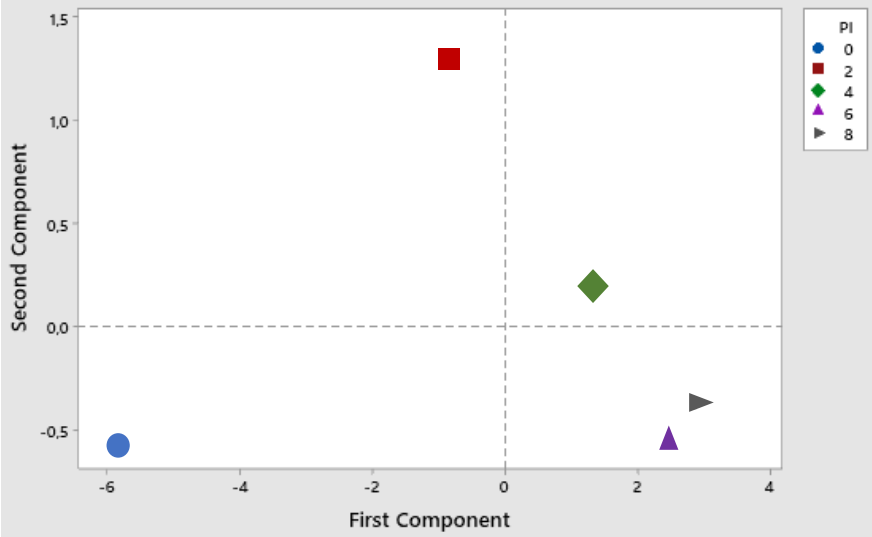


Figure 3. Visualization of the grouping of Galekan cattle PI_0, PI_2, PI_4, PI_6, and PI_8

However, when the cattle reach the PI_6 and PI_8 phases, the growth rates slow down and affect body size. According to Kuswati and Susilawati (2016), growth increases body size that occurs over time, and growth will slow down when the livestock has reached the adult stage. In the PI_0 phase, cattle focus more on frame size growth, determining size development as mature animals. Furthermore, Firdausi et al. (2012) stated that frame size had a very significant effect ($p<0.01$) on daily body weight gain, it was because of the difference's proportions of primary carcass tissue (muscle, bone, and fat) at the same age. Galekan cattle have relatively high productivity with an average adult body weight of 306.31 $\pm$ 60.02 kg. They can adapt to feed conditions in the form of hay and natural grasses that farmers commonly give. In their research, Ahmad et al. (2004) stated that the growth rate of cattle, particularly the highest body weight, occurred due to compensatory growth, which is a condition where cattle become more responsive to feed quality improvements.

The results showed that the morphometric variables of Galekan cattle formed five groups of crowds that were closely related to each crowd variable. Variables close to each other indicate that these variables have a close correlation. Crowds of chest girth, body length, and body weight are in one crowd, so any increase in body length and chest girth will affect body weight and vice versa. The use of chest girth and body length to estimate body weight is often to be done to form a new formula. The study of Suliani et al. (2017) states that cattle body size, including body length and chest girth, can be used to estimate the body weight and carcass weight of cattle. The locomotor size groups of the metacarpal bones, metatarsal bones, and

scapula formed a crowd of one group with head size, namely head length and head width. From this crowd, it can be concluded that the correlation between the size of the locomotor bones and the cattle's head is close. According to Sampurna et al. (2014), the ossa metacarpal, ossa metatarsal, and scapula are the primary growth centers of the body and then create the cranium (spine). The results showed that the withers height and hip height formed a crowd, which means that the withers height will affect the hip height. These two variables contribute to creating body posture. The more excellent withers and hip height value, the taller Galekan cattle. In addition, there was a growth interaction between the wither height and hip height (Pradana et al. 2014). The group of chest-forming Galekan cattle, Ossa vertebrae thoracicae ae and depth chest, was close to the size of the length of the Ossa vertebrae cervicales group. Meantime, the Ossa vertebrae lumbales group formed a separate group, which means that the correlation with other variables was very low. It could be explained that the Ossa vertebrae lumbales are one of the groups of bones that make up the cattle abdomen. Visualization of body size and shape markers based on the results of the PCA of Galekan cattle based on PI_6-PI_8 is presented in Figure 4.

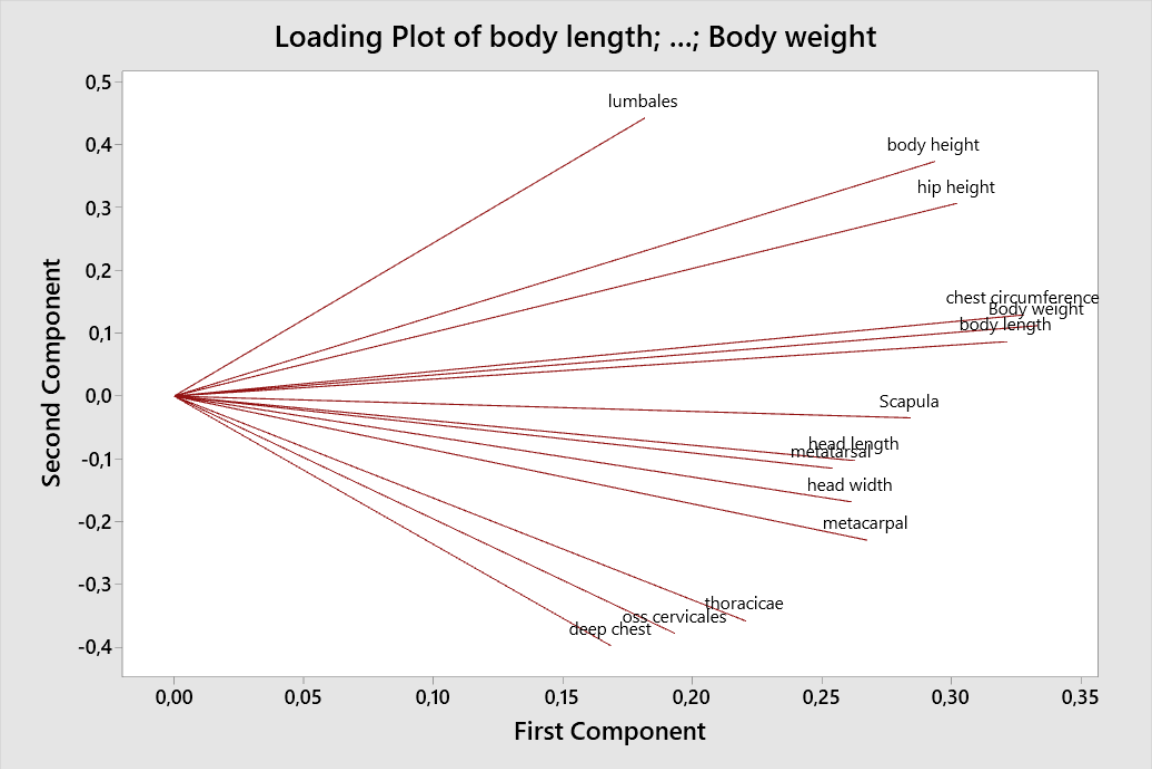


Figure 4. Visualization of the grouping of Galekan cattle based on the correlation variable

CONCLUSIONS

Most Galekan cattle have qualitative characteristics of dominant body color; light brown with smeared body color borders, a black dorsal line, white smeared legs and buttocks, black vulva color, and black tail tip. The color pattern of the head is the same as the dominant body color, the muzzle is black, the upper and lower lips are black, the eye area is smeared with white, the eye circles are black, and the eyelashes are black, and the ears are black. Characteristics of the body shape of Galekan cattle are horns upward, no hump, and thin dewlap.

The high diversity of body sizes of Galekan cattle is shown in PI_2 and PI_4 because, at this stage, the growth rates are very high. Based on morphometrics using T^2-Hotelling, sub-population cattle kept in UPT, Dongko, and Panggul Sub Districts had a significant difference in size ($p<0.05$), which was influenced by the variables

withers height (X_2) and hip height (X_3). The PCA results of Galekan cattle can be characterized based on the component variables of body weight, chest girth, depth chest, Ossa vertebrae lumbales, Ossa metatarsal, and Ossa vertebrae thoracicae ae, which can represent the whole crowd of morphometric variables.

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