Cluster analysis of lombok island local buffalo (*Bubalus bubalis*) based on Principle Component Analysis (PCA)

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Abstract—The Preservation of buffalo cattle in North Lombok and Central Lombok regencies can be done through inventory activities and identification of cattle performance through analysis of morphological characters in order to determine the kinship relationships of buffalo. This study examines the grouping of local buffalo in Central Lombok and North Lombok based on morphological characters. The sample of this study consisted of 16 male and female buffaloes taken from both regions. One way anova analysis results on eight morphological characters of buffalo which include (1) body length, (2) shoulder height, (3) hip height, (4) chest circumference, (5) chest width, (6) head length, (7) head height, and (8) head width shows no difference in mean values of each character in the two observation areas. The results of PCA analysis revealed a map of buffalo morphology distribution which was divided into two groups, i.e. group 1 representing North Lombok buffalo located in quadrant III, while group 2 represented morphological mixtures of North Lombok and Central Lombok buffalo located in quadrant I, II, and IV. The results of the cluster analysis show that some buffalos from North Lombok has similarities with Central Lombok buffalo based on the eight morphological characters.

1. Introduction

North Lombok Regency is one of the regions in West Nusa Tenggara Province which has a considerable potential in agricultural sector. These potentials include agriculture, plantation, forestry, livestock and fisheries [1]. In the field of animal husbandry, the district of North Lombok has large and small livestock resources that continue to be developed. One of the big livestock that becomes potential is buffalo cattle. Based on 2014 buffalo population data, North Lombok Regency ranks fourth in the number of buffalo populations from Lombok region after Central Lombok, West Lombok and East Lombok with a population of 442 buffaloes [2].

In general, the number of buffalo populations in North Lombok Regency is still relatively small compared to other regions in Lombok Island. Although it has not been able to provide a high enough contribution to the economy of North Lombok, the potential of the livestock sector needs to be continuously developed [1]. The development of the livestock sector, especially buffaloes in North Lombok Regency, is supported by land resources, socio-cultural conditions of the community, and the bio-physical condition of buffaloes. Effective land area that can be used as a cultivation area including buffalo livestock is 21,858 ha or 27% of the total area of North Lombok Regency [1]. Whereas in terms of socio-culture, the ownership of buffalo cattle has a special prestige for some people in North Lombok Regency such as in Bayan District. Some people of Bayan still hold...
ancestral traditions known as *wetu telu*. People who hold fast to *Wetu Telu* culture has many traditional ceremonies, sometimes in certain traditional ceremonies such as circumcisions, slaughtering buffalo cattle is a must. In such circumstances, the existence of buffaloes has a very important meaning.

The advantages of bio-physical buffalo support the development of buffalo cattle in North Lombok Regency. Buffalo has the ability to survive well on dry land or land by utilizing low-quality feed such as dry grass. Moreover, buffalo has high enough capacity to deal with pressures and extreme environmental changes [3]. The advantages of bio-physical are very much needed in the development of buffalo cattle in North Lombok Regency, because most of the potential area for livestock development is on dry land which includes three fields, i.e. dry land garden of 16,720 Ha (80.21%), farmland public relations amounting to 4,105 ha (19.69%), and 20 meadow land of Ha (0.10%) [1].

Unlike the North Lombok District, the buffalo population in Central Lombok Regency ranks the top of the population of buffaloes from the Lombok region. Recorded the number of buffalo population in 2014 was 19,293 [2]. The use of buffalo livestock in Central Lombok Regency is used to increase community income, and for consumption needs. Recorded in 2008 as many as 2,403 buffaloes were cut for consumption needs [4]. The geographical conditions of buffalo grazing land in Central Lombok and North Lombok districts are almost the same. Based on the results of observations, buffalo grazing land in Central Lombok Regency, especially in the southern part, has dry conditions as well as most buffalo cattle areas in North Lombok Regency.

According to Muthalib [5], the development and preservation of buffalo in West Nusa Tenggara (NTB) Province including North Lombok and Central Lombok Districts can be done through inventory activities, and identification of buffalo cattle performance in NTB. One of the way that can be done is analyzing morphological characters in order to determine the kinship relationship of buffalo. This is important as basic information in the development of buffalo cattle in NTB Province, especially in North Lombok and Central Lombok Districts. This study examines clustering of local buffalo in Central Lombok and North Lombok based on morphological characters.

### 2. Methodology

#### 2.1 Sample and Research Location

The research sample consisted of 16 male and female buffaloes consisting of 8 buffaloes from Ungga Village, Praya Barat Daya Subdistrict, Central Lombok Regency, and 8 buffaloes taken from Dasan Glumpang Hamlet, Akar-Akar Village, Bayan District, North Lombok Regency. Sampling was done purposely by considering that several buffaloes were still wild, making it difficult to measure morphological parameters.

#### 2.2 Morphological character

Morphological characters measured in this study include (1) body length, (2) shoulder height, (3) hip height, (4) chest circumference, (5) chest width, (6) head length, (7) head height, and (8) head width. Measurement of buffalo’s morphological characters uses measuring tape with accuracy of 0.5 cm by adopting the method of measuring body parameters (Sarbaini, 2004) and cow head (Asoen and Anggraeni, 2011) in Agung et al [6] as follows:

a. Body length (cm), measured straight distance from the shoulder protrusion or tuberculum laterale humeri to the sitting bone or ischii tuber.

b. Shoulder height (cm), was measured from the highest point of the shoulder past to the back, then straight to the ground.

c. Hip height (cm), was measured perpendicular to the first sacrum bone to the ground.

d. Chest circumference (cm), was measured around the chest cavity behind the shoulder or behind the elbow of the front leg perpendicular to the axis of the body.
The 1st International Conference on Engineering and Applied Science
Journal of Physics: Conference Series 1381 (2019) 012007 doi:10.1088/1742-6596/1381/1/012007

2.3 Data Analysis
After performing a morphometric analysis of 8 morphological characters including (1) body length, (2) shoulder height, (3) hip height, (4) chest circumference, (5) chest width, (6) head length, (7) head height, and (8) head width, then the next step is to do a one way ANOVA test to determine the difference in mean values of each morphological character for each district. To find out the grouping of buffalo based on their morphological characters, a PCA (Principle Component Analysis) analysis was carried out and strengthened by cluster analysis by using the Euclidian distance method. PCA and cluster analysis are assisted using a PAST computer program.

3. Result and Discussion

3.1 Measurement of the Character of Buffalo Morphology
The measurement results of morphological characters include (1) body length, (2) shoulder height, (3) hip height, (4) chest circumference, (5) chest width, (6) head length, (7) head height, and (8) the width of the head is shown in Table 3.1 below.

| Buffalo | Body Length | Shoulder height | Hip height | chest circumference | Chest width | Head length | Head height | Head Width |
|---------|-------------|-----------------|------------|---------------------|-------------|-------------|-------------|------------|
| LT1     | 106         | 126             | 120        | 170                 | 40          | 44          | 28          | 25         |
| LT2     | 122         | 117             | 132        | 170                 | 42          | 45          | 27          | 24         |
| LT3     | 124         | 131             | 128        | 168                 | 40          | 44          | 31          | 24         |
| LT4     | 108         | 112             | 116        | 165                 | 34          | 29          | 26          | 16         |
| LT5     | 115         | 114             | 117        | 170                 | 42          | 43          | 32          | 18         |
| LT6     | 132         | 125             | 122        | 170                 | 40          | 44          | 31          | 20         |
| LT7     | 141         | 117             | 112        | 165                 | 36          | 42          | 28          | 18         |
| LT8     | 129         | 118             | 117        | 170                 | 40          | 45          | 27          | 17         |
| LU1     | 139         | 123             | 121        | 170                 | 47          | 44          | 41          | 22         |
| LU2     | 127         | 126             | 123        | 160                 | 37          | 46          | 27          | 21         |
| LU3     | 127         | 124             | 123        | 170                 | 44          | 41          | 29          | 20         |
| LU4     | 115         | 113             | 119        | 150                 | 30          | 38          | 23          | 19         |
| LU5     | 121         | 114             | 119        | 141                 | 27          | 35          | 21          | 22         |
| LU6     | 117         | 123             | 132        | 166                 | 33          | 42          | 25          | 23         |
| LU7     | 132         | 129             | 123        | 170                 | 45          | 44          | 41          | 23         |
| LU8     | 112         | 112             | 119        | 147                 | 31          | 38          | 22          | 19         |
| Average | 122.94      | 120.25          | 121.44     | 163.88              | 38.00       | 41.50       | 28.69       | 20.69      |

Information:
LT: Central Lombok
LU: North Lombok

The results obtained in Table 1.1 show a slight difference with the results obtained by Anggaraeni et al [7], who found that the average body length, shoulder height, hip height, chest circumference, and chest width of male buffalo in NTB respectively were 120. 3 cm; 121.8 cm; 119.4 cm; 164.5 cm; and 57.0 cm. Whereas in this study, various results were obtained compared to the results of the study. The average body length in this study amounted to 122, 94 cm, greater than the results of Anggaraeni et al [7], which is 120.3 cm, but smaller than the results of the study.
of Sitorus and Anggraeni [8], which amounted to 129.50 cm. Characteristics of shoulder height, hip height, chest circumference, and chest width obtained in this study (120.25 cm; 121.44 cm; 163.88 cm; and 38.00 cm) were slightly lower than the results of the measurement of buffalo swamp by Sitorus and Anggraeni [8] in Sumatra, which are 126.38 cm respectively; 125.56 cm; 182.16 cm; and 38.72 cm.

In this study, the measurement of buffalo’s morphological characters was not differentiated by sex, so the measurement results obtained were a mixture of morphometric measurements from male and female individuals. In contrast to previous studies conducted by Sitorus and Anggraeni [8], and Anggaraeni et al [7] which distinguishes buffalo morphometric size based on sex, so that the size can be distinguished between male and female. However, based on the results of a study by Anggaraeni et al [7], it is known that in general there is no significant difference between male and female body sizes. The results obtained in this study reinforce the assumptions of Anggaraeni et al [7]. Based on the results of one way anova analysis of eight buffalo’s morphological characters, it was found that there was no difference in the average value of eight buffalo morphological characters in North Lombok and Central Lombok regencies, both male and female individuals (Table 1.2). These results indicate the uniformity of buffalo body size in the two observation areas. This is presumably because the local buffalo which is the object of research has the same type, namely the type of mud buffalo (swamp buffalo). In addition, the uniformity of body measurements illustrates the high morphometric similarity of a group and the low variation in body measurements that make up body shape conformation [8].

Table 3.2. Results of One Way Anova Analysis of Each Morphological Character

| No | Morphological Character | Sig. |
|----|-------------------------|------|
| 1  | Body Length             | .766 |
| 2  | Shoulders height        | .881 |
| 3  | Hip height              | .513 |
| 4  | Chest circle            | .050 |
| 5  | Chest width             | .402 |
| 6  | Head Length             | .671 |
| 7  | Head Height             | .967 |
| 8  | Head width              | .539 |

3.2 Result of PCA Analysis

To find out the grouping of buffalo based on eight morphological characters from the two observation districts, namely North Lombok Regency and Central Lombok Regency, an analysis of PCA (Principle Componen Analysis) was carried out. The results of the PCA analysis is shown in Figure 3.1 below.

Figure 3.1 Results of PCA Analysis 16 Buffalo Individuals from Two Observation Areas (blue: individual buffalo in Central Lombok, red: individual buffalo in North Lombok)
The results of PCA analysis in Figure 3.1 reveal the spread of the morphometric linear size of buffalo bodies in North Lombok and Central Lombok. Based on Figure 3.1 it is known that the morphological distribution map of buffaloes is divided into two groups, namely group 1 which represents only North Lombok buffalo located in quadrant III, while group 2 represents buffalos’ morphological mixing in North Lombok and Central Lombok which is located in quadrant I, II, and IV. These results reinforce the results of previous studies conducted by Anggaraeni et al [7] which found a grouping of buffalo morphology distribution specifically from the West Nusa Tenggara region compared to swamp buffalo from North Sumatra, Central Java, South Kalimantan, South Sulawesi, and Banten. However, this research needs to be strengthened again by increasing the number of samples and the number of districts so that they can represent the entire NTB region.

3.3 Result of Cluster Analysis

The results obtained from PCA analysis need to be strengthened by analyzing the cluster of individual buffalo from the two observation regions. Cluster analysis was carried out using the euclidian distance method which was assisted by the PAST program. The results of cluster analysis is shown in the following Figure 3.2.

![Figure 3.2 Results of Analysis of Individual Buffalo Clusters from Two Districts, namely Central Lombok Regency (LT) and North Lombok (LU)](image_url)

Based on the analysis result of buffalo individual clusters from two different districts in Figure 1.2, it is known that some buffalo individuals from Central Lombok and North Lombok form separate groups as in individuals LT2 with LU6, and clusters LT6, LU3, and LT8. These results indicate that there are similarities between individual buffaloes which are grouped based on eight morphological characters. Phylogenetic analysis of local buffalo in NTB, especially in Central Lombok Regency, has been carried out by Sukri [9] who carried out phylogenetic tree reconstruction based on microsatellite DNA markers in two different buffalo populations. The results of the study show that genetic mixing occurred between the two buffalo populations studied. It is believed that it is caused by the spreading of buffalo individuals in each population is still open. Although the results of this study indicate the grouping of several individuals in North Lombok buffalo with Central Lombok in one cluster, but it cannot be ascertained whether genetic mixing has occurred or not between the two buffalo populations. Because naturally, the possibility of
breeding between the two populations cannot be done because of the large number of separators between the two populations.

The results obtained in this study only describe the kinship between two buffalo populations which are seen based on their morphological characters. It is very possible if buffalo individuals in North Lombok Regency have morphological characters that are similar or similar to buffalo individuals in Central Lombok Regency, this could be due to environmental influences. According to Surahman [10], there are some weaknesses of using morphological markers in carrying out reconstruction of phylogenetic trees that is highly influenced by the environment and often cannot distinguish genotypes between individuals. To complement this study, it is expected that in future studies, phylogenetic analysis or kinship of buffalo in West Nusa Tenggara is carried out by using DNA markers in order to obtain more stable and better results.

4. Conclusion

Based on the results of one way Anova analysis of eight buffalo’s morphological characters which include (1) body length, (2) shoulder height, (3) hip height, (4) chest circumference, (5) chest width, (6) head length, (7) head height, and (8) head width, it is known that there is no difference in the mean values of each character in the two observation areas, i.e. North Lombok District and Central Lombok Regency. The results of PCA analysis revealed a map of buffalo’s morphology distribution which was divided into two groups, i.e. group 1 which representing only North Lombok buffalo located in quadrant III, while group 2 represented a mixture of buffalo morphology in North Lombok and Central Lombok located in quadrant I, II, and IV. The results of the cluster analysis show that some individuals from North Lombok have similarities with Central Lombok buffalo based on eight morphological characters.

5. References

[1] Lombokutarakab.go.id. (2016). Kabupaten Lombok Utara., http://www.lombokutara.go.id/v1/images/doc/2014/gambaranekonomi.pdf.
[2] Disnakkeswan Prov NTB. (2016). Populasi Ternak. http://www.disnakkeswan.ntbprov.go.id/informasi-2/populasi-ternak/.
[3] Hilmiati, N. (2008). Potensi Kerbau Sebagai Substitusi Daging Sapi di Nusa Tenggara Barat, http://www.ntb.litbang.deptan.go.id/index.php?.
[4] Badan Pusat Statistik Lombok Tengah. (2010). Lombok Tengah Dalam Angka 2008/2009. http://www.lomboktengahkab.go.id/download/tani1.pdf.
[5] Muthalib, H.A. (2005). Potensi Sumberdaya Ternak Kerbau di Nusa Tenggara Barat. Lokakarya Nasional Usaha Ternak Kerbau Mendukung Kecukupan Daging Sapi: Dinas Peternakan Propinsi Nusa Tenggara Barat.
[6] Agung, PP.,Ridwan, M.,Handrie, Indriawati, Saputra, F.,Supratono, & Erinaldi. (2014). Profil Morfologi dan Pendugaan Jarak Genetik Sapi Simmental Hasil Persilangan. JITV, 19 (2), 112-122.
[7] Anggraeni, A.,Sumantri, C.,Prahariani, L.,Dudi, & Andreas, E. (2011). Estimasi Jarak Genetik Kerbau Rawa Lokal Melalui Pendekatan Analisis Morfologi. JITV, 16(3), 199-210.
[8] Sitorus, A.J, & Anggraeni, A. (2008). Karakterisasi Morfologi dan Estimasi Jarak Genetik Kerbau Rawa, Sungai (Murrah) dan Silangannya di Sumatera Utara. http://www.petermakan.litbang.pertanian.go.id/fullteks/lokakarya/lkbo08-5.pdf.
[9] Sukri, A. (2014). Analisis Filogenetik Kerbau Lokal Lombok Tengah (Bubalus bubalis) Berdasarkan Penanda DNA Mikrosatelit. Florea, 2(1), 52-55.
[10] Surahman, M. (2002). Peta genetika tanaman, prinsip dan aplikasinya. Bul.Agron, 30(1), 27-30.