

Factor Analysis of Body Measurements of Zobawng Cows - A Local Hill Cattle of Mizoram, India

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Abstract

Twenty different biometric traits (body length, height at withers, heart girth, paunch girth, forehead width, arm length, elbow length, fore-shank length, thigh length, hind shank length, pes length, tail length, switch length, ear length, head length, eye to eye space, circumference of neck, neck length, circumference of horn and space between horns) in 50 cows of Mizoram local cattle "Zobawng" were recorded from native tracts (*viz.* Champhai and Saiha districts) of Mizoram, India and analyzed by Principal component analysis to explain body conformation. The average of these various traits indicates the local cattle of Mizoram is of smaller type of cattle. Factor analysis with promax rotation revealed five factors which explained about 75.052% of the total variation. Factor 1 described the general body conformation and explained 34.117% of total variation. It was represented by significant positive high loading for leg characteristics (*viz.* arm length, elbow length, fore shank length, thigh length and hind shank length) and neck length. The result suggests that principal component analysis (PCA) could be used in breeding programs with a drastic reduction in the number of biometric traits to be recorded to explain body conformation.

Keywords: Biometric Traits, Local Cattle of Mizoram, Principal Component Analysis, Zobawng

Introduction

Body dimensions have been used to indicate breed, origin and relationship or shape and size of an individual as they give an idea of body conformation. However, principal component analysis (PCA) is a refinement and can explain relationships between biometric traits in a better way when the recorded traits are correlated. It provides information about the relative importance of each variable in characterizing the individuals. This analysis transforms an original group of variables into another group, principal components, which are linear combination of original variables. A small number of these new variables are usually sufficient to describe the individual without losing too much information. The indigenous cattle of Mizoram are still considered as non-descript cattle in the country. Therefore, the present research was undertaken to study the different body measurements, relationships among different body measurements and to develop unobservable factors (latent) to define which of these measures best represent body conformation in cows of local cattle of Mizoram. Thus, the study will help in stabilizing these cattle as a breed and to indulge in the conservation strategies.

Materials and Methods

Source of Data

Data consisted of 20 different body measurements on 50 local cows of Mizoram were collected from their native tract *i.e.*, Champhai and Saiha districts of Mizoram, India. All measurements were recorded twice by the same recorder to minimize the error and to avoid between-recorder effects. The circumference measurements were taken by a measuring tape while the other measures were taken by a mapping stick. The recorded body measurements were body length, height at withers, heart girth, paunch girth, forehead width, arm length, elbow length, fore-shank length, thigh length, hind shank length, pes length, tail length, switch length, ear length, head length, eye to eye space, circumference of neck, neck length, circumference of horn and space between horns.

Statistical Analysis

Mean, standard error and coefficient of variation of body measurements were calculated using SPSS 16.0 software. Data collected were analysed using fixed effect model, by considering the districts effect as fixed so as to adjust the data for significant effect of village if any for further analysis.

Principal Component Analyses

The objective of principal component analysis is to account for the maximum portion of the variance present in the original set of variables with a minimum number of composite variables. Promax rotation was used for rotation of principal factors through the transformation of the factors to approximate a simple structure. The Kaiser rule criterion (Johnson and Wichern, 1982) was used to determine the number of factors *i.e.*, retaining only the factors that have eigen value greater than one. Kaiser's measure of sampling adequacy (MSA) was used to determine whether the common factor model was appropriate. All the analysis was carried out using the SPSS (2001) statistical package for social science.

Results and Discussions

Morphometric Traits

The basic descriptive statistical parameters for all the 20 body measurements in Zobawng cows are presented in Table 1. The body measurements showed insignificant effect of district. There was low coefficient of variation for all the biometrical traits under study. The morphometric characteristics observed in the present study suggested that indigenous bull of Mizoram (Fig. 1) are small size cattle, with short and horizontally placed ears, long tail almost similar to local cows of Manipur (Tolenkhomba *et al.*, 2012) and Siri cattle of Sikkim (Phanchung and Roden, 1996).

The average body length, height at withers and chest girth of adult females of local cattle of Mizoram were more or less similar to other hill cattle of country. In earlier study, Tolenkhomba *et al.* (2013) reported, comparable height at withers (111.34 cm), chest girth (135.34 cm) and paunch girth (140.31 cm) but shorter body length (103.92 cm)

in local cattle of neighboring state Manipur. In another study for Assam hill cattle of India (Kayastha *et al.*, 2011), hearth girth and height at withers were reported as 135.34 cm and 111.34 cm, respectively, similar to present finding. Gaur *et al.* (2004) recorded almost similar heart girth (140.6±0.50 cm), but shorter body length (102.5±0.5 cm) in adult males of Ponwar cattle. Singh *et al.* (2002) also reported higher height at withers (134.36±2.03 cm) in male Deoni cattle.

Table 1: Mean with standard error of various biometric traits of local cows of Mizoram

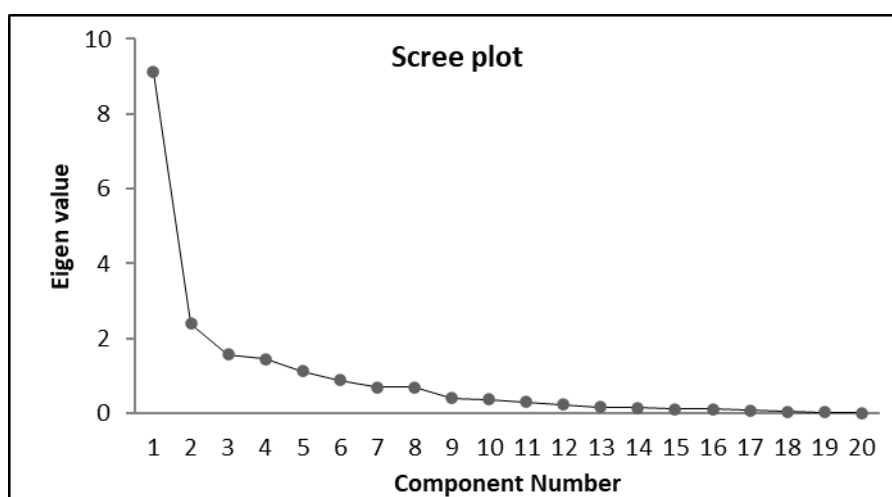
Traits	Measurement	Mean±SE (cm)	Coefficient of variation (%)
Body length	Length between the point of shoulder up to the point of pin bone was measured for both sides and the average was recorded	113.16±1.45	10.25
Height at withers	Distance from the highest point of wither to the ground after allowing the animal to stand	106.58±0.72	5.09
Heart girth	It was measured as circumference of the heart	138.82±1.27	8.98
Paunch girth	Circumference at the pouch region just anterior to the hip joint	144.33±1.48	10.47
Forehead width	Distance between front of both eyes	14.37±0.08	0.57
Arm length	Length between the point of shoulder up to the point of elbow	30.71±0.10	0.71
Elbow length	Length between the knee joint up to the point of elbow	30.43±0.09	0.64
Fore-shank length	Length between the pastern joint up to the knee joint	29.89±0.10	0.71
Thigh length	Length between the hip joint up to the stifle joint	30.50±0.10	0.71
Hind shank length	Length between the pastern joint up to the hock joint	32.71±0.11	0.78
Pes Length	Length between the tarsal joint / hock joint up to the end of distal phalange	31.47±0.10	0.71
Tail length	Length between the root of the tail up to the tip excluding switch at the tip	72.23±0.46	3.25
Switch Length	Length between the tip of the tail up to the end of the switch	24.80±0.28	1.98
Ear length	Distance from the point of attachment of ear to the tip of the ear	15.00±0.09	0.64
Head length	Length from the poll up to the tip of the nostril (Excluding the muzzle) along the nasal bone	35.40±0.11	0.78
Eye to eye space	Distance between the inner canthuses	24.22±0.10	0.71
Neck circumference	Circumference at the middle of the neck	58.85±0.12	0.85
Neck length	Distance from neck attachment to breast	30.49±0.10	0.71
Circumference of horn	Recorded at three places viz. at base, middle and tip for two horn separately and the average was taken	12.78±0.07	0.49
Space between the horns	Space between two horns were measured at three places viz., space between two horns at base, middle and tip	5.81±0.06	0.42

Factor Analysis

The Anti-image correlations computed showed that the partial correlations were low, indicating that true factors existed in the data. This was supported by Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy which was 0.741. Similar estimate of KMO (0.75) was reported by Verma *et al.* (2015) in local cattle of Himalayan state. Tolenkhomba *et al.* (2012) reported lower estimates of sampling adequacy as 0.609 in Manipur bulls. Whereas, Pundir *et al.* (2011) reported higher estimate (0.81) in Kankrej cattle. The estimate of sampling adequacy Kaiser-Meyer-Olkin (KMO) revealed the proportion of the variance in different biometric traits caused by the underlying factors. The overall significance of the correlations tested with Bertlett's test of Sphericity for the biometric traits (chi-square was 7062, P<0.01) was significant and provided enough support for the validity of the factor analysis of data. Smaller estimate of Bertlett's test of Sphericity (5,182.01) as compared to the present study were observed in Kankrej cattle by Pundir *et al.* (2011).

Table 2: Total variance explained by different factors in cows of local cattle of Mizoram

Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings ^a
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	6.823	34.117	34.117	6.823	34.117	34.117	5.787
2	3.266	16.328	50.445	3.266	16.328	50.445	3.93
3	2.395	11.976	62.421	2.395	11.976	62.421	2.043
4	1.393	6.967	69.388	1.393	6.967	69.388	1.662
5	1.133	5.664	75.052	1.133	5.664	75.052	1.588
6	0.872	4.360	79.412				
7	0.854	4.269	83.681				
8	0.684	3.419	87.100				
9	0.612	3.060	90.159				
10	0.513	2.563	92.722				
11	0.419	2.097	94.819				
12	0.316	1.582	96.401				
13	0.218	1.089	97.490				
14	0.208	1.039	98.529				
15	0.113	0.567	99.096				
16	0.082	0.411	99.507				
17	0.049	0.245	99.752				
18	0.031	0.153	99.905				
19	0.016	0.079	99.984				
20	0.003	0.016	100.000				

**Figure 2:** Scree plot showing component number with eigen values.

The estimated factors loading extracted by factor analysis, eigen values and variation explained by each factor are presented in Table 2 and scree plot in Fig. 2. There were five factors extracted with eigen values greater than 1 and accounted for 75.052% of total variance. In previous study, Tolenthomba *et al.* (2012) extracted seven factors with eigen values greater than 1 in cows of local cattle of Manipur. However, Yakubu *et al.* (2009) and Putra *et al.*, (2020) extracted two factors each explaining 86.47% and 73.36% of the total variation in White Fulani bulls and Pasundan cows, respectively. In the present study, the first factor accounted for 34.117% of the variation out of the total of 20 original measurements. It was represented by significant positive high loading for leg characteristics (viz. arm length, elbow length, fore shank length, thigh length and hind shank length) and neck length. This factor seemed to be explaining the body of the bull, *i.e.*, general size of the bull.

In previous study, Tolenkhomba *et al.* (2012) extracted lower first factor accounting for 17.37% of the variation out of the total of 15 original measurements in Manipuri cows. It was represented by height at wither, heart girth, paunch girth and ear length. Pundir *et al.* (2011) reported in Kankrej cows that the first factor explained 38.89% of total variation.

The second factor accounted for 16.328% of total variability in cows. It had comparatively higher loading for body length, hearth girth and paunch girth. In cows of local cattle of Manipur, the second factor accounted for 11.711% of total variability with comparatively higher loading for body length and pes length (Tolenkhomba *et al.*, 2012). The third factor accounted for 11.976% of total variation with high loading for tail length and switch length. The fourth and fifth factors accounted for 6.967% and 5.664% respectively of total variation with no significant high loading for any trait.

Table 3: Component matrix of different factors for biometric traits in cows of local cattle of Mizoram

Traits	Component				
	1	2	3	4	5
Body length	0.226	0.582	0.103	0.299	-0.246
Height at withers	-0.289	0.499	0.465	0.037	0.164
Heart girth	0.489	0.797	-0.087	-0.110	0.126
Paunch girth	0.491	0.799	-0.101	-0.151	0.102
Forehead width	0.613	0.542	0.107	0.154	-0.033
Ear length	0.545	0.590	-0.110	-0.275	-0.162
Tail length	-0.162	0.015	0.519	0.684	-0.293
Switch Length	0.274	-0.043	0.716	0.289	0.023
Neck circumference	0.253	0.007	0.503	0.115	0.461
Neck length	0.835	-0.300	-0.233	0.183	-0.068
Arm length	0.919	-0.300	-0.043	0.123	0.050
Elbow length	0.901	-0.308	-0.176	0.043	-0.028
Fore-shank length	0.918	-0.176	0.002	-0.069	-0.013
Thigh length	0.924	-0.294	-0.035	0.019	0.013
Hind shank length	0.899	-0.284	-0.100	0.122	0.062
Pes Length	-0.278	0.225	-0.545	0.235	0.315
Eye to eye space	-0.051	-0.410	0.488	-0.348	0.458
Head length	0.379	-0.008	0.430	-0.384	-0.391
Circumference of horn	0.473	0.263	0.107	0.140	0.440
Space between the horns	0.256	0.015	0.513	-0.436	-0.161

In bulls of local cattle of Manipur, third factor accounted for 10.49% of total variation, containing high loading for neck length and hind leg length. The fourth factor accounted for 9.07% of total variation with high loading of fore leg length and tail length. The fifth factor accounted for 8.24% and of total variation containing high loading for switch length and six factors, 7.67% with no particular variable having high loading (Tolenkhomba *et al.*, 2013). The communality ranged from 0.518 (circumference of horn) to 0.942 (hind shank length) and unique factors ranged from 0.482 to 0.046 for all the 20 different biometric traits (Table 4). Tolenkhomba *et al.* (2013) reported communality ranged from 0.597 (body length) to 0.857 (hind girth) in local bulls of Manipur. Approximate range of communality *i.e.*, 0.42 to 0.87 was reported by Sadek *et al.* (2006) in Arabian mares. Similar estimates of communality (ranged from 0.79 to 0.93) were observed by Yakubu *et al.* (2009) in White Fulani cattle. The inter-factor correlations between different factors ranged from -0.042 to 0.358 in cows. The first factor showed positive correlation with factors 2, 3 and 4 and negative with 5. In bulls of local cattle of Manipur, narrower range of inter-factor correlations *i.e.*, -0.07 to 0.17 was reported by Tolenkhomba *et al.* (2013). The first factor showed positive correlation with all other factors except the sixth factor.

Table 4: Communalities of different morphometric traits in cows of local cattle of Mizoram

Morphometric traits	Initial	Extraction	Unique factor
Body length	1	0.550	0.450
Height at withers	1	0.577	0.423
Heart girth	1	0.910	0.090
Paunch girth	1	0.923	0.077
Forehead width	1	0.705	0.295
Ear length	1	0.759	0.214
Tail length	1	0.850	0.150
Switch Length	1	0.673	0.327
Neck circumference	1	0.542	0.458
Neck length	1	0.880	0.120
Arm length	1	0.954	0.046
Elbow length	1	0.940	0.060
Fore-shank length	1	0.879	0.121
Thigh length	1	0.942	0.058
Hind shank length	1	0.917	0.083
Pes Length	1	0.579	0.421
Eye to eye space	1	0.739	0.261
Head length	1	0.628	0.372
Circumference of horn	1	0.518	0.482
Space between the horns	1	0.545	0.455

The five extracted factors determine the source of shared variability to explain body conformation in local bulls of Tripura. The first factor contributes effectively to explain general body conformation in local cows of Mizoram. The results suggests that principal component analysis (PCA) could be used in breeding programs with a drastic reduction in the number of biometric traits to be recorded to explain the body conformation.

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Conflict of Interests

There is no conflict of interest.

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