Phenotype and Genetic Analysis of Growth Characteristics of Sabu and Semau Chickens Which are Conserved Ex-Situ

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Abstract. Sabu and Semau chickens are originated from Sabu and Semau islands, East Nusa Tenggara. The aim of this study was to analyze the phenotypic and genetic of growth characteristics of Sabu and Semau chickens which were conserved ex-situ. Four mating groups as treatments and each using 4 males and 24 females, produced 144 chicks as research material. Mating was by artificial insemination. Observations include data on body weight from the age of 0 - 12 weeks. Nested design analysis were used to obtain the variance components used to estimate the heritability. Heritability was estimated based on male, female, and total variance. The results showed that the body weight resulting from the interse mating (SS) was better than other crosses. The estimation of heritability based on male variance ($h^2_S$), SS, MM, and SM showed positive values, while MS are more negative, except 8 weeks of age. Likewise based on females ($h^2_D$) and the total variance ($h^2_{S+D}$). Heritability estimates of body weight were low to hight (-2.31 to 2.33) due to small data or sample size. It can be concluded that Sabu and Semau chickens can be conserved ex-situ.

Keywords: Sabu and Semau, phenotype, genetic, growth, heritability

1. Introduction
Native chicken is one of Indonesia's natural resources, which until now has enough role in supporting the provision of nutrition for the community, especially food sources of animal protein. In addition, native chicken is a reliable source of daily income, especially for low-income communities both in the village and in the city and is a flexible medium of exchange, which can help meet the needs of their owners. Local chicken in the future will still be the foundation as a source of food to meet the needs of animal protein because of some things that benefit the community: cheap, easy to get and liked. Improve local chicken production is necessary to achieved a poultry industry that is both economically viable and self-sustaining. To speed up the poultry industry to better meet the needs in the country and compete in the global market, then the development of chicken farms should not rely only on hybrid chicken. This is based on several considerations, namely: (1) hybrid chicken was very high dependency level on overseas in the procurement of production facilities (seeds, rations, medicines) and technology, (2) the spread of hybrid chicken products have not been able to reach the isolated area, limited only around big cities [15]
Local chickens in the tropics have high genetic variability within their populations [6] and [13] indicating high potential for genetic improvement of these chickens through selective breeding [2]. To effectively local chicken resource, knowledge of genetic variation growth characteristics are very necessary.

Some local chickens that are spread in East Nusa Tenggara (NTT) Province such as Sabu chicken and Semau chicken which have specific advantages and can be used to increase production and productivity of native chickens as well as to fulfill food needs [15] because Sabu chicken has been known good growth rate so that it can produce a higher adult body weight than other native chickens in NTT. Likewise in case with Semau chickens which are alleged to have better disease resistance and maternal abilities. If the two types of chicken are crossed, chicken can be obtained which is fast growth and disease resistant.

In addition, data on the Livestock Service Office of East Nusa Tenggara Province showed that the population of native chickens on the Sabu island has been very small (47,883 heads) and is the lowest population of the 21 regencies/cities after Kupang city, so conservation is now needed. Conservation can be done both in the place of origin (in-situ) and outside the area of origin (ex-situ). The focus of this research is the conservation efforts of Sabu and Semau chickens outside their original areas.

In the context of conservation, knowledge of the growth characteristic both phenotypically and genetically is needed. The estimated variance components and heritability values are needed in conducting livestock selection. Variance component estimation enables the breeders to understand the genetic mechanisms underlying the growth characteristic. Estimates based on sire variance components to determine the proportion of additive variance of the total variance while estimates of additive genetic heritability reflect the degree of inheritance. The estimation of genetic parameters especially additive genetic heritability is therefore essential for designing effective selection programs for the improvement growth characteristic of local chickens. The objectives of this study was to analyze the phenotype and genetic of growth characteristics of Sabu and Semau chickens which were conserved ex-situ.

2. Methodology
This study used 32 adult chickens as parents consisting of 4 Sabu males and 12 Sabu females and 4 Semau males and 12 Semau females. The chickens were mated well through pure marriage (interse mating), namely the Sabu male mated with Sabu females and Semau males mated with Semau females, and crossing, namely Sabu males mated with Semau females and Semau males mated with females Sabu.

Feed given to parents was 395 chicken feed mixed with fine corn and rice bran with 18% protein content and ME 2800 kcal/kg. Feed for chicks consists of BR1 during the starter period of 0-4 weeks, and then BR2 is given until the age of 12 weeks. Feed and water were given in ad libitum. Male and female elders are placed in individual cages, while their offspring are kept in group cages based on mating groups. Mating was by artificial insemination. Observations include data on body weight from the age of 0 to 12 weeks.

Nested design analysis were used to obtain the variance components used to estimate the heritability. Heritability was estimated based on male, female, and total variance. This design mathematical model is:

$$Y_{ijkl} = \mu + \alpha_i + \beta_{ij[i]} + \gamma_{ik[i]} + \varepsilon_{ijkl}$$

Where: $Y_{ijkl}$ is the observation value, $\mu$ is overall mean, $\alpha_i$ is the effect of male, deviation from mean of $i$, $\beta_{ij[i]}$ is the $j$th effect of female nested within the $i$th male, $\gamma_{ik[i]}$ is the $k$th observation nested within $j$th female within $i$th male, and $\varepsilon_{ijkl}$ is random error.

The treatments given were 4 groups of mating, namely:
SS = male Sabu >< female Sabu; MM = Semau male >< Semau female
SM = male Sabu >< female Semau; MS = male Semau >< female Sabu

Each treatment was repeated 4 times, and each replication consisted of 1 male and 3 females. Data obtained were analyzed using SPSS version 23 software.

3. Result And Discussion

Phenotype Analysis

The effect of the mating group on the body weight of chicks from day old chick to the age of 12 weeks as shown in Table 1.

| Mating Groups | Age (weeks) |
|---------------|-------------|
|               | 0           | 4           | 8           | 12          |
| SS            | 28.39 ± 2.10| 209.67 ± 5.26a| 610.42 ± 14.86a| 1024.94 ± 16.76a|
| MM            | 28.28 ± 2.78| 206.83 ± 6.28ab| 602.31 ± 15.18ab| 1012.03 ± 21.31ab|
| SM            | 28.61 ± 3.94| 207.47 ± 7.22ab| 604.31 ± 18.71ab| 1014.97 ± 23.08ab|
| MS            | 27.53 ± 4.03| 206.11 ± 6.90b | 600.83 ± 19.05b | 1003.03 ± 35.95b |

1SS = Sabu><Sabu; MM = Semau><Semau; SM = Sabu><Semau; MS = Semau><Sabu
2Means in the same column with common superscript are not significantly difference [P>0.05]

The data in Table 1 shows that the weight of chicks is based on mating groups, SS is significantly better than the other groups. At day old, the highest initial chicken weight was observed in the SS group while the lowest was noted in MS group. However, statistical analysis of the initial chicks weight showed that the differences among mating groups were not significant. The average initial body weight in this study at 0 day old was in accordance with reported by [5] but was lower than that reported by [4]. The results obtained are closely similar to those reported by [16] that the DOC weight of KUB chickens ranges from 26.8 to 28.5 grams.

At 4, 8, and 12 weeks of age, the SS mating group was consistently higher than the other groups. The present study was in agreed with those found by [4] and [8], higher than those found by [5] but lower than those reported by [7]. The differences could be attributed to differences in native chicken used, management, and environmental effects.

Significant differences among progeny means were noted at 4, 8, and 12 week of age. At 4, 8, and 12 week of age, the highest body weight was observed in the interse mating SS, followed by SM, MM, and the lowest was noted in MS. The SS mating group has a better body weight than the other groups from 4 to 12 weeks of age. Duncan’s test performed SS was significant difference (P<0.05) than MS, but non-significant differences than MM and SM.

The results obtained in this present study explain that Sabu males are able to inherit growth charateristic for their offspring. Male Semau will produce better offspring when mated with female Semau, but in crossing with female Sabu produced the lowest body weight from 0 to 12 weeks of age. Mating between Sabu males and Sabu female or Semau females could be produced offspring that have good enough body weight from 0 to 12 weeks of age. Based on the results obtained, it is necessary to consider cross between Semau males with Sabu females but overall body weight at 12-week-old chickens in this study was higher than that found by [14] that observed at indigenous Assel chicken.

Distribution of variance components

The estimation of the variance component is done by analyzing the hierarchical variance system and the results are presented in Table 2.
Table 2. Distribution of variance components of Sabu and Semau chicken based on mating groups

| Mating Groups | Age [week] | $\sigma^2_s$ | $\sigma^2_d$ | $\sigma^2_{s+d}$ | $\sigma^2_e$ | $\sigma^2_{I}$ |
|---------------|------------|------------|------------|----------------|------------|------------|
| SS            | 0          | -1.50      | -0.19      | -1.83          | 5.17       | 3.48       |
|               | 4          | -2.00      | 11.16      | 9.16           | 26.90      | 36.06      |
|               | 8          | 111.43     | -54.78     | 56.65          | 221.48     | 278.13     |
|               | 12         | 16.41      | -57.46     | -41.05         | 295.60     | 254.55     |
| MM            | 0          | 5.20       | -4.08      | 1.12           | 7.82       | 8.94       |
|               | 4          | 15.88      | -13.38     | 2.50           | 40.75      | 43.25      |
|               | 8          | 0.71       | 84.87      | 85.58          | 227.78     | 313.36     |
|               | 12         | -198.76    | 177.23     | -21.53         | 564.58     | 543.05     |
| SM            | 0          | 5.27       | -3.25      | 2.02           | 14.99      | 17.01      |
|               | 4          | 3.82       | -7.34      | -3.52          | 53.84      | 50.32      |
|               | 8          | 899.31     | -41.07     | 858.24         | 292.27     | 1,150.51   |
|               | 12         | -92.04     | -158.26    | -550.30        | 683.04     | 432.74     |
| MS            | 0          | -5.58      | 6.99       | 1.41           | 17.17      | 18.58      |
|               | 4          | -19.55     | 15.51      | -4.04          | 50.47      | 46.43      |
|               | 8          | 54.77      | -51.28     | 3.49           | 376.23     | 379.72     |
|               | 12         | -65.30     | -147.05    | -212.35        | 1,556.22   | 1,343.87   |

1SS = Sabu×Sabu; MM = Semau×Semau; SM = Sabu×Semau; MS = Semau×Sabu

Data on Table 2 showed that the male variance components in the SS group only appeared at 8 and 12 weeks, while in MM and SM groups appeared at 0, 4 and 8 weeks of age. In the MS crossing group additive variance only appears at the age of 8 weeks. Based on the female component, component variance appeared at 4 weeks (SS), 8 and 12 weeks (MM), 0 and 4 weeks (MS), while group SM did not appear at all. Based on full sib relationship, variance components were appear at 4 and weeks of age (SS), 0, 4, 8 weeks (MM), 0 and 8 weeks of age (SM and MS). Distribution of variance components based on $\sigma^2_s$, $\sigma^2_d$, and $\sigma^2_{s+d}$ ranged from low to high (-550.30 to 899.31) indicated that some of variance components were not applicable.

The distribution of component variance in all mating groups shows varying values, from very low to very high indicates that the genetic potential possessed by the parents cannot be fully passed on to the offspring. This might be caused by the parents used in this study not being properly selected. The variance components only increased until 8 weeks of age and dramatically decreased at 12 weeks of age. This finding is on the contrary to the reported by previous study that genetic variances increased from hatch to 12 weeks of age [9], [10], and [13]. The phenomenon of fluctuating components of variance in this study may possibly be caused by chickens used as parents in this study that have not undergone a selection process.

Estimated Heritability

Estimation of the heritability value of the body weight of Sabu and Semau chicken body weight based on mating group was carried out based on hierarchical analysis of variance and the results are presented in Table 3. Estimation was carried out based on the male components ($h^2_s$), female components ($h^2_d$) and the combined components of male female ($h^2_{s+d}$).

The heritability value estimated based on the component variance shows the number that varies whether between the mating groups or the age of the chicken. The heritability values based on $h^2_s$, $h^2_d$, and $h^2_{s+d}$ were ranged from low to high (-2.31 to 2.33). The value of inheritance based on male components (paternal half sib) shows a trend to decreases with increasing age of chickens. Based on maternal half sib ($h^2_d$), more negative values at 12 weeks (MM, BC, and MS crosses) were found. Likewise, the estimation was based on the combined component ($h^2_{s+d}$). The heritability for body weight in the present study was fluctuated and had negative value or greater than 1, so this was in agreement with [1] and [11] but agree with [12] and [13] that reported a fluctuating trend in heritability estimates of body weight. The differences between the study and the other reports could be
due to differences in species, environmental effects, method of estimation as well error due to small sample [3].

### Table 3. Heritability of Sabu and Semau chickens based on mating groups

| Age (week) | Heritability   | Mating Groups |
|------------|----------------|---------------|
|            | SS             | MM            | SM            | MS            |
| 0          | $h^2_S$        | -1.73         | 2.33          | 1.24          | -1.20         |
|            | $h^2_D$        | -0.11         | 1.16          | 0.62          | -0.60         |
|            | $h^2_{S+D}$    | -0.49         | 0.13          | 0.12          | 0.08          |
| 4          | $h^2_S$        | -0.22         | 1.47          | 0.30          | -1.68         |
|            | $h^2_D$        | -0.11         | 0.73          | 0.15          | -0.84         |
|            | $h^2_{S+D}$    | -0.49         | 0.06          | -0.07         | -0.09         |
| 8          | $h^2_S$        | 1.60          | 0.01          | 3.13          | 0.58          |
|            | $h^2_D$        | 0.80          | 0.00          | 1.56          | 0.29          |
|            | $h^2_{S+D}$    | 0.20          | 0.27          | 0.75          | 0.01          |
| 12         | $h^2_S$        | 0.26          | -1.46         | -2.31         | -0.19         |
|            | $h^2_D$        | 0.13          | -0.73         | -0.95         | -0.10         |
|            | $h^2_{S+D}$    | -0.16         | -0.04         | -0.51         | -0.16         |

However, the ability to inherit the body weight characteristics of Sabu chicken and Semau chicken is quite good. This can be seen from the growth of their offspring that is quite good from the age of 4 to 12 weeks. So it can be concluded that Sabu and Semau chickens can be conserved on *ex situ* systems.

### 4. Conclusion

Phenotypic analysis of the body weight characteristic of Sabu and Semau chicken showed that crossing of male Sabu with female Sabu produced better body weight than other crossing groups from 0 to 12 weeks of age. The distribution of components of variance were fluctuated whether based on the mating groups or chicken age. Estimation of heritability values based on half sib relationship shows tend to increase in value from the time of hatching to the age of 8 weeks, but decreases at the age of 12 weeks. The heritability value of this study is classified as medium. Both Sabu and Semau chickens can be conserved *ex-situ*.

### References

[1] M. A. Adelake, S. O. Peters, M. O. Ozoje, C. O. N. Ikeobi, and A. M. Bambgbose. 2011. Genetic parameters estimates for body weight and linear body weight measurements in pure and cross bred progenies of Nigerian indigenous chickens. *Livestock. Res. Rural. Dev.* 23(1):1-7.

[2] N. Dana, E. H. Vander-Waaij and J. A. Van-Arendonk. 2011. Genetic and phenotypic parameter estimates for body weights and egg production in Horro chicken of Ethiopia. *Trop. Anim. Health. Prod.* 43: 21–28.

[3] V. N. Egibulem and B. Okon. 2018. Genetic Parameter estimates of Guinea fowl (*Numida meleagris*) in South-South Region of Nigeria. *J. Ethio. Anim. Sci.* 1(1):000103.

[4] Eriko, Jatmiko, and H. Nur. 2016. Effect of partial substitution of commercial ration with rice bran on the performance of native chicken. *LLRD.* 2(1): 27-33

[5] S. Faruque, M. S. Islam, M. A. Afroz, and M. M. Rahman. 2013. Evaluation of the performance of native chicken and estimation of heritability for body weight. *J. Bangladesh Aca. Sci.* 37(1): 93-101.

[6] H. Halima, F. W. C. Nesper, A. De-Kock and E. Van-Marle-Koster. 2009. Study on the genetic diversity of native chickens in northwest Ethiopia using microsatellite markers. *African J. Biotech.* 8(7): 1347–1353.
C. V. Lisnahan, Wihandoyo, Zuprizal and S. Harimurti. 2017. Growth Performance of Native Chickens in the Grower Phase Fed Methionine and Lysine-Supplemented Cafeteria Standard Feed. *Pakistan. J. Nut.* 16: 940-944.

A. L. N’dri, B. H. W. Koua, V. S. Ahouchi, and A. B. Adepo-Gourène. 2018. Body weight and growths curve parameters evaluation of three chicken genotypes (Gallus gallus domesticus) reared in clausturation. *J. Advan. Vet. Anim. Res.* 5(2):188-195.

C. C. Ogbu and S. S. I. Omeje. 2011. Within population variation in performance Traits in the Nigerian Indigenous Chicken (NIC). *Int. J. Sci. Nat.* 2[2]: 192-197.

C. C. Ogbu, E.N. Nwachukwu, and C. C. Nwosu. 2015. Variance components and heritability of some growth parameters in purebred nigerian indigenous chickens. *ARPN J. Agric. Bio. Sci.* 10(5): 192-199.

I. J. Ohagenyi, C. I. Emannaa, O. V. Adelowo, S. B. Brenshak, and A. D. Udokainyang. 2012. Heritability estimates of growth traits of the Nigerian ecotype chicken. Proc. of 17th Annual Conference of Animal Science Association of Nigeria. September 9-13, 2012. University of Abuja, Nigeria. Pp: 63-66.

O. A, Ojo, G. N. Akpa, I. A. Adeyinka, and A. O. Iyiola-Tunji. 2010. Estimates of genetic parameters of body weight and conformation traits in Hubbard broiler breeder chicken. *Nigerian J. Anim. Sci.* 12: 15-22.

R. Osei-Amponsah, B. B. Kayang, and A. Naazie. 2015. Phenotypic and genetic parameters for production traits of local chickens in Ghana. *Ani. Gen. Resources.* 53: 45–50.

U. Rajkumar, S. Haunshi, C. Paswan, M. V. L. N. Raju, S. V. R. Rao, and R. N. Chatterjee. 2017. Characterization of indigenous *Aseel* chicken breed for morphological, growth, production, and meat composition traits from India. *Poultry Sci.* 96:2120–2126.

F. M. S. Telupere, H. Sutejo, and E. Hartati. 2017. Phenotypic study results of crosses between local chickens with layer chicken isa brown. 2017. *Proceedings The 7th International Seminar on Tropical Animal Production.* Pp. 788-794.

S. Urfia, H. Indrijani, and W. Tanwiriah. 2017. Growth Curve Model of Kampung Unggul Balitnak (KUB) Chicken. *JIT.* 17(1): 59-66.