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# Components of Variance for Some Economic Traits among Rhode Island Chicken Bred in the Northern Guinea Savanna Zone of Nigeria

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**Abstract:** The data used to calculate the variance components of various production traits was obtained from records of about 4000 hens daughters of about 180 cocks mated to about 1,500 dams and collected over 5 year period. Two strains of Rhode Island Chickens were involved in this study. Within the red strain population sire's contribution to total variation in age at first egg did not exceed 8.6% across the year and 6.9% in the white strain. Except for body weight at 40 weeks of the red strain where the contribution of the sire exceed 14%, the contribution of the sire to the total variation for all the economic traits considered in this study were generally low for both strain of the layer type chickens under consideration. Generally dam component of variance were higher most of the time and in many traits within the red strain population.

**Key words:** Rhode island chickens, animal breeding, layer

## Introduction

Components of variance have been shown to have a wide application in genetic and animal breeding research (Van Vleck and Searle, 1979, Iloeje *et al*., 1981, Iloeje, 1986). They are important in estimating the relative importance of sources of random variation which affect traits of economic importance, as well as being useful in predicting the breeding values of sires and dams. They are also useful for estimating phenotypic and genotypic variance which are very important for the estimation of heritabilities and repeatabilities which are also very critical in the design of effective breeding programmes.

In this report, estimates of sire, dam and sire+dam and error components of variance for some important economic traits in layer type chickens bred in northern guinea savanna zone of Nigeria are presented. The population under study have been under selection for 10 generations.

## Materials and Methods

The experiment was conducted at National Animal Production Research Institute of Ahmadu Bello University, Shika, Zaria which is geographically located between latitude 11 and 12°N and Longitude 7 and 8° E at altitude 640m above sea level in Northern part of Nigeria. The data used to estimate the heritability of various production traits was obtained from records of about 4000 hens daughters of about 180 cocks that were mated to about 1,500 dams. These records were collected over five years during which time selection for egg number to 280 days were practiced. The raw data were edited such that only records with complete information on the economic traits were used in the variance component analysis. Each record contain information on sire, dam, age at first egg, egg production to 280 days, matured egg weight, body weight at 280 days, egg mass and rate of lay.

Components of variance were estimated using the method of Harvey (1966). The statistical model used for variance component analysis is

$Y_{ijk} = \mu + S_i + d_{ij} + e_{ijk}$

Where $Y_{ijk}$ is the record of the k$^{th}$ progeny of j$^{th}$ dam mated to the i$^{th}$ sire.

$\mu$ is the common mean

$s_i$ is the effect of the i$^{th}$ sire

$d_{ij}$ is the effect of the j$^{th}$ dam mated to the i$^{th}$ sire

$e_{ijk}$ is the uncontrolled environmental and genetic deviations attributable to the individual.

All effects were random, normal and independent with expectations equal to zero. Maternal effect is assumed when the variance component from dam group is higher than that of sire component. However when the sire component of variance is higher than the dam component, then the major genes contributing to the expression of such traits are assumed to be sex linked.

## Results and Discussion

Table 1 and 3 showed the variance components obtained using full model (hierarchical) for Rhode Island Red and Rhode Island White Chickens. Table 2 and 4 showed the variance component from all sources as percentages of total variance. Where the variance component is calculated to be negative, the component is set at 0.

Within the red strain population sire's contribution to total variation in age at first egg did not exceed 8.6% across the year and 6.9% in the white strain. Except for body weight at 40 weeks of the red strain where the contribution of the sire exceed 14%, the contribution of the sire to the total variation for all the economic traits considered in this study were generally low for both

Table 1: Variance components (by generation) within the population of Rhode Island Red flocks

| | | Traits | | | | | |
|---|---|---|---|---|---|---|---|
| Gen | Source | ASM | Egg 280d | EWTAV | BWT40 | Lay Rate | Egg mass |
| 1 | sire | 19.75 | 10.59 | 1.28 | 1734.87 | 70.22 | 24570.58 |
| | Dam | 25.13 | 7.37 | 0.40 | 3320.16 | 0.00 | 15956.98 |
| | sire+dam | 44.88 | 17.96 | 1.68 | 5055.03 | 7.22 | 40527.56 |
| | within | 255.77 | 174.66 | 15.19 | 26541.87 | 183.05 | 549524.73 |
| | total | 300.65 | 192.62 | 16.88 | 31596.90 | 190.27 | 590052.29 |
| 2 | sire | 15.73 | 13.47 | 1.42 | 5730.83 | 10.44 | 34712.63 |
| | dam | 35.17 | 11.25 | 0.63 | 3064.74 | 9.67 | 34968.67 |
| | sire+dam | 50.91 | 24.71 | 2.05 | 8795.58 | 20.11 | 69681.30 |
| | within | 645.66 | 208.41 | 11.32 | 29874.14 | 273.84 | 614727.12 |
| | total | 696.56 | 233.12 | 13.37 | 38669.72 | 293.95 | 684408.423 |
| | sire | 27.62 | 3.77 | 2.06 | 865.50 | 7.40 | 16189.04 |
| | dam | 14.51 | 9.26 | 1.38 | 1294.42 | 3.04 | 29782.46 |
| | sire+dam | 42.13 | 13.03 | 3.44 | 2159.92 | 10.44 | 45971.50 |
| | within | 280.64 | 138.96 | 12.29 | 41332.76 | 269.57 | 418893.06 |
| | total | 322.76 | 151.98 | 15.73 | 43492.67 | 280.01 | 464864.56 |
| 4 | sire | 0.00 | 8.11 | 0.87 | 43.07 | 3.11 | 25385.30 |
| | dam | 203.28 | 15.65 | 0.71 | 1612.69 | 38.17 | 48973.64 |
| | sire+dam | 203.28 | 23.76 | 1.57 | 1655.76 | 41.28 | 74358.94 |
| | within | 718.43 | 161.62 | 15.54 | 40572.15 | 289.45 | 521082.84 |
| | total | 921.71 | 185.38 | 17.12 | 42227.91 | 330.73 | 595441.78 |
| 5 | sire | 5.18 | 14.46 | 0.81 | 2204.75 | 17.78 | 32009.27 |
| | dam | 18.96 | 0.00 | 1.36 | 781.51 | 0.00 | 7455.39 |
| | sire+dam | 24.14 | 14.46 | 2.17 | 2986.25 | 17.78 | 39464.66 |
| | within | 193.46 | 163.52 | 10.94 | 36297.34 | 239.55 | 367505.53 |
| | total | 217.61 | 177.98 | 13.11 | 39283.60 | 257.34 | 406970.19 |

Table 2: Variance components (by generation) within the population of Rhode Island flocks as a percentage of total variance

| Year | Source | Traits | | | | | |
|---|---|---|---|---|---|---|---|
| | | ASM | Egg 280d | EWTAV | BWT40 | Lay Rate | Egg mass |
| 1 | Sire | 6.57 | 5.50 | 7.60 | 5.49 | 3.80 | 4.16 |
| | Dam | 8.36 | 3.83 | 2.36 | 10.51 | 0.00 | 2.70 |
| | Sire+Dam | 14.93 | 9.33 | 9.97 | 16.00 | 3.80 | 6.87 |
| | Within | 85.07 | 90.67 | 90.03 | 84.00 | 96.20 | 93.13 |
| | Tot | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2 | Sire | 2.26 | 5.78 | 10.62 | 14.82 | 3.55 | 5.07 |
| | Dam | 5.05 | 4.82 | 4.73 | 7.93 | 3.29 | 5.11 |
| | Sire+Dam | 7.31 | 10.60 | 15.36 | 22.75 | 6.84 | 10.18 |
| | Within | 92.69 | 89.40 | 84.64 | 77.25 | 93.16 | 89.82 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 3 | Sire | 8.56 | 2.48 | 13.09 | 1.99 | 2.64 | 3.48 |
| | Dam | 4.50 | 6.09 | 8.80 | 2.98 | 1.09 | 6.41 |
| | Sire+Dam | 13.05 | 8.57 | 21.89 | 4.97 | 3.73 | 9.89 |
| | Within | 86.95 | 91.43 | 78.11 | 95.03 | 96.27 | 90.11 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 4 | Sire | 0.00 | 4.37 | 5.05 | 0.10 | 0.94 | 4.26 |
| | Dam | 22.05 | 8.44 | 4.14 | 3.82 | 11.54 | 8.22 |
| | Sire+Dam | 22.05 | 12.82 | 9.19 | 3.92 | 12.48 | 12.49 |
| | Within | 77.95 | 87.18 | 90.81 | 96.08 | 87.52 | 87.51 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 5 | Sire | 2.38 | 8.13 | 6.19 | 5.61 | 6.91 | 7.87 |
| | Dam | 8.71 | 0.00 | 10.36 | 1.99 | 0.00 | 1.83 |
| | Sire+Dam | 11.09 | 8.13 | 16.56 | 7.60 | 6.91 | 9.70 |
| | Within | 88.91 | 91.87 | 83.44 | 92.40 | 93.09 | 90.30 |
| | Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

strain of the layer type chickens under consideration. Generally dam component of variation were higher most of the time and in many traits within the red strain population. This is an indication that maternal effect may be more important in the red strain than in the white strain of these layer type chickens. About 78 to 96% of

Table 3: Variance components (by generation) within the population of Rhode Island White flocks

| Gen | Source | Traits | | | | | |
|---|---|---|---|---|---|---|---|
| | | ASM | Egg 280D | EWTAV | BWT40 | Lay rate | Egg mass |
| 1 | Sire | 18.36 | 20.65 | 1.00 | 0.00 | 11.96 | 56928.00 |
| | Dam | 10.12 | 0.00 | 1.51 | 5575.50 | 8.15 | 0.00 |
| | Sire + darn | 28.48 | 20.65 | 2.51 | 5575..50 | 20.11 | 56928.00 |
| | Within | 386..28 | 203.59 | 12.55 | 27731.00 | 288.93 | 627075.81 |
| | Total | 414.76 | 224.23 | 15.06 | 33307.15 | 309.04 | 684003.81 |
| 2 | Sire | 16.39 | 18.37 | 0.79 | 2855.90 | 19.39 | 54633.69 |
| | Dam | 0.00 | 8.72 | 1.62 | 6897.89 | 2.20 | 24734. 11 |
| | Sire +dam | 16.39 | 27.09 | 2.41 | 9753.79 | 21.59 | 79367.79 |
| | Within | 377.63 | 181.69 | 10.74 | 31773.77 | 332.40 | 550254.88 |
| | Total | 394.02 | 208.78 | 13.15 | 41527.57 | 353.99 | 629622.67 |
| 3 | Sire | 14.49 | 10.04 | 1.57 | 3349.13 | 9.97 | 31574.35 |
| | Dam | 32.51 | 6.01 | 1.53 | 5694.17 | 11.57 | 12671.98 |
| | Sire +dam | 47.00 | 16.05 | 3.10 | 9043.30 | 21.54 | 44246.33 |
| | Within | 234.39 | 121.19 | 12.46 | 70739.83 | 264.33 | 385960.65 |
| | Total | 281.89 | 137.24 | 15.56 | 79783.13 | 285.87 | 430206.98 |
| 4 | Sire | 8.05 | 8.60 | 1.19 | 2930.21 | 7.83 | 22153.74 |
| | Dam | 0..00 | 2.33 | 0.32 | 307.87 | 3.32 | 18970.09 |
| | Sire +dam | 8.05 | 10.93 | 1.51 | 3238.08 | 11.14 | 41123.83 |
| | Within | 109.02 | 180.18 | 16.83 | 72569.02 | 291.38 | 545905.46 |
| | Total | 117.06 | 191.12 | 18.34 | 75807.10 | 302.52 | 587029.28 |
| 5 | Sire | 0.00 | 4.97 | 0.77 | 2281.24 | 9.81 | 10980.17 |
| | Dam | 0.00 | 2.90 | 0.04 | 672.96 | 0.00 | 16750.57 |
| | Sire +dam | 0.00 | 7.87 | 0.81 | 2954.20 | 9.81 | 27730.74 |
| | Within | 483.41 | 129.28 | 10.47 | 46735.41 | 285.79 | 307965.32 |
| | Total | 483.41 | 137.15 | 11.28 | 49689.61 | 295.60 | 335696.06 |

Table 4: Variance components (by year) within the population of Rhode Island White flocks as a percentage of total variance

| Gen | Source | Traits | | | | | |
|---|---|---|---|---|---|---|---|
| | | ASM | Egg 280D | EWTAV | BWT40 | Lay rate | Egg mass |
| 1 | sire | 4.43 | 9.21 | 6.64 | 0.00 | 3.87 | 8.32 |
| | dam | 2.44 | 0.00 | 10.03 | 116.74 | 2.64 | 0.00 |
| | sire+dam | 6.87 | 9.21 | 16.67 | 16.74 | 6.51 | 8.32 |
| | within | 93.13 | 90.80 | 83.33 | 83.26 | 93.49 | 91.68 |
| | total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2 | sire | 4.16 | 8.80 | 6.01 | 6.88 | 5.48 | 8.68 |
| | dam | 0.00 | 4.18 | 12.32 | 16.61 | 0.62 | 3.93 |
| | sire+dam | 4.16 | 12.08 | 18.33 | 23.49 | 6.10 | 12.61 |
| | within | 95.84 | 81.03 | 81.67 | 76.51 | 93.90 | 87.39 |
| | total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 3 | sire | 5.14 | 7.32 | 10.09 | 4.20 | 3.49 | 7.34 |
| | dam | 11.53 | 4.38 | 9.83 | 7.14 | 4.05 | 2.95 |
| | sire+dam | 16.67 | 11.69 | 19.92 | 11.33 | 7.53 | 10.28 |
| | within | 83.33 | 88.31 | 80.08 | 88.67 | 92.47 | 89.72 |
| | total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 4 | sire | 6.88 | 4.50 | 6.49 | 3.87 | 2.59 | 3.77 |
| | dam | 0.00 | 1.22 | 1.74 | 0.41 | 1.10 | 3.23 |
| | sire+dam | 6.88 | 5.72 | 8.23 | 4.27 | 3.68 | 7.01 |
| | within | 93.13 | 94.28 | 91.77 | 95.73 | 96.32 | 92.99 |
| | total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 5 | sire | 0.00 | 3.62 | 6.83 | 4.59 | 3.32 | 3.27 |
| | dam | 0.00 | 2.11 | 0.35 | 1.35 | 0.00 | 4.99 |
| | sire+dam | 0.00 | 5.74 | 7.18 | 5.95 | 3.32 | 8.26 |
| | within | 100.00 | 94.26 | 92.82 | 94.05 | 96.68 | 91.74 |
| | total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

the total variation remained unexplained and was attributed to error variance within the red strain. Similar levels of variation were also not accounted for within the population of the white strain. This result is similar to the value reported by Van Vleck *et al.* (1963). Iloeje (1986) also reported a lower percentage contribution of error variance in a study carried out on zebu cattle. Wei and Van Der Werf (1992) reported that the difference between sire and dam components of variance ($ó^2_{dam}$-$ó^2_{sire}$) has been used to estimate dominance variance under the assumption that maternal, common environmental and epistatic effects are negligible and not important.

The variances among full sibs, among others contain ½ additive and ¼ dominance, all epistatic, maternal and common environmental variances or covariances (Falconer, 1989). Theoretically $ó^2_{dam}$ can be overestimated due to each of these effects if they exist. In our study, the common environmental effects for full sibs can be ignored because full sibs were randomly distributed across cages. As seen in some the production trait considered in this study, the sire component of variance was found to be higher than the dam components. Poggenpoel and Duckitt (1988) has described similar phenomenon, especially for egg weight.

Since the variation unaccounted for is very high in both strains in this study, a method of variance component analysis should be designed whereby the remaining variance components apart from those due to sire, dam and sire + dam could be further partitioned into those due to non additive genetic effect such as over dominance and epistatic gene effect and those due to none genetic environmental effects such as feeds, season etc.

A commonly used sire-dam model led to two biases in estimating $h^2$ due to ignoring the dominance effect and animal relationships other than parent-progeny. An additive model including all animal relationships overestimated $h^2$ because it ignored dominance effects.

**Conclusion:** The sources of variation was partitioned into those accounted for by sire and dam groupings. All other sources were collectively referred as being from error. An animal model accounting for additive and dominance effects and REML should be used in analyzing laying hen data to obtain unbiased estimates of $h^2$ and dominance variance. This will remove the biases brought about by the use sire - dam model.

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