PREDICTION OF SEMEN TRAITS FROM BIOMETRIC AND SECONDARY SEXUAL TRAITS IN LINES OF SHIKABROWN ® PARENT STOCK

BY

Samuel Paul, BALAMI

DEPARTMENT OF ANIMAL SCIENCE,
FACULTY OF AGRICULTURE,
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA.

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Samuel Paul, BALAMI
B. Agriculture, University of Maiduguri (2010)
M. Sc/Agric/40178/2012-2013

A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA
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DEPARTMENT OF ANIMAL SCIENCE,
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FEBRUARY, 2016

DECLARATION

I declare that the research work titled "**PREDICTION OF SEMEN TRAITS FROM BIOMETRIC AND SECONDARY SEXUAL TRAITS IN LINES OF SHIKABROWN® PARENT STOCK**" was carried out by me at the National Animal Production Research Institute (NAPRI) Shika, Zaria, Kaduna State, under the supervision of Prof. B. I. Nwagu and Dr. M. Kabir. The information obtained from literature has been acknowledged in the text and a list of references provided. No part of this thesis has been previously presented for another degree or diploma at any University.

_____ _____

BALAMI, Samuel Paul Date

CERTIFICATION

This dissertation titled "**PREDICTION OF SEMEN TRAITS FROM BIOMETRIC AND SECONDARY SEXUAL TRAITS IN LINES OF SHIKABROWN® PARENT STOCK**" by Samuel Paul Balami meets the regulations governing the award of the degree of Masters of Science in Animal Science of the Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.

_____ _____

Prof. B. I. Nwagu — Date
Chairman, Supervisory Committee

_____ _____

Dr. M. Kabir — Date
Member, Supervisory Committee

_____ _____

Prof. S. Duru — Date
Head, Department of Animal Science
Ahmadu Bello University, Zaria

_____ _____

Prof. K. Bala — Date
Dean, School of Postgraduate Studies,
Ahmadu Bello University, Zaria

DEDICATION

With a deep sense of humility, I dedicate this research to God Almighty my creator for keeping me alive and healthy to see to the completion of this phase of my life. I also give gratitude to God for blessing me with wonderful parents Mr. and Mrs. Paul K. Balami, and lovely siblings who stood by me all the way.

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TABLE OF CONTENTS

Page

TITLE PAGE……ii

DECLARATION……...iii

CERTIFICATION……iv

DEDICATION……....v

ACKNOWLEDGEMENTS……vi

TABLE OF CONTENTS……..……..viii

LIST OF TABLES……....xii

ABSTRACT……...……...xiv

CHAPTER ONE……..1

1.0 **INTRODUCTION……1**

1.1 Justification……..3

1.2 Statement of Hypotheses……4

1.3 Objectives……5

CHAPTER TWO……6

2.0 LITERATURE REVIEW……6

2.1 Fertility and Hatchability……...6

2.1.1 Nutritional factors……..6

2.1.2 Breed, age and sex factor……...7

2.1.3 Incubation factor……8

2.1.4 Climatic factor……10

2.1.5 Egg factor……11

2.2 Semen Trait Evaluation in Cocks……..12

2.3 Relationship Between Semen Trait with Biometric and

Secondary Sexual Trait……12

2.4 Effect of Mating Ratio on Reproductive Traits……...13

CHAPTER THREE……...16

3.0 MATERIALS AND METHODS……..16

3.1 Experimental Location……16

3.2 Experimental Animals and Management……16

3.3 Data Collection……21

3.3.1 Body measurement……..21

3.3.2 Measurement of secondary sexual traits……..21

3.3.3 Semen collection……22

3.3.4 Hatching traits ……23

3.4 Incubation and Hatching Procedure……24

3.5 Statistical Analysis……..25

CHAPTER FOUR……27

4.0 RESULTS……...27

4.1 Means and Coefficients of Variation for Body Weight and Biometric Traits at week 52……..27

4.2 Means and Coefficients of Variation for Secondary Sexual Traits……27

4.3 Means and Coefficients of Variation for Semen Characteristics……..28

4.4 Means for Sperm Morphology Defect……28

4.5 Least Square Means for Hatching Traits in Lines of Shikabrown [@] Parent Stock at Varying Mating Ratio……29

4.6 Least Square Means for Day-old Weight (g) of Chicks at Varying Mating Ratio in Lines of Shikabrown [@] Parent Stock……33

4.7 Effect of the Interaction of Mating Ratio and Hatch on Day-old Weight (g) of Chicks in Lines of Shikabrown [@] Parent Stock……33

4.8 Coefficients of Correlation of Body Weight, Biometric and Semen Characteristics in the Dam and Sire Lines……...36

4.9 Coefficients of Correlation of Body Weight, Biometric and Sperm Morphology Defect in the Dam and Sire Lines……38

4.10 Coefficients of Correlation for Secondary Sexual Traits and Semen Characteristics in Dam and Sire Lines……...40

4.11 Coefficients of Correlation for Secondary Sexual Traits and Sperm Morphology Defect in the Dam and Sire Lines……42

4.12 Coefficients of Correlation for Body Weight, Biometric Traits and Secondary Sexual Traits in the Dam and Sire lines……...44

4.13 Multiple Regression Equation for Prediction of Semen Characteristics from Body Weight and Biometric Traits……46

4.14 Multiple Regression Equation for Prediction of Semen Characteristics from Secondary Sexual Traits……46

CHAPTER FIVE……...49

5.0 DISCUSSIONS……..49

5.1 Coefficients of Variation for Body Weight, Biometric , Secondary Sexual Traits and Semen Characteristics in Lines of Roosters of Shikabrown @ Parent Stock at Week 52……49

5.2 Mean Values for Body Weight, Biometric and Secondary Sexual Traits in Lines of Shikabrown @ Parent Stock at Week 52…….49

5.3 Mean Values for Semen Characteristic Traits in Lines of Shikabrown @ Parent Stock at Week 52…….50

5.4 Mean Values for Sperm Morphology Defect in Lines of Shikabrown @ Parent Stock at Week 52…….51

5.5 Effect of Mating Ratio on Hatching Traits in Lines of Shikabrown @ Parent Stock…….52

5.6 Effect of Interaction of Mating Ratio and Hatch on Day-old Weight (g) of Chicks in Lines of Shikabrown @ Parent Stock……53

5.7 Coefficients of Phenotypic Correlation for Body Weight, Biometric, Secondary Sexual Traits and Semen Characteristics in Lines of Shikabrown @ Parent Stock……..53

5.8 Multiple Regression Equation for Prediction of Semen Characteristics from Biometric and Secondary Sexual Traits…….54

CHAPTER SIX……..56

6.0 SUMMARY, CONLUSIONS AND RECOMMENDATIONS……..56

6.1 Summary……..56

6.2 Conclusions…….....58

6.3 Recommendations……..59

REFERENCES……..60

LIST OF TABLES

Page

Table 3. 1: Bird's Vaccination Schedule and Medication for Shikabrown @ Parent Stock……18

Table 3. 2: Composition of Chick, Grower and Breeder Mash in the Diet of Lines of Shikabrown @ Parent Stock……20

Table 4. 1 Means and Coefficients of Variation for Body Weight, Biometric and Secondary Sexual Traits in Lines of Roosters of Shikabrown @ Parent Stock at Week 52……30

Table 4. 2 Means and Coefficients of Variation for Semen Traits in Lines of Roosters of Shikabrown @ Parent Stock at Week 52……31

Table 4. 3 Least Square Means of Hatching Traits in Lines of Shikabrown @ Parent Stock at Varying Mating Ratio……..32

Table 4. 4 Least Square Means for Day-old Weight (g) of Chicks at Varying Mating Ratio in Lines of Shikabrown @ Parent Stock……..34

Table 4. 5 Effect of Interaction of Mating Ratio and Hatch on Day-old Weight (g) of Chicks in Lines of Shikabrown @ Parent Stock……..35

Table 4. 6 Coefficients of Correlation for Body Weight, Biometric and Semen Characteristics in Lines of Roosters of Shikabrown @ Parent Stock……...37

Table 4. 7 Coefficients of Correlation for Body Weight, Biometric and Sperm Morphology Defect in Lines of Roosters of Shikabrown @ Parent Stock……39

Table 4. 8 Coefficient of Correlation for Secondary Sexual Traits and Semen Characteristics in Lines of Roosters of Shikabrown @ Parent Stock……41

Table 4. 9 Coefficients of Correlation for Secondary Sexual Traits and Semen Sperm Morphology Defect in Lines of Roosters of Shikabrown @ Parent Stock……43

Table 4.10 Coefficients of Correlation for Body Weight,

Biometric and Secondary Sexual Traits in Lines of Roosters of Shikabrown @ Parent Stock……...45

Table 4. 11 Multiple Regression Equation for Prediction of Semen Characteristics from Body Weight and Biometric Traits in Lines of Shikabrown @ Parent Stock……..47

Table 4. 12 Multiple Regression Equation for Prediction of Semen Characteristics from Secondary Sexual Traits in Lines of Shikabrown @ Parent Stock……..48

ABSTRACT

An experiment was conducted to predict semen traits from biometric and secondary sexual traits in lines of Shikabrown [@] parent stock chickens. A total of 30 roosters (52 weeks old), 15 each from the dam and sire lines were used for the study. For the effect of mating ratio on egg fertility and hatchability, a total of 15 roosters were mated to 90 hens in the dam and sire lines at mating ratio 1:3, 1:6 and 1:9, and a total of 1711 fertile eggs were hatched in three sets. Biometric traits (body weight-BW, body length-BL, breast girth-BG, drumstick length-DSL and shank length-ShL); secondary sexual traits (comb length-CL, comb width-CW, wattle length-WL and wattle width-WW); semen characteristics (semen colour-SC, semen volume-SV, semen pH, sperm motility-SM, sperm concentration-SCo and sperm live ratio-LR) and sperm morphology defect traits (dead ratio-DR, free tail-FT, bent tail-BT, detached head-DH and coiled tail-CT) were evaluated. Number set-NS, number fertile-NF, number infertile-NI, number hatched-NH, percent fertile-PF, percent infertile-PI, percent hatched-PH and percent hatchability-PTH traits were also measured. Data collected were subjected to ANOVA, correlation and regression procedure of SAS, with significant means separated by DMRT procedure. From the results obtained for biometric traits, significant ($p<0.05$) difference was obtained for BW, BL, DSL and ShL in sire line roosters. Significant ($p<0.05$) difference was observed for CL, CW and WL for secondary sexual traits in the dam line roosters. High coefficients of variation of 31.76 (SV) in the dam line, and 38.09 (SC) and 39.48 (SV) in the sire line were obtained in this study. The results also showed significant differences ($p<0.05$) for SC and SCo in the dam line, and semen pH in the sire line. FT and DH were significant ($p<0.05$) in the sire line. Total sperm morphology defect of 31 % and 29 % were obtained for the dam and sire line roosters respectively. Results obtained for correlation showed significant ($p<0.05$, $p<0.01$,

$p<0.001$) correlation for some of the traits measured. For the prediction of semen traits from biometric traits in the dam line showed low coefficients of determination (R^2) of between 9 % and 28 % in the dam line, and between 9 % and 27 % in the sire line. For prediction of semen traits from secondary sexual traits, coefficients of determination (R^2) of between 3 % and 13 % were obtained in the dam line, and between 2 % and 28 % in the sire line. Result for hatching traits showed significant ($p<0.05$) difference for all traits measured in both lines. Mating ratio affected ($p<0.05$) hatches in the dam and sire lines. However, weight of day-old chicks was not affected by ($p>0.05$) mating ratio in both lines. In conclusion, roosters of the sire line were best for BW (5.52 kg), BL (72.89 cm), DSL (16.13 cm) and ShL (10.73 cm). Positive and significant correlation coefficients of 0.36 (BW and LR), 0.32 (BL and SV), 0.36 (BL and LR) and 0.29 (WW and SCo) in the dam line were obtained. For the sire line, significant positive correlation coefficients of 0.42 (BL and LR), 0.36 (BW and LR) and 0.30 (ShL and SCo) were obtained. High coefficients of variation were obtained for SC (31.76) in the dam line, and SC (38.09) and SV (39.48) in the sire line roosters. Sperm morphology defects of 31 % and 29 % were obtained in the dam and sire line roosters respectively. For the dam line, best PF (89.10 %) was observed in mating ratio 1:3, while best PH (62.67 %) and PTH (72.40) were observed for ratio 1:6. In the sire line, best PF (95.40 %), PH (69.37 %) and PTH (72.83 %) were observed for mating ratio 1:6. It is therefore recommended that the sire line roosters be considered for upgrading of local chicken flock. Alternatively, body measurements (BW, BL, WW and ShL) should be considered in the selection of roosters of good semen quality. Potential still abounds for genetic improvement of SV in the dam line, and SC and SV in the sire line roosters, with younger roosters preferred for enhanced fertility. Also, mating ratio of one cock to six hens (1:6) should be adopted for better hatchability of eggs in laying chicken strains.

CHAPTER ONE

1. 0 INTRODUCTION

Domestic chickens contribute highly to the socio- economic condition of Nigerians. A survey reported the population of backyard poultry in Nigeria to be about 84 million, which amounts to about 60 % of the total poultry population in Nigeria (Jesuyon and Salako, 2013). The poultry industry in Nigeria has undergone a significant boost, from household oriented husbandry to modern and large-scale poultry industry, which can be found in the urban centers today (CBN, 2006). Though the value of livestock resources has grown steadily in recent years, the overall contribution of this sector to agriculture remains relatively low (CBN, 2006). Animal protein supply in Nigeria, especially meat and egg is expensive, inadequate and often out of reach of the majority of the populace. This effect is felt more by a large proportion of the rural population, which constitute over 70 % of the Nigerian population and form over 85 % of the extreme poor in the country (Chukwuji *et al*., 2006). Animal protein deficiency and a continuous rise in population necessitated the need to exploit different animal protein sources, one of which is the poultry industry towards meeting these needs.

Shikabrown layer type breed was developed in Nigeria, at the National Animal Production Research Institute, after being tested for adaptability in the six geo-political zones of the country (Kallah, 1999). The breed was developed from a collapsed population of Rhode Island Red and White egg type chickens imported into the country in 1985, following continuous selection (Adeyinka, 1998).

Selection of cocks of high semen quality is an important practice in breeding programmes, and the evaluation of semen quality characteristics is an important

indicator of the reproductive potentials of males, reported to be the major determinant of egg fertility and hatchability of chickens (Peters *et al*., 2004). Evaluation of the reproductive potentials of males is also needed in the prediction of fertility in natural mating and artificial insemination programmes. The fertilising ability of the breeder cock depends upon several semen quality characteristics, which include sperm concentration, viability and motility (Parker *et al.*, 2000). Sperm motility has been reported to be an essential parameter for normal fertilisation, which is an indirect measure of metabolic activity and sperm viability (Berlinguar *et al.*, 2009). Semen quality is also determined by volume of ejaculates, sperm concentration, sperm motility, percent live sperm and sperm morphology.

Sperm morphology plays a very important role in fertilisation process, influenced by nutrition, season, climatic factors, physiology and genetic make up (Dana *et al*., 2000). Any form of sperm morphological defect is an indicator of decreased fertility in most animal species (Chandler *et al*., 1988), with defect of up to 20 % leading to a reduced fertility (Morrow, 1980). The findings of Reddy *et al*. (1975) showed a negative correlation between abnormal sperm and conception rate. An accurate sperm morphology examination assists animal breeders to eliminate male animals of low fertility prior to natural mating or artificial insemination programmes (Rodriguez-Martinez and Barth, 2007).

Knowledge of correlation between semen traits and other traits such as weight, age, body condition and testicular size could serve as important indicator of the reproductive potentials of males in ruminants (McGary *et al*., 2003). Positive correlation between wattle length, comb length and fertility also indicates that the development of secondary sexual characters may reveal male reproductive quality in some genetic strains (McGary

et al., 2003). The importance of evaluating semen in poultry breeding either for selection of breeder males, or for routine check of their reproductive potentials has also been emphasised in the report of Cheng *et al*. (2002). In their report, Galal *et al*. (2000) noted that genes that govern length of shank, comb and wattle would tend to be inherited linked with genes controlling ejaculate volume and sperm concentration, but independently of those controlling sperm motility and abnormal sperms.

1. 1 Justification

Several studies (Hossari, 1980; El-Sayiad *et al*., 1994; Abdellatif, 1999) have recommended the use of comb length and wattle length as good indicator traits for selection of some quantitative traits in chickens. Larger combs may reliably point to roosters with greater semen production, higher androgen levels (Gilbert, 1971) or increased mating activity (Ligon *et al*., 1990). The most precise technique for the evaluation of semen is by microscopic examination in the laboratory. However, this method exposes birds to stress, infringes on animal welfare and requires expensive facilities and expertise. Thus, indirect method of estimating semen traits, based on the correlated response traits will serve as an alternative in the selection of males of good semen quality (Galal, 2007).

The success of the sustenance of poultry production chain depends on regular and constant supply of day-old chicks; with commercial poultry operators relying on hatcheries for the supply of day-old chicks for production (Stromberg, 1975). Mating system, age of eggs, egg storage condition, flock age, husbandry and rearing practices, incubator temperature and relative humidity and egg turning are among the several factors affecting poultry egg hatchability (Brah and Sandhu, 1989; Tarongoy, *et al*., 1990; Weis, 1991; Gebhardt-Henrick and Mark, 1991; Buhr, 1995 and Permsak, 1996).

Reports have also shown poor egg storage, prolonged egg storage, breeder age, incubation problems, genetic effect of breeds, varieties and individuals within breeds as potential factors leading to poor egg fertility and hatchability (Fairchild *et al*., 2002; Islam *et al*., 2002). From the findings of Orunmuyi *et al*. (2013) on hubbard broilers, mating ratio 1:6 gave the best egg fertility and hatchability for pedigree hatching of chicks. Several works have been conducted on semen characteristics and the effect of mating ratio for pedigree hatching of chickens, but no work has been done on the effect of mating ratio on pedigree hatching of Shikabrown $^{@}$ parent stock. This is the main thrust of this research.

1. 2 Statement of Hypotheses

Null Hypothesis (H_o): Body weight, biometric and secondary sexual traits cannot be used as indicator traits to predict semen traits in lines of Shikabrown $^{®}$ parent stock (roosters).

Alternative hypothesis (H_a): Body weight, biometric and secondary sexual traits can be used as indicator traits to predict semen traits in lines of Shikabrown $^{®}$ parent stock (roosters).

Null hypothesis (H_o): Mating ratio has no association with egg fertility and hatchability in lines of Shikabrown $^{®}$ parent stock.

Alternative hypothesis (H_a): Mating ratio has association with egg fertility and hatchability in lines of Shikabrown $^{®}$ parent stock.

Null hypothesis (H_o): Mating ratio has no association with day-old weight (g) of chicks in lines of Shikabrown $^{®}$ parent stock.

Alternative hypothesis (H_a): Mating ratio has association with day-old weight (g) of chicks in lines of Shikabrown ® parent stock.

1. 3 Objectives

The broad objective of this study is to evaluate the reproductive performance of Shikabrown ® parent stock chickens.

The specific objectives include:

1. To determine the association of semen traits with body weight, biometric traits and secondary sexual traits in lines of roosters of Shikabrown ® parent stock chickens.

2. To evaluate the semen characteristics and sperm morphology defects in roosters of lines of Shikabrown ® parent stock chickens.

3. To evaluate the effect of mating ratio on egg fertility and hatchability and weight (g) of day-old chicks in lines of Shikabrown ® parent stock chickens.

CHAPTER TWO

2. 0 LITERATURE REVIEW

2. 1 Fertility and Hatchability

Egg fertility refers to the percentage of incubated eggs that are fertile, while hatchability refers to the number of fertile eggs that successfully hatch into chicks (Stromberg, 1975). Fertilisation can only be achieved when the gametes of both parents unite, with each of the gametes (sperm and ovum) contributing half the genetic material of both parents. By this, fertility and hatchability are traits contributed by the gametes derived from the two parents. These traits are the major parameters to measure the reproductive performance of chickens, which are greatly under the influence of both genetic and non-genetic or environmental factors (Stromberg, 1975). The low heritability estimate of 0.06 and 0.13 for fertility and hatchability respectively is a pointer to the fact that the environment plays a significant role in the expression of these traits (Sapp *et al*., 2004). Fertility and hatchability have been reported by Islam *et al*. (2002) to be the most important determinant factors in the production of day old chicks, which largely depend on the quality and quantity of the male semen. A number of factors are known to affect fertility and hatchability, and these include; age of birds, age of eggs, egg storage condition, husbandry practices, mating system and incubation conditions (Buhr, 1995; Permsak, 1996). Below are among the major factors affecting fertility and hatchability:

2. 1. 1 Nutritional factors

Since fertility and hatchability traits are lowly heritable, environment plays significant role in their expression. Nutrition is one of the environmental or non-genetic factors affecting these traits. If good quality semen is needed, then the diet of poultry breeders

must be formulated to meet the required feed standards, in both quantity and quality (Brillard, 2007). Although an estimated crude protein (CP) range of between 14 % to 18 % is required for light and medium sized laying exotic birds, a CP of 12 % is adequate for laying hens for high percent fertility (95.6 %) as reported in the research conducted on Saudi Arabian Baladi chickens (Alsobayel, 1992). The composition of lipid in chicken diet is very important in maintaining sperm membrane flexibility, which plays a significant role in the movement of sperm flagella. It also aids in acrosome reaction and fertilisation (Cerolini *et al*., 1997). The research conducted by Ayidin *et al*. (2001) revealed that complete embryonic mortality was recorded in fertile chicken eggs when fed 0.5 % conjugated linoleic acid. Breeder laying hens fed brewery by-product gave improved egg fertility and hatchability (Javanka *et al*., 2010). Improved egg fertility of laying hens was reported when their feed was supplemented with organic selenium (Sel-Plex^{PM}), according to the report of Davtyan *et al*. (2006); Petrosyan *et al*. (2006) and Hanafy *et al*. (2009). Similarly, Agate *et al*. (2000) reported that supplementation of laying hens diet with selenium improved the duration of sperm in the hen's reproductive organ. Supplementation of layers diet with 200mg Sel-Plex^{TM} enhanced egg fertility and hatchability as reported by Osman *et al*. (2010). Replacing soya bean meal with cottonseed meal up to 50 % in the diet of breeder cocks caused decline in sperm production as reported by Adeyemo *et al*. (2007). Reports also showed that gossypol causes infertility, sperm immobility and depressed sperm count in male mammals (Randels *et al*., 1992).

2. 1. 2 Breed, age and sex factor

Fertility and hatchability are traits that receive the contribution of both the cock and the hen. Zygote is formed in an egg when the ovum produced by the hen is fertilised by the

sperm cell produced by the cock. The age of the hen and the cock plays an important part in the fertility and hatchability of eggs, as decline in fertility and hatchability occurs when birds advance in age (Alsobayel, 1992). Fertility rate is higher in the early cycle of bird life. Reports are also available that fertility is higher in light breeds (White leghorn) when compared with heavy breeds of Barred Plymouth rock, Rhode Island Red, New Hampshire and White Rock (Islam *et al*., 2002). A higher percent hatchability was also observed in meat type chickens compared to egg type as reported by Swan (1977). Breed difference has also been observed to show some little effect on egg hatchability, with members of the same breed showing some fertility differences across hatches. These hatch differences are likely to occur due to environment and management system (Islam *et al*., 2002). The report of Brammel *et al*. (1996) showed that male factors affecting fertility are semen quality traits as sperm metabolism, concentration, motility and percent abnormal sperm cells, while factors affecting hen fertility include egg quality, behavior and physical factors.

2. 1. 3 Incubation factor

2. 1. 3. 1 Natural incubation

Natural incubation practiced by broody hens provides eggs that are fertile with the right environment (temperature, humidity and turning condition), which favours the development of the embryo for successful hatching. At the end of lay, broody hens cover their eggs for a period of time before they hatch. The broody hens develop behavioral practices such as spreading of wings, ruffling of feather and clucking noise. Hatchability has been reported to decline when egg number increases beyond ten under a natural brooding condition, which is dependent on bird size (King'ori, 2011). This report also revealed that hatchability is enhanced when broody hens are provided with

feed and water in close proximity. This prevents the hens from moving around to scavenge for food, which negatively affects egg development. Water in close proximity helps the hens to splash it around the egg to provide the right humidity for incubation.

2. 1. 3. 2 Artificial incubation

Knowledge of natural incubation gives a clear picture into the mode of operation of the artificial incubator. This is because the artificial incubator is designed to mimic natural brooding by hens in providing the right environment such as temperature, humidity and egg turning, for proper embryonic development (French, 1997; King'ori, 2011). In the same report, environmental temperature of 37.8 ^{0}C was reported as the optimum for proper embryonic development and hatchability. This optimum temperature ensures proper nutrient utilization by a developing embryo, reported to be the most important factor during egg incubation (Hill, 2001; Lourens, *et al*., 2005). An acceptable range of temperature for egg incubation is between 36 and 38.9 ^{0}C, above or below may result to slow embryo growth or embryo mortality. Temperature above 39.4 ^{0}C or below 35.6 ^{0}C is associated with embryo mortality and lower hatchability, reported to be due to increase in metabolic or endogenous heat (Lourens *et al.,* 2005). The range of humidity considered optimum for incubation is between 70 and 75 % for proper embryonic development. In a similar report, incubating eggs at humidity less than 40 % adversely reduces hatchability. This report also revealed that egg turning is another important factor to account for during incubation due to its influence on hatchability, with turning frequency of 96 times daily considered optimum (Elibol and Brake, 2003). Egg turning of 24 times per day is acceptable under commercial condition according to the report of Freeman and Vince (1974), with lack of egg turning resulting in embryo mortality due to embryo sticking to the egg shell.

2. 1. 4 Climatic factor

Climate is one of the environmental or non-genetic factors, which has the capacity to influence fertility and hatchability of eggs. Heat stress in chickens due to high ambient temperature and relative humidity reduced feed intake to about 20 %, which in turn lead to a decline in internal and external egg quality (King'ori, 2011). The report of Mahmoud *et al*. (1996) showed that high ambient temperature has the tendency of reducing yolk size, albumen consistency and calcium deposit in shell. This reduction occurs due to reduced calcium-estrogen interaction. This is as a result of lowered albumen haugh unit and depressed feed intake by hens, which is a physiological response to reduced heat stress in the body due to metabolism of feed (Ayo *et al*., 2010).

The report of Bank *et al*. (2005) showed that heat stress has the capacity to affect all phases of semen production in breeder cocks. It does that by causing a decline in the differentiation of the epithelium of the seminiferous tubules, resulting in decline in semen quality and quantity over time (Obidi *et al*., 2008). Reports of McDaniel *et al*. (1995; 1996) also revealed that testicular function is greatly impaired through the inhibition of intracellular ion exchange due to heat stress. The report showed that male fertility and *in vitro* sperm-egg penetration declined to about 42 and 52 % respectively when exposed to temperatures of about 32 ^{0}C in comparison with values obtained with males exposed to temperatures of about 21 ^{0}C. Decline in fertility and *in vitro* sperm-egg penetration in heat stressed cocks may be due to decrease in the number of sperm cells stored in the sperm nest gland in the reproductive tract of the hen as reported by Brillard (2003). The study conducted by Penfold *et al*. (2000) revealed that cocks under natural mating condition are exposed to reduced libido and mating activity under heat

stress condition. This according to Penfold *et al*. (2000) may be as a result of dehydration or alteration of secretion of reproductive hormones. Their report also revealed that several sperm abnormalities such as bent head sperm cells, micro-cephalic sperm cells, detach mid-piece and cytoplasmic droplets occur due to heat stress. Environmental temperatures outside thermo neutral zone was also reported to result in a decrease of semen characteristics such as semen consistency, sperm concentration and semen volume according to the report of McDaniel *et al*. (1995).

2. 1. 5 Egg factor

The eggs of chickens are usually fertile four days after the introduction of cocks to hens, and these eggs under normal condition contain all the essential nutrients required for the proper development of the embryo up to the time of hatching. For the embryo to develop and successfully hatch into chick, certain physical characteristics such as egg weight, shell thickness, egg shape index and the consistency of the egg content must be intact (Narushin and Romanov, 2002). Report of Asuquo and Okon (1993) revealed that medium and large eggs have higher hatchability than smaller eggs, which confirms the report of Mandlekar (1981) that egg size has effect on hatchability of eggs. Large (51 and 56 g) and medium (45 and 50g) size eggs have been reported to have fertility and hatchability values of 88.2 and 84.8 % respectively, according to the report of Mandlekar (1981). Medium size eggs of Anak broiler breed gave the best hatchability of 97 % (Abiola *et al*., 2008). Hatchability value of between 66 and 73 % was reported for Kenyan indigenous chicken eggs (King'ori *et al*., 2010), compared to hatchability percentages of between 80 and 90 % reported for exotic hybrid egg and meat strains (MOALD and M, 1993), reason been because the exotic strains lay larger eggs, which have higher hatchability, compared to smaller eggs layed by the local ones. Reports of

Senapati *et al*. (1996) revealed a positive correlation between egg weight and hatchability.

2. 2 Semen Trait Evaluation in Cocks

The report of Nwagu *et al*. (1996) on Rhode Island Red and White breeder cocks gave a semen volume range of between 0.58 and 0.80 ml while a semen volume range of between 0.48 and 0.75 ml was obtained by Lee *et al*. (1999), who worked on cockerels. The findings of Ezekwe *et al*. (2003) on Nigerian local cocks gave a value of 0.39 ml for semen volume. Semen volume of between 0.24 and 0.27 ml was reported for naked neck and frizzle strains of local cocks respectively (Ezekwe and Machebe, 2004). The findings of Nwagu *et al*. (1996) on Rhode Island Red and White breeder cocks also revealed a milky semen color. The report of Kabir *et al*. (2007) on the same stock also gave a milky semen colour. This report also gave the values of 0.42 ml, 73.46 %, 1.47 $\times 10^9$/ml, 64.15 $\times 10^9$/ml and 86.45 % for semen volume, sperm progressive motility, sperm concentration, total sperm per ejaculate and concentration of live sperm cell respectively.

2. 3 Relationship between Semen Traits with Biometric and Secondary Sexual Traits

The findings of Galal (2007) on naked neck and normally feathered chickens showed that body weight, shank length, comb length and wattle length are good predictors of semen traits, with body weight found to be a good predictor of semen volume. Reports from several authors also revealed this significantly positive correlation between body weight and semen volume (Harris *et al*., 1984; Marks, 1985 and Siegel and Dunnington, 1985). On the contrary, Scogin *et al*. (1982) showed a negative correlation between body weight and semen volume in their report. Increased growth rate has also been

found to negatively affect reproductive traits, which is confirmed by the negative correlation between body weight and sperm motility (Siegel and Dunnington, 1985). A similar finding was also reported by Galal (2007), who noted a positive correlation between body weight and percent abnormal sperm. Significantly positive association between length of shank and semen volume, advanced motility, abnormal sperm, dead sperm and coiled tail was also observed in the report of Galal (2007).

The findings of Udeh (2011) gave a correlation of 0.59, 0.70, 0.67 and 0.68 for shank length, beak length, thigh length and wattle length with semen motility, respectively. From the same report, a correlation of 0.67 and 0.60 was obtained for beak length and comb length with sperm concentration, respectively. This report also revealed that correlation coefficient of abnormal sperm; live sperm and volume with body measurement were negative and not significant.

2. 4 Effect of Mating Ratio on Reproductive Traits

Mating ratio has been reported as one of the factors affecting fertility and hatchability of eggs, as large number of males mated to few females could reduce fertility (Alsobayel and Albadry, 2012). Studies have revealed that behavioral factors play significant role in the determination of male efficiency (Burke and Mauldin, 1985). Reduced frequency of courtship and increased aggression are also important behavioural characteristics enhancing the reproductive performance of male breeder broilers (Millman and Duncan, 2000). Reports have shown that males show preference towards certain females compare to others in a flock (Blohowiak *et al*., 1980). Male aggression has also been shown to reduce the accessibility of females to certain males due to previous injuries (Mench, 1993).

The ultimate goal of poultry breeding industry is the production of eggs that successfully hatch into chicks, which ensures the continuity of the industry. Male fertility is often assessed through semen evaluation because of its link with egg fertility and hatchability. The findings of Orunmuyi *et al*. (2013), who worked on Hubbard broiler breeders using mating ratio of 1:6, 1:7 and 1:8 revealed that mating ratio significantly affected number of fertile eggs, number of eggs hatched and percent fertility of eggs. Mating ratio 1:6 appeared superior for percent egg fertility and hatchability, though not significantly different from mating ratio 1:8. It was also observed in that report that mating ratio 1:7 gave a similar performance with ratio 1:8 for percent fertility. The research work conducted by Casanovas and Wilson (1999) gave the best fertility for mating ratio 1:10 for broiler breeders probably due to good level of mating activity with low interference and aggression. The findings of Wilson (2003) on Saudi Arabian Baladi breed of chickens recommended a mating ratio of between 1:12 and 1:15 for light breeds and ratio 1:10 and 1:12 for heavy ones. In another investigation conducted by Alsobayel and Albadry (2012) on Baladi and Leghorn hens, fertility and hatchability in mating ratio 1:6 appeared significantly highest followed by ratio 1:10. Mating ratio of 1:14 gave the lowest fertility and hatchability. Fertility and hatchability of 77.24 % and 78.82 % respectively were obtained for mating ratio 1:6 in a research conducted on white leghorn flock at 20 weeks of age (Firas *et al*., 2009). This result agreed with that of Al-Daraji (2001), but appeared lower than that obtained by Islam *et al*. (2002). In the report of Kabir and Sani (2011) on Shikabrown parent stock using mating ratio 1:8, values of 78.52 %, 52.53 % and 61.02 % were obtained for percent fertility, percent hatch and percent hatchability, respectively.

Breed, age and sex ratio have been found to significantly affect fertility and hatchability of total eggs but not fertile hatchability and embryonic mortality. Increase in age of hens has also revealed a decline in fertility and hatchability of eggs, with similar findings reported for broiler breeders by Tona *et al*. (2001); Bourassa *et al.* (2003); Vieira *et al*. (2005); Elibol and Brake (2006); Zakarias *et al*. (2009); Abudabos (2010) and Al-marshade (2011). In the report of Firas *et al*. (2009), it was revealed that age significantly affected fertility but not hatchability. The report also showed that hatch number did not significantly affect fertility and hatchability.

CHAPTER THREE

3. 0 MATERIALS AND METHODS

3. 1 Experimental Location

This study was conducted at the Breeding Unit of the Poultry Research Programme, National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika-Zaria, Kaduna State, Nigeria. The Research station lies between $11^0$12'N and $7^0$33'E, at an altitude of 691 m above the sea level (Ovimaps, 2011). Shika is situated 22 km northwest of Zaria City, which lies in the guinea savannah zone of Nigeria (Kabir *et al*., 2006). Rainfall starts in late April or sometimes early May, reaches peak between June and September and lasts till October. The harmattan period starts from mid October through January, is immediately followed by dry hot weather from February to May. Temperature ranges during the harmattan period are 14 to 30 ^{0}C and hot season 21 to 36 ^{0}C. Relative humidity varies from approximately 21 % during harmattan to 37 % during the hot season. The average temperature and humidity during the wet season are 24.8 ^{0}C and 77 % respectively (Orunmuyi, 2006; Ovimap, 2011).

3. 2 Experimental Birds and Management

A total of 210 Shikabrown ® parent stock chickens were used for this experiment, consisting of 30 roosters and 180 hens (52 weeks of age) from the dam and sire lines. They were easily identified by their plumage color (sire line chickens are brown while the dam line are white), carefully selected from a large population of Shikabrown ® parent stock. Birds of the two lines were mated at ratio 1: 3, 1: 6 and 1: 9, with each group replicated five times. A total of 30 families were generated, 15 for the dam line and 15 for the sire line, with the roosters allowed to mate with the hens freely during the

experimental period. The birds were kept under a deep litter management system, with the pens (3 m x 1.5 m) fitted with wood shavings. Drinkers, feeders and nest boxes were also provided. The birds were provided with appropriate feed and medication, with water provided *ad libitum*. Details of bird's vaccination schedule and medication is provided in Table 3.1:

Table 3.1: Bird's Vaccination Schedule and Medication for Shikabrown [@] Parent Stock.

Age of birds	Vaccination/medication	Route
Day 1	NDV (Maresk)	Spray
Days 1-15	Multivitamin/antibiotics	Orally
Day 14	IBD-Gumboro (1st dose)	Orally
Day 21	NDV (Lasota)	Orally
Week 4	IBD-Gumboro (2nd dose)	Orally
Week 5	Coccidiostat	Orally
Week 7	NDV-Komorov (1st dose)	Wing jab
	FPV vaccine	Wing jab
Week 8	Deworming (2 Monthly)	Orally
Week 9	Coccidiostat	Orally
Week 12	Coccidiostat	Orally
Week 13	Multivitamin/antibiotic	Orally
Week 16	NDV-Komorov (booster)	Intramuscular

NDV-Newcastle disease vaccine, IBD-infectious bursal disease, FPV-fowl pox vaccine.

Chick mash containing 20 % CP and 2722 Kcal ME/kg was fed between ages 0-8 weeks, grower mash containing 16 % CP and 2737 Kcal ME/kg between 8-18 weeks of age and breeder mash containing 16.6 % CP and 2594 Kcal ME/kg of energy were given to the birds from 18 weeks of age, and throughout the duration of the experiment. All the diets were formulated and compounded at the feed mill of the National Animal Production Research Institute (NAPRI), and were fed twice daily; morning (8:00 am-9:00 am) and afternoon (2:00 pm-4:00 pm). The composition of the diet is given in Table 3.2:

Table 3.2: Composition of Chick, Grower and Breeder Mash in the Diet of Lines of Shikabrown [@] Parent Stock.

Ingredients	Chick mash	Grower mash	Breeder mash
Maize (%)	45.00	34.50	43.45
Wheat offal (%)	06.00	15.00	9.00
Maize offal (%)	10.00	10.00	10.00
Soya bean cake (%)	20.50	10.45	13.00
Groundnut cake (%)	13.45	10.00	13.50
Bone meal (%)	3.00	3.00	3.00
Rice offal (%)	0.00	15.00	0.00
Limestone (%)	1.50	1.50	7.50
Salt (%)	0.30	0.30	0.30
Vitamin premix (%)	0.25	0.25	0.25
Total	100.00	100.00	100.00
Calculated Analysis			
Energy (Kcal ME/kg)	2722.00	2737.00	2594.00
Crude protein (%)	20.01	15.56	16.60
Calcium (%)	1.50	1.50	1.50
Phosphorus (%)	0.55	0.70	1.00

Premix used in this experiment supplied the following per kg of diet:
Vitamin A (stabilized) 10, 0005 iu; Vitamin D3 (stabilized) 2, 250 iu; Vitamin E (stabilized) 5.01 iu; Vitamin K (stabilized) 2.01 mg; Vitamin B2 4.50 mg; Vitamin B6 3.0 mg; Nicotinic acid 22.005 mg; Calcium D-Pantothenate 6.0 mg; Vitamin B12 0.012 mg; Choline chloride 200.10 mg; D.O.T (3,5 dinitroorthotoluamide) 100. 05 mg; Manganese 80.01 mg; Iron 50.01 mg; Zinc 40.005 mg; Copper 2.4 mg; Iodine 1.401 mg; Cobalt 0.20 mg; Selenium 0.051 mg.

3. 3 Data Collection

3. 3. 1 Body measurement

Body weight and four (4) biometric traits were measured on the thirty roosters (30) of the two lines. The anatomical reference points were as described by Monsi (1992) and Udeh *et al*. (2011). The biometric traits include drumstick length (DSL), body length (BL), breast girth (BG) and shank length (ShL). DSL: Measured as the distance between knee and end of femur bone. BL: Measured between the first cervical vertebra and the pygostyle. BG: Measured as the circumference of the chest. ShL: distance from the hock to the extremity of the digitus pedis. Measurements were done according to illustrations by FAO (2012).

Body weight was measured using a weighing scale (FA/JA series) manufactured in China (in kilogrammes), with an acuracy of 0.01 g, while drumstick length (DSL), body length (BL), breast girth (BG) and shank length (ShL) were obtained with the aid of a flexible measuring tape in centimeters (cm). Body weight and biometric traits were measured at 52 weeks of age for each of the roosters during the course of this experiment.

3. 3. 2 Measurement of secondary sexual traits

Comb length (CL), comb width (CW), wattle length (WL) and wattle width (WW) were the four secondary sexual traits measured. CL: measured as the horizontal length of the comb. CW: measured as the height of the comb. WL: measured as the horizontal length of the wattle. WW: measured as the height of the wattle. Measurement of secondary sexual traits was also taken at 52 weeks of age of the roosters, simultaneously with biometric traits during the course of this experiment. During this period, the birds were

restrained to allow for ease of measurement. These measurements were carried out using calibrated ruler in centimeters (cm)

3. 3. 3 Semen collection

Thirty roosters (30) of Shikabrown [@] parent stock, 15 from the dam line and 15 from the sire line were subjected to semen collection and evaluation, at the Artificial Insemination (AI) laboratory of the National Animal Production Research Institute (NAPRI). The roosters were given one week preliminary training for semen ejaculation prior to semen collection. Samples were collected during morning hours (8.00 am-10.00 am), by abdominal massage technique described by Lake and Stewart (1978). The roosters were restrained and a mild pressure was applied around the abdomen by trained technicians. The cloaca everted, ejaculating semen, which were collected in a 5 ml collection tube, and stored in a thermo flask containing warm water at a temperature range of between 38 and 40 ^{o}C. Samples were labeled and immediately evaluated for semen characteristics (semen volume-SV (ml), semen color-SC, semen pH and sperm motility-SM (%). Sperm concentration-SCo (x 10^{9}/ml), live ratio-LR (%) and sperm morphological defects (%) were evaluated under laboratory condition. Semen colour was determined with the aid of a colour chat, and was graded as creamy (3), milky (2) and watery (1), according to Kabir *et al*. (2007). The sperm morphology traits measured were dead ratio (DR-%), free tail (FT-%), detach head (DH-%), coil tail (CT-%) and bent tail (BT-%). The semen samples were collected thrice at 52 weeks of age of the roosters.

3. 3. 4 Hatching traits

Fertile eggs from each pen were collected for a period of seven days post mating. A total of 1711 eggs, 620, 505 and 586 eggs from hatches 1, 2 and 3 respectively were collected, labeled accordingly and taken to the hatchery of the National Animal Production Research Institute (NAPRI) for storage, incubation and hatching. For hatch 1 dam line, 46, 87 and 152 eggs were set for ratio 1:3, 1:6 and 1:9 respectively, out of which 26 (1:3), 42 (1:6) and 72 (1:9) chicks hatched. For hatch 1 sire line, 58, 121 and 156 eggs were set for ratio 1:3, 1:6 and 1:9 respectively, out of which only 30, 76 and 79 chicks hatched for the respective ratios. For hatch 2 dam line, 54, 64 and 122 eggs were set for ratio 1:3, 1:6 and 1:9, out of which 24, 44 and 60 chicks hatched for the respective ratios. For hatch 2 sire line, 33 (1:3), 101 (1:6) and 131 (1:9) eggs were set but only 21 (1:3), 71 (1:6) and 77 (1:9) chicks hatched. For hatch 3 dam line, 67, 79 and 145 eggs were set for ratio 1:3, 1:6 and 1:9 respectively but 43 (1:3), 56 (1:6) and 82 (1:9) chicks hatched. For hatch 3 sire line, 45, 96 and 154 eggs were set for ratio 1:3, 1:6 and 1:9 respectively but only 37 (1:3), 72 (1:6) and 83 (1:9) chicks hatched. Three hatches were collected during the experimental period, and percent fertility (PF), percent hatch (PH) and percent hatchability (PTH) were calculated according to the procedure described in the report of Orunmuyi *et al*. (2013) as follows:

$$Percent\ Fertile = \frac{\text{Total number of fertile eggs}}{\text{Total number of eggs set}} \times 100$$

$$Percent\ Hatch = \frac{\text{Total number of chicks hatched}}{\text{Total number of eggs set}} \times 100$$

$$Percent\ Hatchability = \frac{\text{Total number of chicks hatched}}{\text{Total number of fertile eggs}} \times 100$$

Records of total number of eggs set (NS), number of fertile eggs (NF), number of infertile eggs (NI), number of chicks hatched (NH) and percent infertile eggs (PI) were also obtained.

3. 4 Incubation and Hatching Procedure

The fertile eggs collected were immediately transported to the cold room and stored at controlled temperature and relative humidity range of between 10 and 20 ^{0}C and between 75 and 80 % respectively prior to incubation and hatching. Eggs from the cold room were moved to traying room for sorting, where cracked, dirty, rough, malformed, over sized and under sized eggs were removed. From the traying room, eggs were moved to the fumigation chamber and sprayed with formalin and KMO_4 for 30 minutes to destroy hatchery pathogens. Fumigated eggs were then set on trolleys and fitted into the incubator setter. They were conveyed into the incubator and maintained at temperature and relative humidity range of between 36.9 and 37.3 ^{0}C and between 31 and 35 % respectively, for a period of 18 days. Ventilation and turning were done automatically; turning was done on hourly basis for 24 hours.

Eggs were removed from the incubator at the end of 18 days and candled to remove transparent eggs, which were considered infertile. Candling box was used for candling, fitted with a 60watt bulb because a higher beam could cause embryo mortality. The fertile eggs were then put into hatching baskets, fitted on hatching trolleys and conveyed into the Hatcher component for a period of three days. The Hatcher was also maintained at the same temperature and relative humidity for incubation. At the end of 3 days, all chicks hatched were put in chick boxes and vaccinated against Maresk and Newcastle disease. A total of 20 chicks per mating ratio were sampled at random from the population of chicks hatched and their average weight was obtained using a digital

scale in grammes.

3. 5 Statistical Analysis

All data on semen traits, biometric traits, secondary sexual traits and hatching traits were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of SAS (2004), with significant means separated using Duncan Multiple Range Test (DMRT).

The data on biometric, secondary sexual traits and semen traits were analysed according the following model:

$Y_{ij} = \mu + T_i + e_{ij}$

Where;

Y_{ij} = Record of j^{th} progeny of the i^{th} sire,

μ = Overall mean,

T_i = Line effect on semen characteristics, biometric and secondary sexual traits (dam and sire),

e_{ij} = Random error.

Correlation coefficient was used to estimate the association between body weight, biometric traits, secondary sexual traits and semen traits using PROC CORR procedure of SAS (2004):

$$\sigma_{xy} = {CoV_{xy}}/{\sqrt{Var_x Var_y}}$$

Where;

CoV_{xy} = Covariance of traits x and y

Var_x = Variance of trait x

Var_y = Variance of trait y

Regression coefficient was used to quantify the extent of relationship among these traits as captured by this formular:

$Y_{ij} = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + e_{ij}$

Where;

Y_{ij} = the dependent variable of the i^{th} bird,

a = intercept,

$x_1 \ldots x_4$ = the p^{th} independent variables of the i^{th} bird,

$b_1 \ldots b_4$ = regression coefficient of Y and X,

e_{ij} = experimental error.

All data generated for the hatching traits were analysed according the following model:

$Y_{ijk} = \mu + B_i + T_j + H_k + (B_i \times T_j \times H_k) + e_{ijk}$

Where;

Y_{ijk} = observation of the i^{th} line (B), j^{th} mating ratio (T) and k^{th} hatch

μ = Overall mean,

B_i= effect of the i^{th} line,

T_j= effect of the j^{th} mating ratio

T_k= effect of the k^{th} hatch

$(B_i \times T_j \times H_k)$ = interaction of line, mating ratio and hatch

e_{ijk} = Random error.

e_{ijk}= NIID $(0, \sigma^2)$:- which means that sample error is normally independently identical with zero.

CHAPTER FOUR

4. 0 RESULTS

4. 1 Means and Coefficients of Variation for Body Weight and Biometric Traits at week 52

From Table 4.1, mean values of 5.37±0.04 kg, 71.70±0.38, 36.14±0.27, 15.62±0.20 and 10.42±0.08 cm were obtained for BW, BL, BG, DSL and ShL respectively in the dam line. In the sire line, mean values of 5.52±0.07 kg, 72.89±0.37, 34.84±0.23, 16.13±0.14 and 10.73±0.09 cm were observed for BW, BL, BG, DSL and ShL. BW, BL, DSL and ShL were significant ($p<0.05$) in the sire line roosters, except for BG.

Coefficients of variation for body weight and biometric traits in lines of Shikabrown [@] parent stock roosters were presented in Table 4. 1. The highest variation in the dam line with the value of 8.77 was observed for DSL. The lowest variation with the value of 3.55 was obtained for BL. Values of 5.21, 5.12 and 4.93 were observed for ShL, BW and BG respectively. In the sire line, lowest variation of 3.40 for BL was obtained. The highest variation of 6.89 was observed for BW. In the sire line, coefficients of 5.76, 5.70 and 4.49 were observed for ShL, DSL and BG respectively.

4. 2 Means and Coefficients of Variation for Secondary Sexual Traits

From Table 4. 1, mean values of 11.61±0.11, 6.99±0.09, 5.51±0.15 and 6.41±0.14 cm were obtained for CL, CW, WL and WW in the dam line roosters respectively. Mean values of 11.00±0.14, 6.39±0.13, 4.64±0.07 and 6.12±0.12 cm were also observed for CL, CW, WL and WW respectively in the sire line. Significant ($p<0.05$) difference was observed for CL, CW, WL in the sire line.

Coefficients of variation for the secondary sexual traits were also measured in Table 4. 1. Coefficients of 6.27, 8.60, 17.86 and 14.68 were obtained for CL, CW, WL and WW respectively in the dam line. In the sire line, coefficients of 8.35, 13.50, 10.55 and 12.82 were observed for CL, CW, WL and WW respectively.

4. 3 Means and Coefficients of Variation for Semen Characteristics of Shikabrown roosters at week 52

From table 4.2, mean values of 3.00±0.07 (creamy), 6.96±0.03, 0.45±0.02 ml, 0.99±0.02 %, 2.29±0.03 (x 10^9/ml) and 0.98±0.02 % were observed for SC, pH, SV, SM, SCo and LR respectively in the dam line roosters. In the sire line, mean values of 2.00 (milky), 7.22, 0.44 ml, 0.94 %, 2.17 (x 10^9/ml) and 0.98 % for SC, pH, SV, SM, SCo and LR were obtained respectively. Significant difference ($p<0.05$) was obtained for SC and SCo in the dam line, with FT and DH significant in the sire line.

The coefficients of variation for semen characteristics of lines of Shikabrown $^{@}$ parent stock roosters were represented in Table 4.2. Coefficients of 18.32, 2.91, 31.76, 14.14, 7.42 and 4.08 were observed for SC, pH, SV, SM, SCo and LR respectively in the dam line. In the sire line, coefficients of 38.09, 8.80, 39.48, 22.34, 15.21 and 14.29 were observed for SC, pH, SV, SM, SCo and LR respectively.

4. 4 Means for Sperm Morphology Defects of Shikabrown $^{@}$ parent stock roosters at week 52

Table 4.2 showed the mean values for sperm morphology defect. The values of 0.18±0.01, 0.04±0.04, 0.03±0.03, 0.04±0.03 and 0.02±0.04 % were observed for DR, FT, BT, DH and CT in the dam line roosters respectively. In the sire line, mean values of 0.18±0.01, 0.04±0.03, 0.03±0.04, 0.04±0.02 and 0.02±0.04 % were obtained for DR, FT, BT, DH and CT respectively. Significant ($p<0.05$) difference was observed for FT

and DH in the sire line.

4. 5 Least Square Means of Hatching Traits in Lines of Shikabrown [@] Parent Stock at Varying Mating Ratio

Table 4.3 showed the effect of mating ratio on hatching traits in lines of Shikabrown [@] parent stock. Hatching traits measured during this experiment include number of egg set (NS), number of eggs fertile (NF), number of eggs infertile (NI), number of eggs hatched (NH), percent fertility (PF), percent infertility (PI), percent hatched (PH) and percent hatchability (PTH). Mean values observed for mating ratio 1:3, 1:6 and 1:9 for the two lines were represented in Table 4.3. The hatching traits measured (NS, NF, NI, NH, PF, PI, PH and PTH) for the dam line showed significant difference ($p<0.05$) across the three mating ratios. NS, NF, NI, NH and PI appeared significantly highest in ratio 1:9. Mating ratio 1:6 was significantly higher than ratio 1:3. PF was significant in ratio 1:3, but no significant difference ($p>0.05$) was observed for ratios 1:6 and 1:9 for PF. PH for ratio 1:6 was found to be significant for ratio 1:3 and 1:9. PTH did not show significant difference ($p>0.05$) across mating ratio From Table 4.3 for the sire line, the mean values for NS, NF, NI, NH, PF, PI, PH and PTH were obtained at mating ratios 1:3, 1:6 and 1:9. All the hatching traits measured showed significant difference ($p<0.05$) across mating ratio in the sire line. NS, NF, NH were significantly higher in ratio 1:9. Ratio 1:6 appeared significantly higher than ratio 1:3 in the same traits. NI and PI were found to be significantly higher in ratio 1:9. PF was significantly higher in 1:6. PH and PTH appeared significantly highest in ratio 1:6 compared to the other mating ratios (1:3 and 1:9).

Table 4. 1:Means and Coefficients of Variation for Body Weight, Biometric and Secondary Sexual Traits in Lines of Roosters of Shikabrown [@] Parent Stock at Week 52.

	Dam line		Sire line	
Traits	Means±SE	CV (%)	Means±SE	CV (%)
Biometric traits				
BW (kg)	5.37±0.04[b]	5.12	5.52±0.07[a]	6.89
BL (cm)	71.70±0.38[b]	3.55	72.89±0.37[a]	3.40
BG (cm)	36.14±0.27[a]	4.93	34.84±0.23[b]	4.49
DSL (cm)	15.62±0.20[b]	8.77	16.13±0.14[a]	5.70
ShL (cm)	10.42±0.08[b]	5.21	10.73±0.09[a]	5.76
Sexual traits				
CL (cm)	11.61±0.11[a]	6.27	11.00±0.14[b]	8.35
CW (cm)	6.99±0.09[a]	8.60	6.39±0.13[b]	13.50
WL (cm)	5.51±0.15[a]	17.86	4.64±0.07[b]	10.55
WW (cm)	6.41±0.14	14.68	6.12±0.12	12.82

CV- coefficient of variation, BW-body weight, BL-body length, BG-breast girth, DSL-drumstick length, ShL-shank length, CL-comb length, CW-comb width, WL-wattle length, WW-wattle width, SE-standard error. Means within the same row with different superscripts are significantly different ($p<0.05$).

Table 4. 2: Means and Coefficients of Variation for Semen Traits in Lines of Roosters of Shikabrown @ Parent Stock at Week 52.

	Dam line		Sire line	
Traits	Mean±SE	CV (%)	Mean±SE	CV (%)
Semen characteristics				
Semen Colour	3.00±0.07[a] (creamy)	18.32	2.00±0.12[b] (milky)	38.09
Semen pH	6.96±0.03[b]	2.91	7.22±0.09[a]	8.80
Semen Volume (ml)	0.45±0.02	31.76	0.44±0.03	39.48
Sperm Motility (%)	0.99±0.02	14.14	0.94±0.03	22.34
SCo (x 10^9/ml)	2.29 ±0.03[a]	7.42	2.17 ±0.05[b]	15.21
Live Ratio (%)	0.98±0.02	4.08	0.98±0.02	14.29
Sperm morphology defect				
Dead Ratio (%)	0.18±0.01	44.44	0.18±0.01	50.00
Free Tail (%)	0.04±0.03[b]	50.00	0.03±0.03[a]	66.67
Bent Tail (%)	0.03±0.04	66.67	0.03±0.04	66.67
Detach Head (%)	0.04±0.03[b]	50.00	0.03±0.02[a]	66.67
Coiled Tail (%)	0.02±0.04	150.00	0.02±0.04	150.00

SE-standard error, CV-coefficient of variation, SCo-sperm concentration. Means within the same row with different superscript are significantly different ($p<0.05$).

Table 4. 3: Least Square Means of Hatching Traits in Lines of Shikabrown [@] Parent Stock at Varying Mating Ratio

		Mating ratio			
Lines	Parameter	1: 3	1: 6	1: 9	SEM
DL	NS	55.67[c]	76.67[b]	139.67[a]	7.31
	NF	50.33[c]	66.67[b]	118.67[a]	7.56
	NI	05.33[c]	10.00[b]	21.00[a]	0.42
	NH	31.00[c]	47.33[b]	71.33[a]	5.59
	PF (%)	89.10[a]	86.73[b]	84.80[b]	1.49
	PI (%)	10.03[c]	13.27[b]	15.20[a]	1.49
	PH (%)	55.03[b]	62.67[a]	51.07[b]	5.26
	PTH (%)	61.10[b]	72.40[a]	60.20[b]	6.04
SL	NS	46.33[c]	106.00[b]	147.00[a]	7.63
	NF	41.33[c]	101.33[b]	128.67[a]	6.73
	NI	04.00[b]	04.67[b]	18.33[a]	2.10
	NH	29.33[c]	73.00[b]	79.67[a]	2.64
	PF (%)	92.37[b]	95.40[a]	87.57[b]	2.20
	PI (%)	07.53[b]	04.60[b]	12.43[a]	2.16
	PH (%)	65.83[b]	69.37[a]	54.43[c]	4.94
	PTH (%)	70.93[b]	72.83[a]	62.13[b]	4.78

SEM-standard error of mean, NS-number set, NF-number fertile, NI-number infertile, NH-number hatched, PI-percent infertile, PF-percent fertility, PH-percent hatched, PTH-percent hatchability, SL-sire line, DL-dam line. Means within the same row with different superscript are significantly different ($p<0.05$).

4. 6 Least Square Means for Day-old Weight (g) of Chicks at Varying Mating Ratio in Lines of Shikabrown [@] Parent Stock

Table 4. 4 showed the effect of mating rating ratio on weight of day old chicks hatched. No significant ($p>0.05$) difference was observed for the day old weight (g) of chick at mating ratio 1:3, 1:6 and 1:9 in the two lines studied.

4. 7 Effect of Interaction of Mating Ratio and Hatch on Day-old Weight (g) of Chicks in Lines Shikabrown [@] Parent Stock

Table 4. 5 showed the interaction of mating ratio and hatch on day old weight (g) of chicks. For the dam line, significant ($p<0.05$) difference was observed for the three hatches at ratios 1:3, 1:6 and 1:9. Mating ratio 1:3 and 1:6 did not show significant ($p>0.05$) difference for hatch one. Mating ratio 1:3 appeared significantly higher than 1:6 and 1:9, with 1:9 significantly higher than ratio 1:6 for hatch two. For hatch three, ratio 1:3 differed significantly ($p<0.05$) from ratio 1:6 and 1:9, with 1:6 and 1:9 showing no significant ($p>0.05$) difference.

For the sire line, significant difference ($p<0.05$) was observed for hatches 1 and 3 for day-old weight of chicks. Mating ratio 1:3 was significantly higher than ratio 1:6 and 1:9, with ratio 1:6 also appearing significantly higher than 1:9 for hatch 1. For hatch 3, weight of chicks was observed to be significantly higher for ratio 1:3, while 1:6 and 1:9 did not show significant difference. Hatch 2 did not show significant difference ($p>0.05$) across mating ratio for day old weight of chicks.

Table 4. 4: Least Square Means for Day-old Weight of Chicks (g) at Varying Mating Ratio in Lines of Shikabrown [@] Parent Stock.

	Dam line	Sire line		
Mating ratio	Means	Means	SEM	LOS
1: 3	31.75	32.83	2.74	ns
1: 6	29.92	31.00	2.50	ns
1: 9	29.83	30.25	3.24	ns

LOS-level of significance, SEM-standard error of mean, ns- not significant ($p>0.05$).

Table 4. 5: Effect of Interaction of Mating Ratio and Hatch on Day-old Weight (g) of Chicks in Lines of Shikabrown [@] Parent Stock

		Mating ratio			
Lines	Hatches	1: 3	1: 6	1: 9	SEM
Dam line	H1	28.50[a]	28.75[a]	25.75[b]	0.86
	H2	37.00[a]	30.00[c]	31.50[b]	0.74
	H3	34.75[a]	31.00[b]	31.75[b]	0.78
Sire line	H1	34.00[a]	31.75[b]	27.50[c]	0.73
	H2	33.00	31.50	32.00	0.82
	H3	32.00[a]	29.75[b]	31.25[b]	0.85

SEM-standard error of mean, H-hatch.

4. 8 Coefficient of Correlation of Body Weight, Biometric and Semen Characteristics in the Dam and Sire Lines

Table 4. 6 gave the coefficient of correlation for body weight, biometric and semen characteristics in dam line of Shikabrown [@] parent stock. A highly significant ($p<0.01$) correlation was seen between BL and LR (0.36); SC and SCo (0.51). The correlation between BW with BL (0.28), BG (0.30) and LR (0.36); BL and SC (0.32); BG and SC (0.29); ShL and SV (0.29); SC and pH (0.29); SM with SCo (0.33) and LR (0.31) appeared significant ($p<0.05$). Other traits measured did not show significant ($p>0.05$) correlation.

Table 4. 6 showed the coefficients of correlation of body weight, biometric and semen characteristics in sire line Shikabrown [@] parent stock. A very highly significant ($p<0.001$) correlation was seen between BW with BL (0.46), BG (0.59) and ShL (0.55); BL and ShL (0.47); SC with SM (0.46) and SCo (0.70). BW and DSL (0.40); BL with BG (0.49), SC (-0.43) and LR (0.42); SM and SCo (0.43) were highly significant ($p<0.01$). A significant correlation ($p<0.05$) was observed between BW and LR (0.36); BL and pH (0.30); BG and ShL (0.31); DSL with ShL (0.34) and SCo (0.30); SC and SV (0.29); SM and LR (0.02). Other traits measured, although positive and negative but did not show significant correlation ($p>0.05$).

Table 4. 6: Coefficient of Correlation for Body Weight, Biometric and Semen Characteristics in Lines of Roosters of Shikabrown [@] Parent Stock

Lines	Traits	BW	BL	BG	DSL	ShL	SC	pH	SV	SM	SCo	LR
DL	BW	-										
	BL	0.28*	-									
	BG	0.30*	-0.14	-								
	DSL	-0.28	0.08	-0.20	-							
	ShL	0.03	0.09	-0.08	0.19	-						
	SC	-0.11	-0.16	0.29*	-0.04	-0.07	-					
	pH	-0.10	-0.20	-0.04	-0.06	-0.23	0.29*	-				
	SV	0.07	0.32*	-0.17	0.22	0.29*	-0.02	-0.14	-			
	SM	-0.16	0.21	-0.11	-0.12	0.05	0.10	-0.06	0.03	-		
	SCo	-0.22	0.25	-0.10	0.19	0.01	0.51**	-0.02	0.17	0.33*	-	
	LR	0.36*	0.36**	-0.12	-0.03	0.01	-0.08	-0.03	0.06	0.31*	-0.03	-
SL	BW	-										
	BL	0.46***	-									
	BG	0.59***	0.49**	-								
	DSL	0.40**	0.20	0.13	-							
	ShL	0.55***	0.47***	0.31*	0.34*	-						
	SC	-0.06	-0.43**	-0.17	0.19	-0.08	-					
	pH	0.06	0.30*	0.01	-0.25	0.21	-0.49	-				
	SV	0.02	-0.11	0.06	0.09	-0.19	0.29*	-0.21	-			
	SM	-0.08	-0.08	-0.28	-0.09	-0.10	0.46***	-0.37	0.25	-		
	SCo	0.01	-0.15	-0.14	0.30*	0.13	0.70***	-0.44	0.20	0.43**	-	
	LR	0.36*	0.42**	0.95	0.01	0.08	0.38	0.33	0.61	0.02*	0.26	-

BW-Body weight, BL-body length, DSL-drum stick, BG-Breast girth, ShL-shank length, SC-semen color, SV-semen volume, SM-sperm motility, SCo-sperm concentration, LR-live ratio DL-dam line, SL-sire line, P<0.05=*, P<0.01=**, P<0.001=***

4. 9 Coefficients of Correlation for Body Weight, Biometric and Sperm Morphology Defect in the Dam and Sire Lines

Table 4. 7 gave the correlation of body weight, biometric and sperm morphology defect in dam line of Shikabrown [@] parent stock. Results showed a highly significant correlation ($p<0.01$) for BL with DR (-0.42) and CT (-0.39); DSL and FT (0.43); FT and DH (0.41). A significant correlation was observed between BW with BG (0.30) and DR (-0.36); DR with FT (0.35) and DH (0.33). No significant correlation ($p>0.05$) was observed for the other traits measured though some appeared negative while others positive.

Results obtained for the sire line showed a very highly significant ($p<0.001$) correlation for BW with BL (0.59) and ShL (0.55); BL and ShL (0.47). The correlation between BW with BL (0.46) and DSL (0.40); BL and BG (0.49); DSL and DR (0.40); FT and CT (0.39); BT and CT (-0.39) were found to be highly significant ($p<0.01$). A significant correlation was observed for BL and CT (-0.02); BG and ShL (0.31); DSL and ShL (0.34); DH and CT (0.31). No significant correlation ($p>0.05$) was seen for the other traits observed.

Table 4. 7: Coefficients of Correlation for Body Weight, Biometric and Sperm Morphology Defect in Lines of Roosters of Shikabrown [@] Parent Stock

Lines	Traits	BW	BL	BG	DSL	ShL	DR	FT	BT	DH	CT
DL	BW	-									
	BL	0.28	-								
	BG	0.30*	-0.14	-							
	DSL	-0.28	0.08	-0.20	-						
	ShL	0.03	0.09	-0.08	0.19	-					
	DR	-0.36*	-0.42**	0.12	0.03	-0.01	-				
	FT	-0.12	0.00	0.06	0.43**	-0.11	0.35*	-			
	BT	-0.20	-0.08	-0.17	-0.19	0.12	0.19	-0.17	-		
	DH	-0.01	-0.01	0.03	0.21	-0.02	0.33*	0.41**	0.13	-	
	CT	0.09	-0.39**	0.11	-0.10	0.00	-0.06	0.07	-0.12	0.11	-
SL	BW	-									
	BL	0.46**	-								
	BG	0.59***	0.49**	-							
	DSL	0.40**	0.20	0.13	-						
	SL	0.55***	0.47***	0.31*	0.34*	-					
	DR	0.13	-0.04	0.01	0.40**	0.27	-				
	FT	0.02	-0.19	0.17	-0.10	-0.00	-0.04	-			
	BT	-0.02	0.24	0.08	0.10	0.01	-0.06	-0.20	-		
	DH	-0.08	-0.10	0.10	0.13	0.05	0.22	0.09	-0.05	-	
	CT	-0.02	-0.02*	0.21	-0.03	-0.04	-0.02	0.39**	-0.39**	0.31*	-

BW-Body weight, BL-body length, DSL-drum stick, BG-Breast girth, ShL-shank length, DR-dead ratio, FT-free tail, BT-bent tail, DH-detached head, CT-coiled tail, DL-dam line, SL-sire line, P<0.05=*, P<0.01=**, P<0.001=***.

4. 10 Coefficients of Correlation for Secondary Sexual Traits and Semen Characteristics in Dam and Sire Lines

The result obtained from this study in table 4. 8 for the dam line revealed a very highly significant correlation between CL with CW (0.71), WL (0.65) and WW (0.62); CW with WL (0.61) and WW (0.56); WL and WW (0.61); SC and SCo (0.51). A significant correlation was obtained for WW with SCo (0.29) and LR (-0.35); pH and SC (0.29); SM with SCo (0.33) and LR (0.31). The correlation observed for other traits was not significant ($p>0.05$).

Results obtained for the sire line showed a very highly significant ($p<0.001$) correlation between CL with CW (0.80), WL (0.60) and WW (0.71); CW with WL (0.66) and WW (0.81); WL and WW (0.66); pH and SC (-0.49); SC and SCo (0.70). The correlation for pH and SCo (-0.44); SC and SM (0.46); SM and SCo (0.43) appeared highly significant ($p<0.01$). pH and SM (-0.37); SC and SV (-0.29); SM and LR (0.34) were significant ($p<0.05$). No significant correlation ($p>0.05$) was observed for the other traits measured.

Table 4. 8: Coefficients of Correlation for Secondary Sexual Traits and Semen Characteristics in Lines of Roosters of Shikabrown [@] Parent Stock

Lines	Traits	CL	CW	WL	WW	pH	SC	SV	SM	SCo	LR
DL	CL	-									
	CW	0.71***	-								
	WL	0.65***	0.61***	-							
	WW	0.62***	0.56***	0.61***	-						
	pH	0.14	0.20	0.24	0.14	-					
	SC	-0.12	-0.00	0.04	0.12	0.29*	-				
	SV	0.05	0.06	-0.07	-0.00	-0.15	-0.12	-			
	SM	0.16	-0.02	0.19	0.06	-0.06	0.10	0.03	-		
	SCo	0.21	0.31	0.18	0.29*	-0.02	0.51***	0.17	0.33*	-	
	LR	-0.18	-0.27	-0.22	-0.35*	-0.01	-0.08	0.06	0.31*	-0.03	-
SL	CL	-									
	CW	0.80***	-								
	WL	0.60***	0.66***	-							
	WW	0.71***	0.81***	0.66***	-						
	pH	-0.16	-0.07	-0.04	-0.00	-					
	SC	0.10	0.04	-0.03	0.06	-0.49***	-				
	SV	0.18	0.17	0.07	0.12	0.21	-0.29*	-			
	SM	-0.04	-0.04	-0.07	0.13	-0.37*	0.46**	0.25	-		
	SCo	-0.27	-0.14	-0.12	-0.08	-0.44**	0.70***	0.20	0.43**	-	
	LR	0.26	0.04	-0.00	0.26	0.15	-0.13	0.08	0.34*	-0.17	-

CL-comb length, CW-comb width, WL-wattle length, WW-wattle width, SC-semen color, SV-semen volume, SM-sperm motility, SCo-sperm concentration, LR-live ratio, DL-dam line, SL-sire line, P<0.05=*, P<0.01=**, P<0.001=***.

4. 11 Coefficients of Correlation for Secondary Sexual Traits and Sperm Morphology Defect in the Dam and Sire Lines

Table 4. 9 showed the correlation of secondary sexual traits and sperm morphology defect in dam line Shikabrown [@] parent stock. A very highly significant ($p<0.001$) correlation was seen for CL with CW (0.71), WL (0.65) and WW (0.62); CW with WL (0.61) and WW (0.56); WL and WW (0.61). The correlation between FT and DH (0.41) was observed to be highly significant ($p<0.01$). A significant ($p<0.05$) correlation was seen for WW and DR (0.35); DR with FT (0.35) and DH (0.33). Correlation in the other traits measured did not show significant ($p>0.05$) correlation.

The results observed for the sire line showed a very highly significant ($p<0.001$) correlation for CL with WW (0.80), WL (0.61) and WW (0.75); CW with WL (0.66) and WW (0.81); WL and WW (0.66). The correlation between FT and CT (0.39); BT and CT (-0.39) appeared highly significant ($p<0.01$). A significant ($p<0.05$) correlation was observed for CL and DH (-0.33); WL and DH (-0.32); DH and CT (0.31). Other measured traits appeared not significant ($p>0.05$).

Table 4. 9: Coefficients of Correlation for Secondary Sexual Traits and Sperm Morphology Defect in Lines of Roosters of Shikabrown [@] Parent Stock

Lines	Traits	CL	CW	WL	WW	DR	FT	BT	DH	CT
DL	CL	-								
	CW	0.71***	-							
	WL	0.65***	0.61***	-						
	WW	0.62***	0.56***	0.61***	-					
	DR	0.18	0.27	0.22	0.35*	-				
	FT	0.03	0.20	0.14	0.19	0.35*	-			
	BT	0.17	0.17	0.12	0.18	0.19	-0.17	-		
	DH	0.18	0.16	-0.00	0.23	0.33*	0.41**	0.13	-	
	CT	-0.09	-0.18	0.07	-0.08	-0.06	0.07	-0.12	0.11	-
SL	CL	-								
	CW	0.80***	-							
	WL	0.61***	0.66***	-						
	WW	0.75***	0.81***	0.66***	-					
	DR	-0.26	-0.04	0.00	-0.26	-				
	FT	0.07	0.13	0.09	0.06	-0.06	-			
	BT	-0.08	-0.19	-0.13	-0.15	0.22	-0.20	-		
	DH	-0.33*	-0.23	-0.32*	-0.23	-0.02	0.09	-0.05	-	
	CT	-0.07	0.02	-0.18	-0.21	-0.11	0.39**	-0.39**	0.31*	-

CL-comb length, CW-comb width, WL-wattle length, WW-wattle width, DR-dead ratio, FT-free tail, BT-bent tail, DH-detached head, CT-coiled tail, DL-dam line, SL-sire line, P<0.05=*, P<0.01=**, P<0.001=***.

4. 12 Coefficients of Correlation for Body Weight, Biometric and Secondary Sexual Traits in the Dam and Sire Lines

Table 4. 10 gave the correlation coefficients for body weight, biometric and secondary sexual traits in lines of Shikabrown [@] parent stock. Results obtained for the dam line showed a very highly significant correlation ($p<0.001$) in the correlation between CL with CW (0.71), WL (0.65) and WW (0.62); CW with WL (0.61) and WW (0.56); WL and WW (0.61). A highly significant ($p<0.01$) correlation was observed between BW with BL (0.28) and DSL (-0.28), DSL and WW (0.27). The correlation between BW with BG (0.30) and WL (-0.35) were found to be significant ($p<0.05$). Other traits measured did not show significant correlation ($p>0.05$).

Results observed for the sire line gave a very highly significant ($p<0.001$) correlation between BW with BL (0.46), BG (0.59), ShL (0.55), CL (0.54) and CW (0.60); BL and ShL (0.47); CL with CW (0.80), WL (0.61) and WW (0.75); CW with WL (0.66) and WW (0.81); WL and WW (0.66). The correlation between BW with DSL (0.40) and WW (0.49); BL with BG (0.49) and CL (0.27); DSL and CW (0.25) were highly significant ($p<0.01$). A significant ($p<0.05$) correlation was observed between BW and WL (0.31); BG with ShL (0.31), CL (0.34) and CW (0.30); DSL and ShL (0.34). Positive, negative but not-significant ($p>0.05$) correlation was observed in the other traits measured.

Table 4. 10: Coefficients of Correlation for Body Weight, Biometric and Secondary Sexual Traits in Lines of Roosters of Shikabrown[@] Parent Stock

Lines	Traits	BW	BL	BG	DSL	ShL	CL	CW	WL	WW
DL	BW	-								
	BL	0.28**	-							
	BG	0.30*	-0.14	-						
	DSL	-0.28**	0.08	-0.20	-					
	ShL	0.03	0.09	-0.08	0.19	-				
	CL	-0.15	-0.06	0.11	0.02	0.07	-			
	CW	-0.05	-0.08	0.17	0.07	0.12	0.71***	-		
	WL	-0.11	-0.24*	0.13	-0.23	-0.14	0.65***	0.61***	-	
	WW	-0.35*	-0.07	-0.14	0.27**	0.10	0.62***	0.56***	0.61***	-
SL	BW	-								
	BL	0.46***	-							
	BG	0.59***	0.49**	-						
	DSL	0.40**	0.20	0.13	-					
	ShL	0.55***	0.47***	0.31*	0.34*	-				
	CL	0.54***	0.27**	0.34*	0.12	-0.03	-			
	CW	0.60***	0.15	0.30*	0.25**	0.16	0.80***	-		
	WL	0.31*	-0.05	-0.07	0.22	0.07	0.61***	0.66***	-	
	WW	0.49**	0.15	0.19	0.15	0.12	0.75***	0.81***	0.66***	-

CL-comb length, CW-comb width, WL-wattle length, WW-wattle width,BW-Body weight, BL-body length, DSL-drum stick, BG-Breast girth, ShL-shank length, DL-dam line, SL-sire line, P<0.05=*, P<0.01=**, P<0.001=***.

4. 13 Multiple Regression Equation for Prediction of Semen Characteristics from Body Weight and Biometric Traits

Table 4. 11 showed the equations generated for body weight and biometric traits (BW, BL, BG, DSL and ShL-independent variables) for the prediction of semen characteristics (SV, SC, pH, SM, SCo and LR-dependent variables). From the result obtained for the dam line, low to moderate coefficients of determination (R^2) values of 20, 14, 9, 16, 17 and 28 % were obtained for SV, SC, pH, SM, SCo and LR respectively. Results obtained for the sire line also showed low to moderate coefficients of determination (R^2) values of 9, 26, 25, 11, 27 and 22 % were obtained for SV, SC, pH, SM, SCo and LR respectively.

4. 14 Multiple Regression Equation for the Prediction of Semen Characteristics from Secondary Sexual Traits

Table 4. 12 showed the regression models generated for secondary sexual traits (CL, CW, WL, WW-independent variables) for the prediction of semen characteristics (SV, SC, pH, SM, SCo and LR-dependent variables) in lines of Shikabrown $^{@}$ parent stock. Results obtained for the dam line gave low to moderate coefficients of determination (R^2) values of 3, 7, 9, 10 12 and 13 % were obtained for SV, SC, pH, SM, SCo and LR respectively. Coefficients of determination (R^2) values of 4, 6, 2, 10, 11 and 28 % were obtained for SV, SC, pH, SM, SCo and LR respectively in the sire line, which were also low to moderate.

Table 4. 11: Multiple Regression Equation for Prediction of Semen Characteristics from Body Weight and Biometric Traits in Lines of Shikabrown [@] Parent Stock

Lines	Predictant	Model	R^2
DL	SV	Y= -1.32+0.03BW+0.01BL-0.01BG +0.02DSL+0.06ShL	0.20
	SC	Y= 1.17-0.37BW-0.01BL+0.09BG -0.01DSL+0.10ShL	0.14
	pH	Y= 9.42-0.02BW-0.01BL-0.01BG -0.00DSL-0.08SL	0.09
	SM	Y= 0.95-0.17BW+0.02BL-0.00BG -0.03DSL+0.02ShL	0.16
	SCo	Y=1.34-0.022BW-0.02BL+0.01BG +0.01DSL+0.02ShL	0.17
	LR	Y= -6.27+0.17BW+0.02BL-0.01BG +0.00DSL-0.01ShL	0.28
SL	SV	Y= 0.65+0.04BW-0.01BL+0.01BG +0.03DSL-0.08ShL	0.09
	SC	Y= 9.37+0.08BW-0.17BL+0.01BG +0.23DSL+0.07ShL	0.26
	pH	Y= 5.01+0.11BW+0.09BL-0.09BG -0.27DSL+0.21ShL	0.25
	SM	Y= 2.42+0.14BW+0.01BL-0.05BG -0.02DSL-0.05ShL	0.11
	SCo	Y=3.13-0.08BW-0.05BL-0.01BG +0.11DSL+0.15ShL	0.27
	LR	Y= 1.56+0.04BW+0.01BL-0.00BG-0.06DSL-0.07ShL	0.22

CL-comb length, CW-comb width, WL-wattle length, WW-wattle width, SC-semen color, SV-semen volume, SM-sperm motility, SCo-sperm concentration, DL-dam line, SL-sire line, LR-live ratio, R^2-coefficient of determination.

Table 4.12: Multiple Regression Equation for Prediction of Semen Characteristics from Secondary Sexual Traits in Lines of Shikabrown @ Parent Stock

Lines	Predictant	Model	R^2
DL	SV	Y= 0.20+0.02CL+0.03CW-0.03WL +0.00WW	0.03
	SC	Y= 2.05-0.06CL+0.12CW+0.12WL -0.03WW	0.07
	pH	Y= 7.60-0.11CL+0.02CW+0.01WL +0.07WW	0.09
	SM	Y= 0.76+0.05CL-0.07CW+0.04WL -0.01WW	0.10
	SCo	Y= 1.82-0.03CL+0.07CW-0.00WL +0.04WW	0.12
	LR	Y= 1.19+0.04CL-0.04CW-0.00WL -0.05WW	0.13
SL	SV	Y= 0.13+0.03CL+0.03CW-0.03WL -0.01WW	0.04
	SC	Y= 3.89-0.32CL+0.02CW+0.02WL +0.25WW	0.06
	pH	Y= 6.64+0.13CL-0.05CW-0.19WL +0.06WW	0.02
	SM	Y= 1.10-0.02CL-0.07CW-0.09WL +0.16WW	0.10
	SCo	Y= 3.48-0.18CL+0.06CW+0.01WL +0.04WW	0.11
	LR	Y= 0.49+0.08CL-0.12CW-0.07WL +0.12WW	0.28

CL-comb length, CW-comb width, WL-wattle length, WW-wattle width, SC-semen color, SV-semen volume, SM-sperm motility, SCo-sperm concentration, DL-dam line, SL-sire line, LR-live ratio, R^2-coefficient of determination.

CHAPTER FIVE

5. 0 DISCUSSIONS

5. 1 Coefficients of Variation for Body Weight, Biometric, Secondary Sexual Traits and Semen Characteristics in Lines of Roosters of Shikabrown @ Parent Stock at week 52

Variation is a very important tool often used by animal breeders for genetic improvement of traits (Richard, 1997). From the results obtained in this study, variation in body weight and biometric traits appeared low, ranging between 5.12 and 8.77 in the dam line, and between 3.40 and 6.89 in the sire line. From the results obtained for the dam line for secondary sexual traits, low variations of between 6.27 and 17.86 and between 8.35 and 13.50 were observed for the dam and sire lines respectively. The low coefficients of variation obtained in this study for biometric and secondary sexual traits are expected. This is because the population of chickens used was intensely selected for these traits, showing that selection is reaching plateau. Further selection for these traits may not result in genetic gain in this population. Coefficient of variation for semen characteristics observed from this study revealed a range of between 2.91 and 31.76 in the dam line and a range of between 8.80 and 39.48 in the sire line. For these traits, variation also followed similar trend except for SV (31.76) in the dam line, and SC (38.09) and SV (39.48) in the sire line. High variation suggests the potential for genetic improvement of traits (Olawunmi *et al*. 2008).

5. 2 Mean Values for Body Weight, Biometric and Secondary Sexual Traits in Lines of Shikabrown @ Parent Stock at Week 52

Mean value of 5.37 kg for BW in the dam line, and 5.52 kg for BW in the sire line was obtained for roosters at 52 weeks. The roosters of the sire line were superior for BW (5.52 kg), BL (72.89 cm), DSL (16.13 cm) and ShL (10.73 cm), which could be traced

to the fact that they were bred for body weight. The observed higher values obtained for the Shikabrown roosters at week 52 supports the findings of Abd El Ghany *et al*. (2011), who reported a progressive increase in body weight and morphometric traits with increase in age. The dam line roosters were best for secondary sexual traits (CL-11.61 cm, CW-6.99 cm and WL-5.51 cm). This may be due to the fact that the roosters were bred for egg production.

5. 3 Mean Values for Semen Characteristics in Lines of Shikabrown [@] Parent Stock at Week 52

Results obtained for semen characteristics gave a milky semen colour for roosters of the dam line, which agreed with the milky semen colour reported by Nwagu *et al*. (1996), who worked on Rhode Island White breeder cocks. The findings of Kabir *et al*. (2007) on the same stock also showed milky semen colour which also concords with what was obtained for the dam line. The creamy SC obtained for roosters of the dam line showed high concentration of sperm cells, which could be linked to better fertility compared to the milky SC obtained for the sire line roosters. The significant SCo obtained for the roosters of the dam line further explained this claim. Semen pH of 7.22 obtained for the sire line was within the alkaline range reported by Peters *et al*. (2008), who reported a value of 7.01 for cockreals. Values for semen colour of 7.54, 7.80 and 7.40 were reported by Tuncer *et al*. (2006), Bar *et al*. (2001) and Orunmuyi *et al*. (2013) respectively. Semen volumes of 0.45 ml (dam line) and 0.44 ml (sire line), observed in this study were lower than what was obtained by Nwagu *et al*. (1996), who reported a range of between 0.58 and 0.80 ml for Rhode Island White breeder cocks. The findings of Kabir *et al*. (2007) on Rhode Island White breeder cocks gave semen volume of 0.42 ml, slightly lower than the value obtained in this study. The report of Lee *et al*. (1999) gave a higher range of semen volume of between 0.48 and 0.75 ml. A lower semen

volume of 0.39 ml was reported by Ezekwe *et al*. (2003) for Nigerian local cocks, while Ezekwe and Machebe (2004) reported 0.24 ml and 0.27 ml for naked neck and frizzle strain of local cocks, respectively. Sperm motility values of 99 % and 94 % were observed from this study for the dam and sire lines respectively. The sperm motility value of 73 % obtained by Kabir *et al*. (2007) was lower than the motility value obtained from this study. The motility values observed here were lower than the values obtained by Orunmuyi *et al*. (2013), who reported a value of 84 % for Hubbard broilers. The motility value reported from this study fell within the range of motility values of between 70 % and 88 % reported by Peters *et al*. (2008). Sperm concentration values of 2.29 x 10^9/ml for the dam line and 2.17 x 10^9/ml for the sire line obtained in this study were lower than 3.91 x 10^9/ml observed by Orunmuyi *et al*., (2013). Sperm concentration value of 1.47 x 10^9/ml was observed by Kabir *et al*. (2007), which was lower than what was obtained in our study. Sperm live ratios of 98 % (dam line) and 98% (sire line) obtained from this study were lower than the findings of Kabir *et al*. (2007), who reported a value of 86 %. Several factors may have resulted in the differences observed, which range from age, breed and strain of chickens used (Tabatabaei *et al*., 2010), nutrition (Omeje and Ude, 1998; Kabir *et al*., 2007), temperature (Hafez and Hafez, 2000; Anderson, 2001) and photoperiod (Lake and Stewart, 1978).

5. 4 Mean Values for Sperm Morphology Defect in Lines of Shikabrown [@] Parent Stock at Week 52

Sperm morphology defect indicates decreased fertility in most species (Chandler *et al*., 1988), with a defect of up to 20 % resulting in reduced fertility (Morrow, 1980). DR, FT, BT, DH and CT were the sperm morphology defect traits observed in this study. Results obtained for the dam line showed a total percent morphology defect of 31 %,

while 29 % was observed for the sire line. These defects might have resulted from abnormal spermatogenesis attributable to nutrition, age and pollution as reported by Bar *et al*. (2001). Careless handling of semen during collection and screening was also reported to be a potential cause of sperm morphology defect (Ajayi *et al*., 2011). The roosters worked with were ageing and the findings of Tabatabaei *et al*. (2009) also revealed that ageing has the tendency of increasing spermatozoa defect.

5. 5 Effect of Mating Ratio on Hatching Traits in Lines of Shikabrown [@] Parent Stock

Results obtained for the dam line showed a significant ($p>0.05$) difference between the traits measured in the three mating ratio (1:3, 1:6 and 1:9) except for PTH. In another research conducted by Orunmuyi *et al*. (2013) on hubbard broilers using mating ratios 1:6, 1:7 and 1:8, the best percent egg fertility (82.52 %) was obtained for mating ratio 1:6, which is in line with what was observed for the sire line of Shikabrown [@] parent stock. This also agrees with the work of Alsobayel and Albadry, (2012), who also found the best egg fertility (97.92 %) and hatchability (98.12 %) in mating ratio 1:6 for Baladi and Leghorn hens. Differences in the values observed could be as a result of breed, age and incubation condition as reported by king'ori (2011). Also, mating ratio 1:6 was superior for percent fertility (77.24 %) and hatchability (78.82 %) in a study carried out on white leghorn flock at 20 weeks of age (Firas *et al*., 2009). PF of 86.73 % and 95.40 % for the dam and sire lines respectively, observed in this study were higher than what was obtained by Firas *et al*. (2009). Age and breed difference may have resulted to these differences. Hatchability of 78.82 % obtained by Firas *et al*. (2009) was also higher than the PTH of 72.40 % and 72.83 % observed from this study for the dam and sire lines respectively. PF, PH and PTH of 89.10 % (1:3), 86.73 % (1:6) and 84.80 % (1:9) respectively, observed in this study for the dam line were higher than 78.52 %

(1:8) reported by Kabir and Sani (2011) who worked on Shikabrown parent stock. In a similar report, PH of 52.53 % (1:8) was lower than 55.03 % (1:3) and 62.67 % (1:6) obtained in this study for dam line. Similar finding also revealed that PTH of 61.02 % (1:8) obtained was lower than 72.40 % (1:6) observed for the dam line. PF, PH and PTH observed by Kabir and Sani (2011) were lower than what was observed from this study for the sire line. This could be due to egg handling, incubation condition, age and other factors affecting egg fertility and hatchability as reported by King'ori (2011).

5. 6 Effect of Interaction of Mating Ratio and Hatch on Day-old Weight of Chicks in Lines of Shikabrown [@] Parent Stock

Results obtained showed significant ($p<0.05$) difference across hatches at mating ratio 1:3, 1:6 and 1:9 in both the dam and sire lines studied. Several incubator factors such as temperature, humidity and turning condition might have resulted to these differences as reported by Elibol and Brake (2003); Lourens *et al*. (2005). The findings of King'ori (2011) showed egg collection, handling, and egg storage condition as additional factors likely to result to these differences.

5. 7 Coefficient of Phenotypic Correlation for Biometric, Secondary Sexual Traits and Semen Characteristics in Lines of Shikabrown [@] Parent Stock

Genetic correlation is a measure of the strength, consistency and reliability of the relationship between the breeding value of one trait and the breeding value of another trait, brought about by pleiotropy (Richard, 1997). Correlation is an important tool in the hand of an animal breeder because it permits the prediction of the magnitude and direction of dependent traits on the direct selection of a principal trait (Laxmi *et al*., 2002). The findings of Verma *et al*. (1983) revealed that for the improvement of a trait of economic value in animals, establishment of the correlation between the selected trait and its effect on other traits is important. This information is important especially in a

flock population that is undergoing continuous selection, which is likely to introduce changes in genetic correlation among traits (Sharma *et al*., 1996). From the results obtained for the dam and sire lines, various degrees of associations were observed between body weight, biometric and secondary sexual traits with semen traits. This is in line with the findings of Abd El Ghany *et al*. (2011), who also reported association between body weight and semen traits. The association observed from this study between body weight, biometric traits and secondary sexual traits with semen traits is also in accordance with the findings of Udeh *et al*. (2011) and Orunmuyi *et al*. (2013). The findings of Orunmuyi *et al*. (2013) revealed a positive correlation for body weight with semen volume, and a negative correlation between body weight with semen pH, which agrees with the observation of this study, with a negative correlation between the two traits as also reported by Makhafola *et al*. (2012). This means that a particular gene has contribution in the expression of the associated traits. Positive correlation among the traits means that the improvement of one trait leads to improvement in the correlated trait. Inverse is the case of negatively correlated traits.

5. 8 Multiple Regression Equation for the Prediction of Semen Characteristics from Biometric and Secondary Sexual Traits

Correlation only gives the association between traits but does not quantify the contribution of independent variables in predicting a dependent variable. Regression on the other hand gives the unit contribution of each of the independent variable in the prediction of a dependent variable (Richard, 1997).

From the results of this study, a range of between 9 and 28 % for the dam line and between 9 and 27 % for the sire line were observed for biometric traits with semen traits. Results observed for prediction of semen traits from secondary sexual traits gave a range of between 3 and 13 % for the dam line, and a range of between 2 and 28 % for

the sire line. The low coefficients of determination obtained for the dam and sire lines were lower than what was reported by Galal (2007), who worked on naked neck and normal feathered cocks. The implication of low coefficients of determination obtained in this study showed that the biometric and secondary sexual traits measured are not efficient in predicting semen traits.

CHAPTER SIX

6. 0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6. 1 Summary

An experiment was conducted to predict semen traits from biometric and secondary sexual traits in lines of Shikabrown [@] parent stock chickens. A total of 30 roosters (52 weeks old), 15 from the dam line and 15 from sire line were used for the study. For the effect of mating ratio on egg fertility and hatchability, a total of 15 roosters were mated to 90 hens in the dam and sire lines at mating ratio 1:3, 1:6 and 1:9, and a total of 1711 fertile eggs were hatched in three sets. Biometric traits (body weight-BW, body length-BL, breast girth-BG, drumstick length-DSL and shank length-ShL); secondary sexual traits (comb length-CL, comb width-CW, wattle length-WL and wattle width-WW); semen characteristics (semen colour-SC, semen volume-SV, semen pH, sperm motility-SM, sperm concentration-SCo and sperm live ratio-LR) and sperm morphology defect traits (dead ratio-DR, free tail-FT, bent tail-BT, detached head-DH and coiled tail-CT) were evaluated. Number set-NS, number fertile-NF, number infertile-NI, number hatched-NH, percent fertile-PF, percent infertile-PI, percent hatched-PH and percent hatchability-PTH traits were also measured.

Data collected were subjected to ANOVA, correlation and regression procedure of SAS, with significant means separated by DMRT procedure. From the results obtained for biometric traits, significant ($p<0.05$) difference was obtained for BW, BL, DSL and ShL in sire line roosters. Significant ($p<0.05$) difference was observed for CL, CW and WL for secondary sexual traits in the dam line roosters. High coefficients of variation of 31.76 (SV) in the dam line, and 38.09 (SC) and 39.48 (SV) in the sire line were

obtained in this study. The results also showed significant differences ($p<0.05$) for SC and SCo in the dam line, and semen pH in the sire line. FT and DH were significant ($p<0.05$) in the sire line. Total sperm morphology defect of 31 % and 29 % were obtained for the dam and sire line roosters respectively. Results obtained for correlation showed significant ($p<0.05$, $p<0.01$, $p<0.001$) correlation for some of the traits measured. Positive correlation coefficients of 0.36 (BW and LR), 0.32 (BL and SV), 0.36 (BL and LR) and 0.29 (WW and SCo) in the dam line were obtained. For the sire line, significant positive correlation coefficients of 0.42 (BL and LR), 0.36 (BW and LR) and 0.30 (ShL and SCo) were obtained. Regression models generated for the prediction of semen traits from biometric traits in the dam line showed low coefficients of determination (R^2) of between 9 and 28 % in the dam line, and between 9 and 27 % in the sire line. For prediction of semen traits from secondary sexual traits, coefficients of determination (R^2) of between 3 and 13 % were obtained in the dam line, and between 2 and 28 % in the sire line. Result for hatching traits showed a significant ($p<0.05$) difference for PH (62.67 %) and PTH (72.40 %) for mating ratio 1:6 in the dam line. PF (95.40 %), PH (69.37 %) and PTH (72.83 %) were significant ($p<0.05$) for mating ratio 1:6 in the sire line. Mating ratio affected ($p<0.05$) hatches in the dam and sire lines. However, weight of day-old chicks was not affected by ($p>0.05$) mating ratio in both lines.

In conclusion, roosters of the sire line were best for BW (5.52 kg), BL (72.89 cm), DSL (16.13 cm) and ShL (10.73 cm). Positive correlation coefficients of 0.36 (BW and LR), 0.32 (BL and SV), 0.36 (BL and LR) and 0.29 (WW and SCo) in the dam line were obtained. For the sire line, significant positive correlation coefficients of 0.42 (BL and LR), 0.36 (BW and LR) and 0.30 (ShL and SCo) were obtained. High coefficients of variation were obtained for SC (31.76) in the dam line, and SC (38.09) and SV (39.48)

in the sire line roosters. Sperm morphology defects of 31 % and 29 % were obtained in the dam and sire line roosters respectively. For the dam line, best PF (89.10 %) was observed in mating ratio 1:3, while best PH (62.67 %) and PTH (72.40 %) were observed for ratio 1:6. In the sire line, best PF (95.40 %), PH (69.37 %) and PTH (72.83 %) were observed for mating ratio 1:6.

It is therefore recommended that the sire line roosters be considered for upgrading of local chicken flock. Alternatively, body measurements (BW, BL, WW and ShL) should be considered in the selection of roosters of good semen quality. Potential still abounds for genetic improvement of SV in the dam line, and SC and SV in the sire line roosters, with younger roosters preferred for enhanced fertility. Also, mating ratio of one cock-six hens (1:6) should be adopted for better hatchability of eggs in laying strains of chickens.

6. 2 Conclusion

1. Roosters of the sire line were significantly superior to the roosters of the dam line for BW (5.52 kg), BL (72.89 cm), DSL (16.13 cm) and ShL (10.73 cm) as against the values of 5.37 kg, 71.70 cm, 15.62 cm and 10.42 cm observed for BW, BL, DSL and ShL respectively for the dam line.

2. Significant positive correlation values of 0.36 (BW and LR), 0.32 (BL and SV), 0.36 (BL and LR) and 0.29 (WW and SCo) were observed for the dam line. For the sire line, significant positive correlation values of 0.42 (BL and LR), 0.36 (BW and LR) and 0.30 (ShL and SCo) were observed.

3. High variation was observed in the dam line for SV (31.76), and in the sire line for SC (38.09) and SV (39.48).

4. Total sperm morphology defect of 31 % and 29 % in the dam line and sire line respectively were obtained in this study.

5. For the dam line, mating ratio 1:3 was superior for PF (89.10 %), while PH (62.67 %) and PTH (72.40 %) were superior for ratio 1:6. For the sire line, ratio 1:6 was superior for PF (95.40 %), PH (69.37 %) and PTH (72.83 %).

6. 3 Recommendations

1. The sire line roosters should be considered in upgrading of local chicken flock.

2. Breeders should consider the use of body measurement (BW, BL, WW and ShL as an alternative method in the selection of roosters of good semen quality for breeding or artificial insemination programmes.

3. Potential still abounds for genetic improvement of semen volume in the dam line, and semen colour and semen volume in the sire line through selection. Additionally, younger roosters should be considered for enhanced fertility in breeding or artificial insemination programmes.

4. Mating ratio of one cock to six hens (1:6) should be encouraged among farmers because it improves hatchability.

5. Reproductive traits such as semen and hatching traits are generally lowly heritable, research should be carried out to improve these traits through the improvement of the environment (health, nutrition, climate, management, etc).

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