EVALUATION OF PRODUCTION TRAITS IN TWO STRAINS OF LAYER CHICKENS UNDER RELAXED SELECTION

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DECLARATION

I hereby declare that the work in the thesis titled "*EVALUATION OF PRODUCTION TRAITS IN TWO STRAINS OF LAYER CHICKENS UNDER RELAXED SELECTION"* has been performed by me in the Department of Animal Science under the supervision of Professors B.I. Nwagu and I.A. Adeyinka. The information derived from literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at any University.

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CERTIFICATION

This thesis titled "*EVALUATION OF PRODUCTION TRAITS IN TWO STRAINS OF LAYER CHICKENS UNDER RELAXED SELECTION*" by Jamila JOBIN meets the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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ABSTRACT

This study was conducted to determine strain differences on some production and egg quality traits in 200 birds of synthesized Grand Parent Stock (Male and female lines) under relaxed selection. The hens used were from the same hatch and under the same management practices. Production traits studied were age at sexual maturity (ASM), body weight at 18 and 20 weeks of age (BW18 and BW20), egg number (EN), average egg weight (AEW), and rate of lay (RL). Egg weight (Ewt), egg length (El), egg width (Ewdt), albumen weight (Albwt), yolk weight (Ywt), shell weight (Swt) albumen height (Albht), yolk height (Yht), shell thickness (Sth) were measured. Haugh's unit (HU) and shell index (SI) were also obtained for egg quality traits. Significant differences ($P < 0.05$) were obtained for ASM, AEW and BW20 between strains. Male line had higher mean values in ASM (161.50 days) and AEW (43.66g) but Female line had better mean value for ASM (158.79days). For egg quality traits, significant ($P < 0.05$) differences were also observed in Ewt, El, Ywt, Swt and HU. Higher mean values were obtained for all traits (Ewt, El, Ywt, and Swt) with the exception of HU in the Female line than the Male line. Pearson correlation pooled for growth and egg production traits for the two strains showed that ASM had moderate to high negative and significant ($P < 0.01$) relationship with EN, BW18 and BW20. ASM was also positively correlated with RL and AEW. There was a positive and highly significant ($P < 0.01$) relationship between EN with RL, BW18 and BW20. while AEW had no significant ($P > 0.05$) relationship with all other traits. BW18 and BW20 had the highest level of correlation (0.87) which was positive and highly significant. It can be concluded that, the female line had better performance than the male line in ASM (158.79 vs 161.50 days), BW18 (1176.87 g vs 1171.62 g) and BW20 (1370.17 g vs 1327.39 g). Coefficients of variation within strains for most studied traits were higher than 20%. The phenotypic correlations among studied traits vary in magnitude and direction implying stability of the traits in both strains under relaxed selection. Since the coefficient of variation of most of the studied traits within the individual strains had values higher than 20% it is therefore recommended that selection can still be resumed and appreciable response to selection can be obtained.

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CHAPTER ONE

1.0 INTRODUCTION

The goal of breeders is to improve the performance of their flock. One of the major tools available for this improvement is selection. Selection is the act of choosing those individuals that will become parents of the next generation with the aim of improving the performance of the flock or population. The various selection methods used based on phenotypic measurement includes: mass selection, progeny testing, tandem selection, independent culling level, and selection index (Bourdon, 2000).

Genetic improvement in animals and plants for food consumption has been practised and realised since domestication. Intensive improvement, increasingly with incorporation of genetic principles, has been undertaken for a century or more (Hill, 2008). Much of this has been highly intensive and effective, notably in poultry. There are consequently concerns that genetic variation is being exhausted and continued gains cannot be expected (Hill, 2008). The genetics of a metric character centres round the study of its variation (Falconer and Mackay, 1996). It is assumed that genetic variances either remains constant during selection or that any changes in variance can be predicted solely from the variance components of the base population. Selection experiments have been the basis for testing theories, hypotheses, and predictions of quantitative genetic theory. In addition, selection experiments enable researchers to estimate genetic parameters, test alternate breeding schemes, and study the causes of selection limits and plateaus and develop means to overcome them (Reddy, 1996).

Continued genetic progress, especially in traits of growth efficiency, with little evidence of selection limits surprised many breeders in the past; however, with quantitative

genetic theories developed by many researchers, poultry breeders came to realize that although one-half of total response to selection occurs early in the selection process, one can predict the number of generations in which response can be obtained from the knowledge of effective population size (Ne). The probability of fixation of an allele, and thus a selection limit, was postulated by Robertson (1960) as a function of effective population size, initial gene frequency, and selection coefficient.

In long-term selection experiments, it is often noticed that some traits reach a plateau in relatively few generations. A classical selection response represents a linear change over generations of selection, followed by decreased response until some selection limit is reached. A further decrease in response occurs because of random drift in finite populations when dominance is present; inbreeding effects lower responses further. This reduction in response is especially true for fitness traits (Falconer and Mackay, 1996). Response to selection is also influenced by negative genetic correlations among selected traits and fitness; however, breeders should be aware of the approximate half-life generation and have ready suitable and alternate scheme to test. The approximate half-life generation could serve as a reference point at which to cross to another unrelated line or relax selection pressure rather than waiting for the actual selection limit to occur. This scheme would increase additive genetic variance at a time when it may be beginning to decline significantly (Eisen, 1980).

In a review of artificial selection, Hill (2011) stated that part of the uses and need for conventional selection despite recent advances are that it will continue to furnish raw materials needed to estimate the magnitude of variation arising from mutations due to selection; to estimate numbers and effects of quantitative trait loci (QTL) by mapping

the selected lines and as a demonstration to breeders that selection using modern methods could be effective. There has been tremendous progress in productive poultry breeding in the past few decades. Industrialized battery-caged hens lay up to 300 eggs annually compared to 30 eggs per year by indigenous scavenging hens commonly found in most African countries (Riise *et al*., 2005). Various aspects of egg production have been brought under practical genetic control by the commercial sub-sector dominated by international companies. Many other economic important traits have been improved by selection. Further improvement will depend on reevaluation and refinement of selection methods and practices. One of the methods of reevaluating selection and selection response is relaxed selection. Relaxed selection is a selective phenomenon that occurs when selective pressures are either eliminated or dramatically reduced resulting in the absence of pressure and the evolutionary pathways that comes into play as a result of imposed directional selection.

1.1 JUSTIFICATION

The concept of relaxed selection was studied at earlier times, but there exist few current works on its impact on already selected populations. This work was designed to evaluate differences between two strains of layer chickens where relaxed selection exists.

Consequently the following hypotheses are put forward:

H_0: There is no difference between two strains of layer type chickens from populations with relaxed selection.

H_A: There is difference between two strains of layer type chickens from populations with relaxed selection.

The Objectives of this study therefore are;

- To determine variations in production and egg quality traits between two strains under relaxed selection.
- To estimate phenotypic correlation among production and egg quality traits in the two strains of birds under relaxed selection.

CHAPTER TWO

2.0 LITERATURE REVIEW.

2.1 GENETIC IMPROVEMENT OF LIVESTOCK

Genetic improvement of livestock and poultry is based on two alternative approaches: crossbreeding and artificial selection (Szwaczkowski *et al*., 2003). Crossbreeding leads to the creation of more heterozygotes and in consequence to greater genetic variation of population. By contrast, selection determines both genetic gain and inbreeding rate. The inbreeding effects include increased homozygosity, a higher risk for the incidence of lethal or deleterious recessive alleles, and decrease in performance and fitness traits (Milgior *et al*., 1995).

2.2 ARTIFICIAL AND NATURAL SELECTION

Artificial selection is one of the best-understood aspects of the domestication process (Price and King, 1968) and is the only genetically based mechanism that is unique to domestication. Artificial selection may be applied either inadvertently (unconsciously) or intentionally (consciously). The aim of artificial selection is to improve some particular traits and thus it is generally directed towards extreme phenotypic values. Natural selection, however, often favours intermediate expression of metric traits unless these traits are very closely associated with fitness. Therefore, plateaus observed in artificial selection experiments could result from a conflict between directional and opposing natural selection rather than from a loss of additive genetic variance (Price, 2002).

Artificial selection has been demonstrated for a plethora of phenotypic traits. The average rate of phenotypic change in response to (conscious) artificial selection stands

in sharp contrast to the relatively slow rate of evolutionary change in free-living populations of wild animals (Lush, 1945; Haldane, 1949). In a few generations of intense artificial selection, populations of animals have been altered with respect to a wide variety of traits (Siegel, 1975; Grandin, 1998; Rauw *et al*., 1998).

According to Nordskog (1965) who stated that over the past years a number of interesting selection experiments have been conducted with laboratory organisms, principally *Drosophila*, *Tribolium* and mice with the most important generalizations from these being that:

(1) Genetic changes generally are quite predictable in the short run but not in the long run.

(2) Most populations seem to reach a plateau in 20-40 generations of selection for a single trait.

(3) More often than not, additive genetic variance as usually estimated, is not exhausted after the population has plateaued.

(4) Reproduction becomes increasingly difficult as selection continues.

The variety of physical and behavioural traits seen in the many breeds of domestic dogs (Scott and Fuller, 1965) reflects the genetic changes that can be realized in a species through conscious artificial selection and hybridization. Dog breeds are more diverse in shape and conformation than any other domestic animal species. Artificial selection has not only been used to establish various breeds within domestic animal species but it has also been used to establish populations differing in very specific characteristics. For example, Bernon and Siegel (1983) demonstrated the extent to which sexual performance in male chickens has been artificially selected for in 20 generations.

Certain theoretical difference does exist between artificial and natural selection. Artificial selection is goal-oriented from the standpoint that man selects those individuals for breeding which he believes will transmit a desired phenotype. Thus, all artificial selection occurs prior to reproduction. In natural selection, some selection occurs prior to reproduction because some individuals do not live long enough to breed (Price, 2002). Differential reproduction is the essence of the natural selection process. In the latter, selective advantage can only be measured after an animal's contribution to future generations is determined. Natural selection is goal-oriented only from the standpoint that it is directed towards maximizing individual fitness. The Fitness or selective value has been defined as the proportionate contribution of offspring to the next generation due to variations between individuals in viability and fertility (Falconer and Mackay, 1996). A considerable amount of theory exists, treating artificial selection and natural selection separately, but only rarely is their action considered jointly (Verghese, 1974). Consideration of optimum and directional selection simultaneously reveals that an equilibrium between the two opposing systems of selection could be established where genetic variance would still be present. It is to be expected that such equilibrium between directional and natural selection for intermediates also exists where over dominance serves as the determining factor in fitness (James, 1962).

Artificial selection may reduce fitness by providing a selective advantage for non adaptive traits. In artificial selection, the breeder not only decides which animals will serve as breeding stock but also the number of breeding opportunities for each individual. In both artificial and natural selection, an animal producing only a few offspring may contribute as many or more reproducing offspring for the next generation

than one that produced many young. However, this is more likely under artificial selection because it is typically a more intense selection process.

Darwin, in an 1859 letter to Lyell (cited in Richards, 1998) contrasted artificial and natural selection. First, Darwin noted that artificial selection brings about changes more rapidly than natural selection. Animal scientists agree that the intensity of artificial selection is usually much greater than the intensity of selection occurring in nature (Lush, 1945). Secondly, Darwin maintained that man can only select for the external and visible phenotypic characteristics of the organism. While this was true when Darwin was alive, successful selection has now been demonstrated for a host of physiological traits (e.g. nerve conduction velocity, Hegmann, 1975; adrenocortical response, Jones *et al*., 1994) due to modern-day technological advances. Thirdly, Darwin believed that artificial selection is pursued to meet man's desires and whims rather than necessarily for the good of the individuals comprising the population. It is difficult to argue this point when so much of artificial selection is directed at very specific phenotypic traits with little impact on general fitness.

Current interest in longevity and lifetime reproductive success in economically important species (i.e. animals reared for food and fiber) constitutes a rare exception to Darwin's observation. Reed and Bryant (2000) and others have demonstrated that experimental populations of insects maintained in the laboratory under a shortened generation-interval breeding program exhibited reduced longevity, presumably because of the random accumulation of deleterious alleles negatively affecting this trait. There is an apparent trade-off between longevity and early progeny production. This result is interesting, considering that shortened generation intervals are recommended to attain

the most rapid response to artificial selection. Youngson and Verspoor (1998) cited several reports supporting the hypothesis that the lifetime reproductive success of hatchery reared Atlantic salmon (S. salar) is reduced relative to their wild counterparts because of selection for production traits and the effects of domestication. It is believed that artificial selection could be used to test the importance of specific characters on survival and reproduction (i.e. how natural selection works). This hypothesis has been supported in several ways.

Artificial selection should proceed more rapidly in the direction of more favourable genetically homeostatic conditions (Lerner, 1954). Artificial selected for back fat thickness in Duroc pigs was carried out by Hetzer and Miller (1972) over 16 generations, selection in both directions was successful but the rate of genetic change was 1.8 times greater for the high back fat line Increased fat deposition is considered beneficial for many traits associated with fitness.

Belyaev (1979) strongly believed that during domestication, previously existing co-adapted gene complexes are lost and new co-adapted gene complexes become established after many generations of artificial selection for specific traits. Differences in response to relaxed and reversed selection in artificially selected lines can prove useful in identifying the existence of such favourable combinations of heterozygous gene complexes at loci affecting the selected traits

2.3 REVIEWED DEFECTS IN ANIMALS UNDERGOING ARTIFICIAL SELECTIONS

When domestication happens, some traits that are important for survival in wild will have a decreased value in total fitness (Mignon-Grasteau *et al*. 2005). Therefore, there will be an increase in other components such as production. This continuous selection for production related traits will increase the occurrence and magnitude of undesirable effects of physiological, immunological and reproductive traits, and consequently jeopardizes animal welfare (Rauw *et al*., 1998). Behavior as a fundamental mechanism of adaptation allows animals to adapt to the new environments (Jensen, 2006). On the other hand, genes under selection pressure for increased production simultaneously affect behavior; therefore affecting the adaptive capacity of the selected animals. To explain this phenomenon, Beilharz *et al*. (1993) proposed the resource allocation theory, in which under selection within a particular environment, the resources used by the animal are optimally distributed between the important traits of breeding and production. Consequently, any additional selection of a production-related trait without a concurrent increase in resources, leads to declines in other traits, due to a re-allocation of resources. Therefore, effects of selection on behavior may have serious consequences on the welfare of animals (Jensen, 2006) since domestication is a process of selection for behavior (Belyaev, 1979).

A model was proposed by Van der Waaij (2004) to describe underlying mechanisms and the consequences of selection on allocation of resources to production which decreases survival and reproductive rate. For example, individuals with high genetic potential for growth may divert resources to achieve that potential from immune responsiveness and, therefore, become more vulnerable to pathogens and diseases

(Siegel, 1989). There exists a negative correlation between well-being related behaviours and economical traits in most livestock species (Newman, 1994). It seems that domestication has led domesticated animals to less-energy demanding behaviours (Price, 1999) and selection for high production in laying hens has decreased general activity and social interaction (Schütz and Jensen, 2001). Lindqvist *et al*. (2009) showed that red jungle fowl (Gallus gallus) responded more actively to food deprivation than the White Leghorn layers.

Also, in comparison to red jungle fowl, White Leghorn seems to be less cautious, more fearless and having impaired spatial learning ability (Schütz *et al*., 2001; Lindqvist and Jensen, 2009; Lindqvist *et al*., 2009). Artificial selection in domestic turkeys has resulted in an inability of males to copulate and domesticated turkey females must be artificially inseminated (Price, 1999). Long-term selection for egg production and body weight in turkeys has decreased disease resistance, walking ability and semen production (Nestor *et al*., 1996), also egg production and hatching of fertile eggs are decreased (Nestor *et al*., 2000). In laying hens, selection for non-broody behavior has resulted in strains of chickens which don't incubate eggs or brood chicks (Price, 1999). Selection for body weight in chicken has depressed immune performance (Miller *et al*., 1992), antibody production (Cheema *et al*., 2003) and damaged the hypothalamic satiety mechanisms (Burkhart *et al*., 1983) which has led to a failure in diminishing the hunger drive and consequently to hyperphagia or overconsumption. Also selection for higher body weight decreased bursa weight in turkeys (Li *et al*., 2001). It is reported that there is a negative correlation between bursa weight at hatching and post-hatching weight in chicken (Muir and Jaap, 1967). There is a negative relationship between body weight and reproduction in poultry, both across and within stocks and selection for egg

production or growth has correlated response in unselected traits including behaviour (Newman, 1994). Domestication and artificial selection for production have increased fearfulness of the White Leghorn compared to red jungle bird (Schütz *et al*., 2004). Domestic fowls which are selected for growth are phlegmatic and have excessive appetites and reduced motor ability (Siegel, 1989). This enhances the propensity for obesity and affects their well-being. Intensive selection for higher growth rate in broilers was negatively correlated with increasing the incident of ascites syndrome (Deeb *et al*., 2002) and caused leg problems (Christensen, 1998). Gaya *et al*. (2007) showed that there is a genetic trend of decreasing heart weight in broiler line which can cause higher mortality rate. In comparison to fast growing, slow growing strains of chicken had better locomotors activity and lower mortality rate (Castellini *et al*., 2002).

Beside farm animals, intensive selection on other animals has developed problems. Ovarian structure and reproductive efficiency in mice is affected by long-term selection for body weight (Bernardi *et al*., 2009). Selection for high litter size allocated the resources to maintenance in mice (Rauw *et al*., 1998). Kolstad *et al*. (2006) showed that selection for increased body weight in Atlantic cod (Gadus morhua) is positively correlated with spinal deformity. Selection response for body length of brown trout was correlated with food intake capacity and increased feeding requirements (Mambrini *et al*., 2004).

2.4 CONCEPT OF RELAXED SELECTION

Environmental changes often eliminate or weaken a source of selection or selection pressure that was formerly important for the maintenance of a particular trait. Such circumstances are often termed ‘relaxed selection’ (Lahti *et al*., 2009). Thus, eyesight is

said to be under relaxed selection in lightless caves; a habitat free of predators relaxes selection on previously evolved defences against them; and the disappearance of toxins or pathogens results in relaxed selection for resistance. Relaxing selection from one source leaves other sources to operate on the trait, so these cases are a subset of the ubiquitous occurrence of changed selection. Cases of relaxed selection are of particular interest because removing a previously important source of selection can increase the probability of a trait losing its contribution to the fitness of the organism and, consequently, lead to an increased probability of trait loss (Haldane, 1932)

2.3.1 Contexts in which Selection is Relaxed

A variety of circumstances can arise that tend to relax or weaken selection. This includes: - low population size and inbreeding which can lead to the reduced efficacy of selection (Hartl and Clark, 2007). Laboratory studies using artificial selection and experimental evolution have sought to relax selection in this way for decades, to observe patterns of neutral evolution (Burch *et al*., 2007).

Changes in the genetic or phenotypic makeup of an organism can shield genes, alleles or traits from selection. Gene duplication and polyploidy are examples of such changes: genes or genomes replicate such that selection can act on one copy but is relaxed on the other, sometimes leading to novel gene functions (Roth *et al*., 2007). Plasticity in trait expression can relax selection: genetic differences that are not expressed as phenotypic differences can accumulate, whereas in other environments those differences could have phenotypic effects that are subject to selection (Rutherford and Lindquist, 1998).
Reproductive value declines with the age of an organism, so the strength of selection on all traits will tend to decline over a lifespan, leading to senescence (Williams, 1957).

Ways in which an environmental change can relax a source of selection on a trait:

Selection of any form (balancing or directional) can be relaxed. For illustrative purposes, we consider here a quantitative trait held by stabilizing selection at a particular value (e.g. of size or intensity of expression). A hypothetical environmental change could relax selection in one of the following ways:-

In the most extreme case, selection could be removed completely, resulting in a flattening of the fitness landscape influencing the trait (Figure Ia). Alternatively, and perhaps more likely in a natural context, trait changes in one direction could remain deleterious, whereas changes in the other direction become neutral (Figure Ib) (Haldane, 1933). For example, predator escape behaviours might no longer be elicited in a predator-free environment and so is neutral, but increasing the probability of expressing these behaviours in the absence of predators would incur an energetic

Another form of relaxed selection is continued but weaker stabilizing selection resulting in a broadening of the fitness peak without a change in trait means (Figure Ic). This could occur in polluted waters where turbidity compromises female assessment of male courtship displays in fish (Wong *et al*., 2007) or else if correlations with other functional traits cause current trait values to be maintained. Alternatively, the selective optimum of a trait might decrease owing to remaining sources of selection, including selection on correlated traits (Figure Id). An example might be relaxed selection for sexual reproduction in apomictic plants that still require pollen for endosperm fertilization. The removal of one of the two functions of pollen resulted in a shift of optimal pollen production to a lower level (Whitton *et al*., 2008)

Combinations of the above phenomena (Figure Ib–d) are possible and are probably common. One such combination is illustrated in Figure Ie, which involves regions of neutrality in trait space (as in Figure Ib), lower fitness differences among trait values (as in Figure Ic) and a skewed weakening of selection resulting in a shifted optimum (as in Figure Id). Cavefish eyes might fit this pattern: they appear to be in a trade-off with other sensory systems (e.g. taste), causing a reduction in the optimal expression of eyes in a lightless environment (Jeffery, 2005). This selection is probably weaker than that on eyes of surface fish; and continued early development of cavefish eyes suggests that, below some threshold of expression, eye development is close to neutral.

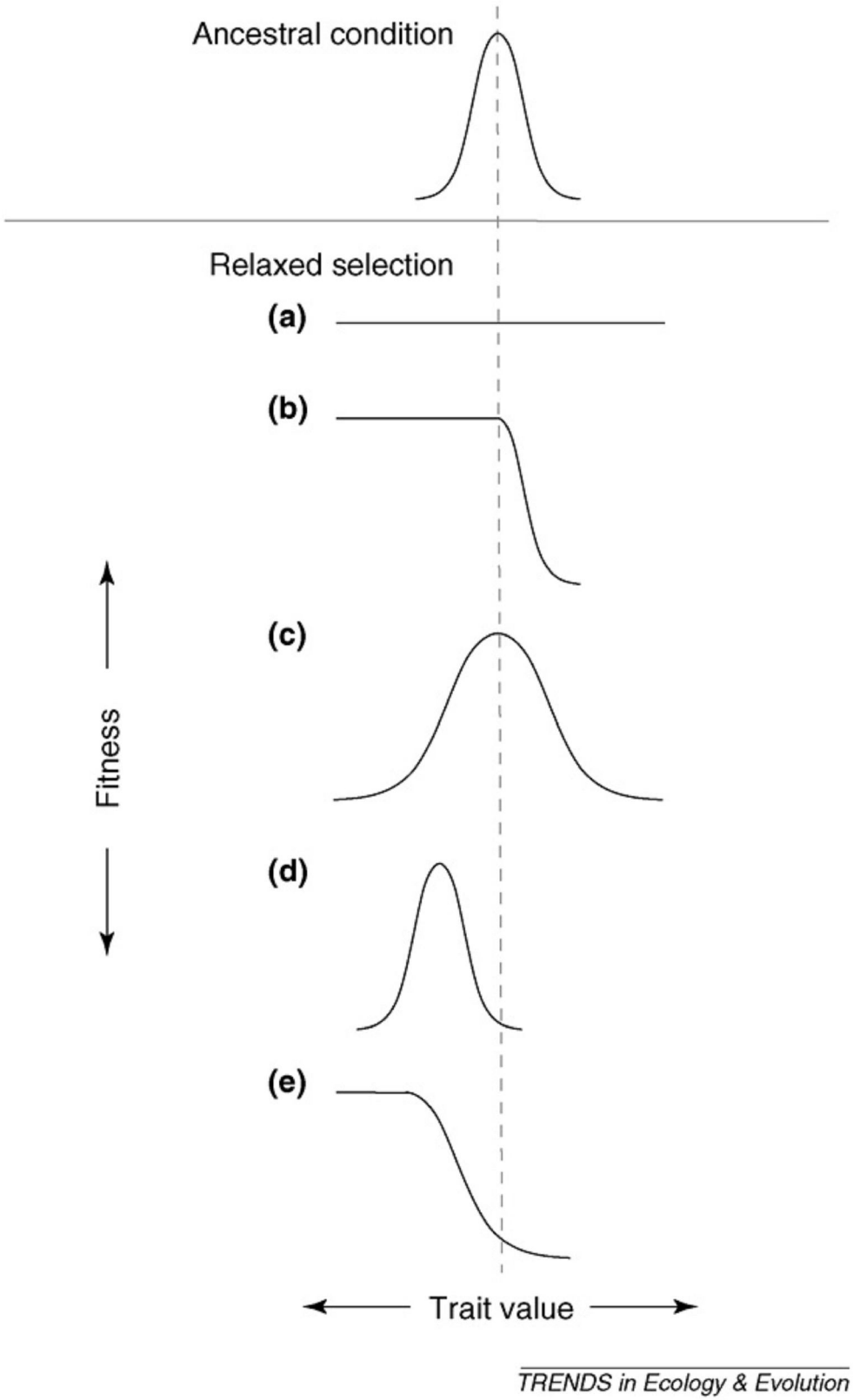


Figure 1: Patterns of impact of relaxed Selection on Trait Value. Source: Lahti *et al*. (2009)

2.5 POULTRY BREEDING

Poultry breeding involves populations in which gene frequencies are influenced by selection. The genetic change as a result of selection is manifested by the change in the heritability estimates. The evidence of changes in the genetic constitution of a population under selection is manifested by changes in phenotypic performance Chatterjee *et al*. (2001). Correlations permit prediction of direction and magnitude of change in the dependent trait as a correlated response to direct selection of the principal trait (Laxmi *et al*., 2002). Thus correlations are of great interest to the breeder. The extent and direction of correlated selection response are determined by the genetic correlation or covariance between the concerned traits (Verma *et al*., 1983). Therefore, for improving the total economic value of an animal, it is important to know both the effect of the trait actually being selected and its effect on the other traits. This information becomes more relevant especially in flocks that undergo selection, in view of the fact that continued selection tends to bring about change in the genetic correlations among traits (Sharma and Krishna, 1998).

Genetic improvement can take several forms, but it must follow an ordered hierarchy of events which starts from understanding of production and marketing systems, choice of appropriate breeds or strains that can sometimes lead to replacements of existing breeds. It can also lead to establishment of an effective pure breeding and cross breeding systems and further improvement through selection of superior genotypes within populations that best suit the production and marketing conditions (Nimbkar *et al*., 2008).

The study of egg production and its related traits such as age and body weight at sexual maturity attracted the attention of several investigators who found that there were wide variations in these traits between different breeds and/or strains of chickens (Iraqi *et al.*, 2007). This genetic diversification has been exploited to improve their productivity. Price *et al*. (1998) in a study of hematocrit values in weight-selected and relaxed lines of White Rock Chickens stated that a trend existed at 106 d, at this age packed cell volume (PCV) were higher for HWR (high weight relaxed lines) than HWS chickens (high weight selected lines). Dunnington and Siegel, (1996) ascribed difference between HWR and HWS chickens to delayed sexual maturity and development in the selected lines as compared to their respective relaxed lines. This reasoning was stated to be consistent with an age effect for HWR and LWR (low weight relaxed lines) and HWS males. The LWS (low weight selected lines) chickens did not exhibit any change in PCV throughout the experiment, which was expected because their sexual maturity is greatly delayed due to anorexia (Zelenka *et al*., 1988, Dunnington and Siegel, 1996).

Demands for resources in intensely selected lines may at times be in conflict, creating negative correlations between traits because individuals cannot simultaneously satisfy all demands (Dunnington and Siegel, 1996). Also, noting the established relationship between low feed conversion ratios, rapid protein accretion, and high PCV (Scheele *et al*., 1991; Lubritz *et al*., 1995), it is feasible that males with heavier juvenile BW were going through a metabolic period during which feed efficiency or growth of muscle mass were diminished due to allocation of resources, a metabolic state that less developed females and smaller males had not yet reached. Both sexes of HWR showed a high positive correlation between PCV1 and PCV2. This association in which individuals with higher PCV at 29 d would also have the higher PCV at 106 days was

not evident for the other lines. The correlation among HWR may be linked to maturity, as HWR chickens reach sexual maturity earlier than those of the other three lines studied here, and to genetic status of the line with respect to selection intensity and overall fitness. It has also been suggested that when lines are subjected to intense selection pressures, physiological parameters may be reset (Dunnington and Siegel, 1996). The two HW lines, under intense selection for high body weight for many generations, would need PCV levels at a higher concentration to accommodate oxygen demands. It is possible that chickens of the relaxed line, without continued selection pressure, became more stabilized than HWS at the new level, with a more uniform rate of change in PCV. It follows that PCV is closely associated with onset of sexual maturity and rate of development within a line.

2.6 IMPROVEMENT FOR EGG PRODUCTION IN CHICKENS

In commercial egg type chicken breeding three and four way crosses are used to produce commercial layers. The primary breeders use closed nucleus breeding programmes, with birds kept under maximum bio-security. All grandparents and parents are produced from a closed nucleus for the worldwide demand of commercial layers. The breeding goals have been focused for several decades on increasing number of eggs per hen housed. Additional traits have become more important during the last decade, that is, feed efficiency, internal and external egg quality and general adaptability. Prior to each selection, weights for individual traits within the selection index are adjusted to meet market demands. Breeding stock and commercial layers have to be bred to perform adequately in a variety of systems ranging from large intensive battery-cage units to free range management under different environmental conditions world-wide (Preisinger and Flock, 1998). Despite intensive selection for egg production the

decrease in genetic variation observed in closed commercial lines is not yet critical. Peak production is approaching the biological limit of one egg a day. During the period of biological limit, genetic and phenotypic variations have been significantly reduced. But for early production (sexual maturity) and late production (persistency) genetic variation is still high. In a mating scheme avoiding full and half sib mating no serious inbreeding depression is observed.

To achieve continued future genetic progress, selection pressure will shift to other traits like internal and external egg quality and perhaps behaviour traits which still respond to selection (Preisinger and Flock, 1998). As stated by Arthur (1986), all leading egg-type breeders today probably use a combination of cross-line and pure-line records for line improvement. Combinations of pure-line and cross-line data for breeding value estimation allow more genetic progress than selecting on pure-line or cross-line information (Wei, 1992). Especially for traits with low heritability such as liveability and egg production, selection is not exclusively on the basis of pure-line information from the minimal disease environment of a typical breeding farm. Data from extensive field testing programmes with pedigreed test commercials are used for selection to reduce the impact of genotype x environment interactions.

Egg production is still the primary trait for the genetic-economic improvement of laying hens. The average production curve of a flock is usually described in terms of three parameters:

- age at 50 % production (average sexual maturity)
- peak rate of lay (and age at peak)
- persistency of production.

2.7 AGE AT SEXUAL MATURITY

There are numerous reports in literature on factors that influence the onset of sexual maturity in avian females (Marks and Kinney, 1964; Dunnington and Siegel, 1984; Hocking, 1993; Eitan and Soller, 2001). The controlling or initiating factors, however, are still not completely understood. First, there are questions relative to measuring the onset of sexual maturity. Age at sexual maturity has been defined as the age at first egg or the presence of the first hard-shelled egg in the uterus, as detected by palpation (Anthony *et al*., 1993), this procedure of measuring sexual maturity may influence the results of a given experiment also research has shown that a number of factors will contribute to the observed variability in the onset of sexual maturation (Reddish *et al*., 2003).

Critical age, weight and body composition have been suggested as necessary correlates of sexual maturity (Podisi *et al*., 2011). The majority of data suggests that sexual maturity is the end result of a combination of factors including pattern of body weight gain, chronological age, and body composition. A combination of these factors must be met or satisfied for the female to become sexually mature (Reddish *et al*., 2003).

In human, the attainment of a critical body weight of 48 kg and a fat percentage of 22% for the onset of puberty in girls was proposed in the early 1970s (Frisch and Revelle 1970). Recent interest in this issue has been reignited by the observed early puberty in girls associated with increasing levels of obesity (Kaplowitz, 2008, Aksglaede *et al*., 2009). Similarly, agricultural species that have been intensely selected for early growth, such as broiler chickens, have also become heavier and higher in body fat content, with negative effects on their reproductive performance as adults (Hocking *et al*., 2002,

Brewer and Balen 2010). Early maturity has also been associated with reproductive problems such as abnormal ovarian hierarchies in chickens (Lacassag and Jacquet 1965, Hocking *et al*. 1987, Hocking 2004).

An alternative view based on chicken studies is that the fat deposition is a result of processes associated with steroidogenesis driven by the development of the ovary (Hocking and Robertson 2000). Some authors have suggested that there is a minimum fat requirement and that body weight is not a limiting factor for achievement of sexual maturity (Robinson *et al*. 2001) whereas Soller *et al*. (1984) showed that a critical body fat content was not required for the attainment of puberty. While some data point to a possible minimum fat requirement to attain sexual maturity, a cautious approach is needed to identify the actual mechanisms involved (Chen *et al*., 2007) and that there is possible distortion due to effects of selection (Reddish *et al*., 2003). A range of 149 – 202 for age at sexual maturity in Rhode Island Red and Rhode Island White chickens was reported (Omeje, 1987).

2.8 EGG NUMBER

Literature reports on egg production in chickens were interested in the assessment of number of eggs produced during short periods of the production curve. Egg production in domestic fowl can be described using various production periods. These periods include part year (280 days), Annual (480-500 days) and residual (above one year). The most widely used criterion in most poultry selection experiment is the part year egg production, which has the characteristic of reducing the generation interval by half consequent upon which the rate of genetic gain is increased (Orunmuyi, 2006). The domestic hen has been bred to accomplish nearly daily ovulation with the result that she

lays an egg per day. Nwagu *et al*. (2007) reported a range of 27.99 to 39.15; 25.34 to 40.74 for Egg280 D in the male and female lines of Rhode Island Red respectively when the outstanding producers were not yet selected and 38.38 to 50.94; 37.03 to 51.25 for the population of the selected group for a five year period. While the control population where selection was not carried out had values ranging from 19.94 to 38.31. They reported that there was an average gain of 12.87 and 14.36 eggs for the male and female lines respectively when compared to the control population. Orunmuyi (2006) reported values of 58.40 vs 59.92 and 79.91 vs 61.34 for strain A and B in these traits in two generations of study.

2.9 AVERAGE EGG WEIGHT

The control of egg size is an extremely important facility to the egg producer. Too low an egg weight often leads to a reduction in income and too heavy an egg weight tends to result in an increase in the proportion of downgrades towards the end of lay. The breeder seeks the best compromise. In hot countries, or in summer, heat has a marked limiting effect on feed intake and causes a reduction in performance. Good management of the lighting program and good control of feeding timetable allows us to reduce the harmful effects of high temperatures. The breeder can change average egg weight appreciably (say 2 to 3 g) by altering the age at sexual maturity or by changing the body weight of the pullet at sexual maturity (ISA, 2009-2012).

The breeding company defines his objectives according to the position of his strain relative to the requirements of his clients. Each strain has, therefore, a potential range of egg weights, which can vary by about 3.5 g. For some strains a real effort has been made to reach marketable egg weights rapidly from start of lay while avoiding an increase in egg weight at the end of lay. To illustrate this, we have taken the results of

the Leystad Random Sample Test (2000) for the main brown egg strains. These tests have the merit of being able to compare the different strains in the same environment. (ISA, 2009-2012). Some of the factors influencing egg weight in chicken include:

2.10 SEXUAL MATURITY AND BODYWEIGHT OF PULLET

2.10.1 Variability in Sexual Maturity

Sexual maturity changes according to variations in day length during the rearing period. With increasing day lengths, it is brought forward; with decreasing day lengths, it is retarded. Morris (1967) noticed that the difference in sexual maturity between spring and autumn depends on the amplitude of the variation in day length. The variation in sexual maturity is associated with considerable variations in the number of eggs produced as well as their average weight. This was studied in detail during the nineteen seventies, when lighting programmes were researched thoroughly. To illustrate these effects, ISA (2010-2012) reproduce the results of trials carried out by Morris (1980) and Koutoulis (1997), who stimulated ISABROWN pullets at 8 weeks of age by increasing day length by 0, 4 and 8 hours. They obtained a change in mean egg weight of 3 g without changing the overall egg mass. These investigations showed that mean egg weight increases by 1 g, when sexual maturity is retarded by one week. Compensating for this, the number of eggs was reduced or increased by about 4.5 eggs for each change of one week in age at start of lay. By using appropriate techniques, the age at start of lay can be changed so as to produce eggs of a weight required by the market without affecting the total egg mass-produced (ISA, 2009-2012).The body weight of the pullet at sexual maturity is the principal cause of variation in average egg weight. Two experiments using ISABROWN are shown in Tables 2.1 and 2.2 to illustrate this phenomenon.

Table 2.1: The influence of pullet body weight at sexual maturity on performance

	Trial 1		Trial 2			
Pullet body weight (g)	1343[1]	1539[1]	1535[2]	1585[2]	1620[2]	1665[2]
Age at 50% lay (days)	141	142	141	141	143	142
Rate of lay (%)	82.8	83.8	91.3	92.1	91.0	91.0
Mean egg weight (g)	59.9[a]	61.4[b]	60.5[x]	60.7[x]	61.8[y]	61.7[y]
Egg mass (g/d)	49.6[a]	51.4[b]	55.3	55.8	56.2	56.1
Total egg mass (g)	17.830[a]	18.520[b]				
Food conversion ratio (g. feed/g. Egg)	2.23[a]	2.18[b]	2.02	2.01	2.01	2.03

[1]body weight at 119 days [2]body weight 123 days

Source: Bougon (1996).

Table 2.2: The influence of ISA brown pullet body weight at first egg on egg weight (g) over different periods

Period	Pullet body weight at first egg (g)			
(weeks)	1300g – 1500g	1500g-1700g	1700g-1900	>1900g
18-28	49.75	53.25	56.05	57.60
28-40	57.55	59.20	61.03	62.35
40-60	61.65	62.55	64.55	65.80

Source: Lewis and Perry (1995)

From all of the above he concluded that the body weight of the pullet at sexual maturity is the main factor determining average egg weight. Changing sexual maturity is one method, which we can use to vary the body weight of the pullet at start of lay. For brown egg strains, and particularly the ISABROWN, a strain on which very many experiments have been carried out, variation in pullet body weight of 80 g at sexual maturity will lead to a change in mean egg weight of about 1g (ISA, 2009-2012).

2.11 BODY WEIGHT AND SELECTION

Advances in genetic selection make today's commercial layers quite different from those of a decade ago (Jacob and Miles, 2000). Body weight is less, age at housing and age at 5 percent production are earlier, total egg numbers have increased, egg mass is greater, and feed conversion has improved considerably. Body weight is very important. Smaller birds at peak or shortly following their peak in egg production often do not have the physical capacity to consume enough feed to provide adequate energy and will be forced to rely on body stores. This puts these birds in negative energy balance with weight loss occurring during the peak in egg production. Egg production declines slightly post-peak and is often referred to as "post-peak" production drop. It is more common to see this slight production drop in flocks with the best uniformity (Jacob and Miles, 2000).

Body weight is regarded as a function of framework or size of the animal and its condition (Philip 1970). One of the main factors influencing egg size and feed intake is body size (Robinson and Sheridan 1982; Summer and Leeson 1983). Variation in body weight within a flock can be attributed to genetic and environmental factors that impinge on individuals. (Ayorinde and Oke 1995). The poultry producer wants birds of

minimum possible size and weights that will maximize production of standard sized eggs at an economic rate and still maintain market carcass value at the end of the production period. Uniformity of body weight in pullets and laying hens is an important management concern. To achieve early maturity and egg production, it is very important to have correct body weight and uniformity in the growing period (Lacin *et al*., 2008).

The relationships among live body measurement in egg-type poultry have been discussed by Omeje and Nwosu (1984), Ayorinde *et al.* (1988), Oni *et al*. (1991) and Adenowo *et al*. (1995). Breeders are thus interested in heritability of the traits and their genetic and phenotypic correlations. Evidence obtained by Du Plessis and Erasmus (1972) indicated that larger hens within a bloodline laid bigger eggs than those with smaller body weights. This is supported by Ricklefs (1983) who reported that larger body size resulted in large egg length, width and mass, all factors affecting egg weight. Ranges reported by Orunmuyi (2006) were 987.92 g and 1167.06 g; 1681.82 g and 1598.51 g for strain A and B of Rhode Island Chicken respectively for BWT20 and BWT40 respectively. Nwagu *et al*. (2007) reported values for the Rhode Island Red and Rhode Island White strains as 1600 g vs 1754g for BWT40 over a five - year study period.

2.12 RATE OF LAY

Rate of lay is defined as the number of eggs produced in a given period of time. If the bird lays more eggs in a given time higher is its rate of lay. Clutch size determines the rate of lay. If the bird lays more number of eggs per clutch it is usually a better layer than the bird which lays fewer numbers of eggs. It is a lowly heritable trait. Family

selection for this trait can bring about improvement (Reddy *et al*., 2011). The values reported for this trait by Orunmuyi (2006) were 54.81 and 51.41; 72.66 and 55.55 for strain A and B in generation 1and 2 of selection.

2.13 EGG QUALITY TRAITS

Egg quality is a general term that relates to various standards that are imposed on the eggs based on appearance which determines its acceptability and suitability (Jacob *et al*., 2000). These standards can be broken down into those used for determining the quality of the egg shell itself (external egg quality) and those standards which relate to the quality of the interior of the egg (internal egg quality). Some of these standards are based on subjective measures of egg quality and some are based on a more quantitative measure of egg quality. Egg quality traits have received considerable attention by breeders because of their economic importance in the poultry industry. Modern consumers are concerned with freshness, but they also demand quality and this extends to appearance, colour and freedom from extraneous material of any kind. Haugh unit is widely used as a criterion of albumen quality (Orunmuyi, 2006).

In poultry, the productivity and quality of the eggs is important for economical breeding and also for propagation of the flocks (Kumari *et al*., 2008; Chaudhary *et al*. (1999). The authors also reported that the egg quality characteristics of poultry species were influenced by factors of strains, environment, generations and age.

Laxmi *et al*. (2002) reported that egg weight was positively correlated with specific gravity, shape index, shell thickness, albumen percent, Haugh unit, albumen index, yolk

index and negatively correlated with shell percent and yolk percent at the phenotypic level in IWD strain of White Leghorn.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 LOCATION OF EXPERIMENT

This study was carried out at the Poultry Research Programme breeding Farm of the National Animal Production Research Institute (NAPRI), Shika, Zaria, Kaduna State. The Poultry Research Programme Farm lies between 11 □ 12□ 42□ N and 7□ 33□ 14□ E at an altitude of 691m above sea level (Ovimaps, 2012). The area falls within the Northern Guinea Savannah having an average annual rainfall of 1100mm, which starts from late April or early May to mid-October, followed by a dry period (which is divided into early and late dry periods). The early dry period is characterized by cold dry weather and lasts from October to January. While the late dry period is characterized with hot-dry weather and lasts from February to April. The mean temperature is about 24.4 ^{0}C (14.5-39.5 ^{0}C) with the lower temperatures occurring during the early dry season and the higher temperatures during the late dry season. The relative humidity during the dry and wet seasons is 21% and 72% respectively. The description is as reported in Akpa and Jokthan (1996).

3.2 DESCRIPTION OF THE ORIGINAL STOCK.

Omeje (1987) has given a complete description of the foundation stock and the breeding activities prior to the commencement of the selection activities. This has also been summarized by Oni (1996), Adeyinka (1998) and Nwagu (2004).

3.3 Experimental Animals

100 birds each from the two strains of Rhode Island Chickens (Red and White) belonging to the breeding unit of Poultry Research Programme of National Animal

Production Research Institute (NAPRI) were used for this study. They were obtained from male and female line populations of birds previously selected for egg number (Strain 1 and strain 2) and selection has been relaxed for a while (about five years). Strain 1 has gold plumage and Strain 2 has silver plumage**.**

3.4 Management Practices

3.4.1 Nutrition

Chick mash containing 20 % CP and 2722 Kcal ME/kg was given to the chicks up to 8 weeks. The ration was changed to grower ration containing 16 % CP and 2737Kcal ME/kg from eight weeks to point of lay. At point of lay, layer mash containing 17% CP and 2594Kcal ME/kg was offered to the birds. Feed and water were given *ad-libitum* daily. The feed was prepared by the institute (NAPRI).

3.4.2 Brooding and rearing

Chicks were brooded and reared on the floor at the brooding house of the breeding section of the poultry breeding unit. Electric bulbs and kerosene stoves were used as sources of heat. Feed was placed in flat feeders and water in plastic drinkers commonly used for chicks. The birds were brooded from day old to 6 weeks after which they were transferred to the rearing house. At fifteen weeks, the experimental birds were randomly selected and taken to the battery cage house where they were placed into individual cage for easy monitoring of their production performance.

3.5 TRAITS STUDIED

3.5.1 Growth and Egg Production Traits

- Body weight (g) at 18, and 20 weeks of age (BW18 and BW20);

- Age at sexual maturity (ASM) which is the hen's age in days from day old until laying the first egg.
- Egg number (EN) which was the number of eggs laid from ASM to the end of the 28th week of age.
- Rate of lay (RL%). Which was calculated as;

$$RL = \frac{\text{Number of eggs laid from ASM till 28th week}}{\text{Number of days from ASM to 28th week}} \times 100$$

- Mean egg weight(g) at 28th week of age, the weight of each hen's egg was taken for seven days within their 28th week from which the average egg weight of each hen was calculated (AEW).

3.5.2 Egg Quality Characteristics

Eggs for physical quality studies were collected within the first two weeks in lay and analyzed for both internal and external quality traits. Egg weight (g), yolk weight (g), albumen weight (g) and air dried shell weight (g) were measured with digital scale (Diamond Series A04) with a sensitivity of 0.1g. Egg heights and widths (cm) were measured with Vernier calipers. Eggs were broken into a flat plate to measure yolk height and albumen height using Vernier calipers. The thickness of the shell was the average of the blunt, middle and sharp points of the egg using a micrometer screw gauge (cm), the presence or absence of meat spot (Mspot) was recorded as visible. Albumen quality was measured in Haugh units (Haugh, 1937), using data on egg weight and albumen height as expressed in the Haugh formula: $HU = 100\log (H + 7.5 - 1.7W^{0.37})$

Where H = albumen height in mm, W = egg weight in grams.

Shape index (SI) was the width /length ratio (maximum width of the egg x 100/length of the egg).

3.6 DATA ANALYSIS

Data was analysed using the GLM procedure of Statistical Analysis System (SAS, 2002). Means were separated using Least Significant Difference procedures of this software. Pearson correlation coefficient was used to determine phenotypic correlation among traits studied.

The model equation for this study is as shown below

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

Y_{ij} = Observation of performance on two strains of layer chickens where selection has been relaxed.

Where μ is the overall mean

S_i is the fixed effect of strains (i=1, 2)

e_{ij} is the random error

e_{ij} are independent normally distributed random variables with $E(e_{ij}) = 0$ and $V(e_{ij}) = \sigma^2$

CHAPTER FOUR

4.0 RESULTS

4.1 DESCRIPTIVE STATISTICS OF PRODUCTION AND EGG QUALITY TRAITS IN THE POOLED AND INDIVIDUAL STRAINS.

Tables 4.1 to 4.6 show the descriptive statistics of all the studied traits, for the two strains and individual strains. Overall mean for ASM was higher in strain 1 than strain 2, while the coefficient of variation (CV %) for ASM was higher in strain 2 (7.44%) than strain1 (6.72%). Also the means for EN, BW18 and BW20 were higher in strain 2 than in strain 1 while AEW and RL were lower for strain 2 compared to strain 1. The degree of spread about the mean was greatest with EN, with a value of 39.70 %, 38.93 % and 40.62 % in the combined strains, strain 1 and strain 2 respectively.

Among egg quality traits Strain 2 had higher mean values compared to the combined and strain 1 in most of the internal and external traits studied. The Mspot had the highest spread about the mean, with values above 100 %.

Table 4.1: Descriptive Statistics of Production Traits in Strain 1

Traits	N	Means ±SE	Standard deviation	CV %	Variance	Minimum	Maximum
ASM (days)	100	161.50±1.08	10.85	6.72	117.69	140.00	186
EN	100	24.91±0.97	9.70	38.93	94.04	3.00	45.00
AEW (g)	100	43.66±1.40	14.01	32.08	196.17	38.00	66.50
RL (%)	100	62.24±2.07	20.68	33.23	427.85	5.46	97.22
BW 18 (g)	100	1171.62±10.41	104.06	8.88	10828.12	907.00	1402.00
BW 20 (g)	100	1327.39±12.36	123.57	9.31	15269.03	1033.00	1601.00

ASM- Age at sexual maturity; EN- Egg number; AEW- Average egg weight; RL- Rate of lay; BW18- Body weight at18 week of age; BW20- Body weight at 20 weeks of age

Table 4.2: Descriptive Statistics of Production Traits in Strain 2

Traits	N	Means ±SE	Standard deviation	CV %	Variance	Minimum	Maximum
ASM (days)	100	158.79±1.18	11.82	7.44	139.62	132.00	192.00
EN	100	25.27±1.03	10.26	40.62	105.35	2.00	49.00
AEW (g)	95	42.98±1.29	12.59	29.29	158.53	38.00	66.50
RL (%)	100	58.49±1.81	18.13	31.00	328.65	5.56	100.00
BW 18 (g)	100	1176.87±12.21	122.09	10.37	14907.08	853.00	1440.00
BW 20 (g)	100	1370.17±13.25	129.60	9.67	17566.91	978.00	1650.00

ASM- Age at sexual maturity; EN- Egg number; AEW- Average egg weight; RL- Rate of lay; BW18- Body weight at18 week of age; BW20- Body weight at 20 weeks of age

Table 4.3: Descriptive Statistics for Production Traits Combined for the two Strains

Traits	N	Means ±SE	Standard deviation	CV %	Variance	Minimum	Maximum
ASM (days)	200	160.15±0.81	11.40	7.12	129.85	132.00	192.00
EN	200	25.09±0.70	9.96	39.70	99.23	2.00	49.00
AEW (g)	195	47.95±0.95	13.31	30.71	177.04	38.00	66.50
RL (%)	200	60.36±1.37	19.49	32.29	379.89	5.46	100.00
BW 18 (g)	200	1174.25±8.00	133.18	9.64	12809.86	853.00	1440.00
BW 20 (g)	200	1348.78±9.16	129.60	9.61	16795.30	978.00	1650.00

N- number of birds; SE- standard error ASM- Age at sexual maturity; EN- Egg number; AEW- Average egg weight; RL- Rate of lay; BW18- Body weight at18 week of age; BW20- Body weight at 20 weeks of age

Table 4.4: Basic Statistics for Egg Quality traits for Strain 1

Traits	N	Mean±SE	Standard deviation	CV %	Variance	Minimum	Maximum
Ewt (g)	56	41.91±0.39	2.73	6.51	7.44	35.40	48.10
Eht (cm)	56	5.01±0.04	0.27	5.29	0.07	4.56	5.93
Ewdt (cm)	56	3.88±0.03	0.26	6.69	0.07	3.62	4.96
Albwt (g)	56	24.88±0.33	2.45	9.84	5.99	20.10	31.20
Ywt (g)	56	10.97±0.13	0.97	8.87	0.95	8.3	12.7
Albht (cm)	56	0.61±0.01	0.09	15.13	0.009	0.39	0.91
Yht (cm)	56	1.48±0.02	0.15	9.78	0.02	1.21	1.89
Swt (g)	56	5.08±0.07	0.52	10.15	0.27	3.50	6.00
Sth (cm)	56	0.41±0.005	0.04	9.58	0.001	0.22	0.50
Mspot	56	0.36±0.06	0.48	135.38	0.23	0	1
HU	56	83.09±0.81	6.05	7.28	36.62	66.19	98.65
SI	56	0.77±0.008	0.06	7.29	0.003	0.63	0.95

Ewt- Egg weight; Eht- Egg height; Ewdt- Egg width; Albwt- Albumen weight; Ywt- Yolk weight; Albht- Albumen height; Yht- yolk height; Swt- shell weight; Sth- shell thickness; Mspot- meat spot; HU- Haugh's unit; SI- Shape index

Table 4.5: Basic Statistics for Egg Quality traits for Strain 2

Traits	N	Mean±SE	Standard deviation	CV %	Variance	Minimum	Maximum
Ewt (g)	56	45.13±0.58	4.34	9.63	18.87	37.50	57.30
Eht (cm)	56	5.20±0.03	0.23	4.41	0.05	4.66	5.81
Ewdt (cm)	56	3.94±0.03	0.19	4.87	0.04	3.62	4.96
Albwt (g)	56	25.24±0.75	5.58	22.11	31.14	22.00	32.6
Ywt (g)	56	13.69±0.60	4.52	33.00	20.42	10.3	30.0
Albht (cm)	56	0.60±0.01	0.09	14.37	0.007	0.40	0.83
Yht (cm)	56	1.47±0.02	0.14	9.45	0.02	1.20	1.86
Swt (g)	56	5.33±0.08	0.61	11.40	0.37	4.1	6.6
Sth (cm)	56	0.42±0.004	0.03	7.31	0.0009	0.36	0.49
Mspot	56	0.27±0.06	0.45	166.82	0.20	0	1
HU	56	81.25±0.85	6.36	7.83	40.46	64.69	93.82
SI	56	0.76±0.006	0.04	5.48	0.002	0.67	0.97

Ewt- Egg weight; Eht- Egg height; Ewdt- Egg width; Albwt- Albumen weight; Ywt- Yolk weight; Albht- Albumen height; Yht- yolk height; Swt- shell weight; Sth- shell thickness; Mspot- meat spot; HU- Haugh's unit; SI- Shape index

Table 4.6: Basic Statistics for Egg Quality traits combined for the two Strains

Traits	N	Mean±SE	Standard Deviation	CV %	Variance	Minimum	Maximum
Ewt (g)	112	43.52±0.37	3.96	9.09	15.65	35.4	57.3
Eht (cm)	112	5.12±0.02	0.26	5.16	0.07	4.56	5.93
Ewdt (cm)	112	3.91±0.02	0.23	5.86	0.05	3.47	4.97
Albwt (g)	112	25.06±0.41	4.29	17.13	18.43	9.30	32.60
Ywt (g)	112	12.33±0.33	3.53	28.62	12.46	8.30	30.00
Albht (cm)	112	0.61±0.01	0.09	14.72	0.01	0.39	0.91
Yht (cm)	112	1.48±0.01	0.14	9.60	0.02	1.20	1.71
Swt (g)	112	5.20±0.05	0.57	11.04	0.33	3.50	6.60
Sth (cm)	112	0.41±0.003	0.04	8.51	0.001	0.22	0.50
Mspot	112	0.31±0.04	0.47	148.99	0.22	0.00	1.00
HU	112	82.17±0.59	6.25	7.60	39.04	64.69	98.65
SI	112	0.77±0.005	0.05	6.54	0.003	0.63	0.97

Ewt- Egg weight; Eht- Egg height; Ewdt- Egg width; Albwt- Albumen weight; Ywt- Yolk weight; Albht- Albumen height; Yht- yolk height; Swt- shell weight; Sth- shell thickness; Mspot- meat spot; HU- Haugh's unit; SI- Shape index

4.2 Means ±Standard Error of Means for Production and Egg Quality Traits

Table 4.7 showed the means for egg production traits of the two strains. Coefficient of variation for the production traits was 7.08 for ASM and 40.05 for EN. Significant differences ($P < 0.05$) were obtained in ASM, AEW and BW20. Strain 1 had higher mean values in ASM and AEW while Strain 2 had a better mean value for ASM and a significantly higher mean value for BW20. EN, RL and BW18 showed no significant differences between strains

Table 4.8 showed the egg quality traits of the two strains of birds. CV ranged from 4.77% for Eht to 146.46% for Mspot. Significant ($P < 0.05$) differences were observed in Ewt, Eht, Ewdt, Ywt, Swt, Sth and HU with Strain 2 having the higher mean values than Strain 1 for all traits with the exception of HU where strain 1 had higher mean value. Albwt, Albht, Yht, Mspot and SI were not statistically different among the two strains.

Table 4.7: Mean ± SEM and coefficient of variation (CV) for Growth and Egg Production Traits of Strains under Relaxed Selection

	Strain1	Strain2	CV	SEM
ASM (days)	161.50^{b}±1.134	158.79^{a}±1.134	7.08	1.13
EN	24.91±0.998	25.27±0.998	40.05	1.01
AEW (g)	43.66^{a}±0.363	42.98^{b}±0.372	17.56	0.82
RL (%)	62.24±1.945	58.49±1.945	32.51	1.96
BWT18 (g)	1171.62±11.343	1176.87±11.343	9.71	11.40
BWT20 (g)	1327.39^{b}±12.813	1370.17^{a}±12.813	9.56	12.89

[ab]Means with different superscripts on the same row are significantly different ($P < 0.05$) ASM- Age at sexual maturity; EN- Egg number; AEW- Average egg weight; RL- Rate of lay; BW18- Body weight at18 week of age; BW20- Body weight at 20 weeks of age

Table 4.8: Mean ± SEM and coefficient of variation (CV) of Egg Quality traits of Strains under Relaxed Selection

Traits	Strain 1	Strain 2	CV	SEM
Ewt (g)	41.91[b]	45.13[a]	8.09	0.35
Eht (cm)	5.02[b]	5.20[a]	4.77	0.02
Ewdt (cm)	3.88[b]	3.94[a]	5.88	0.02
Albwt (g)	24.88	25.24	17.27	0.43
Ywt (g)	10.97[b]	13.69[a]	27.02	0.33
Albht (cm)	0.61	0.60	14.94	0.01
Yht (cm)	1.49	1.47	9.77	0.01
Swt (g)	5.08[b]	5.33[a]	10.79	0.06
Sth (cm)	0.41[b]	0.42[a]	8.58	0.00
Mspot	0.36	0.27	146.46	0.05
HU	83.09[a]	81.26[b]	7.58	0.62
SI	0.78	0.76	6.35	0.01

[ab]Means with different superscripts on the same row are significantly different ($P < 0.05$) Ewt- Egg weight; Eht- Egg height; Ewdt- Egg width; Albwt- Albumen weight; Ywt- Yolk weight; Albht- Albumen height; Yht- yolk height; Swt- shell weight; Sth- shell thickness; Mspot- meat spot; HU- Haugh's unit; SI- Shape index

4.3 Pearson Correlation Coefficients for Production and Egg Quality Traits

Table 4.9 showed the Pearson correlation coefficients for growth and egg production traits in Strain 1. ASM has a negative and very significantly high relationship with EN; it also has a significant and negative relationship with BW18 and BW20. There was positive but non significant relationship between AEW, RL and ASM. Same was observed between AEW and RL, BW18, BW20. Also RL had no significant relationship with BW18 and BW20. A very high and positive relationship was observed between EN and RL. The highest significantly positive relationship was observed between BW18 and BW20 (0.90).

Table 4.10 showed the Pearson correlation coefficients for growth and egg production traits within Strain 2. ASM has a negative and very high significant relationship with EN; it also has a high significant and negative relationship with BW18 and BW20. A negative but non significant relationship exists between EN and AEW. There was positive but non significant relationship between AEW, RL and ASM.

Table 4.11 showed the Pearson correlation coefficients for growth and egg production traits pooled for both strains under relaxed selection. ASM had moderate to high negative and highly significant ($P < 0.01$) relationship with EN, BW18 and BW20. It was positively but not significantly correlated with RL and AEW. EN had positive and highly significant relationship with RL, BW18 and BW20 while AEW had no significant phenotypic relationship ($P > 0.05$) with RL, BW18 and BW20. BW18 and BW20 had the highest level of correlation (0.87) which was positive and very highly significant ($P < 0.001$).

Table 4.12 showed the Pearson correlation coefficients for egg quality traits in Strain 1. Ewt had positively high and significant relationship with Eht, Ewdt, Albwt, Yht, and Swt. It had positive and low correlation with Ywt, Sth, Mspot and SI. Negative correlation existed with Albth and HU, only with HU was the relationship significant ($P < 0.05$). Eht showed positive relationship with Ewdt, Albwt, Ywt, Yht, Swt, Sth and Mspot while it was negatively correlated with Albth, HU and SI with varying levels of significance. HU showed negative relationship with most traits with the exception of Albht and Yth where it showed significantly ($P < 0.01$) high and positive correlations.

Table 4.13 showed the Pearson correlation coefficients for egg quality traits in Strain 2. Ewt showed positive and high significant relationship ($P < 0.01$) with Eht and Swt, very high significant relationship ($P < 0.001$) with Ewdt and Albwt but a non significant relationship ($P > 0.05$) with Ywt, Albht, Yht, and HU. Eht showed a non significant relationship ($P > 0.05$) with Ewt, Sth and Mspot; it had a negative and very high significant relationship ($P < 0.001$) with SI, highly significant ($P < 0.01$) negative relationship with Albht, Yht, and HU. Eht also showed a positive and highly significant relationship with Albwt and Ywt. Other internal and external traits showed varying coefficient of relationships, in direction (positively or negatively correlated) and level of significance.

Table 4.14 showed the Pearson correlation coefficients for egg quality traits pooled for Strain 1 and Strain 2. Ewt had positive, high and significant ($P < 0.01$) relationship with Eht, Ewdt, Albwt, Ywt and Swt. It was lowly and positively correlated with Yht, Sth and Mspot, negatively correlated with Albht and SI which were not significant ($P > 0.05$). Ewt however, had a negative and highly significant relationship ($P < 0.01$) with

HU. Eht followed the same pattern with most traits with the exception of SI where it had highly significant ($P < 0.01$) and negative relationship. HU was only positively and significantly ($P < 0.01$) correlated with Albht and Ywt. All other internal and external quality traits varied widely in magnitude, direction (positive or negative) and level of significance

Table 4.9: Phenotypic Correlation Coefficients of Growth and Egg Production Traits in Strain 1

Traits	ASM	EN	AEW	RL	BWT18	BWT20
ASM		-0.67***	0.18 ^{ns}	0.02^{ns}	-0.29**	-0.34**
EN			0.14 ^{ns}	0.72***	0.29**	0.36**
AEW				0.006 ^{ns}	0.16 ^{ns}	0.17 ^{ns}
RL					0.13 ^{ns}	0.15 ^{ns}
BWT18						0.90***
BWT20						

ns- not significant (P > 0.05); *- significant (P < 0.05); **- highly significant (P < 0.01) ; ***- very highly significant (P < 0.001) ASM- Age at sexual maturity; EN- Egg number; AEW- Average egg weight; RL- Rate of lay; BW18- Body weight at18 week of age; BW20- Body weight at 20 weeks of age

Table 4.10: Phenotypic Correlation Coefficients of Growth and Egg Production Traits in Strain 2

Traits	ASM	EN	AEW	RL	BWT18	BWT20
ASM		-0.47***	0.15 ^{ns}	0.25**	-0.23**	-0.27**
EN			-0.14 ^{ns}	0.67***	0.34**	0.42***
AEW				0.02 ^{ns}	0.08 ^{ns}	0.06 ^{ns}
RL					0.21**	0.26**
BWT18						0.84***
BWT20						

ns- not significant (P > 0.05); *- significant (P < 0.05) ; **- highly significant P < 0.01); ***- very highly significant (P < 0.001) ; ASM- Age at sexual maturity; EN- Egg number; AEW- Average egg weight; RL- Rate of lay; BW18- Body weight at18 week of age; BW20- Body weight at 20 weeks of age

Table 4.11: Phenotypic Correlation coefficients of Growth and Egg Production Traits in the Combined Strains

Traits	ASM	EN	AEW	RL	BWT18	BWT20
ASM		-0.57***	0.18**	0.14**	-0.26**	-0.32***
EN			-0.14*	0.69***	0.31***	0.39***
AEW				0.02 ns	0.11 ns	0.07 ns
RL					0.16**	0.19**
BWT18						0.87***
BWT20						

ns- not significant (P > 0.05); *- significant (P < 0.05); **- highly significant (P < 0.01); ***- very highly significant (P < 0.001). ASM- Age at sexual maturity; EN- Egg number; AEW- Average egg weight; RL- Rate of lay; BW18- Body weight at18 week of age; BW20- Body weight at 20 weeks of age

Table 4.12: Phenotypic Correlation Coefficients of Egg Quality Traits in Strain 1

	Ewt	Eht	Ewdt	Albwt	Ywt	Albht	Yht	Swt	Sth	Mspot	HU	SI
Ewt		0.80***	0.62***	0.60***	0.09 ^{ns}	-0.14 ^{ns}	0.33**	0.74***	0.03 ^{ns}	0.14 ^{ns}	-0.39**	-0.08 ^{ns}
Eht			0.31**	0.44**	0.13 ^{ns}	-0.10 ^{ns}	0.31**	0.59***	0.03 ^{ns}	0.04 ^{ns}	-0.32**	-0.52***
Ewdt				0.48**	-0.07 ^{ns}	0.05 ^{ns}	0.22^{ns}	0.36**	-0.02 ^{ns}	0.24**	-0.12 ^{ns}	0.65***
Albwt					-0.73***	-0.12 ^{ns}	0.03 ^{ns}	0.39**	0.03 ^{ns}	0.10 ^{ns}	-0.27*	0.08 ^{ns}
Ywt						0.06 ^{ns}	0.27**	0.10 ^{ns}	-0.07 ^{ns}	-0.08 ^{ns}	0.02^{ns}	-0.17 ^{ns}
Albht							0.17 ^{ns}	-0.14 ^{ns}	-0.12 ^{ns}	0.12 ^{ns}	0.96***	0.12 ^{ns}
Yht								0.14 ^{ns}	-0.09 ^{ns}	0.05 ^{ns}	0.07^{ns}	-0.06 ^{ns}
Swt									0.37**	0.16 ^{ns}	-0.33**	-0.15 ^{ns}
Sth										0.16 ^{ns}	-0.13 ^{ns}	-0.03 ^{ns}
Mspot											0.08 ^{ns}	0.18 ^{ns}
HU												0.15 ^{ns}
SI												

ns- not significant (P > 0.05); *- significant (P < 0.05); **- highly significant (P < 0.01); ***- very highly significant (P < 0.001); Ewt- Egg weight; Eht- Egg height; Ewdt- Egg width; Albwt- Albumen weight; Ywt- Yolk weight; Albht- Albumen height; Yht- yolk height; Swt- shell weight; Sth- shell thickness; Mspot- meat spot; HU- Haugh's unit; SI- Shape index

Table 4.13: Phenotypic Correlation Coefficients of Egg Quality Traits in Strain 2

	Ewt	Eht	Ewdt	Albwt	Ywt	Albht	Yht	Swt	Sth	Mspot	HU	SI
Ewt		0.48**	0.53***	0.74***	0.13 ^{ns}	-0.02^{ns}	-0.02 ^{ns}	0.38**	0.24^{ns}	0.23^{ns}	-0.20^{ns}	0.13 ^{ns}
Eht			0.19^{ns}	0.40**	0.27**	-0.27**	-0.27**	0.22*	0.13 ^{ns}	0.18 ^{ns}	-0.36**	-0.51***
Ewdt				0.47**	0.02 ^{ns}	-0.11 ^{ns}	-0.13 ^{ns}	0.32**	0.23^{ns}	0.18 ^{ns}	-0.18 ^{ns}	0.75***
Albwt					-0.19^{ns}	-0.08 ^{ns}	-0.17 ^{ns}	0.37***	0.25**	0.24**	-0.20^{ns}	0.15 ^{ns}
Ywt						-0.26**	0.17 ^{ns}	0.05 ^{ns}	-0.08 ^{ns}	-0.17 ^{ns}	0.02**	-0.17 ^{ns}
Albht							0.35**	-0.02 ^{ns}	-0.06 ^{ns}	0.13 ^{ns}	0.98***	0.10 ^{ns}
Yht								-0.16 ^{ns}	-0.07 ^{ns}	0.004 ^{ns}	0.36**	-0.07 ^{ns}
Swt									0.59***	0.06 ^{ns}	-0.09^{ns}	-0.13^{ns}
Sth										0.06 ^{ns}	-0.11 ^{ns}	-0.11 ^{ns}
Mspot											-0.17 ^{ns}	0.03 ^{ns}
HU												0.09 ^{ns}
SI												

ns- not significant (P > 0.05); *- significant (P < 0.05); **- highly significant (P < 0.01); ***- very highly significant (P < 0.001); Ewt- Egg weight; Eht- Egg height; Ewdt- Egg width; Albwt- Albumen weight; Ywt- Yolk weight; Albht- Albumen height; Yht- yolk height; Swt- shell weight; Sth- shell thickness; Mspot- meat spot; HU- Haugh's unit; SI- Shape index

Table 4.14: Phenotypic Correlation Coefficients of Egg Quality Traits in the Combined Strains

	Ewt	Eht	Ewdt	Albwt	Ywt	Albht	Yht	Swt	Sth	Mspot	HU	SI
Ewt		0.69***	0.54***	0.59***	0.23**	-0.10 ^{ns}	0.14 ^{ns}	0.63***	0.15 ^{ns}	0.11 ^{ns}	-0.35***	-0.06 ^{ns}
Eht			0.26**	0.37***	0.24**	-0.20**	-0.03^{ns}	0.44***	0.12 ^{ns}	0.08 ^{ns}	-0.37***	-0.53***
Ewdt				0.42***	0.01 ^{ns}	-0.05 ^{ns}	0.01 ^{ns}	0.34**	0.15 ^{ns}	0.19*	-0.17 ^{ns}	0.68***
Albwt					-0.60***	-0.10 ^{ns}	-0.03 ^{ns}	0.37***	0.10 ^{ns}	0.13 ^{ns}	-0.23**	0.09 ^{ns}
Ywt						-0.02 ^{ns}	0.16 ^{ns}	0.15 ^{ns}	-0.01 ^{ns}	-0.11 ^{ns}	-0.08 ^{ns}	-0.18 ^{ns}
Albht							0.27**	-0.09 ^{ns}	-0.09 ^{ns}	-0.01 ^{ns}	0.96***	0.11 ^{ns}
Yht								-0.02 ^{ns}	-0.09 ^{ns}	-0.03 ^{ns}	0.22**	0.03 ^{ns}
Swt									0.48***	0.08 ^{ns}	-0.25**	-0.04 ^{ns}
Sth										0.09 ^{ns}	-0.13 ^{ns}	0.04 ^{ns}
Mspot											-0.03 ^{ns}	0.11 ^{ns}
HU												0.13 ^{ns}
SI												

ns- not significant (P > 0.05); *- significant (P < 0.05) ; **- highly significant (P < 0.01) ; ***- very highly significant (P < 0.001) ; Ewt- Egg weight; Eht- Egg height; Ewdt- Egg width; Albwt- Albumen weight; Ywt- Yolk weight; Albht- Albumen height; Yht- yolk height; Swt- shell weight; Sth- shell thickness; Mspot- meat spot; HU- Haugh's unit; SI- Shape index

CHAPTER FIVE

5.0 DISCUSSION

5.1 DIFFERENCES BETWEEN MALE AND FEMALE LINES IN EGG PRODUCTION TRAITS

Observed significant difference in ASM between the two strains agreed with several authors who have reported that significant differences exist in egg type chickens for ASM across strains (Abubakar *et al*., 1991; Orunmuyi, 2006; Nwagu *et al*., 2007; Yahaya *et al*., 2009). The result obtained did agree with the findings of Orunmuyi (2006) in both generations, Nwagu *et al*. (2007) and Yahaya *et al*. (2009) where the dam line (Strain 2) attained sexual maturity (158 days) earlier than the sire line 161 days (strain 1). It disagrees, however, with the finding of Abubakar *et al*. (1991) who reported the male line as the better performing line. Values obtained were within the range reported by Omeje (1987); he reported a range of 149 days to 202 days for the sire line and 154 days to 214 days for the dam lines across grandparent and parent lines. According to Lahti *et al*. (2009) relaxed selection may result in the broadening of the selection peak without concomitant increase in trait mean. It appears that ASM has not changed drastically in a population where selection has been relaxed compared to population where selection was carried out. This could mean that the selection peak is gradually being widened, but no obvious reduction or increase in ASM as compared to literature report has occurred since selection was relaxed.

Differences observed in AEW did not agree with the report of Orunmuyi (2006) who reported the sire line to have a significantly higher value for AEW than the

dam line. However, the values obtained in this study were lower than those reported by Ajeigbe (1992), Orunmuyi (2006), Nwagu *et al*. (2007) and Yahaya *et al*. (2009) probably due to the age at which the weight was recorded. Also significant differences between the two strains observed for BW20 was in agreement with the observation of these authors but was at variance with the report of Abubakar (1991). BWT 20 values were higher than the value reported by Orunmuyi (2006) and Yahaya *et al*. (2009) in both generations of selection for both strains. It may be safely assumed within the scope of this study that the relaxation of selection pressure in these strains is tending towards the stabilization of the strains for the studied traits. This is in agreement with the report of Siegel and Honaker (2009) that Chickens, like other animals, allocate nutritional resources to different physiological activities including maintenance, growth, reproduction, immunity and social interactions. Genetic selection can cause changes in the allocations of these resources, favouring some physiological traits or functions while disadvantaging others (Gross *et al*., 2002).

5.2 DIFFERENCES BETWEEN MALE AND FEMALE LINES IN EGG QUALITY TRAITS

Observed differences in Ewt, Eht, Ywt, Swt and HU in this study were in accord with various literature reports that significant differences exist among egg strains for internal and external traits (Ajeigbe, 1992; Ledur *et al*., 2000; Ledur *et al*., 2002; Orunmuyi, 2006). The variation in Ewt between the strains agreed with the observation of Orunmuyi (2006) but disagrees with Ajeigbe (1992).Variation in Eht, Swt and HU were in dissonance with the reports of both Ajeigbe, (1992) and Orunmuyi, (2006). Since egg quality traits are fitness related, it may be

probable that relaxed selection pressure within these strains tended to normalise these traits around the mean value required for breeding in any situation where body weight influences and its known positive correlation with egg weight tended to draw it beyond that optimum point.

5.3 PHENOTYPIC CORRELATION COEFFICIENTS BETWEEN EGG PRODUCTION TRAITS

The moderate to high and negative phenotypic correlation between ASM and EN, BW18 and BW20 in Tables 9, 10 and 11 implies that selection based on ASM will lead to appreciable decrease in EN, BW18 and BW20 and these observations were in agreement with literature reports on the phenotypic association amongst these traits (Orunmuyi, 2006; Ghorbani and Kamali, 2007). It is of note that both strains and their pooled phenotypic correlations had the same trend, this may suggest that each strain is being restored to the post selection relationship among these traits, so that strain differences previously obtained due to selection are being reversed. The high positive correlation estimates obtained between BW18 and BW20 agreed with the general observation that body weight at all ages are highly heritable and are positively correlated (NIIR, 2004).

The negative phenotypic correlation obtained between number of eggs per day and all body weight traits suggest that the relationship could become more antagonistic during the process of selection. Phenotypic correlations of egg number with other economic traits followed the trend in literature. The negative correlation of egg number with age at sexual maturity (- 0.47 to -0.67) but

positive correlation with rate of lay at the phenotypic level is an indication that birds with lower age at sexual maturity had more days in lays, laid more regularly and had higher egg number and this agrees with the observation of Chatterjee and Misra (2001) and Orunmuyi (2006).

Observed low and positive relationship between AEW and most economic traits of interest with the exception of the low and negative relationship between this trait and EN in strain 2 and the combined strains agreed with the report of Saini *et al*. (1991) but were at variance with the report of Orunmuyi (2006). The low values obtained may be an indication of reversal in gains made in AEW within the strains due to the influence of relaxed selection pressure caused by plasticity (differences) in trait expression as described by Rutherford and Lindquist, (1998) who stated that genetic differences that are not expressed as phenotypic differences can accumulate, whereas in other environments those differences could have phenotypic effects that are subject to selection and also to variations in adapted gene complexes or formation of new forms which influences the correlations between these traits.

5.4 PHENOTYPIC CORRELATION COEFFICIENTS BETWEEN EGG QUALITY TRAITS.

Not much work has been carried out on the impact of relaxed selection pressure on internal and external egg quality traits, also little work exist in literature as to the egg quality traits in these strains of birds before and after selections were carried out. Observed moderate to high and positive relationship between Ewt and Eht, Ewdt, Albwt, Ywt and Swt observed in this study agrees with the

observations of Minvielle and Oguz (2002) who stated that there were strong phenotypic correlations between egg weight and most of its component parts. This indicates the presence of pleiotropic effect of Ewt genes on other internal and external quality traits. However no consistent trend exists when comparing this with the observed relationship in each individual strain. Observed low to moderate relationship between Ewt and Mspot in the combined and individual strains show a direct relationship which although has a low level of statistical significance might be a pointer to an increasing incidence of meat spot and blood spot in the strains due to increasing body weight as evidenced by the greater means for BW20 obtained when compared to previous studies on this birds, since Mspot is largely undesirable both in breeding and marketing.

The trend of strong and negative relationship of HU and SI to Ewt and other egg quality parameters indicates that proportional increase in either HU or SI will lead to a proportionate decrease in other traits, this agrees with the observations made by some authors such as Iscan and Akcan (1995); Ozcelik (2002); Kul and Seker (2004); Alkan *et al*. (2010) who variously stated that a negative phenotypic relationship normally exists between egg shape index and egg weight. However these were at variance with the report of Sezer, (2007) who reported a positive correlation between SI and Ewt. Wherever low phenotypic correlation exists in either direction, it implies that variation in one trait is only slightly attributable to variation in the other traits.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 SUMMARY

1) The maintenance of the variation between strains for most of the production and egg quality traits within the range reported during the initial selection period may indicate the broadening of the selection peak without concomitant increase in trait mean.
2) Observed phenotypic correlations between egg production and egg quality traits for each of the strains was similar in pattern to the pooled correlations for most economic and egg quality traits. This may point to the fact that relaxed selection is maintaining the relationship between traits at a constant level.
3) From basic statistics mean and standard error of mean for most of the traits evaluated, it became clear that strain 2 had better performance than strain 1

6.2 CONCLUSION

1. The female line (strain 2) had better performance than the male line in terms of ASM (158.79 Vs 161.50 days respectively), BW18 (1176.87 g Vs 1171.62 g) and BW20 (1370.17 g Vs 1327.39 g). The Rhodes Island chicken from which these strains were developed are known to be dual purpose breeds, in the absence of selection pressure for egg number, resources were redistributed to meat production . This explains why higher values for BW20 were obtained than previous reports (987.92 Vs1167.06) when selection was carried out. So it

becomes evident that relaxed selection gradually altered selection responses previously obtained in these strains.

2. The coefficient of variation of most of the studied traits within the individual strains had values higher than 20% therefore selection can still be resumed and appreciable response to selection can be obtained.
3. Phenotypic correlations between traits studied in the two strains vary both in magnitude and direction implying stability of the production and egg quality traits. Relaxed selection is gradually influencing these strains and broadening selection peak but due to phenotypic correlations among traits within strains the mean value for most traits are still being maintained (149 – 202 day for ASM)

6.3 RECOMMENDATION

The coefficient of variation of most of the studied traits within the individual strains had values higher than 20% therefore selection can still be resumed and appreciable response to selection can be obtained.

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Appendix A: Experimental chick, grower, and layer mash

	Chick mash	Grower mash	Layer mash
Maize %	45.00	34.45	43.45
Maize Offal %	10.00	10.00	10.00
Groundnut Cake %	13.05	10.00	13.50
Soya bean cake %	20.90	10.50	13.00
Wheat offal %	6.00	15.00	9.00
Rice offal %	0.00	15.00	0.00
Bone meal %	3.00	3.00	3.00
Limestone %	1.50	1.50	7.50
salt %	0.30	0.30	0.30
Premix %	0.25	0.25	0.25
Total	100	100	100
Calculated analysis			
Crude Protein	20.01	15.56	16.60
Energy	2722	2737	2594

Appendix B: Vaccination/medication schedule

Age of bird	Vaccination/medication
Day 1	NDV (i/o) + Mareks
Day 1 – 15	Anti stress
Day 10	IBDV – First dose
Day 24	IBDV – Second dose
Week 3 (for 5 days)	Coccidiostat
Week 4	NDI (I)
Week 6 (for 5 days)	Coccidiostat
Week 7	NDV (K) First dose + FPV
Week 8	Dewormer
Week 9 (for 5 days)	Coccidiostat
Week 12 (for 5 days)	Coccidiostat
Week 16	NDV (K) Second dose
Week 17 (for 1 day)	Dewormer

- NDV (i/o) – Newcastle disease vaccine (intra occular)
- NDV (L) - Newcastle disease vaccine (Lasota)
- NDV (K) - Newcastle disease vaccine (Kumarov)
- IBV – Infectious Bursal disease vaccine (Gumboro)
- FPV – Fowl pox vaccine