Bayero Journal of Pure and Applied Sciences, 2(1):177 - 182
Received: February, 2009
Accepted: May, 2009

EVALUATION OF LAYER TYPE CHICKENS UNDER RECIPROCAL RECURRENT SELECTION

***H. K. Yahaya[1], O. O.Oni[2], G. N. Akpa[3] and I. A. Adeyinka[4]**
[1]Department of Applied Science, Kaduna Polytechnic Kaduna
[2]Agricultural Research Council of Nigeria, Abuja.
[3]Department of Animal Science, Ahmadu Bello University, Zaria.
[4]National Animal Production Research Institute, Shika, Zaria.
*Correspondence author

ABSTRACT
Matings within pure male and female lines, and between pure male and female lines were carried out to produce purebred male line (AA x AA), female line (BB x BB), cross (AA x BB) and reciprocal cross (BB x AA). A total number of 364 pullets arising from 207 hens and 23 cocks in generation 1 and 440 pullets from 70 hens and 10 cocks in generation 2 under selection were monitored in individual cage units for part period of egg production up to 280 days of age. Parameters considered were age at sexual maturity (ASM), body weight at 20 and 40 weeks of age (BW 20 and BW40), egg weight average (EWTAV) and egg production up to 280 days (Egg 280). A non-significant difference among purebreds but a significant difference ($P<0.05$) between them and the crosses for all the traits considered were observed. The crosses (including the reciprocal) had lower ASM (163.10 ± 0.79 to 192.25 ± 0.4 vs 184.02 ± 1.17 to 197.99 ± 0.09 days), higher BW20 (718.61 ± 14.33 to 1477.53 ± 33.01 vs 713.17 ± 11.70 to 1173.17 ± 9.36 g) and BW40 (1858.11 ± 0.41 to 2158.26 ± 10.16 vs 1794.54 ± 32.00 to 2040.05 ± 12.93 g).They also laid heavier eggs (52.95 ± 0.30 to 55.32 ± 0.28 g) vs 52.58 ± 0.22 to 54.67 ± 0.28 g) and produced higher number of eggs up to 280days (45.09 ± 0.78 to 85.32 ± 0.70 vs 45.69 ± 0.98 to 71.62 ± 0.48), than the two purebreds, respectively. Percentage heterosis for ASM was negative for all crossbred groups and was positive for most of the other traits. Since heterosis is favourable in all the traits considered dams of the cross bred groups can be used for commercial egg production.

Keywords: Evaluation, layer type chickens, reciprocal recurrent selection, heterosis

INTRODUCTION

The primary objective of a poultry breeder is to alter gene frequencies and distribution by employing various mating systems/selection methods to improve different traits of economic importance that will maximize the efficiency of production and increase profitability (Siegel and Dunnington, 1997). Such traits include egg number, egg weight, fertility, hatchability, growth rate, and meat quality and viability. There are different classes of selection methods, each with several variants. Reciprocal recurrent selection is designed to exploit both the additive and non-additive genetic variation. The reciprocal recurrent selection (RRS) is essentially a recurrent programme to mate selected males of line A with females of line B and B-line males with A-line females to produce test crosses. This is followed by switch mating to produce pure-line AxA and BxB half sibs of the test crosses. In reciprocal recurrent selection, the selection of purebred animals is based on the performance of AxB and BxA hybrids, the segregating populations (A and B) are utilized on both sides of the cross (Wei and Van-der Steen, 1991). This method of selection increases the frequency of both additive and non-additive genes, hence improve pure-line as well as cross-line performance. The main reason for this is that crossbreds often exhibit heterosis that indicates the existence of non- additive effects and the two populations under reciprocal recurrent selection do not have identical gene frequency which causes the covariance between them to be small or negative (Wei and Van-der Steen, 1991). Reciprocal recurrent selection leads to a high performance for lowly heritable and heterotic traits (King, 1971). This study evaluates production performance in the pure breds and heterosis for egg production traits in the cross bred groups.

MATERIALS AND METHODS

Study site and climate: The study was carried out at the Poultry Breeding Unit of National Animal Production Research Institute (NAPRI), Shika, Zaria. The Institute is located between latitude 11 and 12^0N and longitude 7 and 8^0E at an altitude of 640m above sea level. Shika is located within the Guinea savanna ecological zone of Nigeria. The mean annual rainfall is 1107mm and is seasonally distributed as follows; 0.1% in the late dry season (January – March) 25.8% in the early wet season (April – June), 69.6% in the late wet season (July – September) and 4.5% in the early dry season (October to December) (Osinowo *et al.,*1993). The mean annual temperature is 24.4^0C. The mean relative humidity is 21% during the period of dry cool weather called harmattan and 72% during the rainy season.

Stock composition and management: A total of 108 and 12 pedigreed hens and cocks respectively from the male line while a total number of 90 and 10 pedigreed hens and cocks respectively from the female line were selected to produce pullets used in generation 1. In the first generation 35 and 5 pedigreed hens and cocks respectively were selected in each line to produce purebred and crossbred progenies used in generation 2. A cock was allocated such that half sib or full sib mating was totally avoided. To produce the reciprocal crosses, the cocks of the female line were interchanged with the cocks of the male lines. After hatching, the chicks were identified by using wing band on the right wing. Daily feeding and clean water were provided to all birds ad-libitun.

Data Collection and Analysis

Data was collected on the following traits.

Age at sexual maturity, which was taken as the number of days from hatch to first egg. Body weight at 20 weeks was obtained by weighing each surviving pullet in each genetic group without fasting. Body weight at maturity (BW40) was obtained by taking the average weight of each surviving pullets at 35, 36, 38 and40 weeks of age without fasting.

Egg Weight: The average weight of two to three eggs (g) per hen at 35, 36, 38 and 40 weeks for each genetic group was taken and recorded.

Egg Number: This was taken as number of eggs laid by each pullet up to 280 days for the different genetic groups.

Selection was practiced for egg production trait using Singh and Demfple's (1989) index that took into account the individual paternal half –sibs records. A total number of 364 pullets in generation 1 and 440 pullets in generation 2 belonging to both pure and cross-bred groups were utilized in the analysis. The traits recorded on the individual pullets were age at sexual maturity (ASM), body weight at 20 and 40 weeks of age (BW 20 and BW 40) egg weight average (EWTAV) and egg production up to 280 days (Egg 280).

The means of the various genetic groups were computed using the following models

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

where μ = mean of the population

h_i = effect of i^{th} hatch

eij = random error (error terms were assumed to be randomly and normally distributed with expectation equals to zero).

Where hatch was found to have a significant effect, the data was corrected for hatch effect using least squares procedures described by Harvey (1987). Tests of significant at 0.05% was carried out using Duncan multiple range test (Steel and Torrie, 1980).

Estimation of heterosis : Heterosis among the cross-bred chicks was estimated as the mean cross-bred deviation expressed in percentage of midparent performance as outlined by Omeje and Nwosu (1988).

RESULTS

Tables 1, 2 and 3 show the mean performance for different production traits in the purebred and their respective crossbred groups in generation 1,2 and in the combined generation. Comparism of age at sexual maturity shows that significant differences (P<0.05) exist among all the genotypes in generation 1 and between the pure lines and their cross bred groups, with the cross bred groups maturing earlier than the purebreds. At 20 weeks of age, significant difference was not observed between the pure lines irrespective of the generation but significant difference (P<0.05) was observed between the cross-bred groups. At 40 weeks, significant differences exist in the pure lines only in generation 1, whereas there is no significant difference observed between the cross-bred groups irrespective of the generation. No significant difference was observed in egg weight average for generations 2 and combined generation in the pure lines buy exist between the cross-bred groups. However, significant difference (P<0.05) exists between the pure lines and their cross-bred groups for this trait. For mean egg production up to 280 days, no significant difference exists between the pure lines for second and combined generations except in the first generation. Significant difference was observed in generation 1 and 2 for the cross-bred groups but not in the combined generation. However, the cross-bred groups remarkably (P<0.05) produced more eggs than their counterpart pure lines.

Table 4 shows the heterotic effect for production traits among the cross-bred groups in generation 1,2 and in the combined generation. Results obtained reveal negative heterosis for age at sexual maturity both in the cross (-5.42 to -11.57%) and in the reciprocal cross, respectively (-2.41 to -11.58%). In the cross, the results revealed positive heterosis for both body weight at 20 weeks (10.51 to 23.79%) and 40 weeks (2.63 to 7.73%) of age except in generation 1 were it was negative. However, heterosis was positive at 20 weeks (0.62 to 28.01%) and 40 weeks (3.68 to 12.46%) of age in the reciprocal cross respectively. Equally, positive heterosis was observed both in the cross (2.06 to 5.60%) and in the reciprocal cross (0.64 to 1.95%) for egg weight average. For egg number up to 280 days heterosis was positive both in the cross (8.78 to 15.40%) and in the reciprocal cross (7.51 to 20.12%) except in generation 1 where it was negative for the reciprocal cross.

Table 1: Least square means and standard errors for production traits in the purebreds, cross and reciprocal cross of layer type chickens: Generation 1

Parameters	Genotypes			
	AA x AA	**BB x BB**	**AA x BB**	**BB x AA**
ASM (days)	197.99$\pm$0.09^{a}	196$\pm$0.12^{b}	186.31$\pm$o.24^{d}	192.25$\pm$0.44^{c}
BW20Wks (g)	713.17$\pm$11.70^{b}	715.17$\pm$11.74^{b}	789.22$\pm$10.46^{a}	718.61$\pm$14.33^{b}
BW40Wks (g)	1794.54$\pm$32.00^{b}	1982.99$\pm$14.49^{a}	1858.11$\pm$0.041^{a}	1958.33$\pm$13.66^{a}
EWTAV (g)	54.67$\pm$0.28^{a}	51.78$\pm$0.30^{b}	54.32$\pm$0.11^{ba}	53.92$\pm$0.20^{ba}
Egg280	45.69$\pm$0.98^{c}	48.98$\pm$0.81^{b}	54.63$\pm$0.98^{a}	45.09$\pm$0.78^{c}

AAxAA = purebred male line,BBxBB = purebred female line, AAxBB = cross, BBxAA = reciprocal cross.
a,b,c,d means with the same superscripts are not significantly different at P<0.05, ASM = age at sexual maturity, BW20 = Body weight at 20 weeks of age, BW40 = Body weight at 40 weeks of age, EWTA = Egg weight average, Egg 280 = Egg production up to 280 days

Table 2: Least square means and standard errors for production traits in the pure breds, cross and reciprocal cross of layer type chickens: Generation 2

Parameters	Genotypes			
	AA x AA	**BB x BB**	**AA x BB**	**BB x AA**
ASM (days)	184.84$\pm$0.68^{a}	184.02$\pm$1.17^{a}	163.10$\pm$0.79^{b}	163.08$\pm$0.69^{b}
BW20Wks (g)	1135.24$\pm$8.20^{c}	1173.17$\pm$9.36^{c}	1428.74$\pm$15.80^{b}	1477.53$\pm$33.01^{a}
BW40Wks (g)	1966.69$\pm$8.85^{b}	2040.05$\pm$12.93^{b}	2158.26$\pm$10.16^{a}	2252.99$\pm$48.01^{a}
EWTAV (g)	52.65$\pm$0.19^{b}	52.58$\pm$0.22^{b}	55.56$\pm$0.36^{a}	52.95$\pm$0.30^{b}
Egg280	70.44$\pm$0.62^{c}	71.62$\pm$0.48^{c}	80.46$\pm$1.29^{b}	85.32$\pm$0.70^{a}

a,b,c means with the same superscripts are not significantly different at P<0.05, ASM = age at sexual maturity, BW20 = Body weight at 20 weeks of age, BW40 = Body weight at 40 weeks of age, EWTA = Egg weight average, Egg 280 = Egg production up to 280 days

Table 3: Least square means and standard errors for production traits in the purebreds, cross and reciprocal cross of layer type chickens: Combined generations

Parameters	Genotypes			
	AA x AA	**BB x BB**	**AA x BB**	**BB x AA**
ASM (days)	188$\pm$0.60^{a}	187.12$\pm$0.85^{a}	173.02$\pm$2.25^{b}	175.26$\pm$1.86^{b}
BW20Wks (g)	989.52$\pm$20.20^{c}	1013.47$\pm$29.42^{c}	1150.25$\pm$56.66^{b}	1185.93$\pm$45.19^{a}
BW40Wks (g)	1929.63$\pm$16.74^{b}	2012.11$\pm$9.99^{b}	2022.78$\pm$22.63^{a}	2148.39$\pm$22.67^{a}
EWTAV (g)	52.91$\pm$0.17^{b}	52.63$\pm$0.18^{b}	55.32$\pm$0.28^{a}	53.80$\pm$0.18^{b}
Egg280	62.50$\pm$1.17^{b}	63.26$\pm$1.56^{b}	68.40$\pm$2.75^{a}	67.60$\pm$2.68^{a}

a,b,c means with the same superscripts are not significantly different at P<0.05, ASM = age at sexual maturity, BW20 = Body weight at 20 weeks of age, BW40 = Body weight at 40 weeks of age, EWTA = Egg weight average, Egg 280 = Egg production up to 280 days

Table 4: Heterosis for production traits among the crossbred groups (%).

Traits	Generation 1		Generation 2		Combined Generation	
	AA x BB	**BB x AA**	**AAxBB**	**BB X AA**	**AA x BB**	**BB X AA**
ASM	-5.42	-2.49	-11.57	-11.58	-7.75	-6.56
BW20	10.51	0.62	23.79	28.01	14.85	18.42
BW40	-1.62	3.68	7.73	12.46	2.63	9.01
EWTAV	2.06	1.31	5.60	0.64	4.83	1.95
Egg280	15.40	- 4.74	13.28	20.12	8.78	7.51

DISCUSSION

The significant differences observed among the pure lines and cross-bred groups in most of these traits categorised them as distinct groups. The range of age at sexual maturity obtained in this study for the pure lines were similar to those report by Oni *et al* (1992), Mshelia *et al* (1994) but lower than those by Adeyinka (1998) and Nwagu (2004). The results obtained in the crosses were indications that selection for improved egg number in the parental lines had resulted in appreciable improvement in the performance of the terminal crosses of the two parent lines as shown in Tables 2 and 3. This could be attributed to the fact that cross-breds often exhibit heterosis which often shows the existence of non-additive effects (Falconer, 1996).

The significantly lower age at sexual maturity observed in the cross-bred groups than in the pure lines agrees with the findings of Singh *et al* (1992). Similarly lower age at sexual maturity has been reported by Chaubal *et al* (1994) and Kicka (1997) in white Leghorn pullets than in their parental lines. The non-significant difference observed between the crosses for this trait (generation 2 and combined generation) is in line with the report of Chaubal *et al* (1994) and El-Salamony *et al* (2002).

A significant lower body weight at 20 and 40 weeks of age respectively observed in the pure-breds as against the cross-breds in all generations agree with the findings of Chaubal *et al* (1994).The range of mean body weight at 40 weeks of age observed in this study for the male line is similar to values reported by Oni *et al* (1994),Mshelia *et al.* (1994), Adeyinka (1998) and Nwagu (2004) for this breed/ line. The lack of difference observed between the crosses (cross and reciprocal cross) could be attributed to the absence of sex linked and/ or maternal effect in intercrossing of the strains involved (Singh *et al.,* 1992). A non-significant difference between the cross and reciprocal cross had been reported by Chaubal *et al* (1994), El-Salamony (2002) and Abdel (2003).

The mean egg weight observed in this study shows good performance in all the genotypes across generations. Average egg weight of chickens in the range of 50 to 56g has been recommended by (FAO, 2003). Egg weight of 51g had been reported by Kicka *et al* (1997) for Rhode Island Red chickens while Abubakar *et al.* (1990) reported 52.7g for mature egg weight in Rhode Island Red chickens. The results obtained in this study also fall within the range earlier reported by Adeyinka (1998) and Nwagu (2004) in the selected male and female lines. A non-significant difference obtained between the male and female lines in this work agrees with the findings of Mschelia *et al* (1994) and Laly-John et al (2000).The significant difference observed between the cross-bred groups in this study also corresponds with the report of Singh *et al* (1992) and Chaubal et al (1994). This work futher agreed with the report of El-Salamony *et al* (2002), Abdel (2003), Udeh and Omeje (2005) and Nwachuku *et al.* (2006)for egg weight. For egg production up to 280 days, significantly lower production observed in the pure lines than cross-breds across all the generations were in conformity with the findings of Singh et al (1992), Chaubal *et al* (1994), Minvielle et al (2002) and khalil *et al* (2004). This work further agreed with the findings of Amali and Horns (2001) and Abdel (2003). The higher egg production observed in the cross than the pure lines could be associated with lower age at sexual maturity of the crosses and also to the fact that crossbreds exhibit heterosis which indicates the presence of non-additive gene effect. Udeh and Omeje (2005) had asserted that non-additive genetic effects were responsible for the inheritance of this trait in cross-bred group. Significant difference between the cross-bred groups is in agreement with the findings of El-Salamony et al (2002) and Nwachukwu (2006). The negative heterosis observed for age at sexual maturity across generations were desirable. It implies that cross-bred groups would reach age at first egg earlier than their counter part purelines. This is confirmed by the lower number of days obtained in the cross-bred groups irrespective of generations. Hoste (1989) had earlier reported negative heterosis with a significant increase across generations for age at first egg in the domestic fowl. Positive percentage heterosis was obtained for body weight at 20 and 40 weeks of age for the cross-bred groups across most of the generations. Singh *et al.* (1992) and Fairfull *et al* (1987) had earlier reported positive heterosis for body weight. Results obtained in the present work futher agreed with the report by El-Salamony et al (2002).

The relatively low heterotic values for egg weight trait in this study could suggest that egg weight of the base flock used were mostly governed by additive and residual gene effects. This is consistent with the report of Fairfull *et al* .(1987),Fairfull (1990) and Croen *et al* (1998) that heterosis for egg weight was low and ranged from 0 to 5%. The low heterosis for this trait further agrees with the findings of Singh *et al.* (1992), Bordas *et al.* (1996) and Udeh and Omeje (2005). Positive heterosis observed for egg production both in the cross and reciprocal cross across most generations agreed with the observations that heterosis for egg production is typically above 10% (Fairfull and Gowe 1986). The range of percentage heterosis observed for this trait were also in line with those reported by Flock (1980); Fairfull *et al.* (1987), Bordas *et al* (1996) and Nestor *et al.* (2004).This further agrees with the report of Sheridan (1986) and Groen et al (1998) that heterosis for egg production was substantial. The cross and reciprocal cross-bred groups differed in their heterotic performance on egg production traits mainly due to the nature and the degree of gene frequency differences between the parental lines since heterosis is directly proportional to heterozygosity (Falconer, 1989).

CONCLUSION

It can be concluded from the findings of this study that no significant differences were observed between the two pure lines. The cross-bred groups had better performance in all the traits considered. Heterosis for age at sexual maturity was negative but desirable and was low for egg weight average. Since heterosis is favourable in all the traits considered dams of the cross bred groups can be used for commercial egg production.

REFERENCES

Abdel Galil, M. A. (2003). Performance of the 2nd Generation chickens produced from crossing a control flock of Rhode Island Red. *A paper presented at the 15th Annual conference of the Nigerian Society for Animal Production. Ago-Iwoye Abeokuta, Nigeria.* 4pp Dandarawi with commercial egg type chickens *Egypt J. Agric Res*. 82(2): 751-761.

Abubakar, B. Y; Oni O. O., Ogundipe S. O. and Olorunju, S. A. S (1990). Genetic Analysis of

Adeyinka, I. A. (1998). Short term response to selection in layer type chickens. *Ph.D thesis submitted to the Dept. of Animal Science, Ahmadu Bello University, Zaria Nigeria.* 112pp.

Amali, M.A. and Horn P. (2001). Heterosis in egg production in different parts of the laying period of layers of Rhode Island Red origin selected by RRS selection in two environments. Part 1. Heterosis in egg production in the original populations after few generations of RRS selection. *Acta Agraria Kaposvariensis:* 5(2): 23-30.

Bordas, A; Merat, P. and Minuivelle, F. (1996). Heterosis in egg laying lines under divergent selection for residual feed consumption. *Poultry Sci./America Associations of Instructors and Investigation in Poultry husbandary* 75(1) :20-24.

Chaubal, D.V., Solanki, J.V; Shukai, R.K; Rank, D.N; Mishra, R.K; and Khama K. (1994). Performance of White Leghorn pullets under reciprocal recurrent selection for two generation. *Indian J. Poult. Sci.* 29 (3): 211-217.

El-Salamony, A.I., Abou-Ashour, A.M; Ezzeldin, Z.A 2002. A study of heterosis in some egg production traits in Norfa layers. *Egypt. J. Agric Res*. 80(3): 1337-1352.

Fairfull, R.W. and Gowe, R.S. (1986). Use of breed resources for poultry egg and meat production. *3rd World Congress on genetics Applied to livestock production* 10: 242-256.

Fairfull R.W., Gowe, R.S. and Nagal, J. (1987). Dominance and epistatis in heterosis of White Leghorn strain crosses. *Canadian J. of Anim. Sci.* 67: 663-680

Fairfull, R.W. (1990). Heterosis in poultry Breeding and Genetics (Crawford, R.D. Ed).Elservier, Amsterdam ,The Netherlands, pp. 914-933

Falconer, D.S. (1989):Introduction to Quantitative Genetics 2nd edition, London. Inc

Falconer, D.S and Mockey, T.F.C. 1996. Introduction to Quantitative Genetics 4th edition. ELBS Longman, Hong Kong.

FAO (2003) Animal Production and Health. *Food and Agricultural Organisation of the United Nations. Rome, Italy*.

Groen, A.F; Heelsum A.V; Kimani, C.W. and Van Druncu, C.P (1998). Heterosis and reciprocal effects for egg laying traits estimated from a full dialed cross with six commercial White Leghorn lines, using mixed model analysis. *Arch Geflugelk* 62 (3): 115-120.

Harvey, W.R. (1987). *Users guide for LSMLMW, mixed model least squares and maximum likelihood computer programme. PC version.* Mimeograph, Ohio State University, OH, USA.

Hoste, S. 1989. Selection for early maturity in the domestic fowl. *Proceedings of the 31st British Poultry Breeders Roundtable Conference* pp 1-3.

Khalil, M.K., Al-Homidan, A. H. and Hermes H.I. 2004. Crossbreeding components in age at first egg and egg production for crossing Saudi chickens with White Leghorn. *Livestock Research for Rural Development* 16 (1). 10pp

Kicka, M.A.M; Stino, F.K.R and Kamar, G.A.R. 1997. Genetic studies on some economical traits of chickens in subtropics. *Egypt. J. Anim. Prod.* 11 (1): 41-46.

King, J.W.B. 1971. Crossbreeding of pigs and poultry. *Proceedings of the X th International Congress on Animal Production.* Pp 117-130.

Laly-John, C., Jalaludeen, A and Anitha P. 2000. Impact of selection for part period egg production in two strains of White Leghorn. *Indian J. Poult. Sci.* 35 (2): 156-160

Minvielle, F. Monvoisin, J. I. Costa, J and Maeda Y. 2000. Long term egg production and heterosis in quail lines after within line or reciprocal recurrent selection for high early egg production. *British Poult. Sci*. 41 : 150-157.

Mshelia, J.L., Abubakar B.Y., Dim N.I., Oni O.O. and Adeyinka I.A. 1994. Variance component analysis of reproductive and productive traits in Rhode Island Red and White chikens. *A paper presented at the 19th annual conference of the Nigerian Society for Animal production. Benin, Nigeria.* 12pp.

Nestor K.E; Anderson, J.W; Patterson, R.A. and Velleman, S.G. 2004. Genetic variation in body weight and egg production in an experimental line selected long-term for increased egg production; A commercial Dam line and Reciprocal crosses between lines. *Poultry Science* 83: 1055-1059.

Nwachukwu, E.N., Ibe, S.N. and Ejekwu, K. 2006. Short-term egg production and egg quality characteristics of F_1 crosses of Normal, Naked Neck and Frizzle chicken X Exotic Broiler Breeder stock in a humid tropical environment. *Proceedings of the 31st Annual Confrence of Nigerian society for Animal Production.* Pp 27-30.

Nwagu, B.I 2004. Estimation of genetic parameters using different methods in Rhode Island chickens selected for part-period egg production. *Ph.D thesis submitted to the Dept. of Animal Science Ahmadu Bello University, Zaria, Nigeria.* 103pp.

Omeje, S. S. I and Nwosu, C. C 1998. Utilization of Nigerian chicken in poultry breeding. Assesment of heterosis in growth and egg production. *J. Anim. Breed and Genetics* 105 : 417- 425.

Oni, O.O, Abubakar B.Y, Ogundipe S.O, Adeyinka I. A and Nwagu B.I. 1994. Age and body weight at sexual maturity in Rhode Island chickens. *A paper presented at the 19th Annual Conference of the Nigerian Society for Animal production. Benin, Nigeria.* 6pp

Oni, O.O., Abubakar, B.Y., and Oyedepo, F. D 1992. Inheritance of body weights and sexual dimorphism in two strains of Rhode Island chickens. *A paper present at the 17th Annual Conference of the Nigerian Society for Animal Production Abuja-Nigeria.* 11pp.

Oni, O.O., Abubakar, B.Y., Ogundipe, S.O. and Olorunju, S.A.S 1992 Comparative performance of Rhode Island Red and White strains for egg production *J. Anim. Prod. Res.* 12(2): 89-91.

Osinowo,O. A, Abubakar, B. Y. And Trimnell, A. R. 1993. Genetic and phenotypic relationship between gestation length, litter size and litter birth weight in yankasa sheep. *Anim Prod Sci* 34 : 11- 18

Sheridan, A.K. 1986. Selection for heterosis from cross-bred populations: Estimation of the F1 heterosis and its mode of inheritance. *Brit Poult.Sci.* 27: 541-550

Siegel, P.B and Dunnington, E.A 1997. Genetic selection strategies-population Genetics. 1. *Poult. Sci.* 76: 1062-1065.

Singh, N.P., Chaudhary, M.L., Brah, G.S and Sandhu, J.S. 1992. Evaluation of two White Leghorn strains and their reciprocal crosses for part year productivity. *Indian J. of Poult. Sci.* 27(3): 139-143.

Singh, R.P and Demfple, L. 1989. Optimizing multi stage selection in a modified reciprocal recurrent selection programme considering cost and rate of genetic progress. *40th annual meeting of the European Association of Animal Production. Durblin, Ireland, Vol. 1 (summaries).167.*

Steel, R.G and Torrie, J.H. 1980 Principles and procedures of statistics. 2nd ed. Mc Graw Hill. London, pp. 633.

Udeh, I. and Omeje, S.I. 2005. Heterosis for egg production in native by exotic inbred chicken crosses. *Nig. J. Anim. Prod.* 32(1): 7-20.

Wei and Vender Steen, H.A.M. 1991. Comparison of reciprocal recurrent selection with pure-line selection systems in animal breeding (A review) *Anim. Breed. Abst.* 59(4): 281-297.