INTERNATIONAL JOURNAL OF
POULTRY SCIENCE

Egg Production Performance and Prediction of Standard Limits for Traits of Economic Importance in Broiler Breeders

Murad Ali, M. Farooq, F. R. Durrani, N. Chand, K. Sarbiland and A. Riaz
Department of Poultry Science, NWFP, Agricultural University, Peshawar, Pakistan
E-mail: durraniff@yahoo.com

Abstract: The present study was conducted on broiler breeders maintained in 24 different farms located in Mansehra and Abbotabad to investigate egg production performance and develop standard limits for production traits of economic importance. Average number of day-old chicks received at a broiler breeder farm was 19076.29, out of which 16449.08 birds attained sexual maturity and were housed in laying houses. Total hens housed represented 14037.32 females and 1559.70 males (a male to female ratio of 1:9). Reserved male stock (852.06 birds) was 5.18% of the total population. Average mortality during 323.46 days of growth and production period was 13.77%, representing 2.97, 4.99 and 5.81% mortality during brooding, growing and laying periods, respectively. Average age at point-of-lay, age at peak-of-lay and egg laying period were 164.67, 232.83 and 155.46 days. Age at point-of-lay ($r = 0.227$) and age at peak-of-lay ($r = 0.333$) were found positively but non-significantly correlated with total mortality in a flock. On the other hand flock size was found negatively correlated with age at point ($r = -0.052$) and age at peak-of lay ($r = -0.415$; $p<0.04$). Egg laying period was found negatively but non-significantly correlated with flock size ($r = -0.147$) and positively correlated with total mortality in a flock ($r = 0.255$). Egg laying period was found positively and significantly ($P<0.027$) associated with percent lay ($b = 5.770$). Average peak percent lay and percent lay was 83.09 and 59.67%, respectively. Percent lay was found non-significantly and positively correlated with flock size ($r=0.184$) and mortality ($= 0.085$). Similar findings were observed for peak percent lay. Percent lay was found positively and significantly ($P<0.033$) associated with peak percent lay ($b = 0.625$). Peak percent lay was found negatively associated with age at peak of lay ($b = -0.324$; $P<0.001$) and positively associated with age at point of lay ($b = 0.891$; $P<0.001$). Average hen-day and hen-housed egg production was 103.32 and 95.10 eggs, respectively. Hen-day ($r = -0.067$) and hen-housed egg production ($r = -0.074$) was found negatively and non-significantly correlated with flock size. Hen-day egg production was found positively associated with peak percent lay ($b = 1.600$; $P<0.035$) and egg laying period ($b = 0.627$; $P<0.001$). Percent lay, peak percent lay, egg laying period and hen-day and hen-housed egg production was lower than that reported in the literature. Standard limits for minimum number of hens to be housed, maximum level of mortality, maximum age at point of lay, maximum age at peak of lay, minimum peak percent lay, minimum percent lay, egg laying period in response to percent lay and egg laying period in response to hen-day production were 4172.21 birds, 13.11%, 164.36 days, 35.33 weeks, 79.99%, 67.64%, 28.06 weeks and 65.54 weeks, respectively. The standard limits mentioned for various traits shall be maintained in order to make broiler farming more productive.

Key words: Egg production, broiler breeders, flock size, egg laying period

Introduction

Boiler breeder production is one of the profitable production activities than broiler and layer production. A broiler breeder could generate Rs. 786±49.8 as net profit giving 106±7.34% return over the invested capital (Farooq *et al.*, 2001) as compared to broiler (Rs. 7/broiler per flock; Asghar *et al.*, 2000) and layer farming (Rs. 38.26±6.66 per layer; Farooq *et al.*, 2003). However, breeder farming is not that simple and easy, as it requires special rearing environment and huge investment than any other poultry production activity. Thus, it's beyond the approach of every farmer. Farmers involved in broiler breeder production should therefore keep a vigilant eye on management and better care and know the important production traits to make it more

profitable. A broiler breeder hen usually starts egg production at the age of 23-24 weeks and produces around 183 hatchable eggs out of 199 total hens housed eggs produced in 65 Weeks of its laying cycle (North, 1984). Farooq *et al.* (2001) reported smaller per hen-housed egg production (188±0.56 eggs) representing 88±0.23% hatchable and 14±0.18%, un-hatchable eggs than that reported by North (1984). Probable reason for that could be shorter egg laying cycle and poor rearing environment in former than in later case. Egg production is a function of feed consumed, age at point-of-lay, age at peak-of-lay, peak percent lay, percent hen-day egg production, laying period, rearing environment, health care and overall management of the flock. Thus, any variation in the

aforementioned traits will result in a wide variability. Therefore, care must be exercised to fulfill all the production requirements in an appropriate way thereby ensuring better productivity. Mortality plays a major role in the determining profits from broiler breeders as it is a function of dead and culled birds over the growth and production period. Higher mortality rate has been reported to adversely affect production performance of broiler breeders. Mortality and its negative association with net profit had also been reported by Farooq *et al.* (2001); Zahir-ud-Din *et al.* (2001); Asghar *et al.* (2000). North (1984) reported poor economic performance of breeders at mortality level of more than 10%.

Broiler breeders are usually produced in a healthy rearing environment to ensure better production performance. Keeping management factor to be constant, study of various production traits and developing standard limits for traits of economic importance would be more meaningful as it will enable the farmers to set their production goals and avoid unnecessary losses. The present study would therefore, be an effort to study egg production performance, investigate relationship between various traits and develop standard limits for traits of economic importance in broiler breeders.

Materials and methods

The present study was conducted on broiler breeders maintained in Mansehra and Abbotabad to investigate egg production performance and develop standard limits for traits of economic importance. Data from only 24 broiler breeder farms were collected as majority of the farmers were not eager to provide the desired information. Information regarding flock size, mortality, culling, number of hens housed, number of males in the flock, number of reserved males for the flock, age at first lay, age at peak of lay, peak percent lay, percent lay, hen-day egg and hen-housed egg production were obtained from the records maintained at the farms.

The data were analyzed, using relevant statistical methods of data analysis, namely, weighted mean, regression procedures and quadratic functions. To account for wide variability in production traits weighted means were calculated instead of simple averages, using the following equation;

$$X = \Sigma\, W_iX_i/\Sigma W_i$$

Where "X" is weighted mean, "Xi" the variable, "Wi" the weight factor/number for a particular variable.

First egg laid was considered as age at point of lay while flock obtaining maximum percent lay on any day was considered as peak percent lay and the day was regarded as age at peak of lay. Percent lay on daily basis was calculated using the following formula given by North (1984);

Number of eggs produced on daily basis
-- x100
Number of birds available in the flock on that day

Average for the whole egg laying period of hen-day percent lay was worked out and termed as percent lay. Hen-day egg production on daily basis was calculated by adopting the following formula given by North (1984);

Number of eggs produced on daily basis

Number of birds available in the flock on that day

Hen-day egg production for the whole period was worked out by summing up the daily hen-day egg production of the flock.

Hen-housed egg production was worked using the following formula given by North (1984);

Total number of eggs produced by a flock

Total number of hens housed

Following form of quadratic function was used to study relative association among various production traits of economic importance;

$$Y = \beta_0 + \beta_1X_i + \beta_2X_i^2$$

Where; "Y " is response variable, "β_0" the intercept, "β_1" first slope of the regression line, "β_2" second slope of the regression line and "X_i" the regressors (Wonnacott and Wonnacott, 1985).

To develop standard limits for individual traits, results obtained from the aforementioned equation were solved one by one taking first and second derivatives of the slopes of the regression lines.

Correlations between flock size, hens housed, hen-housed egg production, hen-day egg production, percent mortality, age at point-of-lay, age at peak-of-lay, peak percent lay, percent lay and egg laying period was worked out using the following definition;

$$r_{X,Y} = \frac{Cov\,(X,\,Y)}{\sigma_X\sigma_Y}$$

Results and Discussion

Flock size: Average number of day old chicks received at a broiler breeder farm in Mansehra and Abbotabad districts was 19076.29, out of which 16449.08 birds reached sexual maturity and were housed in laying houses (Table 1). Farooq *et al.*, 2001 reported a higher flock size (26245 birds) in Abbotabad and Mansehra districts than the present finding. Reduction in flock size was observed with the passage of time which could be attributed to introduction of broiler breeders in other parts of the country than in Mansehra and Abbotabad. Early on broiler breeders were reared in the aforementioned areas but now broiler breeders are

Table 1: Production performance of broiler breeders in Abbotabad and Mansehra districts

Parameter	Mean
Day-old chicks received (#)	19076.29
Hen-housed (#)	14037.32
Males with hen-housed (#; a)	1559.70
Reserved males (#; b)	852.06
Total males for a breeding flock (#; a+b)	2796.96
Sex error (%)	0.18
Male to female ratio	1:9.00
a. Mortality during brooding (%; 0-6 weeks)	2.97
b. Mortality during brooding (%; 7-24 weeks)	4.99
c. Mortality during brooding	5.81
(%; 25th week till disposal) Total mortality (%; a+b+c)	13.77
Age at point-of-lay (days)	164.67
Age at peak-of-lay (days)	232.83
Peak percent lay	83.09
Percent hen-day egg production	59.67
Hen-day egg production (#)	103.32
Hen-housed egg production (#)	95.10
Egg laying period (days)	155.46

Mortality at any stage also include culled birds

reared in most parts of the country. Total hens housed represented 14037.32 females and 1559.70 males. Male to female ratio in a flock was 1:9. Farooq *et al.* (2001) also reported similar ratio of males to females in a broiler breeder flock. Reserved male stock was 5.18% (852.06 birds) of the total population. Usually 5% reserved stock is recommended for a breeder flock and any value beyond this limit is considered as sex error meaning additional number of males included in the flock at the time of sexing of day-old chicks. Sex error (0.18%) in the present study was lower than the admissible limit of 1.5% as reported by Farooq *et al.* (2001).

Positive association existed between number of hens housed and percent lay. An average of 4172.21 birds was predicted to be the minimum number of hen-housed (HH) in egg laying houses for better egg production. The positive sign of the second derivative (x$''$) of equation I suggested that further increase in flock size will result an increase in percent lay. However, predicted number of hens to be housed was smaller than the actual number of hens housed in the present study, suggesting reasonable flock size in the area.

Percent lay = 113.961 - 0.8528HH + (0.0001022HH)^2 (I)
(t=4.326)*** (t=-0.385)^{NS} (t=0.295)^{NS}
(Adjusted R^2 = 8.5%;),   (NS = Non-significant)
*** = Highly significant),   x$'$ = 4172.21 birds
x$''$ = 0.0002044

Mortality: Number of birds died or culled from a flock during growth and production periods was considered as mortality in breeder flocks, therefore mortality calculated and presented here also include culls. Average mortality during 323.46 days of growth and

production period in broiler breeders in Abbotabad was 13.77% (Table 1). Total mortality represented 2.97, 4.99 and 5.81% mortality during brooding, growing and laying periods, respectively in broiler breeders. Mortality in the present study was higher than that reported (8.81%) by Farooq *et al.* (2001) and admissible level of mortality worked out by North (1984) for profitable egg production. The higher mortality rate in the present study could probably be due to rigorous culling as a result of smaller egg and chick price in the market during the year 2002. Day-old chick price during the year 2002 was so low that it was not even compensating cost of production per egg, therefore, hatchery owners decided to discard 30% eggs for obtaining desirable market price of day-old chick (Personal communication; Dr. Gul Raiz; SB Poultry Breeder).

Predicted optimal value of Percent mortality (PM) for better percent lay was 13.11%. The negative sign of second derivative (x$''$) of the equation II indicated that mortality above this level will result in poor lay.

Percent lay = 55.990 + 0.459PM - 0.0175PM^2 (II)
          (t=11.832)^{NS} (t=0.763)^{NS} (t=-0.691)^{NS}
(Adjusted R^2 = 6.3%),   (^{NS} = Non-significant
*** = Highly significant   ** = Relatively significant)
x$'$ = 13.11%,   x$''$ = -0.035

Age at point-of-lay and age at peak-of-lay: Average age at point-of-lay was 164.67 days whereas age at peak-of-lay was 232.83 days (Table 1). North (1984) also reported similar age at point and peak-of-lay in broiler breeders. The similarity in ages at point and peak-of-lay could probably be due to more or less uniform management practices and genetic make-up of the breeders.

Table 2: Pearson's correlations between various traits

	2	3	4	5	6	7	8	9	10
1	0.994	-0.074	-0.067	0.000	-0.052	-0.425	0.303	0.184	-0.147
	0.000	0.730	0.756	0.999	0.810	0.043	0.150	0.390	0.494
2	-	-0.064	-0.074	-0.091	-0.072	-0.443	0.288	0.189	-0.138
		0.766	0.732	0.674	0.738	0.034	0.172	0.375	0.520
3		-	0.986	0.224	0.324	0.169	0.242	0.584	0.960
			0.000	0.292	0.122	0.442	0.254	0.003	0.000
4			-	0.369	0.345	0.184	0.273	0.574	0.950
				0.076	0.098	0.400	0.197	0.003	0.000
5				-	0.256	0.224	0.134	0.085	0.255
					0.227	0.304	0.532	0.695	0.228
6					-	0.556	0.345	0.147	0.299
						0.006	0.099	0.492	0.156
7						-	-0.339	-0.176	0.236
							0.114	0.422	0.278
8							-	0.575	0.074
								0.003	0.730
9								-	0.459
									0.024

1. Flock size
2. Hens housed
3. Hen-housed egg production
4. Hen-day egg production
5. Percent mortality
6. Age at point-of-lay
7. Age at peak-of-lay
8. Peak percent lay
9. % hen-day egg production
10. Egg laying period

As shown in Table 2, age at point-of-lay (r=0.227) and age at peak-of-lay (r=0.333) were found positively but non-significantly correlated with total mortality in a flock suggesting an increase in both aforementioned traits with increase in mortality rate. Flocks with higher mortality may be under more stressful conditions leading to a delay in sexual maturity. On the other hand flock size was found negatively correlated with age at point (r=-0.052) and age at peak-of lay (r=-0.415; p<0.04; Table 2), suggesting a reduction in age at sexual maturity and age at peak of lay. Probably farmers maintaining larger flock sizes would have gone for better management practices than farmers maintaining a smaller flock size.

Optimal level of age at point-of-lay (APL) for higher percent lay was found to be 164.36 days. The negative sign of the second derivative (x'') of equation III suggested that any delay in age at point of lay beyond this limit will result a drastic decrease in percent lay.

Percent lay = -4545.077 +65.210APL - 0.171APL^2 (III)
$\quad$ (t=-2.894)*** (t=2.924) *** (t=-2.914)***
(Adjusted R^2 = 23.7%), $\quad$ (*** = Highly significant)
x' = 164.36 days, $\quad$ x '' = -0.342

Optimum level of age at peak of lay (AAPL) for higher percent lay was 35.33 weeks, suggesting that any delay in age at peak of lay beyond this limit will result a drastic decrease in total percent lay as was evident from the negative sign of the second derivative $(x''$; equation IV).

Percent lay = 238.656 + 10.175AAPL - 0.144APPLsq (IV)
$\quad$ (t=1.025)^{NS} (t=0.737) ^{NS} (t=-0.730)^{NS}
(Adjusted R^2 = 2.9%), $\quad$ (^{NS} = Non-significant)
x' = 35.33 weeks, $\quad$ x'' = -0.288

Egg laying period: Average egg laying period among broiler breeders in Abbotabad and Mansehra districts

was 155.46 days. Egg laying period was found negatively but non-significantly correlated with flock size (r=-0.147) and positively correlated with total mortality in a flock (r=0.255; Table 2). Average egg laying period in the present study was lower than that reported by North (1984) who reported almost 364 days of egg laying period in the broiler breeders. The smaller egg laying period in the present study is attributable to unstable market price of chicks and eggs. The farmers thus, would have tried to reduce egg laying period in order to get a new flock in egg production soon.

Beside other egg traits, egg laying period up to a greater extent depends on prevalent market price of day-old chick. When the price of day-old chick is not attractive in the market and or not compensating cost of production, the farmers usually cull the flock or follow molting. Thus, keeping in view such constraints, egg laying period was optimized using percent lay and hen-day egg production as response variables. However, prevalent market price of hatchable eggs or day-old chick and cost of production should be given priority for making any decision on egg laying period. Keeping prevalent market price of day-old chick aside egg laying period (ELP) was optimized taking one by one percent lay (equation V) and hen-day egg production as response variables (equation VI). Minimum level of egg laying period for better percent lay 196.40 days. The positive sign of second derivative (x'') of the equation V suggested that the predicted egg laying period was the break even point and egg laying period shouldn't be less than 196.40 day in any case for better lay. Any egg laying period this limit would be more productive provided prevalent market price of day-old chick is attractive for the farmers.

Percent lay =33.614 + 0.295ELP + 0.0007510ELP^2 (V)
$\quad$ (t=5.807)*** (t=4.192)*** (t=3.691)***

(Adjusted R^2 = 47.6%), (*** = Highly significant)
x' = 196.40 days (28.06 weeks), x'' = 0.001502
Maximum level of egg laying period (ELP) for higher hen-day egg production was found to be 65.54 week. North (1984) also reported similar egg laying period for higher hen-day egg production in broiler breeders. The negative sign of the second derivative (x'') of equation VI suggested that the predicted level was the maximum point for egg laying period and any increase beyond this level will result in poor hen-day egg production.
Hen-day egg production =
-33.388   +   7.551ELP   -   0.05761ELP^2 (VI)
(t=-1.638)^{NS} (t=4.354)***   (t=-1.641)^{NS}
(Adjusted R^2 = 90.5%), (*** = Highly significant;
^{NS} =Non-significant), x' = 65.54 weeks, x'' = 0.11522

Peak percent lay and percent lay: Average peak percent lay and percent lay in broiler breeders in Abbotabad and Mansehra districts was 83.09 and 59.67%, respectively (Table 1). North (1984) reported a higher rate of lay in broiler breeders than the present findings. The smaller percent hen-day production in the present study could be due to poor management conditions.
Percent lay was found non-significantly and positively correlated with flock size (r=0.184) and mortality (=0.085; Table 2). Similar findings were observed for peak percent lay. The findings suggested an increase in percent hen-day egg production with increase in flock size and mortality. Infect mortality included culled birds and rigorous culling for better productivity would have ensured higher egg production.
Minimum level of percent lay (PL) for higher hen-day egg production was found to be 67.64%. The positive sign of the second derivative (x'') of equation VII suggested that the predicted level was the minimum point for percent and any increase beyond this level will result improvement in hen-day egg production.
Hen-day egg production =
- 922.895   +   30.846PL   +   0.228PL^2 (VII)
(t=-1.118)^{NS} (t=1.068)^{NS} (t=0.905)^{NS}
(Adjusted R^2 = 29.3%),   (^{NS} =Non-significant)
x' = 67.64%,   x'' = 0.456,
Minimum level of peak percent (PPL) for higher hen-day egg production was 79.99%, suggesting that any increase in peak percent lay beyond this limit will result an overall improvement in hen-day egg production which was also evident from the positive sign of the second derivative (x''; equation VIII).
Hen-day egg production =
- 2614.907   +   63.034PPL   +   0.394PPL^2 (VIII)
(t=-1.090)^{NS} (t=1.084)^{NS} (t=1.120)^{NS}
(Adjusted R^2 = 4.49%),   (*** = Highly significant;
^{NS} =Non-significant),   x' = 79.99%,   x'' = 0.788

Hen-day and hen-housed egg production: Number of eggs produced by a breeder was calculated on the basis of hen-day and hen-housed egg production. Average hen-day and hen-housed egg production was 103.32 and 95.10 eggs, respectively (Table 1). North

(1984) reported higher hen-day and hen-housed egg production than the present findings. The smaller hen-day and hen-housed egg production in the present study is attributable to smaller egg laying period.
As depicted in Table 2, hen-day (r=-0.067) and hen-housed egg production (r=-0.074) was found negatively and non-significantly correlated with flock size, suggesting that increase in flock size will result a decrease in hen-day and hen-housed egg production.

Conclusions and Recommendations: Percent hen-day egg production, peak percent lay, egg laying period and hen-day and hen-housed egg production was lower than that reported in the literature. Standard limits for minimum number of hens to be housed, maximum level of mortality, maximum age at point of lay, maximum age at peak of lay, minimum peak percent lay, minimum percent lay, egg laying period in response to percent lay and egg laying period in response to hen-day production were 4172.21 birds, 13.11%, 164.36 days, 35.33 weeks, 79.99, 67.64%, 28.06 weeks and 65.54 weeks, respectively. Efforts shall be made to maintain a maximum egg laying period in future. The standard limits mentioned for various traits shall be achieved in order to make broiler breeder farming more profitable and ensure maximum productivity.

References
Asghar, A., M. Farooq, M. A. Mian, Perveez and A. Khurshid, 2000. Economics of broiler production in Mardan Division. J. Rural Development and Administration, Vol. XXXII: 56-64.
Farooq, M., M. A. Mian, S. Faisal, F. R. Durrani, M. Arshad and A. Khurshid, 2001. Status of broiler breeder stocks in Abbotabad and Mansehra. Sarhad J. Agri., 17: 489-495.
Farooq, M., Zahoor-ul-Haq, M. A. Mian, F. R. Durrani and M. Syed, 2003. Cost of production, gross return and net profit in commercial egg production. Pak. J. Vet. Sci., 23: 41-47.
North, M. O., 1984. Breeder Management. In Commercial Chicken Production Manual. The Avi. Publishing Company. Inc. Westport, Connecticut. 240-243, 298-321 pp.
Wonnacott, R. J. and T. H. Wonnacott, 1985. Introductory statistics. 4th Ed. John Wiley and Sons, New York, pp: 424-450.
Zahir-Uddin, M. Farooq, F. R. Durrani, N. Chand and J. Ahmed, 2001. Status of broilers produced in Swat, Pakistan. Livestock Research for Rural Development (13)3: http: / /www. cipav. org. co/ lrrd/ lrrd13/3/zahi133.htm