Performance of Floor Reared White Leghorn Layer on Different Stocking Density and Feed Restriction Regimes

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Abstract: Increase in feed prices in recent years has stimulated renewed interest in the area of feed restriction and simultaneously the birds have to provide space for feeding, watering and normal movements for their optimum growth and production. Thus, a great emphasis has been laid on feeding system, which employs the use of quantitative or qualitative feed restriction. During growing phase 468 White Leghorn (WLH) birds from random bred control population housed on deep litter housing system were exposed to three feeding regimes viz. T1 (ad lib.), T2 (Skip-two-days a week) and T3 (75% of ad lib.) on three different stocking densities viz. S1 (2.5 ft²/bird; 20 birds/pen), S2 (2.0 ft²/bird; 25 birds/pen) and S3 (1.5 ft²/bird; 33 birds/pen) to form nine combinations of feed regimes and stocking density. Between 20 to 32 weeks of age, T1, T2 and T3 birds gained 31.76, 45.19 and 70.82 percent of body weight. The T1×S1 birds were heavier (1904.5±39.9 g) than other groups at the end of laying phase. The maximum feed consumed by T1 group (117.91±4.17 g) followed by T2 (116.61±3.80 g) and T3 group (108.28±3.61 g), which differed significantly. T1×S1 birds consumed daily about 102 g feed and was significantly lower from other interaction groups. The birds kept under T1×S1 treatment gave maximum hen day egg production (64.36±6.78%) followed by T1×S2 (63.83±0.28%) and T1×S3 (61.71±4.84%). Hen housed egg production followed almost the same pattern with hen day egg production. Skip-two-days a week and 1.5-ft²/bird treatment (T3×S2) produced eggs of 54.52±1.24 g weights, which were acceptable in market. It appears that skip-two-days fed birds reared on the density of 1.5 ft²/bird to be the most promising interaction group with respect to lower feed consumption during the laying period.

Key words: Body weight, feed intake, egg production, layer, stocking density

Introduction
The birds have to provide space for feeding, watering and normal movements for their optimum growth and production. Several management factors influence the early growth and livability of chicken. The stocking density and feeding management during laying phase of the birds are two important factors for optimum body weight, feed consumption, egg production and egg weight of the birds during laying phase. Of these, adequate stocking density was considered the most important one, being observed for the present study.

Materials and Methods
Anand is located at latitude of 22.35° N and 72.55° E. Nineteen weeks old 468 pullets of random bred control population of eight strains of White leghorn (WLH) were used as experimental birds. These birds were exposed to feeding treatments viz. T1 (ad lib), T2 (Skip-two-days a week) and T3 (75% of ad lib) during growing phase. During laying phase, birds were randomly distributed in three stocking density treatments viz. S1 (2.5 ft²/bird; 20 birds/pen), S2 (2.0 ft²/bird; 25 birds/pen) and S3 (1.5 ft²/bird; 33 birds/pen) on deep litter system in 2 replications of each treatment embarrassing 156 birds in each replication. The laying birds were given ration (18.30% CP and 2658 kcal/kg of feed ME) comprised of maize-50%, rice polish-11%, deoiled rice bran-04%, ground nut cake-18%, fish meal-07%, shell grit-06%, molasses-2%, mineral mixture-2% and vitamin preparation-100 g. The birds were maintained under similar managerial condition. A standard schedule was followed in carrying out routine farm operations. The blood samples were collected at 40th and 72nd week for the estimation of total serum protein (Lowery et al., 1951) and total cholesterol (Schoenheimer and Sperry, 1934) from 6 birds per replication. The data of body weight were analyzed by completely randomized design where as data of feed consumption and egg production were analyzed by two factorial completely randomized designs.

Results and Discussion
Body weight: At the end of growing period (20 wks) there were significant differences (p<0.05) in body weights among T1 (1292.51±9.79 g), T2 (1174. 91±6.19) and T3 (985.74±7.94 g) feeding treatment groups because of 12
and 28% less feed consumption by T2 and T3 birds compared to ad lib fed birds. The body weights during laying phase are depicted in Table 1.

It was observed that between 20 to 32 weeks of age birds on ad lib feeding gained 31.76% body weight only (i.e. percent of body weight at 20 week of age), while it was quite significantly (p<0.01) higher to a level of 45.19% and 70.82% in T2 and T3 birds, respectively. Thus, they compensated their body weight deficit at 32 week of age. Surprisingly, T3 birds showed 1.4 and 2.2 times more growth rate than those of T2 and T1 birds, respectively. Rapid gain in body weight due to higher feed consumption by previously restriction fed birds (Lee and Moss, 1986) resulted into comparable body weight of ad lib in restricted groups in even less than 5 weeks of ad lib feeding period. Similarly, Narahari et al. (1975) also observed non-significant (p>0.05) difference in body weight at 32 weeks in egg type pullets fed with 20 or 30% feed restriction Vs ad lib during growing period while Robbins et al. (1986) in broiler breeders did not observe significant (p<0.05) difference in body weight at 42 week of age in 20 and 30% and 50% feed restriction compared with ad lib feeding. Thus, 25% feed restriction during growing phase seems to be not so severe and at par with body weight at 32 week as well 40 weeks of age. The rate of increase from 40 to 56 weeks was static and small with 0.29% only in T1 birds and while negative for restricted birds in T2 (-1.76%) and T3 (-1.34%). This might be due to phase of higher egg production and less body fat reserve in restricted group in addition to nutritional availability even at ad lib feeding. Balnavé (1984) concluded that the loss of body weight during the period of peak egg production was because the nutrient intake failed to meet the metabolic requirement and it was again more severe in previously restricted birds with less body reserve. Concomitantly, a consistent increase in ambient temperature from 15.31°C at 39 weeks to 34.66°C (peak) at 60 weeks of age (January to May) also contributed substantially to lower feed consumption and in turn lower body weight. The ideal temperature for chicken ranges from 15 to 20°C. Above 25°C there is reduction in feed efficiency (Singh, 1990). Narahari et al. (1975) observed non-significant (p>0.05) difference in body weight at 64 weeks of age between ad. lib. (1700 g) and 80% (1775 g), 70% (1795 g) and even 60% (1660 g) of ad lib fed birds. The average body weight at the end of 20th week was 1152.23±10.21, 1147.99±9.10 and 1145.00±7.99 g on stocking density treatments of S1 (2.5 ft2), S2 (2.0 ft2) and S3 (1.5 ft2), respectively (Table 1). Rapid increase in body weight was observed in all the density groups from 20 weeks through 32 weeks of age. At 32 weeks of age the birds weighed 1696.01±15.29, 1684.29±14.81 and 1702.07±12.82 g for S1, S2 and S3 treatment respectively. This reflected that the birds with lower floor space of 1.5 ft2 per bird grew better (48.54%) in comparison to 2.0 ft2 (46.72%) or 2.5 ft2 (47.19%) floor space per bird. Subsequently, at 40, 56 and 72 weeks of age there was no significant (p>0.01) effect of stocking density on body weights of the birds, indicating the same magnitude of growth rate. However, during 40 to 56 weeks, there was a decline in the rate of body weight gain in all density treatment groups being -0.79; -0.58 and -1.43% for S1, S2 and S3 groups respectively. This was also coincided with decreasing trend in feed consumption as well as an intensive phase of egg production. Non significant (p>0.05) difference in body weight for different stocking density observed in the present finding agrees with the reports of Lee (1989).
The increase in weight gain between 32 to 56 weeks of age due to higher stress adaptation to both feeding and density treatments. This reflecting severe effect of space competition for feeding space (Mench et al., 1986), increased stress and higher corticosterone level in blood (Pesti and Howarth, 1983) or reduced activity (Chand and Razdan, 1976). Reddy et al. (1981) observed more feed consumption (99.75 g) in less densely (2.66 ft²/bird) birds than those of more densely (2.0 ft²/bird) kept birds (97.26 g). The increased feed consumption with increase in stocking density has been observed (Lee, 1989; Chand and Razdan, 1976). However, Koelkebeck and Cain (1984) could not observe this effect ranging from 940 to 3730 cm²/laying bird densities.

Irrespective feeding and density effect, the body weights of birds at different ages. Days a week fed birds reared on larger floor space of 2.5 ft²/bird (T ×S) had significantly (p<0.01) higher (120.20±3.99) than birds on S ad lib feeding system during laying phase in ad lib fed birds than birds on 70% ad lib feeding during growing phase. But Lee et al. (1971) could not observe significant differences in feed intake from 20-60 weeks of age between 10 or 30% feed restricted and ad lib fed birds during growing phase. However, Johnson et al. (1984) observed significantly more feed consumption during laying phase in skip-two-days a week fed birds than 70% ad lib fed birds relating to higher egg production.

The average daily feed consumption g/bird/day during the laying phase by S birds (2.5 ft²/bird) was significantly (p<0.01) higher (120.20±3.99) than birds on S ad lib (111.61±3.80) and skip-two-days birds (108.28±3.61). There were significant (p<0.01) differences between all the treatment groups. Thus, compared to skip-two-days a week, 75% ad lib fed birds during growing phase were fully adjusted to ad lib feeding system during laying phase. The feed consumption increased recorded between 20-22 to 40-42 and then decline upto 70-72 wks of age (Table 1). It is likely that the restricted fed birds have developed an apparent adaptive process for low maintenance requirement or might have improved their feed utilization efficiency per unit body weight gain (Nair et al., 1977). Reddy and Eswaraiah (1988) and Fattori et al. (1991) observed higher feed consumption during laying phase in ad lib fed birds than birds on 70% ad lib feeding during growing phase. But Lee et al. (1971) could not observe significant differences in feed intake from 20-60 weeks of age between 10 or 30% feed restricted and ad lib fed birds during growing phase. However, Johnson et al. (1984) observed significantly more feed consumption during laying phase in skip-two-days a week fed birds than 70% ad lib fed birds relating to higher egg production.

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Hen-day egg production (%): Razdan (1976) observed nonsignificant (p>0.05) differences in hen-day production (%) from 20 to 72 weeks of age was cm floor space per bird. While, Mohan feed consumption at high environmental temperature not differ significantly from both the space treatment (34.75°C) at 60 weeks of age of the birds. The lowest be advantageous whereas birds on 1.5 ft/bird also did effect of higher ambient temperature that was peaked (60.76±2.01%) showing that more space did not turn to lowest at 60 weeks of age (82.53±1.90), pointing the birds on 2.5 ft/bird space gave only 221.15±7.31g a rapid decline in feed consumption was observed to the production of 222.04±5.04 (61.00±1.39%) eggs. While Fig. 2: Average feed consumption (g/bird/d) Lee (1987) observed higher egg production in restricted 61.75±1.86, 59.11±0.77 and 60.55±1.23 percent for T , observed significantly (p<0.01) higher egg production percent days and 75 percent ad lib fed birds at 2.5-ft/bird floor space were at par for feed consumption and significantly lower (p<0.05) than other interaction groups (Table 2). There was a sharp linearly increase in feed consumption observed between 20 to 22 weeks of age (72.87±1.91 g) to a peak observed between 38 to 40 weeks of age (141.13±2.58 g) resulted into 56% rapid increase in body weight from 20 (1149 g) to 40 (1788 g) weeks of age. This was also coupled with decrease in environmental temperature (August to December) from 28°C at 22 weeks to 20.8°C at 36 weeks of age. After 40 weeks of age, there was little variation in feed consumption up to about 50 weeks of age. But, thereafter a rapid decline in feed consumption was observed to the lowest at 60 weeks of age (82.53±1.90), pointing the effect of higher ambient temperature that was peaked (34.75°C) at 60 weeks of age of the birds. The lowest feed consumption at high environmental temperature with period effect was also recorded by Chand and Razdan (1976) to balance heat.

**Hen-day egg production (%):** The hen day egg production (%) from 20 to 72 weeks of age was 61.75±1.86, 59.11±0.77 and 60.55±1.23 percent for T , T and T birds, respectively. Correspondingly, the total egg production number was 224.77±6.76, 215.17±2.81 and 220.40±4.48, respectively. However, the treatment groups have non significant (p>0.05) difference (Table 1). Initially during 4 weeks of laying, ad lib fed birds had significantly (p<0.01) higher hen-day egg production (30.03±6.10%) by 2.7 times more than skip-two-days fed birds (70 or 80% of ad lib) respectively and resulted into non-significant (p>0.05) differences. The higher egg production by 75 percent ad lib fed birds over ad lib fed birds continued until the end of laying phase lead to non-significant (p>0.05) differences in egg production. All the treatment groups showed peak production during 32-36 weeks of age producing maximum eggs by T birds (82.64±1.74%) followed by T (82.03±1.51%) and T (81.82±0.95%) birds. The trend of decline in egg production was practically the same in three feeding treatment birds. Lee (1987) observed higher egg production in restricted 61.75±1.86, 59.11±0.77 and 60.55±1.23 percent for T , observed significantly (p<0.01) higher egg production 74.61±1.03) and 9.33% (T ) fed birds over ad lib fed birds continued until the end of laying phase lead to non-significant (p>0.05) differences. The higher egg production by 75 percent ad lib fed birds over ad lib fed birds continued until the end of laying phase lead to non-significant (p>0.05) differences in egg production. All the treatment groups showed peak production during 32-36 weeks of age producing maximum eggs by T birds (82.64±1.74%) followed by T (82.03±1.51%) and T (81.82±0.95%) birds. The trend of decline in egg production was practically the same in three feeding treatment birds. Lee (1987) observed higher egg production in restricted fed birds (70 or 80% of ad lib) than those of control birds on account of maturation of oviducts and greater rate of follicular growth, possibly caused by altered gonadotropin output. While non significant (p>0.05) feeding effect on hen-day egg production between 70 percent ad lib (74.1%), skip-two-days (65.5%) and control (70.7%) birds were recorded by Lee (1987). However, egg production in skip-two-days group and 70 percent ad lib fed birds were lower than control birds. Similarly, Nair et al. (1977), Lee (1987) and Reddy and Eswaraiah (1988) also failed to observe significant difference (p<0.01) in egg production between ad lib and restricted fed egg-type or broiler breeder birds ranging from 70 to 90 percent of ad lib feeding. The birds on 2.0 ft/bird space had maximum egg production of 222.04±5.04 (61.00±1.39%) eggs. While birds on 2.5 ft/bird space gave only 221.15±7.31egg (60.76±2.01%) showing that more space did not turn to be advantageous where as birds on 1.5 ft/bird also did not differ significantly from both the space treatments and gave 217.5±1.15 eggs (59.66±0.31%). Lee (1989) observed nonsignificant (p>0.05) differences in hen-day egg production by keeping the birds in stocking densities ranging from 1 ft (929 cm) to 4.3 ft (4000 cm) floor space per bird. While, Mohan et al. (1991) observed significantly (p<0.01) higher egg production with the birds provided with higher floor space of 2.0-2.5 ft/bird (82.34%) than the birds provided with the lower floor space of either 1.75-2.00 ft/bird (79.68%) or 1.50-1.75 ft/bird (77.39%). It is interesting to note that during 56-60 weeks of age, which was coincided with the hottest period of the season (May, 32.53°C), the birds provided with medium space of 2.0 ft/bird were more comfortable and produced maximum egg (54.66%) which was 7.05 and 6.34 percent higher than the birds provided with space of 2.5 or 1.5 ft/bird (48.32%) respectively. Reddy et al. (1981) observed higher egg production in the birds kept at the space of 2.0 ft/bird (76.53%) than less densely kept birds at 2.66 ft/bird (76.01%). Seventy five percent ad lib fed birds with lowest density of (2.5 ft/bird) gave comfort and resulted into maximum hen-day egg production (64.36±6.78%) in spite of stresses of higher body weight (1670 to 1780 g), higher...
Fig. 3: Percent hen day egg production

metabolism and increase in ambient temperature from 15.31 to 31.09°C. While the same feeding group at 2 ft²/bird space (59.67±6.06%) and 1.5 ft²/bird space (59.15±5.94%) gave significantly lower than that with space of 2.5 ft² (61.71±4.84%) and 2.0 ft² (63.83±0.28%) per bird (Table 1). The hen-day egg production during the laying cycle (20 to 72 weeks) was 60.47±0.78 percent. However, during 20-24 weeks of age, hen-day egg production was 14.40±4.61 percent. It rapidly and significantly increased during 24-28 weeks (53.12±4.71%) and attained peak production during 32-36 weeks (82.16±0.81%). Subsequently, the egg production declined marginally and non-significantly until 44-48 weeks of age (76.27±1.53%). But it turned to significant decline from 48-52 weeks (69.72±0.96%) up to 56-60 weeks (50.19±2.33%). From 60 weeks egg production remained almost constant up to 72 weeks of age ranging from 45.5 to 51.06 percent. The higher ambient temperature (34.75°C) during May adversely affected the egg production during 60-64 weeks (45.49±2.07).

Hen housed egg production: The hen-housed production was maximum for ad lib fed birds (58.48±2.43%) followed by 25% restriction (55.42±1.83%) and 11 percent restriction birds (54.32±1.62%). This corresponded with the higher liveability percent during the laying period of T₁ birds (89.28%) followed by T₂ (84.93%) and T₃ (84.81%) birds (Table 1). There were significant differences between the treatment groups during 20-28 weeks of age while 28-32 weeks there were at par between ad lib and skip two days. After 32-36 weeks, there were no significant differences between the treatment groups up to the end of laying period at 72 weeks. Fattori et al. (1991) did not observe significant difference in mean hen-housed egg production between lower restriction of 8 percent (60.00%) and higher restriction of 24 percent (59.8%) or the standard treatment (59.8%). During 32-36 weeks, S₁ birds had the highest hen-housed egg production (78.57±1.61%) followed by S₂ (77.16±2.04%) and S₃ (76.91±1.54%) birds. However, the differences were nonsignificant (p>0.05). Unlike hen-day production, S₁ birds had the highest pooled period mean (20-72 weeks) hen-housed egg production (57.04±2.78%) followed by S₂ (56.46±1.93%) and S₃ (54.72±1.29%) birds. This was a result of highest liveability of the S₁ birds (87.50%) followed by S₂ (86.67%) and S₃ (84.85%) birds. In agreement with the present finding, Reddy et al. (1981) observed higher hen-housed egg production in the birds kept in 2.66 ft²/bird (75.64%) than the birds kept in density of 2.00 ft²/bird (74.26%).

The pooled mean (20-72 weeks) T₁×S₁ (60.04±4.78%), T₁×S₂ (59.73±3.60%) and T₁×S₃ (58.74±6.21%) birds were the better producers after reaching peak production (Table 2), but T₂×S₃ ranked third position as the birds can not compensate their lower egg production during the early phase lay. T₁×S₃ birds had lowest egg production (51.11±5.39%). During the early phase of lay (20-36 weeks) ad lib fed birds (T₁) with significantly higher body weight than the restricted groups produced maximum egg either at the density of 2.0 or 2.5 ft²/bird. But from 36 weeks onwards to 68 weeks i.e., after reaching peak production, in almost all the laying periods 75 percent ad lib either at 2.5 ft²/bird or 2.0 ft²/bird space performed best and T₂×S₃ birds ranked third.

The pattern of period effect on hen-housed egg production was the same as hen-day egg production but the values were at a lower side by about 7 percent. This difference was due to the difference in mortality at different periods.

Conclusion: The birds compensated their body weight deficit of growing phase during 20-32 weeks of age resulted in to non significant effect of either feed or density on body weight at the end of laying period. It appears that skip-two-days fed birds reared at the density of 1.5 ft²/bird to be the most promising interaction group with respect to lower feed consumption during the laying period without any significant adverse effect on hen housed egg production.

References

Balnave, D., 1984. The influence of body weight deficit of growing phase during 20-32 weeks of age resulted in to non significant effect of either feed or density on body weight at the end of laying period. It appears that skip-two-days fed birds reared at the density of 1.5 ft²/bird to be the most promising interaction group with respect to lower feed consumption during the laying period without any significant adverse effect on hen housed egg production.

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