

## PRODUCTION PERFORMANCE OF ASEEL CHICKEN UNDER FREE RANGE, SEMI-INTENSIVE AND CONFINEMENT REARING SYSTEMS

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### ABSTRACT

An experiment was conducted to investigate the effects of 3 different rearing systems [free range (FR), semi-intensive (SI), and confinement (CF)] on productive production performance in 4 varieties of Aseel chicken [Lakha (LK), Mushki (MS), Peshawari (PW), and Sindhi (SN)]. A total of 168 adult hens were assigned to 12 treatment groups, 3 (rearing systems) × 4 (Aseel varieties) factorial arrangement in 7 randomized complete blocks, replicated 14 times with individual hen in each (42 hens from each variety; 56 hens in each rearing system). Data regarding body weight (BW), body weight gain (BWG), uniformity (UF), and livability (LB) were collected fortnightly whereas egg production (EP), egg weight (EW), and egg mass (EM) were recorded on daily basis. The data were analyzed by a two-way ANOVA technique under factorial arrangement. The results manifested the highest ( $P < 0.05$ ) BW ( $2419.11 \pm 30.23$ ), EP ( $35.90 \pm 0.56$ ), EM ( $202.08 \pm 3.66$ ), and LB ( $98.81 \pm 0.93$ ) in CF whereas BWG was found to be the highest in SI ( $729.82 \pm 30.06$ ) system. Among different Aseel varieties, SN hens demonstrated enhanced BW ( $2433.81 \pm 30.46$ ), UF ( $87.50 \pm 5.59$ ), EW ( $46.60 \pm 0.40$ ), EM ( $208.96 \pm 3.20$ ), and better EP ( $35.91 \pm 0.50$ ) than MS and LK whereas PW revealed the highest EP ( $36.04 \pm 0.97$ ) with better UF ( $79.17 \pm 7.68$ ) than MS. Interaction of rearing systems and Aseel varieties showed differences ( $P < 0.05$ ) among means except LB ( $P > 0.05$ ), portraying enhanced BWG in LK ( $768.57 \pm 63.63$ ); improved EP in PW ( $38.00 \pm 1.94$ ); better EW ( $46.80 \pm 0.75$ ), EM ( $214.12 \pm 4.52$ ) in SN under SI whereas only SN showed the highest BW under CF ( $2566.43 \pm 53.20$ ) and maximum UF under FR ( $100.00 \pm 0$ ).

**Key words:** Aseel varieties, Rearing systems, Production performance.

### INTRODUCTION

Globally over the last many years there is a growing public concern about the welfare of animals. Keeping in view, the international regulations have been established to ban or restrict the use of conventional systems and greater use of free range (FR) or enriched cage systems is in vogue (Berg, 2002; American Veterinary Medical Association, 2010; Lay *et al.*, 2011). European Union banned the use of conventional battery cage system in 2012 and alternatively, new enriched colony cages or FR production systems were introduced (Leinonen *et al.*, 2014).

In FR area, there is availability of various feed items such as grasses, legumes, beans, insects, earthworms and grit stones, which not only improve the nutrition of laying hens but also lower the cost of feed (Mattocks, 2002; Anand *et al.*, 2008; Blair, 2008; Lay *et al.*, 2011), sustaining egg production (EP). Additionally, birds under free-range or organic systems have complete freedom for scavenging, feed selection and other similar activities that improve their welfare (Ponte *et al.*, 2008) as well as help in expression of their natural behavior, which otherwise seems impossible in total confinement (CF) or poultry house (Zelnter and Maurer, 2009). In commercial poultry production, fully formulated diet is

usually used whereas under FR, birds fulfill their nutritional requirements from forage which reduces the overall cost of production (Fanatico *et al.*, 2013).

The increasing demand for non-commercially produced poultry products is the reflection of growing inclination of people towards production of indigenous poultry (Blackburn, 2006). Likewise, in Pakistan, FR poultry production is gradually gaining popularity for the production of safe and antibiotic free organic food. Keeping in view the rising demand of FR eggs and meat, small scale poultry farmers with open sided houses can fully capitalize market potential by producing FR organic poultry using indigenous breeds (Iqbal *et al.*, 2012).

Indigenous chicken has attained great attention world-wide due to its better immunity and adaptability to the local climatic conditions (Khan, 2015). Aseel is recognized as one of the major indigenous poultry breeds found in Indo-Pak subcontinent and mainly used either in cock fighting or as backyard poultry in rural areas (Khan, 2004). Efforts for the conservation and further improvement of Aseel chicken are still in progress for the revival of rural poultry farming system (Haunshi *et al.*, 2013). Aseel is characterized by its aggressive behavior, upright posture, small wattles, pea comb, prominent shoulders, narrow sternum and hard muscular thighs with strong legs (Dohner, 2001). On the basis of its hardiness and adaptability to the local inclement conditions, Aseel

can be used for FR poultry production. Hence, present study was planned with the objective to determine the effect of 3 rearing systems [FR, semi-intensive (SI), and CF] on production performance in 4 varieties of Aseel chicken [Lakha (LK), Mushki (MS), Peshawari (PW), and Sindhi (SN)].

## MATERIALS AND METHODS

**Experimental site:** The present experiment was conducted at Indigenous Chicken Genetic Resource Centre (ICGRC), Department of Poultry Production, University of Veterinary and Animal Sciences (UVAS), Lahore. The effects of 3 rearing systems on production performance in 4 varieties of indigenous Aseel chicken were investigated for the duration of 16 wk (31-46 wk) during the months of August to November 2015. Experimental procedures were in compliance with the guidelines and code of practice of UVAS, Lahore and ethical approval was granted before the conduct of the experiment.

**Experimental birds:** In total, 168 adult hens (30-wk-old), from 4 varieties of indigenous Aseel chicken (42 hens/variety), reared at ICGRC, were randomly allotted to 12 treatment groups, in a 3 (rearing systems)  $\times$  4 (Aseel chicken varieties) factorial arrangement in 7 randomized complete blocks, replicated 14 times with one hen in each replicate (56 hens/rearing system; 14 hens/treatment group; 168 total replicates).

**Management of experimental birds and rearing systems:** Experimental birds were maintained in an independent open-sided laying house with North to South dimension measuring 6.10  $\times$  6.10 m (37.21 m<sup>2</sup>), laced with 2 rows of 3-tiered laying cages measuring 5.18  $\times$  1.52 m (47.24 m<sup>2</sup>, 2.37 birds/m<sup>2</sup>) with sloping wire floor to facilitate egg collection. The removable dropping trays were fitted under the mesh floor for the removal of fecal material. Hens were kept separately in different cage units (0.49  $\times$  0.72  $\times$  0.46 m) to get the individual record of each hen regarding production performance. Feeding of the hens was done through removable individual trough feeders installed outside the cage units and watering through the automatic nipple drinking system fitted therein. Photoperiod of 16L:8D was maintained until the end of the experimental period. Light intensity in open-sided laying house and under the FR trees remained similar with negligible fluctuations.

Free range area of 32.5 m  $\times$  16.5 m (536 m<sup>2</sup>), with stocking density of 0.21 birds/m<sup>2</sup> for FR and SI rearing systems, was located adjacent to the open-sided laying house and covered with the shady trees. Throughout the experiment, the average daily indoor and outdoor temperature (25°C, range 19 to 31°C) and RH (45 to 60%) were similar with minimum fluctuation among the rearing systems. Same prophylactic and

hygienic protocols were followed in all the rearing systems. Free range area was enriched with seasonal fodders (legumes, beans, lentils, peas, grasses, herbs and shrubs). Replication in FR was done with the help of fish-net and installed bamboos. Water pans with 3-L capacity and individual nest box units were placed outdoor in each replicate. The hen in each replicate was tagged to get separate record for production performance. To protect the experimental birds from FR predators, location was covered with 2.44 m high wire mesh fencing.

Birds under CF rearing system spent 24 h in laying cages with 100% allowance of broiler breeder layer ration (0600 h), following the nutrient requirements of parent stocks. The breeder ration was formulated according to the recommendations of National Research Council (1994) and Leeson and Summers (2005), with 2,906 kcal/kg ME, 16.00% CP, 2.81% calcium and 0.36% phosphorus. Birds under SI rearing system were kept for 4 h (0900-1300 h) in FR and for onward 20 h (1300-0900 h) in laying cages with 50% allowance (1800 h) of the same ration. In SI rearing system, the birds were carefully handled and placed in cages gently to avoid stress. However, hens under FR rearing system were given 8 h (0900-1700 h) access to the FR area and initially shepherded (1700 h) to the laying house (stocking density, 1.5 birds/m<sup>2</sup>) for onward 16 h (1700-0900 h) stay on floor, rice husk (20 cm) as bedding material. Nipple drinking system was already installed therein and FR hens were offered 25% feed allowance of same ration (1800 h) in removable trough feeders.

**Data collection:** During the experiment, body weight (BW) was recorded fortnightly whereas egg production (EP) and egg weight (EW) were recorded on daily basis. Body weight gain (BWG), egg mass (EM), uniformity (UF) and livability (LB) were calculated on fortnightly basis. At the end of experiment, UF% was calculated on the basis of  $\pm 10\%$  fluctuation in average body weight within each treatment group and LB% was calculated by recording the mortality daily and reported as a percentage of birds alive in each treatment group. For recording of BW g and EW g, electronic balance with an accuracy of 0.01 g was used, according to the method adopted by Ahmad *et al.* (2014).

**Statistical analysis:** Prior to analysis, uniformity of the data was examined for all parameters and validated for the normality. The collected data were subjected to the two-way Analysis of Variance (ANOVA) technique as a randomized complete block design, with rearing systems and Aseel varieties as main effects, using the GLM procedure under factorial arrangement (SAS, 2002-03). The interaction of rearing systems and Aseel varieties was also verified. Comparison among treatment means were made through Duncan's Multiple Range test (SAS, 2002-03). An individual hen was considered as

experimental unit and variations among treatment means were considered to be significant at  $P < 0.05$ .

## RESULTS AND DISCUSSION

**Body weight (g):** Overall means demonstrated significant difference ( $P < 0.05$ ; Table 1) in BW with respect to different rearing systems, Aseel varieties, and their interaction. Birds kept under CF and SI rearing systems exhibited enhanced BW ( $2419.11 \pm 30.23$ ) and ( $2388.39 \pm 27.20$ ), respectively than those reared under FR ( $2290.46 \pm 25.69$ ). Minimum activity or exercise in CF rearing system might be the factor behind enhanced BW. Body weight, similarly, was also found to be elevated in broiler breeder (Hameed *et al.*, 2012), quails (Akram *et al.*, 2000), cockerels (Olaniyi *et al.*, 2012) and turkeys (Herendy *et al.*, 2004) reared under CF than those under FR. Improved BW of broilers, furthermore, has already been reported in CF rearing system as compared with those reared under FR (Połtowicz and Doktor, 2011). Similarly, it was also observed that FR rearing reduced BWG in birds as compared with the indoor reared ones (Wang *et al.*, 2009).

Among different Aseel varieties, SN hens displayed greater BW ( $2433.81 \pm 30.46$ ) as compared with those of PW ( $2295.95 \pm 31.77$ ), which might be attributed to the SN variety own genetic potential for heavy BW as genetic difference (Bell and Weaver, 2005), frame structure and production traits have already been described to contribute in varying BW (Hurwitz *et al.*, 1998). Variation in BW, in the same way, was reported by some other studies conducted on Aseel showing that BW varies from variety to variety (Ahmad *et al.*, 2014; Khan, 2015) or breed to breed (Thakur *et al.*, 2006). Interaction of rearing systems with varieties depicted maximum BW in birds of SN variety under CF ( $2566.43 \pm 53.20$ ) whereas PW manifested the lowest BW under FR ( $2192.86 \pm 49.00$ ). The synergistic effect of the genetic potential for higher weight of SN and CF rearing system might be the plausible reason behind enhanced BW.

**Body weight gain (g):** Body weight gain differed markedly ( $P < 0.05$ ) with respect to different rearing systems alone and in interaction with Aseel varieties as well. However, Aseel varieties independently could not show any difference in BWG. Birds under SI rearing system indicated improved weight gain ( $729.82 \pm 30.06$ ) as compared with those reared under FR ( $596.17 \pm 25.78$ ).

Comfort, welfare and exercise in SI rearing system as compared with the totally CF might enhance the efficiency of digestive system enabling it to better feed conversion to BWG. Similar results have already been reported reflecting improved BWG in SI system as compared with CF (Santos *et al.*, 2005). In other studies, it was also disclosed that BWG or growth rate of birds

raised in indoor (Wang *et al.*, 2009) as well as under conventional treatments (Castellini *et al.*, 2002) was improved as compared with FR. Interaction of rearing systems with Aseel varieties revealed higher ( $P < 0.05$ ) BWG in LK under SI ( $768.57 \pm 63.63$ ) and the lowest in PW under FR ( $497.14 \pm 44.63$ ).

**Uniformity (%):** Uniformity was found to be varying ( $P < 0.05$ ) in Aseel varieties as well as in their interaction with the rearing systems. However, rearing systems independently exerted no influence ( $P > 0.05$ ) on UF. Similarly, in another study, no difference in UF was traced where pullets were reared under FR and in cages (Golden *et al.*, 2011). Higher UF was reflected by hens of SN ( $87.50 \pm 5.59$ ) and PW ( $79.17 \pm 7.68$ ) than those of MS ( $58.33 \pm 5.27$ ). This variation in UF may be attributed to the difference in genetic make-up of Aseel varieties as in literature it is claimed that UF is influenced by genotype of different breeds, some breeds show higher UF whereas others show lower one (Ahmed, 2015). Interaction of different rearing systems and Aseel varieties yielded variations in UF displaying maximum in SN birds under FR ( $100.00 \pm 0$ ) and minimum in MS under SI ( $50.00 \pm 0$ ) rearing system.

**Egg production (%):** Overall means revealed difference ( $P < 0.05$ ) in EP with respect to rearing systems, Aseel varieties, and their interaction as well. Improved EP was observed in birds reared under both CF ( $35.90 \pm 0.56$ ) and SI ( $34.65 \pm 0.77$ ) rearing systems than those reared under FR ( $31.43 \pm 0.66$ ). This may be attributed to the balanced diet with better intake in both systems as compared with FR where the birds were on natural scavenging with 25% feed allowance only. Corroborating these findings, Krawczyk and Gornowicz (2010) reported better EP in birds under CF than those under FR. Greater EP, similarly, has already been reported in CF system than FR (Pavlovski *et al.*, 1992) establishing the positive relationship between CF or cage system and EP (Voslarova *et al.*, 2006).

Among different varieties, hens of PW ( $36.04 \pm 0.97$ ) and SN ( $35.91 \pm 0.50$ ) varieties showed better EP than those of both MS ( $32.50 \pm 0.75$ ) and LK ( $31.54 \pm 0.75$ ). Difference in genotype of all these varieties may be the cause of variation in their EP as disparity in EP due to different genetic make-up (Akhtar *et al.*, 2007) or strains (Hanan, 2010) or breed (Ipek and Sahan, 2004) has been clearly illustrated in earlier studies. In the same way, other studies on Aseel chicken also support the claim of variation in EP (Iqbal *et al.*, 2012) and further describe maximum EP in PW whereas minimum in LK variety of Aseel (Ahmad *et al.*, 2014). Likewise, discrepancy in EP among different Aseel varieties was also claimed in a recent trial on Aseel (Khan, 2015). Interaction of rearing systems with varieties demonstrated maximum EP in PW both under SI ( $38.00 \pm 1.94$ ) and CF

(37.62±1.45) systems and only in SN under SI (36.62±0.65) rearing system.

**Egg weight (g):** Aseel varieties separately and in interaction with different rearing systems showed difference ( $P<0.05$ ) in EW on overall means basis. However, rearing systems alone could not display any influence on EW. Among varieties, hens of SN Aseel produced eggs with the highest EW (46.60±0.40) followed by those of MS (44.64±0.42) and both of LK (43.53±0.38) and PW (43.17±0.35). Potential reason for producing the heaviest eggs might be attributed to the higher BW of respective birds as it is reported that BW and EW are positively correlated (Khan, 2015). It is also believed that EW depends on the breed or strain (El-Fiky *et al.*, 2000; Aboul-Hassan, 2001). Significant ( $P<0.05$ ) difference in EW has already been reported due to the difference in BW or genotype of Aseel hens (Ahmad *et al.*, 2014) and indigenous Desi, Cobb 500, Fayoumi, RIR and Sonali (RIR × Fayoumi) chickens (Islam and Dutta, 2010). A recently conducted study on Aseel varieties also highlighted the variation in their EW (Khan, 2015). Interaction of rearing systems and Aseel varieties demonstrated maximum EW in SN under SI (46.80±0.75) and minimum in LK (42.55±0.50) and PW (42.81±0.51) under FR.

**Egg mass (g):** Significant difference ( $P<0.05$ ) was found in EM with respect to different rearing systems, Aseel varieties and their interaction. Greater EM was produced in birds reared under CF (202.08±3.66) and SI (192.49±4.99) rearing systems as compared with those in FR (173.34±4.42). This elevated EM may be due to more number of eggs produced in CF and SI systems as EM is the product of egg number and EW (Khan, 2015). Greater

EM, similarly, in CF or battery system was also observed in another study (Mostert *et al.*, 1995), which is the clear manifestation of positive correlation between CF/cage system and EM (Voslarova *et al.*, 2006).

Among varieties, EM remained the highest in SN (208.96±3.20) followed by PW (194.66±5.93) and both MS (181.51±4.84) and LK (172.09±5.14). Improved EM in SN may be attributed to its comparatively higher egg number and EW (Yousaf and Ahmad, 2006; Hassan *et al.*, 2008; Aygun and Olgun, 2010). Discrepancy in EM has already been evidenced in a recent conducted study on different Aseel varieties, which indicated enhanced EM in robust Mianwali variety (Khan, 2015). Ahmad *et al.* (2014) conducted an experiment on Aseel and stated variations in EM in different varieties. Interaction of rearing systems and Aseel varieties indicated maximum EM in SN under SI (214.12±4.52) and decreased EM in LK under FR (152.05±4.10).

**Livability (%):** Overall means revealed significant ( $P<0.05$ ) difference in LB with respect to rearing systems whereas non-significant ( $P>0.05$ ) difference with respect to Aseel varieties separately and their interaction with the rearing systems. Livability was found to be greater in CF (98.81±0.93) as compared with FR (95.24±0.80). Disease, predation and injuries due to cannibalism might be the cogent reasons behind the lower level of LB in FR laying hens (Golden *et al.*, 2011; Holt *et al.*, 2011; Elson, 2015). Likewise, a study was conducted to compare FR system with furnished cage system, demonstrated an elevated level of LB in cage system than in FR (Black and Christensen, 2009; Sherwin *et al.*, 2010) portraying cage system a better choice in term of survivability of birds as compared with the FR (Weeks *et al.*, 2012).

**Table 1. Overall productive performance in four varieties of Aseel under FR, SI, and CF rearing systems (31-46 wk).<sup>1</sup>**

| Variables <sup>2</sup>                           |           | BW<br>(g)                    | BWG<br>(g)                  | UF <sup>*</sup><br>(%)     | EP<br>(%)                 | EW<br>(g)                 | EM<br>(g)                  | LB<br>(%)                 |
|--|-----------|------------------------------|-----------------------------|----------------------------|---------------------------|---------------------------|----------------------------|---------------------------|
| <b>Effects</b>                                   |           |                              |                             |                            |                           |                           |                            |                           |
| <b>Rearing systems<sup>3,4</sup></b>             |           |                              |                             |                            |                           |                           |                            |                           |
| <b>FR</b>  |           | 2290.46±25.69 <sup>b</sup>   | 596.17±25.78 <sup>b</sup>   | 78.12±7.38                 | 31.43±0.66 <sup>b</sup>   | 44.04±0.39                | 173.34±4.42 <sup>b</sup>   | 95.24±0.80 <sup>b</sup>   |
| <b>SI</b>  |           | 2388.39±27.20 <sup>a</sup>   | 729.82±30.06 <sup>a</sup>   | 68.75±6.25                 | 34.65±0.77 <sup>a</sup>   | 44.38±0.42                | 192.49±4.99 <sup>a</sup>   | 98.21±0.93 <sup>a,b</sup> |
| <b>CF</b>  |           | 2419.11±30.23 <sup>a</sup>   | 673.14±33.55 <sup>a,b</sup> | 75.00±6.68                 | 35.90±0.56 <sup>a</sup>   | 45.03±0.39                | 202.08±3.66 <sup>a</sup>   | 98.81±0.80 <sup>a</sup>   |
| <b>Varieties<sup>5,6</sup></b>                   |           |                              |                             |                            |                           |                           |                            |                           |
| <b>LK</b>  |           | 2373.19±31.15 <sup>a,b</sup> | 666.28±33.34                | 70.83±7.68 <sup>a,b</sup>  | 31.54±0.75 <sup>b</sup>   | 43.53±0.38 <sup>c</sup>   | 172.09±5.14 <sup>c</sup>   | 96.83±1.25                |
| <b>MS</b>  |           | 2361.00±37.14 <sup>a,b</sup> | 673.14±37.90                | 58.33±5.27 <sup>b</sup>    | 32.50±0.75 <sup>b</sup>   | 44.64±0.42 <sup>b</sup>   | 181.51±4.84 <sup>c</sup>   | 97.62±1.19                |
| <b>PW</b>  |           | 2295.95±31.77 <sup>b</sup>   | 663.47±40.37                | 79.17±7.68 <sup>a</sup>    | 36.04±0.97 <sup>a</sup>   | 43.17±0.35 <sup>c</sup>   | 194.66±5.93 <sup>b</sup>   | 98.41±1.05                |
| <b>SN</b>  |           | 2433.81±30.46 <sup>a</sup>   | 662.61±35.58                | 87.50±5.59 <sup>a</sup>    | 35.91±0.50 <sup>a</sup>   | 46.60±0.40 <sup>a</sup>   | 208.96±3.20 <sup>a</sup>   | 96.03±1.73                |
| <b>Rearing systems × varieties<sup>7,8</sup></b> |           |                              |                             |                            |                           |                           |                            |                           |
| <b>FR</b>  | <b>LK</b> | 2279.57±45.48 <sup>b,c</sup> | 628.14±27.27 <sup>a,b</sup> | 62.50±12.50 <sup>a,b</sup> | 28.62±0.82 <sup>d</sup>   | 42.55±0.50 <sup>d</sup>   | 152.05±4.10 <sup>d</sup>   | 92.86±0                   |
|  | <b>MS</b> | 2349.43±63.49 <sup>b,c</sup> | 638.00±74.33 <sup>a,b</sup> | 62.50±12.50 <sup>a,b</sup> | 29.12±0.61 <sup>d</sup>   | 44.33±0.52 <sup>b-d</sup> | 161.57±4.64 <sup>c,d</sup> | 95.24±2.38                |
|  | <b>PW</b> | 2192.86±49.00 <sup>c</sup>   | 497.14±44.63 <sup>b</sup>   | 87.50±12.50 <sup>a,b</sup> | 32.50±0.86 <sup>b,c</sup> | 42.81±0.51 <sup>d</sup>   | 173.79±4.80 <sup>c</sup>   | 97.62±2.38                |
|  | <b>SN</b> | 2340.00±28.09 <sup>b</sup>   | 621.42±38.71 <sup>a,b</sup> | 100.00±0 <sup>a</sup>      | 35.50±1.23 <sup>a,b</sup> | 46.49±0.77 <sup>a</sup>   | 205.97±7.00 <sup>a</sup>   | 92.86±4.12                |
| <b>SI</b>  | <b>LK</b> | 2405.71±62.53 <sup>b,c</sup> | 768.57±63.63 <sup>a</sup>   | 62.50±12.50 <sup>a,b</sup> | 31.25±1.11 <sup>c,d</sup> | 42.96±0.58 <sup>c,d</sup> | 168.22±7.38 <sup>c,d</sup> | 97.62±2.38                |
|  | <b>MS</b> | 2365.00±84.08 <sup>b</sup>   | 700.71±84.58 <sup>a</sup>   | 50.00±0 <sup>b</sup>       | 32.75±0.86 <sup>b,c</sup> | 44.28±0.81 <sup>b-d</sup> | 181.24±6.02 <sup>b,c</sup> | 100.00±0                  |
|  | <b>PW</b> | 2387.86±34.34 <sup>b</sup>   | 741.42±47.61 <sup>a</sup>   | 87.50±12.50 <sup>a,b</sup> | 38.00±1.94 <sup>a</sup>   | 43.47±0.64 <sup>b-d</sup> | 206.39±11.55 <sup>a</sup>  | 97.62±2.38                |
|  | <b>SN</b> | 2395.00±31.77 <sup>b</sup>   | 708.57±48.02 <sup>a</sup>   | 75.00±0 <sup>a,b</sup>     | 36.62±0.65 <sup>a</sup>   | 46.80±0.75 <sup>a</sup>   | 214.12±4.52 <sup>a</sup>   | 97.62±2.38                |
| <b>CF</b>  | <b>LK</b> | 2434.29±38.33 <sup>a,b</sup> | 602.14±60.46 <sup>a,b</sup> | 87.50±12.50 <sup>a,b</sup> | 34.75±1.01 <sup>a,b</sup> | 45.08±0.59 <sup>a-c</sup> | 196.00±6.96 <sup>a,b</sup> | 100.00±0                  |
|  | <b>MS</b> | 2368.57±51.62 <sup>b</sup>   | 680.71±36.65 <sup>a,b</sup> | 62.50±12.50 <sup>a,b</sup> | 35.62±1.19 <sup>a,b</sup> | 45.32±0.83 <sup>a,b</sup> | 201.73±7.62 <sup>a,b</sup> | 97.62±2.38                |
|  | <b>PW</b> | 2307.14±57.56 <sup>b,c</sup> | 751.85±71.54 <sup>a</sup>   | 62.50±12.50 <sup>a,b</sup> | 37.62±1.45 <sup>a</sup>   | 43.23±0.74 <sup>b-d</sup> | 203.80±9.81 <sup>a</sup>   | 100.00±0                  |
|  | <b>SN</b> | 2566.43±53.20 <sup>a</sup>   | 657.85±90.67 <sup>a,b</sup> | 87.50±12.50 <sup>a,b</sup> | 35.62±0.65 <sup>a,b</sup> | 46.50±0.64 <sup>a</sup>   | 206.80±5.07 <sup>a</sup>   | 97.62±2.38                |

<sup>1</sup>Note: <sup>a-d</sup>Means bearing different superscript letters in columns within rearing systems, varieties, and rearing systems × varieties categories show significant (P 0.05) differences whereas no superscript letters on means indicate that the differences are not significant (P>0.05)

<sup>2</sup>BW = Body weight; BWG = Body weight gain; UF = Uniformity; EP = Egg production; EW = Egg weight; EM = Egg mass; LB = Livability

<sup>\*</sup>UF (%) was calculated on the basis of ±10% of average BW in each treatment group

<sup>3</sup>FR = Free range; SI = Semi-intensive; CF = Confinement

<sup>4</sup>Each value represents the mean of 4 replicates of 14 birds each

<sup>5</sup>LK = Lakha; MS = Mushki; PW = Peshawari; SN = Sindhi

<sup>6</sup>Each value represents the mean of 3 replicates of 14 birds each

<sup>7</sup>Interaction of rearing systems and Aseel varieties comprised 12 treatment groups

<sup>8</sup>Each value represents the mean of 1 replicate of 14 birds each

**Conclusions:** From the findings, it can be concluded that CF rearing system showed optimum performance in terms of BW, EP, EM, and LB whereas BWG was found to be the highest in SI. Sindhi variety showed enhanced BW, UF, EW, EM, and better EP than MS and LK. Peshawari variety showed the highest EP and better UF than MS. Interaction of rearing systems and Aseel varieties demonstrated enhanced BWG in LK; improved EP in PW; greater EW and EM in SN under SI rearing system. Sindhi variety only revealed the highest BW under CF and maximum UF under FR.

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