

**Production and reproduction performances of
CSML X Hansli crossbred chicken under
intensive system of management**

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**POST GRADUATE DEPARTMENT OF POULTRY SCIENCE
COLLEGE OF VETERINARY SCIENCE AND ANIMAL
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ODISHA UNIVERSITY OF AGRICULTURE AND
TECHNOLOGY
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IN

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By

Amit Kumar Mishra

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CERTIFICATE-I

This is to certify that the thesis entitled **“Production and reproduction performances of CSML X Hansli crossbred chicken under intensive system of management.”** submitted in partial fulfilment of the requirements for the award of the degree of **Master of Veterinary Science (Poultry Science)** to the Odisha University of Agriculture and Technology is faithful record of bonafide and original research work carried out by **Amit Kumar Mishra** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

It is further certified that the assistance and help received by him from various sources during the course of investigation has been duly acknowledged.

CHAIRMAN

ADVISORY COMMITTEE

CERTIFICATE-II

This is to certify that the thesis entitled “**Production and reproduction performances of CSML X Hansli crossbred chicken under intensive system of management.**” submitted by **Amit Kumar Mishra** to the Odisha University of Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirements for the degree of **Master of Veterinary Science (Poultry Science)** has been approved/disapproved by the students’ advisory committee and the external examiner.

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Place: Bhubaneswar

(Amit Kumar Mishra)

Dated:

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ABBREVIATIONS

AICRP	:	All India Coordinated Research project
ASM	:	Age at Sexual Maturity
B.A.	:	Breast Angle
cm	:	Centimeter
CP	:	Crude Protein
CSML	:	Coloured Synthetic Male Line
DM	:	Dry Matter
DORB	:	De-oiled Rice Bran
<i>et al.</i>	:	and other (Latin et alii)
etc.	:	so on (Latin et cetera)
F.C.	:	Foot Candle
FCR	:	Feed Conversion Ratio
Fig.	:	Figure
HDEP	:	Hen Day Egg Production
HHEP	:	Hen Housed Egg Production
HU	:	Haugh Unit
i.e.	:	that is (id Est)
I/M	:	Intra Muscular
I/N	:	Intra Nasal
I/O	:	Intra Ocular

ABSTRACT

A cross breed chicken is a breed of higher productivity as well higher adaptability to native environment. They can serve us highly proteinaceous foodstuff. Two hundred forty day old CSML X Hansli cross bred chicks were randomly distributed in 3 replicate groups to have 80 chicks per replicate group. They were given feed and water on ad-libitum basis. Then during the grower stage (8th -20th week), sex separated feeding was practiced. Male and female chicken were housed separately. Restricted feeding was practiced throughout the period. After completion of grower stage, around 80 female layers were taken and randomly distributed into 8 replicas. Feed was allotted to layers @ 110 g/ day/bird and the feeding continued from 21st to 52nd week. Proper vaccination schedule and medication were followed. Birds were reared up to 52 weeks of age. The following parameters such as Growth performance, Feed conversion efficiency, Mortality at different ages, Linear body measurement, Egg Production %, egg production performances, Age at sexual maturity in females, External egg quality parameters, Internal egg quality parameters were studied at different ages. The body weight of male and female of experimental cross at 8th week of age was 755.33±4.95g and 679.44±6.49g respectively. The body weight of male and female of the above cross at 20th week of age was 2403.94±61.72g and 1900.95±27.29g respectively. The FCR gradually increased from 1.72±0.01 at 1st week of age to 2.96±0.02 at 8th week of age. The FCR was significantly higher ($p \leq 0.01$) in male as compared to female at grower phase. The linear body measurements of male birds were significantly higher ($p \leq 0.01$) than that of female birds at all ages except shank width. The age at first lay of these birds was 170.00±0.27 days. The peak egg production 70.75±1.12 was obtained at 308.25±0.16 days. The egg weight increased significantly ($p \leq 0.05$) from 25th week of age (43.29±1.23) to 52nd week of age (53.00±1.73). The albumen index was 0.0957±0.007 at 30th week of age and 0.1026±0.003 at 52nd week of age. The above measured characters were compared with different crossbreeds and some native breeds which indicates dual purpose persona of these birds.

INTRODUCTION

Poultry industry has brighter scope in terms of production and upbringing of people from the trap of malnutrition and poverty. It has greater potential of creating jobs and ensuring family health by supplying high quality animal protein. Poultry rearing can be used as an alternative sustainable source of earning too. But still some issues exist that need to be addressed in order to run the poultry sector to its highest pace.

Now-a-days, the backyard poultry farming system which is an age old practice but was neglected with the practice of intensive system of management during the last 3 decades has again gained momentum. Mostly indigenous birds are reared in backyard with low production potential. Native birds are excellent mothers but take more time to attain sexual maturity. Native chicken meat is preferred over broiler meat due to its characteristic aroma and toughness. Native chicken egg is also highly valued. With increase in income and health awareness more and more people now prefer backyard chicken products. It has created a great opportunity for small, marginal and land less farmers, who are traditional backyard poultry farmers to strengthen and increase their income from backyard poultry rearing. However, productivity of the indigenous birds in terms of body weight and egg production is very less. In order to make backyard poultry farming a remunerative enterprise, it is necessary to improve the productivity. Now cross breeding of indigenous chicken with high producing broilers or layers are being tried in order to enhance the productivity of indigenous poultry birds. The chicken so developed are expected to have improved production besides having better disease resistance and adaptability to local climatic conditions. In such cases it is important to develop location specific chicken varieties utilizing local native chicken population.

As a thrust area of research, All India, Coordinate Research Project on Poultry Breeding has been conducting extensive cross breeding programmes involving local chicken populations. As a part of this programme, AICRP, Bhubaneswar centre has been assigned to develop a meat type chicken variety using the native Hansli chicken and Coloured synthetic male and female lines. As per the program, the F1 crosses of Hansli X CSML and their reciprocals are being developed and tested which will be latter used to develop the terminal triple cross.

The present experiment entitled, “**Production and reproduction performances of CSML X Hansli crossbred chicken under intensive system of management.**” is a part of this breeding research programme. This investigation has been planned with the following objectives to study:

- 1) Growth performance of CSML X Hansli crosses under intensive system of management.
- 2) Egg production of this cross,
- 3) Egg quality traits of this cross.

REVIEW OF LITERATURE

2.1 Growth Performance

2.1.1 Body weight and body weight gain

Adedokun and Sonaiya (2002) reported significantly higher body weights in the Dahlem Red x Nigerian indigenous chicken crossbred females than pure Nigerian indigenous chicken females at 8 weeks (468 ± 33.1 and 252 ± 29.5 gm) respectively.

Chatterjee *et al.* (2002) evaluated the direct and reciprocal crosses of Brown Nicobari with ILI-80, a commercial strain of White Leghorn and found that the body weight at 8 weeks of age of ILI-80 M X Brown Nicobari to be 413 ± 8.12 g, Brown Nicobari X ILI-80 to be 407 ± 9.06 g and standard Nicobari to be 222 ± 12.60 g. The body weights at different ages were much higher than under intensive management systems due to better care, management and feeding of the birds.

Saadey *et al.* (2008) reported that the body weight of Fayoumi (F) x WL, F x RIR, (Sanai) S x WL and S x RIR at day old were 31.73g, 40.45g, and 34.71g respectively. At 4th week body weight was Fayoumi (F) x WL (89.91 g), F x RIR(210.28g), (Sanai) S x WL (291.02 g), S x RIR (108.45 g), WL x F (96.82g), RIR x F(219.71g), WL x S(242.71g) and RIR x S(117.46g), At 8th week body weight was Fayoumi (F) x WL(362.57g), F x RIR(553.89g), (Sanai) S x WL(702.53g), S x RIR (430.09g), WL x F(383.11g), RIR x F(537.57g), WL x S(610.57g) and RIR x S(400.68g).

Haunshi *et al.* (2009) conducted a study on some indigenous variety like Miri type and some improved variety like Gramapriya and Vanaraja. They found that the body weight of Gramapriya (male- 2544.20 ± 62.24 g, female- 1810.42 ± 60.38) and Vanaraja (male- 3323.00 ± 64.08 g, female- 2277.00 ± 37.02 g) was higher than that of the Miri type (male- 1507.00 ± 44.70 g, female- 1214.14 ± 20.65 g) indigenous birds on sex separated basis.

Hazel LN and Lamoreux (1947) studied the "heritability" of variation in body weight at 22 weeks of age and sexual maturity, and to estimate the probable influence

of "maternal effects" and of "nicking" upon such variation when close inbreeding is avoided.

Padhi *et al.* (2014) studied and estimated that chicks of PDI x PD4 cross had both exotic and indigenous inheritance in farmer's field under backyard system of rearing. They found that the average body weight of male and female were 1671 and 1371 g respectively at 20 weeks and corresponding body weights were 2784 and 2178 g at 40 weeks.

Ndofor-Foleng *et al.* (2015) estimated and mentioned the body weight of crosses of BG1 (Local cocks (EC) × Exotic females (EF)) was (38.60±0.032g) and BG2 (exotic cocks (EC) × local females (LF)) was (36.58±0.22) at day old age. The body weight of BG2 (exotic cocks (EC) × local females (LF)) was (240.0±0.10) and BG1 (Local cocks (EC) × Exotic females (EF)) was (302.0±0.4g) at 4th week age. At 8th week of age the body weight of crosses of BG1 (Local cocks (EC) × Exotic females (EF)) was (702.0±0.4g) and BG2 (exotic cocks (EC) × local females (LF)) was (559±0.26) respectively.

Padhi *et al.* (2015) estimated four different crossbreds such as PD1× PD4 (A), PD1 × PB2 (B), PD1x PD3 (C) and PD1 × IWI (D) developed under intensive system of rearing for backyard poultry farming. Body weights, body conformation traits were evaluated during starter and grower period and production performances were evaluated up to 52 weeks of age. It was found that in both male and female body weights during the starter period at day 0, 2, 4, 6, 7 and 8 weeks of age and during the growing period at 10, 12, 14, 16, 18 and 20 weeks of age differed significantly between crosses. As compared to other crosses, B possessed higher body weight irrespective of age.

Ekka *et al.* (2016) measured the growth performance and linear body measurements of Hansli, CSML and Hansli x CSML cross chicken up to 8weeks of age under intensive system of management. They found that body weight of CSML, Hansli and Hansli x CSML were 1993.55, 740.33 and 1159.45g respectively at 8th week of age. Rate of body weight gain was similar for 7th and 8th week in CSML and Hansli x CSML. The rate of BW gain in CSML increased up to 7th week and then declined, whereas the rate of feed intake in Hansli and Hansli × CSML increased till 8th week of age.

Nwenya *et al.* (2017) mentioned that the day-old body weight of crosses of Naked neck rooster × Naked neck hen (22.17g), Frizzle rooster × Frizzle hen (23.83g), Naked neck rooster × Frizzle hen (25.50g), Frizzle rooster × Naked neck hen (29.50g). At 16th week of age the body weight was 654.00g, 773.67g, 895.96g and 972.83g respectively.

Feed intake

Bharambe and Garud (2012) experimented on the laying performance of 5 different types of improved poultry crossbred namely Giriraja x Delham Red (T₁), Delham Red X White Leghorn (T₂), Giriraja x Asselkaka (T₃), Delham Red x Giriraja (T₄), Asselkaka x Giriraja (T₅) and two purebred groups like Delham Red and Vanraja. During early laying period i.e.19-33 weeks of age and peak laying period i.e.34-40 weeks of age, the feed consumption differed significantly (P< 0.05) between the groups. They estimated that feed consumption in early and peak laying period was highest in crossbred i.e. 829.78 and 855.68g/week/bird than in the purebreds i.e. 787.00 and 840.8g/week/bird.

Dutta *et al.* (2012) studied the growth performance, production performance and economic efficiencies of four meat breeds *viz.*, Cobb 500, ISA Brown, Fayoumi and *Sonali* and estimated the parameters such as initial body weight (IBW), 5-wk rearing period (RP), achieved body weight (ABW), feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR). According to their study, broiler of Cobb 500 was the best-preferred chicken and cockerel of ISA Brown the least preferred chicken as FI values are concerned.

Iqbal *et al.* (2012) conducted an experiment to study the laying traits and egg geometry of four varieties (Lakha, Peshawari, Mushki and Mianwali) of Aseel chicken for four weeks. They recorded data from ten hens of each variety for feed intake and analysed through one-way ANOVA. Significant differences were observed in feed intake during 3rd week (P<0.01) and 4th week (P<0.05). The Aseel chickens consumed 71.7±13.8 g of feed per day on an overall basis.

Dubey *et al.* (2013) estimated the juvenile growth rate and FCR in Kadaknath breed of fowl up to 20 weeks of age under intensive system of management. The mean

weekly feed consumptions were recorded from one to eight weeks of age as 21.29 ± 0.11 , 46.43 ± 0.71 , 82.60 ± 0.90 , 104.38 ± 2.09 , 115.45 ± 2.66 , 150.51 ± 1.17 , 163.63 ± 2.99 and 244.52 ± 2.62 g, respectively. From three to five month of age, it was 1682.09 ± 38.59 , 1739.05 ± 11.84 and 1622.83 ± 7.14 g, respectively.

Jha *et al.* (2013) conducted an experiment to study the production performance and mortality pattern of crosses of Dahlem Red and local Desi birds under intensive system of management. They observed that as compared to their parent birds, there is significant variation in growth rate of crosses. The crosses showed significantly ($P < 0.05$) higher feed intake than local desi birds.

Feed Conversion Ratio (FCR)

Debata *et al.* (2012) observed that the feed conversion ratio in Black Rock, Red Cornish and Vanaraja birds at 4, 8, 12, 16, 20 and 24 weeks as 1.76, 1.76, and 1.83; 2.22, 2.08 and 2.16; 2.80, 2.68 and 2.76; 3.50, 3.22 and 3.40; 4.20, 3.77 and 4.07 and 5.09, 4.57 and 4.99 respectively in the coastal climatic condition of Odisha reared under intensive system of management.

Taha and AbdEl-Ghany (2013) evaluated the growth performance of crossbred lines of two Egyptian chicken strains and reported that FCR of MS (Mandarah x El-Salam) and SM (El-Salam X Mandarah) were 7.02 ± 0.27 and 7.10 ± 0.25 respectively.

Khawaja *et al.* (2013) reported that the FCR of RIFI (RIR male \times Fayoumi female) and FIRI (Fayoumi male \times RIR female) were 4.68 ± 0.11 and 5.20 ± 0.10 at chick phase.

Padhi *et al.* (2015) conducted an experiment to study four different crossbreds PD1 \times PD4 (A), PD1 \times PB2 (B), PD1 \times PD3 (C) and PD1 \times IWI (D) developed for backyard poultry farming under intensive system of rearing. They estimated that, feed conversion ratio (FCR) from 0–8 weeks of age was best in B followed by A, C and D.

Ekka *et al.* (2016) estimated the growth performance and linear body measurements of Hansli, CSML and Hansli x CSML cross chicken up to 8 weeks of age reared under intensive system of management. They recorded feed consumption on weekly basis and mortality on daily basis. They estimated 8th week FCR as 2.17, 2.58

and 2.26 for CSML, Hansli and Hansli × CSML respectively and found that the values did not differ significantly ($P>0.05$).

Nwenya *et al.* (2017) estimated that the FCR at 8th week of age of the crosses of Naked neck rooster × Naked neck hen, Frizzle rooster × Frizzle hen, Naked neck rooster × Frizzle hen, Frizzle rooster × Naked neck hen were 4.31, 4.81, 5.61 and 5.81 respectively and at 16th week 6.34, 7.3, 7.51, 8.13 respectively.

Mortality

Nwachukwu *et al.* (2006) evaluated the growth performance and linear body measurements of main crossbred E × NL and reciprocal NL × E and reported that the mortality rate of main crossbred E × NL and reciprocal NL × E was found to be 5.70 % and 8.51 % respectively.

Khawaja *et al.* (2013) conducted an experiment to study the mortality of RIFI (RIR male × Fayoumi female) and FIRI (Fayoumi male × RIR female) at different age. They observed that the mortality of RIFI and FIRI at chick phase were 2.80 ± 0.23 and 2.69 ± 0.13 and at grower phase were 7.30 ± 0.21 and 7.10 ± 0.19 respectively.

Padhi *et al.* (2015) estimated four different crossbreds PD1× PD4 (A), PD1 × PB2 (B), PD1x PD3 (C) and PD1 × IWI (D) reared for backyard poultry farming under intensive system of management. They observed that, irrespective of age the mortality % was lowest in D.

Ekka *et al.* (2016) observed the growth performance and linear body measurements of Hansli, CSML and Hansli x CSML crossbred chicken up to 8weeks of age reared under intensive system of management. They recorded the mortality which was highest in CSML (8.88%) followed by Hansli × CSML (7.77%) and Hansli (6.66%).

Linear Body Measurements

Taha and AbdEl-Ghany (2013) conducted an experiment to study the linear body measurements of crossbred lines of two Egyptian chicken strains at 8th week of age. They observed that the keel Length (KL) of both male and female of MS (Mandarrah x El-Salam) were $8.33\pm 0.02\text{cm}$ and $8.31\pm 0.02\text{cm}$, respectively.

Adedeji *et al.* (2015) estimated the growth performance of Gr male X Alpha female, reciprocal Alpha male X Gr female and Alpha male X White Leghorn (WL) female crosses. They observed that the keel length of above crosses was $14.77\pm 0.26\text{cm}$, $13.80\pm 0.66\text{cm}$ and $12.13\pm 0.23\text{cm}$ respectively at 8th week of age.

Padhi *et al.* (2015) evaluated four different crossbreds PD1× PD4 (A), PD1 × PB2 (B), PD1x PD3 (C) and PD1 × IWI (D) developed for backyard poultry farming reared under intensive system of management. Shank length and keel length were measured at 6, 8, 18 and 20 weeks of age in both the sexes differed significantly between the crosses. The maximum increase in shank length and keel length were achieved by 20 weeks of age. The shank length at 40 weeks of age differed significantly between different crosses.

Atansuyi *et al.* (2017) measured the shank length of Normal Feather, Naked neck, Marshall broiler, Frizzle feather at 8th week of age. The shank length of Normal Feather, Naked neck, Marshall broiler, Frizzle feather were 9.98cm, 9.63cm, 8.02cm and 9.62cm respectively and chest girth were $20.92\pm 0.42\text{cm}$, $27.22\pm 0.30\text{cm}$, $20.12\pm 0.25\text{cm}$ and $23.05\pm 0.25\text{cm}$ respectively.

Reproduction performance

Age at Sexual Maturity

Rahman *et al.* (2004) reported that age at sexual maturity of Fayoumi x RIR and RIR x Fayoumi was 151 and 147 days respectively.

Khalil *et al.* (2004), reported that ASM of SL (Baladi Saudi X White leghorn) and LS (White leghorn X Baladi Saudi) *i.e.* 179.3 ± 12.8 days and 168.5 ± 12.7 days respectively.

Munisi *et al.* (2015) estimated that age at sexual maturity of CB (Cool ecotype X Broiler), BC (Broiler X Cool ecotype), WB (Warm ecotype X Broiler) and BW (Broiler X Warm ecotype) was 171 ± 11.6 , 175 ± 10.8 , 159 ± 15.5 and 140 ± 12.2 respectively.

Egg Production

Haunshi *et al.* (2009) conducted a study on some indigenous variety like Miri type and some improved variety like Gramapriya and Vanaraja and found that the 40th week egg production of Miri Type, Gramapriya and Vanaraja was 33.59 ± 0.997 , 26.82 ± 1.622 and 13.37 ± 1.097 respectively. They found that the 52nd week egg production of Miri Type, Gramapriya and Vanaraja was 31.24 ± 0.72 , 32.35 ± 1.09 and 25.86 ± 1.22 respectively.

Haunshi *et al.* (2011) studied on the characterization of two Indian native chicken breeds for production and egg traits. They observed higher 40th week egg production ($P < 0.001$), higher egg specific gravity ($P < 0.05$), higher albumen ($P < 0.001$) and shell ($P < 0.009$) percentages in the Kadaknath, whereas the Aseel breed had a higher yolk index ($P < 0.004$), higher yolk percentage ($P < 0.001$), and higher yolk-to-albumen ratio ($P < 0.001$). They concluded that the breeds differed on various egg traits.

Haunshi *et al.* (2013) studied the egg production and its persistency of Aseel and Kadaknath breeds and found that there were multiple peaks in the HDEP% of these breeds in their laying period.

Padhi *et al.* (2015) observed four different crossbreeds PD1× PD4 (A), PD1 × PB2 (B), PD1x PD3 (C) and PD1 × IWI (D) developed under intensive system for backyard poultry farming. They recorded that, the egg production up to 72 weeks of age was the highest in C followed by D, A and B.

Kumar *et al.* (2016) conducted a research to study HDEP% of some indigenous chicken of Kerala. They found that the breed obtained multiple peaks of HDEP% in their laying period.

Lambertz *et al.* (2018) studied the performance and behavior of purebred Bresse-Gauloise and crossbred Bresse-Gauloise × New Hampshire. They observed multiple peaks of egg production in those breeds.

Dinesh (2018) conducted an experiment to observe sexual maturity and egg production traits of native chicken germplasm of Himachal Pradesh. They observed that the 52nd week hen day egg production of 3 generations i.e. G₁ (57.58), G₂ (63.58) and G₄ (72.45) were lower than G₃ (83.33).

Egg Quality Traits

Yeasmin *et al.* (2003) observed the laying performance of RIR X Deshi Dwarf, and Fayoumi × Deshi Normal and reported that 32.08g and 32.03g were the initial egg weight of RIR X Deshi Dwarf and Fayoumi X Deshi Normal.

Silversides *et al.* (2006) observed 3 strains of hens: Babcock B-300, a small-bodied commercial white-egg layer; ISA-Brown, a commercial brown-egg layer; and an unselected Brown Leghorn line (BL) and found that the yolk weight and albumen weight increased with increase in age.

Niranjan *et al.* (2008) estimated the different egg quality traits at different ages of four chicken varieties i.e. cross1 (C1), cross 2(C2), Vanaraja (C3) and Gramapriya (C4) to evaluate the effect of genetic group and age on the above egg quality traits. After analysing the data, they found a significant effect ($P < 0.01$) on all the traits at different ages. Egg weights were significantly higher in Vanaraja and C1 cross. The egg weights ranged from 57.06+0.27 g (Vanaraja) to 58.58+0.29 g (C1 cross) and 60.07+0.28 g (Vanaraja) to 61.34+0.35 g (C1 cross) at 40 and 64 weeks of age respectively.

Rajkumar *et al.* (2009) evaluated the egg quality traits in three naked neck genotypes such as NaNa (homozygous), Nana (heterozygous), and nana (normal). They observed that albumen weight decreased at 40th week of age as compared to 28th week of age.

Singh *et al.* (2009) observed production performance and egg quality traits between 4 strains of beak-trimmed layers: 3 commercial strains Lohmann White (LW), H&N White (HN), Lohmann Brown (LB) and a non-commercial cross between Rhode Island Red (male) and Plymouth Barred Rock (female). They found that the albumen index did not change significantly with age.

Silversides (2010) observed the Laying performance of six pure lines of chickens and four commercial hybrids at Agassiz Research Centre. They observed the breeds and estimated the for per kg mass at 50 weeks of age i.e. Blue White Leghorn

(2.18), Burgundy White Leghorn (2.26), Black White Leghorn (2.34), Columbia Plymouth Rock (2.59), Barred Plymouth Rock (2.49), Rhode Island Red (2.35), Babcock 300 (1.99), Shaver White (2.08), Shaver 2000 (2.05), Shaver 579 (2.12).

Bharambe and Garud (2012) studied the peak egg production of some breeds of Konkan region of India i.e. some improved poultry crossbred namely, - Giriraja x Delham Red (T₁), Delham Red x White Leghorn (T₂), Giriraja x Asselkala (T₃), Delham Red x Giriraja (T₄), Asselkala x Giriraja (T₅) and two purebred groups like Delham Red and Vanaraja. They found that the cross in this study was higher peak egg production than that of the above birds.

Khawaja *et al.* (2012) studied on egg quality parameters of Desi, Fayoumi and Rhode Island Red (RIR) breeds and found that FCR per kg egg weight of these birds were 8.70 ± 0.20 , 6.79 ± 0.25 and 5.02 ± 0.26 respectively.

Haunshi *et al.* (2013) studied the egg production and its persistency of Aseel and Kadaknath breeds and found that the value of peak egg production of the experimental cross was higher than that of Aseel (67.57%) and lower than that of Kadaknath (75.56%).

Padhi *et al.* (2014) observed chicks of PDI x PD4 cross having both exotic and indigenous inheritance under backyard system of rearing. There was a significant difference in egg weight at different weeks between the crosses.

Padhi *et al.* (2015) estimated four different crossbreeds such as PD1 x PD4 (A), PD1 x PB2 (B), PD1 x PD3 (C) and PD1 x IWI (D) under intensive system of rearing developed for backyard poultry farming. There was a significant difference in egg weight at different weeks between the crosses.

Munisi *et al.* (2015) evaluated that the shape index at 40th week of age of CB (Cool ecotype X Broiler), BC (Broiler X Cool ecotype), WB (Warm ecotype X Broiler) were 62.4 ± 8.2 , 74.03 ± 3.7 and 75.2 ± 4.7 respectively.

Ibrahim *et al.* (2019) conducted an experiment to study 7 commercial (ComCb) breeds such as Dominant Red Barred (DR), Dominant Sussex (DS), Lohmann Brown (LB), Lohmann-Dual, NOVOgen Brown (NB), NOVOgen Color (NC), and local Koekoek (KK) and 3 experimental (ExpCb) crossbreeds such as DR x KK (R x K), DS x DR (S x R), and KK x DS (K x S). They found that the FCR per dozen egg of the experimental cross was lower than that of the above breeds.

MATERIALS AND METHODS

The research was done with objectives to study:

- a) Growth performance of CSML X Hansli crosses under intensive system of management
- b) Egg production of this cross
- c) Egg quality traits of this cross.

Location of Research work:

The research work was conducted in the poultry farm of the AICRP on Poultry Breeding, Post Graduate Department of Poultry Science, C. V. Sc. and A.H, OUAT, Bhubaneswar.

Experimental Technique

Coloured Synthetic Male Line (CSML) males and Hansli females were housed in breeding pens in the ratio of 1:7. Eggs were collected and hatched. Two hundred forty day old CSML X Hansli cross bred chicks were randomly distributed in 3 replicate groups to have 80 chicks per replicate group. They were given feed and water on ad-libitum basis. Then during the grower stage (8th -20th week), sex separated feeding was practiced. Male and female chicken were housed separately. Restricted feeding was practiced throughout the period. After completion of grower stage, around 80 female layers were taken and randomly distributed into 8 replicas. Feed was allotted to layers @ 110 g/ day/bird and the feeding continued from 21st to 52nd week.

Management Procedure

The floor of poultry sheds was cleaned and disinfected properly. The rice husk was spread and covered with paper. The feeding troughs and water fountains were placed. Chicken were provided floor space@ 0.5sq ft/bird for first 3 weeks @ 1 sq. ft/bird from 3rd - 8th weeks, @2 sq. ft/bird from 9th week up to laying stage.

Brooders were fitted with electric bulbs to provide 1foot candle light at chick level. The chicks were given 23 hours of lighting and a dark period of 1 hour per day during brooding phase. During grower phase (i.e. 9th -20th week of age) they required a

normal light hour in a day. No artificial light is to be provided during this phase. But, after 20th week around 30 minutes of artificial lighting is to be added every week in order to achieve 16 hours of total lighting period including natural light and artificial light. In no way layers had to be provided more than 16 hours of lighting.

The experimental chicks were fed on ad-libitum basis from 1st week to 8th week. Then during the grower stage (9th week – 20th week) sex separated feeding was practiced. Restricted feeding was practiced throughout this period. The layer birds were fed with experimental diet @ 110g per bird i.e. from 21st week to 52nd week of age.

Three types of rations were prepared for chicks (0-8th weeks), grower (9th -20th weeks) and layers (21st – 52nd weeks). The experimental diets were analyzed for proximate compositions as per AOAC (2019). Calcium value was found out according to the method modified by Talapatra *et al.* (1940) and total phosphorus content was found out as per IS: 1374- 1968. The gross and proximate compositions of experimental diets were depicted on Table 3.1. The vaccination was followed as per standard operating procedure and was depicted schedule in Table 3.2.

Table 3.1 Gross and proximate composition of experimental diets

Ingredient	Chick (%)	Grower (%)	Layer (%)
Gross composition			
Maize	60	58.5	60
Soyabean meal	30	17.5	19.5
DORB	7	21	12
Broken Rice	0	0	3
Mineral mixture	3	3	5
Common salt	0.3	0.3	0.3
Trace mineral	0.1	0.1	0.12
Vitamin premix	0.3	0.3	0.3
Choline chloride	0.5	0.5	0.5
Anti Coccidial	0.5	0	0.5
Toxin binder	0.2	0.2	0.2

Proximate Composition (% on DM basis)			
Moisture	9.23	9.27	9.17
CP	20	16	16.5
Ether extract	4.14	4.55	4.2
Crude fibre	4.22	4.91	4.82
Total ash	9.43	10.17	10.61
Acid insoluble ash	2.6	2.63	2.54
Nitrogen free extract	62.23	62.25	64.39
Calcium	0.9	0.93	2.97
Av. Phosphorus	0.45	0.45	0.42
Metabolizable Energy (ME)*	2850 kcal/kg	2753 kcal/kg	2754 kcal/kg

* Calculated values

Table 3.2: Vaccination schedule

Age	Name of vaccine	Route of administration	Dose
1st day	Marek's disease vaccine	S/C	0.2ml
5th day	RD-F1 strain Vaccine	I/O or I/N	One drop
14 th day	day IBD Vaccine (Intermediate strain)	I/O	One drop
28th day	RD- Lasota strain	I/O or I/N	One drop
35th day	IBD Vaccine (Intermediate strain)	I/O	One drop
6th week	Fowl pox vaccine	Wing web	0.2ml
8th week	RD-R2B Vaccine	I/M	0.5ml
18th week	ND Killed vaccine	I/M	0.5ml

Data Collection

Data on the body weight, body weight gain, feed intake, FCR (feed conversion ratio), mortality and some linear body measurements like shank length, shank circumference, shank width, body height, keel length, body length, chest girth, neck length, breast angle were collected during the experiment. A brief description of the methods followed is given below.

Body Weight

The body weights were measured at weekly interval during the chick stage and then biweekly at grower stage. At laying stage, it was measured at 5 weeks interval. A digital electronic balance was used to record body weight nearest to 1.0 g accuracy.

Body Weight Gain

Weekly body weight gain was measured by subtracting body weight of previous week from that of current week body weight.

Feed Intake

Feed intake was measured by subtracting left-over feed from the total weekly feed allotted at the beginning of the week. The cumulative feed intake was calculated by adding feed intake of each week up to 8 weeks in the chick stage.

FCR (Feed Conversion Ratio)

FCR and Cumulative FCR were estimated as per formulae given below:

$$\text{Weekly feed conversion ratio} = \frac{\text{weekly feed consumption in kg}}{\text{Weekly body weight gain in kg}} \times 100$$

$$\text{Cumulative feed conversion ratio} = \frac{\text{Cumulative feed consumption in kg}}{\text{Cumulative body weight gain in kg}} \times 100$$

Mortality

Daily mortality of birds was recorded and expressed treatment wise on weekly basis.

Linear Body Measurements

Linear body measurements include shank length, shank circumference, shank width, body height, keel length, body length, chest girth, neck length, breast angle was taken and recorded.

Shank Length

Length of shank was measured by using electronic digital caliper with accuracy of 0.1 cm. It is the length between hock joint and carpal joint.

Shank Circumference

A measuring tape with 0.1 cm accuracy was used to measure the circular length of shank at the middle point between hock joint and carpal joint.

Shank Width

A digital caliper with accuracy 0.1 cm was used to measure the width of shank.

Body Height

A measuring tape with 0.1 cm accuracy was used to measure the height of bird i.e. from the tip of beak to the nail of middle digit.

Keel Length

A measuring tape of 0.1 cm accuracy was used to measure the length of keel bone.

Body Length

A measuring tape with accuracy of 0.1 cm was used to measure the length between the tip of the beak to the tip of tail.

Chest Girth

A measuring tape with accuracy of 0.1 cm was used to measure the circular length of chest of birds.

Neck Length

The length between the base of head and v shaped notch on the keel bone was measured by measuring tape with 0.1 cm accuracy.

Breast Angle

The inner angle between the two sides of keel bone was measured by breast meter with accuracy of 1 degree.

These all the above linear measurements were studied at 8th, 12th, 16th, 20th and 40th weeks of age.

Age at Sexual Maturity

The age at which the flock attained 5% egg production was taken as the age at sexual maturity and was expressed in days.

Egg Production

The crossbreed chicken produced eggs from 25th week to 52nd week of age. The egg production was calculated as per hen day egg production basis. The age at peak egg production age was calculated from comparing 5 days rolling average egg production.

$$\begin{aligned} \text{Hen day egg production (\%)} \\ = \frac{\text{Total no. of egg produced during the period}}{\text{No. of hen days in the same period}} \times 100 \end{aligned}$$

Egg Quality Traits

Eggs were collected randomly from all the 8 replicate groups from day one of laying period to 52nd week of age on daily basis. All the fresh eggs of last day of every week from each replicate group were collected to study the external egg quality traits such as egg weight, egg length, egg diameter and shape index. But twenty eggs of last day of every week were collected randomly at 30th, 40th, 45th and 52nd weeks from each replicate group to study the internal egg quality traits such as albumen weight, yolk weight, shell weight, albumen ratio (%), yolk ratio (%), shell ratio (%), albumen index, yolk index, Haugh unit and shell thickness etc.

At first the evaluation of physical measurements of eggs such as egg weight, length, width and shape index were done. Thereafter, yolk index, albumen index, Haugh unit and shell thickness were determined by breaking the eggs. After breaking the eggs, the inner contents were poured on a levelled glass plate placed on a table, so that, the

yolk and thick albumen were remained intact. Weighing balance, flat plane glass slab, digital caliper and spherometer were used for measuring the different characters of the above eggs.

Egg Weight

It was measured by electronic top pan balance with an accuracy of 0.1 g.

Egg Length

It was measured by digital caliper with an accuracy of 1 mm.

Egg Diameter

It was measured by digital caliper with an accuracy of 1 mm.

Shape Index

It was calculated as per the given formula (Shultz 1953)

$$\text{Shape index} = \frac{\text{Width of the egg}}{\text{Length of the egg}} \times 100$$

Yolk Weight

It was measured by Electronic top pan balance with an accuracy of 0.1 g.

Shell Weight

It was measured by Top pan balance with an accuracy of 0.1 g.

Albumen Weight

It was calculated by subtracting yolk weight and shell weight from total egg weight. Albumen weight = Egg weight – (yolk weight + Shell weight)

Albumen Ratio (%)

It was calculated by dividing albumen weight with total egg weight and multiplied by 100.

$$\text{Albumen ratio(\%)} = \frac{\text{Albumen weight}}{\text{Egg weight}} \times 100$$

Yolk Ratio (%)

It was calculated by dividing yolk weight with total egg weight and multiplied by 100.

$$\text{Yolk ratio(\%)} = \frac{\text{yolk weight}}{\text{egg weight}} \times 100$$

Shell Ratio (%)

It was calculated by dividing shell weight by egg weight and multiplied by 100.

$$\text{Shell ratio(\%)} = \frac{\text{shell weight}}{\text{egg weight}} \times 100$$

Albumen Index

The albumen height was calculated by spherometer and albumen width was calculated by digital caliper. The albumen index was calculated as the height of egg albumen per unit width of egg albumen. (Heiman and Caver 1936)

$$\text{Albumen index} = \frac{\text{Mean height of albumen in mm}}{\text{Mean width of albumen in mm}}$$

Yolk Index

The yolk height was calculated by spherometer and yolk width was calculated by digital caliper. The yolk index was calculated as the height of egg yolk per unit width of egg yolk.

$$\text{Yolk index} = \frac{\text{mean height of yolk in mm}}{\text{mean width of yolk in mm}}$$

Haugh Unit

It was calculated by the following formula given by Haugh (1937).

$$\text{Haugh Unit} = [100\text{Log}(H+7.57-1.7W^{0.37})]$$

H = Average height of albumen in mm.

W = Average weight of the egg in gram.

Shell Thickness

It was measured using Ames thickness measure by taking three pieces of shell from three different part such as air shell, sharp end and equator.

Analysis of Data

SPSS tool was used to analyse the complete data. These data were analysed using t-test and ANOVA in order to check the significance level. Graphical charts were prepared by using Microsoft Office 2010.



Figure 3.1 Adult Male CSML Chicken (Sire)



Figure 3.2 Adult Female Hansli (Dam)



Figure 3.3 Adult CSML x Hansli Male



Figure 3.4 Adult CSML x Hansli Female



Figure 3.5 Recording Day Old Body Weight of Chicks



Figure 3.6 Straight Run Chicks



Figure 3.7 Feeding of Chicks in Tray Feeder



Figure 3.8 Feeding of Chicks in Trough Feeder



Figure 3.9 Grower CSML x Hansli Male



Figure 3.10 Grower CSML x Hansli Female



Figure 3.11 Grower CSML x Hansli Flock



Figure 3.12 Adult CSML x Hansli Flock



Figure 3.13 Measurement of Shank Length



Figure 3.14 Measurement of Breast Angle



Figure 3.15 Measuring Egg Length



Figure 3.16 Measurement of Yolk Diameter



Figure 3.17 Measurement of Albumen Height

RESULTS

The present experiment was carried out to study the production performances of CSML X Hansli crossbred chicken from day one to 52nd week of age reared under intensive system of management. The entire experimental was divided in to three phases viz. Chick, grower and layer phases. The results obtained from this investigation have been presented in this chapter.

Experiment 01: Performances of CSML x Hansli chicks (0-8 weeks) under intensive system of management

4.1.1 Body weight

The weekly body weights of CSML X Hansli chicks from day one to 8th week of age are presented in Table 4.1. The weekly body weights of experimental chick are depicted graphically in Figure 4.1 and Figure 4.2. The male and female chicks grew from their day-old body weight of 34.66±0.22g and 34.33±0.18g to the 8th week body weight of 755.33±4.95g and 679.44±6.49g respectively. The body weight of male chicks was significantly ($p \leq 0.01$) higher than those of female chicks at all ages except for day-old and 1st week of age. On combined sex basis, the day-old and 8th week body weight of chicks was 34.49±0.19g and 717.39±5.68g respectively.

Table 4.1: Mean weekly body weight of CSML X Hansli chicks

Age	Body weight in grams					
	Male	N	Female	N	P Value	Combined Sex
Day Old	34.66±0.22	125	34.33±0.18	115	0.301NS	34.49±0.19
1st week	83.72±0.48	124	82.57±0.42	114	0.147NS	83.14±0.08
2nd week	136.97±0.09	124	134.05±0.08	114	0.000**	135.51±0.08
3rd week	204.93±0.49	124	199.34±1.01	113	0.007**	202.14±0.74
4th week	284.54±0.55	124	268.98±1.00	113	0.000**	276.76±0.23
5th week	377.69±2.04	124	350.27±4.10	113	0.003**	363.98±3.07
6th week	489.94±1.59	124	441.00±3.02	113	0.000**	465.47±2.30
7th week	615.50±3.66	124	552.88±3.75	113	0.000**	584.19±3.66
8th week	755.33±4.95	124	679.44±6.49	113	0.000**	717.39±5.68

** Mean values differ significantly ($p \leq 0.01$), NS-Non significant

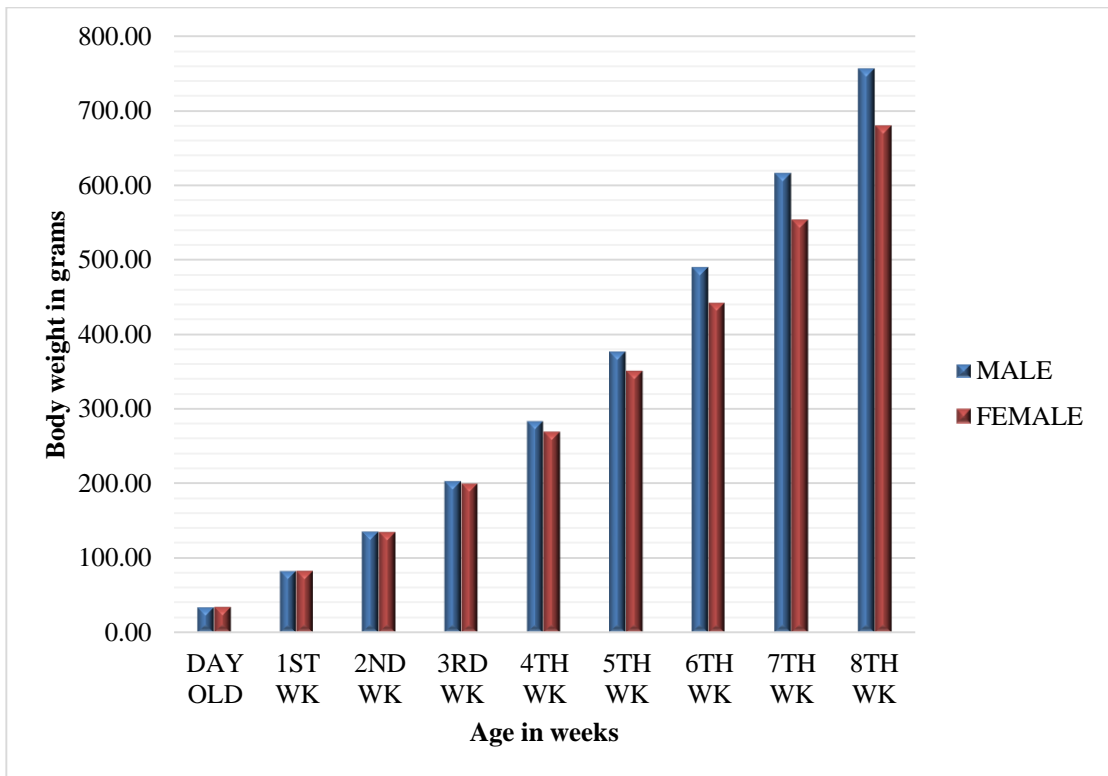


Fig 4.1: Mean weekly body weights of CSML x Hansli chicks on sex separated basis.

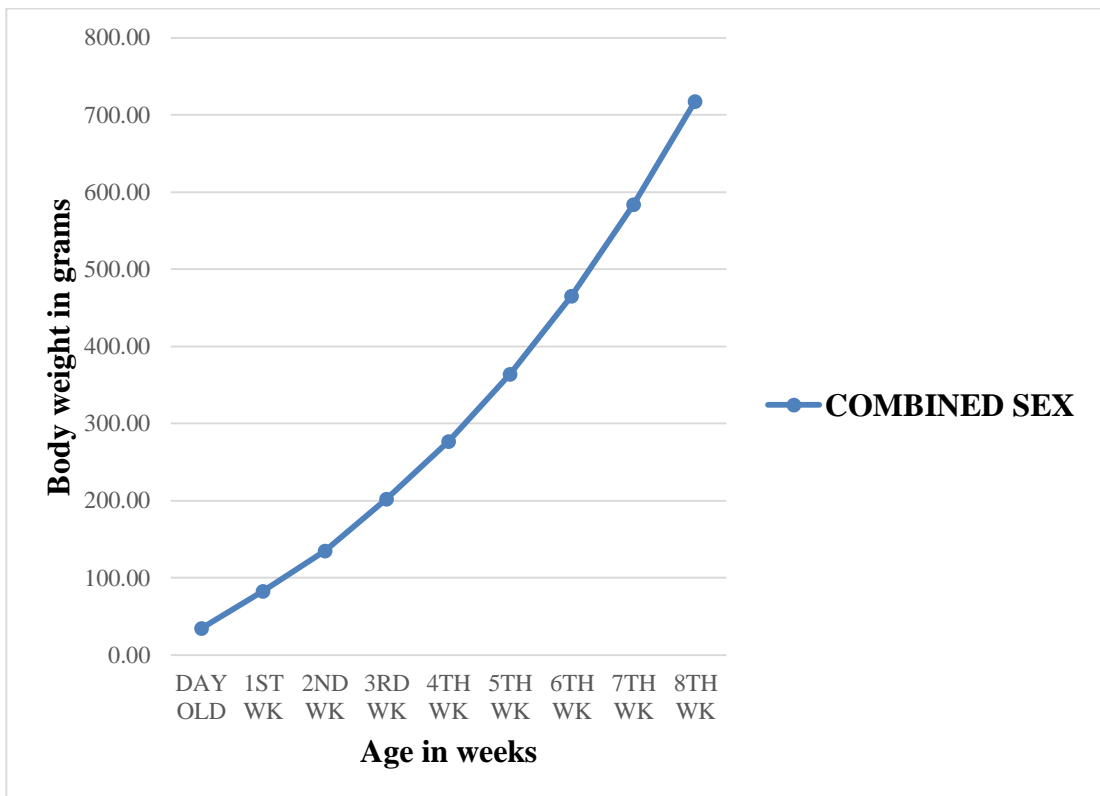


Fig 4.2: Mean weekly body weights of CSML x Hansli chicks on combined sex basis.

4.1.2. Body weight gain

The weekly body weight gains of CSML X Hansli cross chicks from 1st to 8th week of age are presented in Table 4.2 and illustrated in Figure 4.3 and Figure 4.4. The body weight gain increased progressively with increase in age on sex separated and combined sex basis. The highest weekly body weight gain of male and female chicks was observed at 8th week of age i.e. 139.83±0.37g and 126.56±0.63g respectively. The body weight gain of male chicks was significantly ($p \leq 0.05$) higher than those of female chicks at all ages except for 1st week of age. On combined sex basis, the 1st and 8th week body weight gain of chicks was 48.61±0.05g and 133.19±0.38g respectively.

Table 4.2: Mean weekly body weight gain of CSML X Hansli chicks

Age	Body weight gain in grams					
	Male	N	Female	N	P Value	Combined Sex
1st week	49.05±0.15	124	48.16±0.12	114	0.082NS	48.61±0.05
2nd week	53.25±0.61	124	51.35±0.17	114	0.039*	52.30±0.38
3rd week	67.96±0.48	124	65.29±0.30	113	0.009**	66.63±0.31
4th week	79.61±0.40	124	69.63±0.26	113	0.000**	74.62±0.19
5th week	93.14±0.15	124	81.29±0.47	113	0.000**	87.22±0.30
6th week	112.25±0.50	124	90.73±1.12	113	0.000**	101.49±0.77
7th week	125.56±2.08	124	111.89±0.86	113	0.003**	118.73±1.36
8th week	139.83±0.37	124	126.56±0.63	113	0.000**	133.19±0.38

** Mean values differ significantly ($p \leq 0.01$), *Mean values differ

significantly ($p \leq 0.05$), NS-Non significant

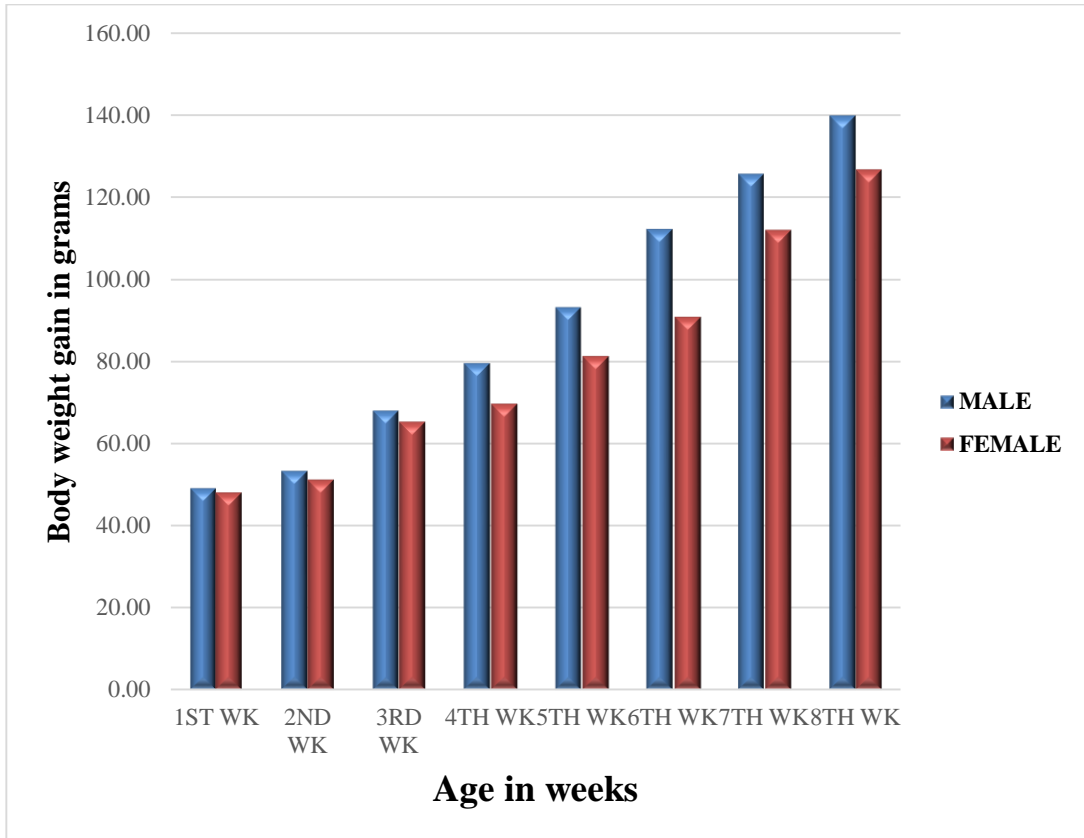


Fig 4.3: Mean weekly body weight gains of CSML x Hansli chicks on sex separated basis

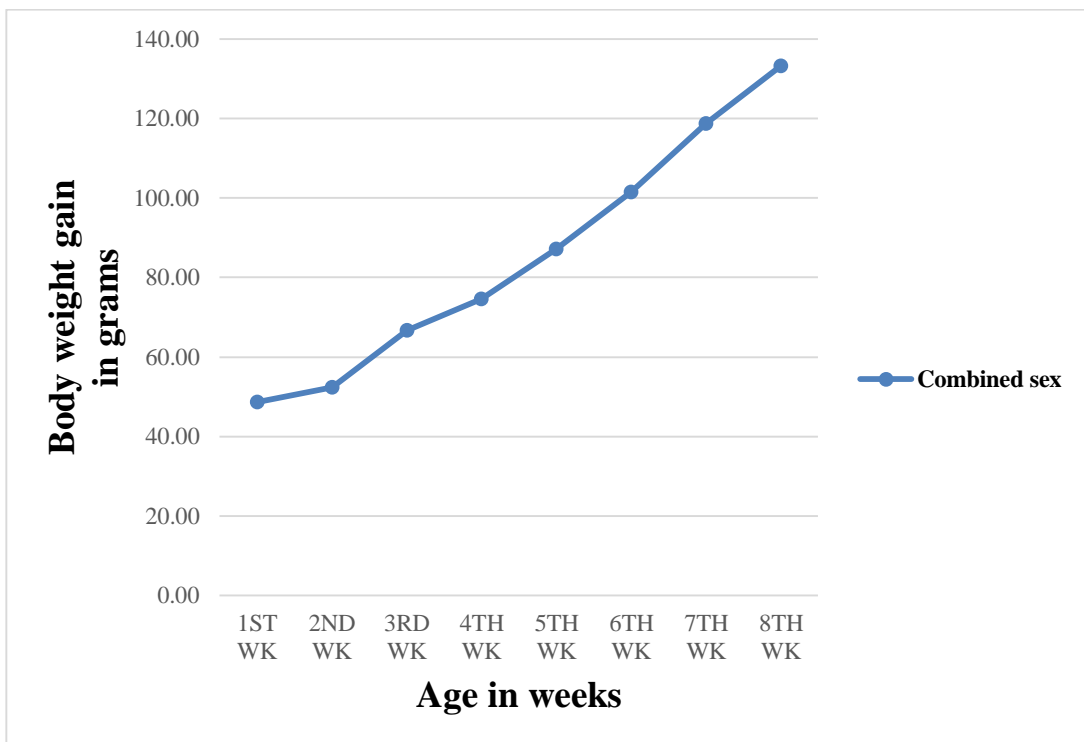


Fig 4.4: Mean weekly body weight gains of CSML x Hansli chicks on combined sex basis

4.1.3 Feed Intake and Feed Conversion Ratio (FCR)

The weekly and cumulative feed intake and FCR of CSML x Hansli cross chicks on combined sex basis from 1st-8th weeks are presented in Table 4.3 and illustrated in Figure 4.5 and Figure 4.6. The feed intake pattern showed a gradual increase with advancement of age from 1st week of age (83.42±0.02g/bird) to 8th week of age (393.81±0.37g/bird). Cumulative feed intake was 1630.18±2.86g/bird at the end of 8th week.

FCR of chicks was gradually increased from 1st week of age (1.72±0.01) to 8th week of age (2.96±0.02). The cumulative FCR at 8th week of age was 2.39±0.02.

Table 4.3: Mean weekly and cumulative feed intake and FCR of CSML X Hansli chicks on combined sex basis

Age	Feed intake (g/bird)	Cumulative feed intake (g/bird)	FCR	Cumulative FCR
1st week	83.42±0.02	83.42±0.02	1.72±0.01	1.72±0.01
2nd week	98.20±0.38	181.62±0.41	1.88±0.01	1.80±0.01
3rd week	129.46±0.23	311.08±0.45	1.94±0.01	1.86±0.01
4th week	160.14±0.58	471.21±1.48	2.16±0.01	1.95±0.01
5th week	199.51±0.30	670.73±1.76	2.29±0.01	2.04±0.01
6th week	245.13±0.16	915.85±1.89	2.44±0.02	2.13±0.01
7th week	320.52±0.68	1236.37±2.52	2.71±0.02	2.25±0.01
8th week	393.81±0.37	1630.18±2.86	2.96±0.02	2.39±0.02

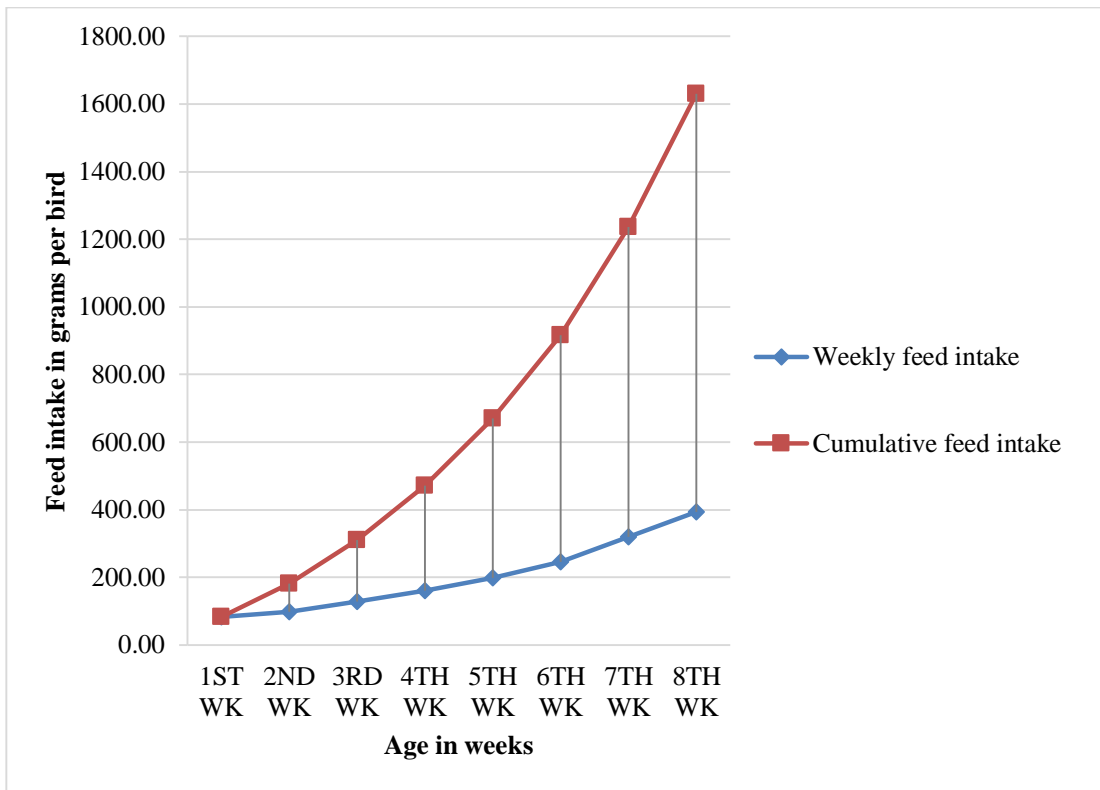


Fig 4.5: Weekly and cumulative feed intake of CSML x Hansli chicks

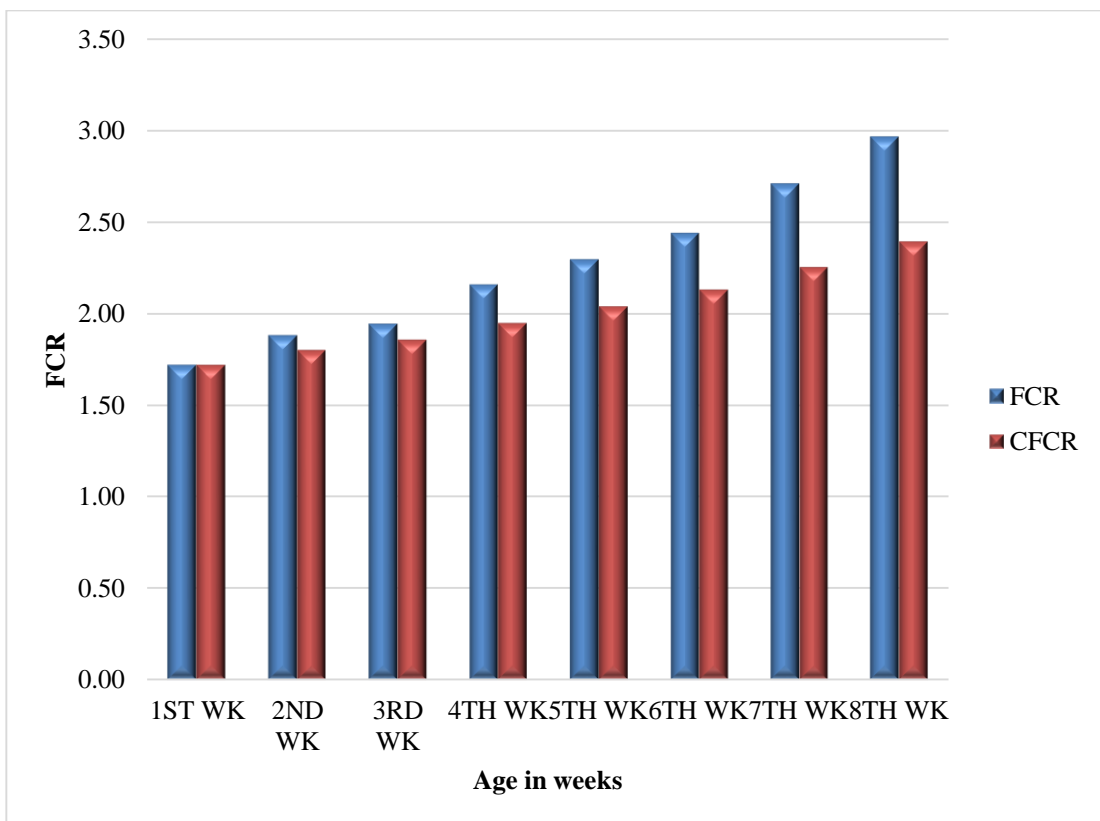


Fig 4.6: Weekly and cumulative FCR of CSML x Hansli chicks

4.1.4. Body measurements

The 8th week mean linear body measurements of CSML x Hansli chicks are represented in Table 4.4 and depicted in Figure 4.7. The keel length (11.20±0.17cm) and body length (47.80±1.50cm) of males were significantly ($p \leq 0.01$) higher than those of females. The breast angle of males was 45.33±0.99° which was significantly ($p < 0.01$) higher than that of females with a mean value of 36.87±1.16°. All linear body measurements were significantly ($p \leq 0.01$) higher in male as compared to female at 8th week of age except shank width which did not differ significantly between sexes.

Table 4.4 Mean linear body measurements of experimental chicks at 8th week of age

Parameters	Linear body measurements		
	Male	Female	P Value
Shank length (cm)	8.29±0.05	7.85±0.04	0.000**
Shank circumference (cm)	4.54±0.05	3.99±0.05	0.000**
Shank width (cm)	1.20±0.11	0.93±0.13	0.119NS
Height (cm)	62.00±0.69	50.57±0.82	0.000**
Keel length (cm)	11.20±0.17	8.85±0.23	0.000**
Body length (cm)	47.80±1.50	36.63±0.57	0.000**
Chest girth (cm)	26.15±0.43	24.21±0.33	0.001**
Neck length (cm)	9.58±0.11	8.90±0.13	0.000**
Breast angle (degree)	45.33±0.99	36.87±1.16	0.000**

** Mean values differ significantly ($p \leq 0.01$), NS-Non significant

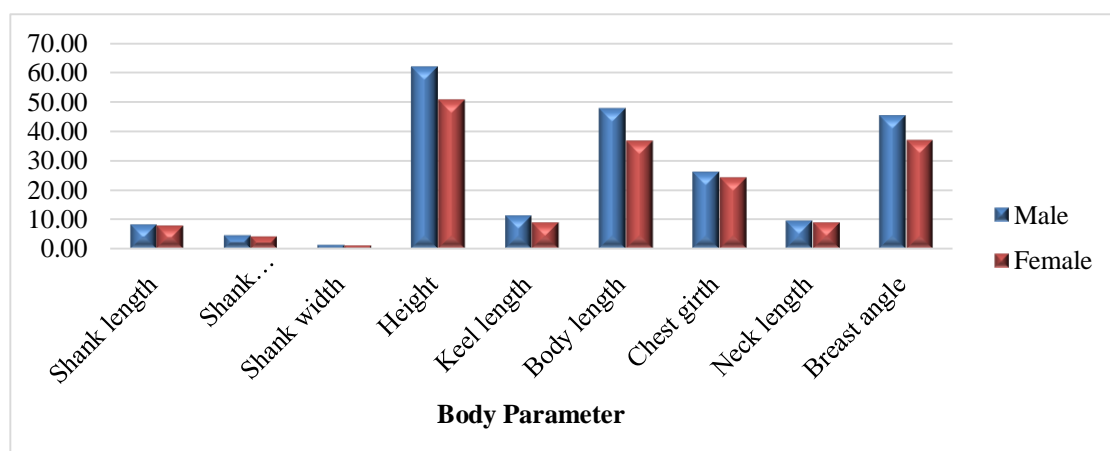


Fig. 4.7: Mean linear body measurements of experimental chicks at 8th week of age.

4.1.5 Mortality (%)

The mortality of CSML x Hansli crossbred chicken from day-old to 8th week of age recorded daily and presented on weekly basis which have been represented on Table 4.5. The mortality during day-old to 8th week of the experiment was 1.25%.

Table 4.5 Mortality of CSML x Hansli chicks

Age (Weeks)	No of birds died
1	2
2	0
3	1
4	0
5	0
6	0
7	0
8	0
Total	3
Mortality (0-8weeks) %	1.25%

Experiment 02: Performance of CSML x Hansli grower (9- 20 weeks) under intensive system of management

4.2.1 Body weight

The biweekly body weight of CSML x Hansli growers from 9th to 20th week of age on sex separated basis are represented on Table 4.6 and depicted in Figure 4.8. The body weights of male and female birds at 10th week were 1143.38±17.86g and 994.95±7.43g respectively, which increased to 2403.94±61.72g and 1900.95±27.29g at 20th week of age. The body weight of males was significantly higher ($p \leq 0.01$) than that of females at all ages.

Table 4.6 Mean biweekly body weight of CSML X Hansli growers

Age	Body weight in grams				
	Male	N	Female	N	P Value
10th week	1143.38±17.86	70	994.95±7.43	112	0.001**
12th week	1436.39±22.48	70	1287.45±15.92	111	0.005**
14th week	1695.82±32.78	70	1488.62±15.85	110	0.004**
16th week	1894.75±49.54	69	1638.71±24.70	110	0.009**
18th week	2095.58±63.96	69	1795.82±18.49	110	0.003**
20th week	2403.94±61.72	68	1900.95±27.29	110	0.001**

** Mean values differ significantly ($p \leq 0.01$)

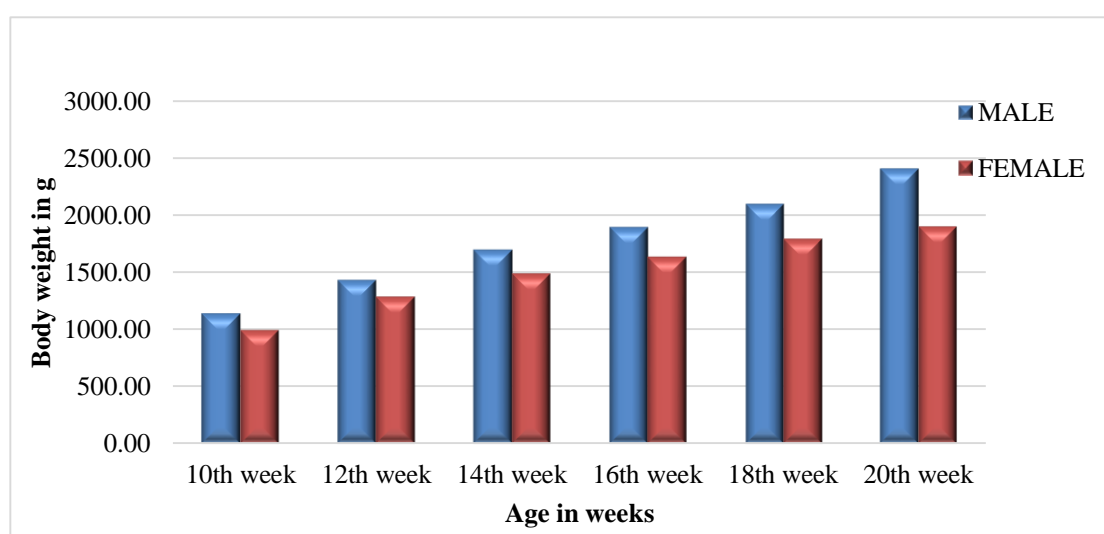


Fig 4.8: Mean biweekly body weights of CSML x Hansli cross Growers on sex separated basis

4.2.2. Linear body measurements of CSML x Hansli growers at 12th week of age

The mean linear body measurements of CSML x Hansli crosses at 12th week of age are presented in Table 4.7. At 12th week of age the Shank length in male and female were 8.72±0.08cm and 8.37±0.04cm respectively. Keel lengths were 11.50±0.12cm and 9.79±0.17cm in male and female respectively. Breast angle at the same period of time was 50.40±1.31° and 41.80±1.43° in male and female respectively. All the linear body measurements of male birds were significantly ($p \leq 0.01$) higher than those of female birds at 12th week of age except shank width.

Table 4.7 Mean linear body measurements of CSML x Hansli growers at 12th week of age

Parameters	Linear body measurements		
	Male	Female	P Value
Shank length (cm)	8.72±0.08	8.37±0.04	0.001**
Shank circumference (cm)	5.47±0.14	4.58±0.04	0.000**
Shank width (cm)	1.52±0.12	1.26±0.08	0.080NS
Height (cm)	65.53±0.54	57.45±0.54	0.000**
Keel length (cm)	11.50±0.12	9.79±0.17	0.000**
Body length (cm)	52.10±1.19	46.15±0.32	0.000**
Chest girth (cm)	34.11±0.22	32.26±0.23	0.000**
Neck length (cm)	13.37±0.18	9.76±0.27	0.000**
Breast angle (degree)	50.40±1.31	41.80±1.43	0.000**

** Mean values differ significantly ($p \leq 0.01$), NS-Non significant

4.2.3. Linear body measurements of CSML x Hansli cross growers at 16th week of age

The mean linear body measurements of CSML x Hansli crosses at 16th week of age are illustrated with Table 4.8. At 16th week the Shank length in male and female were 9.40±0.14cm and 8.86±0.05cm respectively. Keel lengths were 12.56±0.14cm and 10.73±0.17cm in male and female respectively. Breast angle at the same period of time was 55.30±1.31° and 45.90±1.73° in male and female respectively. All the linear body measurements of male birds were significantly ($p \leq 0.01$) higher than those of female birds at 16th week of age except shank width.

Table 4.8 Mean linear body measurements of CSML x Hansli growers at 16th week of age

Parameters	Linear body measurements		
	Male	Female	P Value
Shank length (cm)	9.40±0.14	8.86±0.05	0.001**
Shank circumference (cm)	5.69±0.15	4.63±0.04	0.000**
Shank width (cm)	1.62±0.10	1.38±0.13	0.163NS
Height (cm)	69.05±0.87	64.60±0.34	0.000**
Keel length (cm)	12.56±0.14	10.73±0.17	0.000**
Body length (cm)	60.19±1.18	55.79±0.51	0.003**
Chest girth (cm)	34.39±0.24	32.43±0.17	0.000**
Neck length (cm)	14.43±0.19	10.79±0.30	0.000**
Breast angle (degree)	55.30±1.31	45.90±1.73	0.000**

** Mean values differ significantly ($p \leq 0.01$), NS-Non significant

4.2.4. Linear body measurements of CSML x Hansli cross growers at 20th week of age

The mean linear body measurements of CSML x Hansli crosses at 20th week of age are illustrated with Table 4.9. At 20th week of age the Shank length in male and female were 9.85±0.17cm and 9.11±0.09cm respectively. Keel lengths were 14.26±0.09cm and 12.70±0.35cm in male and female respectively. Breast angle at the same period of time was 60.10±0.91° and 49.70±1.16° in male and female respectively. All the linear body measurements of male birds were significantly ($p \leq 0.01$) higher than those of female birds at 20th week of age except shank width.

Table 4.9 Mean linear body measurements of CSML x Hansli growers at 20th week of age

Parameters	Linear body measurements		
	Male	Female	P Value
Shank length (cm)	9.85±0.17	9.11±0.09	0.001**
Shank circumference (cm)	5.92±0.18	4.72±0.04	0.000**
Shank width (cm)	1.73±0.09	1.48±0.09	0.070NS
Height (cm)	73.80±0.83	70.60±0.64	0.006**
Keel length (cm)	14.26±0.09	12.70±0.35	0.000**
Body length (cm)	65.43±0.69	60.51±0.67	0.000**
Chest girth (cm)	34.60±0.21	32.57±0.17	0.000**
Neck length (cm)	15.72±0.22	12.02±0.27	0.000**
Breast angle (degree)	60.10±0.91	49.70±1.16	0.000**

** Mean values differ significantly ($p \leq 0.01$), NS-Non significant

4.2.5. Mortality %

The mortality of CSML X Hansli growers from 9th to 20th weeks of age recorded daily and predicted on weekly basis in Table 4.10. The mortality during grower phase (9th to 20th week) was 2.78%.

Table 4.10 Mortality of CSML x Hansli growers

Age (Weeks)	No of birds died
9	0
10	1
11	0
12	1
13	0
14	1
15	1
16	0
17	0
18	0
19	0
20	1
Total	5
Mortality (9-20weeks) %	2.78%

**Experiment 03: Performance of CSML x Hansli cross layers (21st to 52nd week)
under intensive system of management**

4.3.1 Body weight

The body weights of CSML X Hansli adults from 21st to 52nd week of age recorded at 5 weeks interval are reproduced on the Table 4.11 and Figure 4.9. The male and female grew from their 25th week body weight of 2751.67±30.45g and 2106.97±17.57g to the 52nd week body weight of 3600.50±16.50g and 2793.25±3.75g respectively. The body weight of male adult birds was significantly ($p \leq 0.01$) higher than those of female adult birds at all ages.

Table 4.11 Mean body weight of CSML X Hansli adults

Age	Body weight in grams				
	Male	N	Female	N	P Value
25th week	2751.67±30.45	19	2106.97±17.57	98	0.000**
30th week	3025.23±27.98	19	2315.27±12.73	95	0.000**
35th week	3169.97±88.75	19	2561.13±31.05	95	0.002**
40th week	3379.55±34.96	18	2711.14±29.54	95	0.000**
45th week	3465.19±50.85	16	2790.29±12.96	86	0.000**
52nd week	3600.50±16.50	16	2793.25±3.75	84	0.000**

** Mean values differ significantly ($p \leq 0.01$)

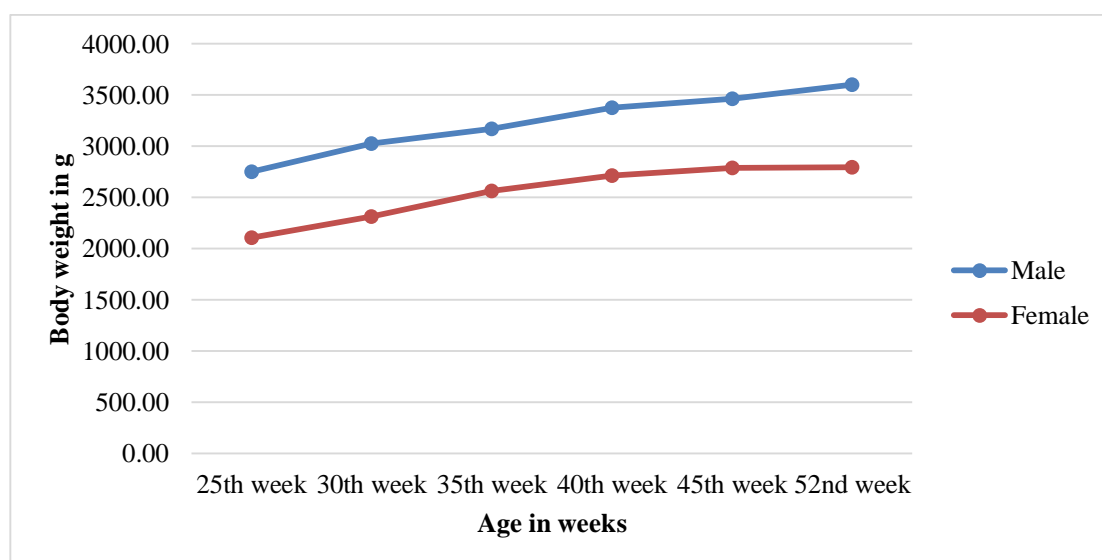


Fig 4.9 Mean body weights of CSML x Hansli adults on sex separated basis.

4.3.2 Body weight gain

The weekly body weight gain of CSML x Hansli cross birds during different periods from 21st to 52nd weeks of age (sex separated basis) at 5 weeks interval are represented in Table 4.12 and Figure 4.10. In males and females, the weekly body weight gains were highest during the period of 21st -25th week of age. During the same period the weekly body weight gains were 54.71±3.25g and 41.66±1.43g respectively for males and females. The body weight gain decreased gradually with advancement of age of the birds in both the sexes. At all stages the body weight gain of males was significantly ($p<0.01$) higher than the females.

Table 4.12 Mean weekly body weight gain of CSML X Hansli adults

Period	Weekly body weight gain in grams				
	Male	N	Female	N	P Value
21st-25th week	54.71±3.25	19	41.66±1.43	98	0.000**
26th-30th week	54.71±3.66	19	41.66±4.39	95	0.000**
31st-35th week	51.18±2.23	19	40.73±2.15	95	0.001**
36th-40th week	44.17±6.15	18	34.37±2.68	95	0.001**
41st-45th week	20.13±0.30	16	15.83±0.99	86	0.003**
46th-50th week	11.6±0.10	16	8.20±0.14	84	0.007**

** Mean values differ significantly ($p\leq 0.01$)

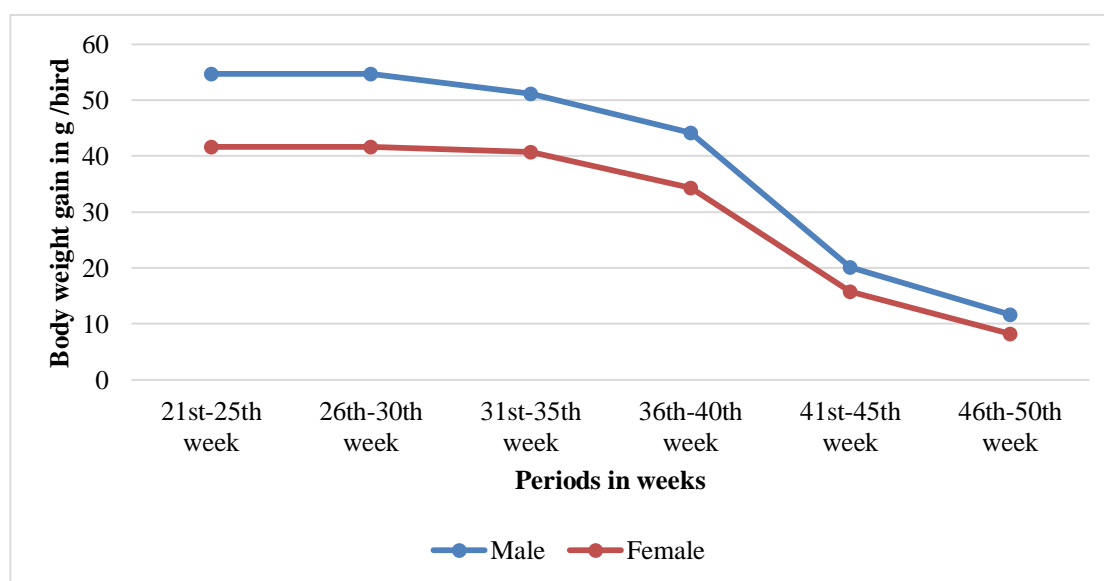


Fig 4.10 Mean weekly body weight gains of CSML x Hansli cross adults

4.3.3. Mean linear body measurements of experimental birds at 40th week of age

The mean linear body measurements of CSML x Hansli crosses at 40th week of age are presented in Table 4.13. At 40th week of age the Shank length in male and female were 10.06±0.11cm and 9.45±0.09cm respectively. Keel lengths were 15.34±0.23cm and 13.50±0.22cm in male and female respectively. Breast angle at the same period of time was 68.00±0.91° and 56.92±0.92° in male and female respectively. All the linear body measurements of male birds were significantly ($p \leq 0.01$) higher than those of female birds at 40th week of age except shank width.

Table 4.13 Mean linear body measurements of CSML x Hansli adults at 40th week of age

Parameters	Linear body measurements		
	Male	Female	P Value
Shank length (cm)	10.06±0.11	9.45±0.09	0.000**
Shank circumference (cm)	6.16±0.07	4.88±0.08	0.000**
Shank width (cm)	1.96±0.20	1.50±0.17	0.092NS
Height (cm)	84.20±0.66	72.91±0.87	0.000**
Keel length (cm)	15.34±0.23	13.50±0.22	0.000**
Body length (cm)	81.21±0.98	62.20±1.55	0.000**
Chest girth (cm)	37.57±0.23	33.95±0.57	0.000**
Neck length (cm)	15.77±0.56	12.61±0.55	0.000**
Breast angle (degree)	68.00±0.91	56.92±0.92	0.000**

** Mean values differ significantly ($p \leq 0.01$), NS-Non significant

4.3.4 Hen Day Egg Production (HDEP)

The weekly hen day egg production of CSML x Hansli birds up to 52nd week are presented in Table 4.14 and depicted graphically in Figure 4.11. At 25th week the HDEP was 5.58±0.35 %, which was then increased to 63.34±0.91 % at 28th week of age. Then the weekly HDEP was decreased to 34.73% at 30th week and again increased and reached a higher value i.e. 53.47±1.72 % at 32nd week of age. The peak egg production (70.75±1.12 %) was obtained at 44th week of age. At 40th week of age the HDEP was 48.82±0.83 %, whereas it was 43.33±5.24 % at 52nd week of age. There were multiple peaks of egg production seen within the period of laying i.e. up to 52nd week.

Table 4.14 Weekly hen day egg production up to 52nd week of age

Age in weeks	Weekly HDEP%	Age in weeks	Weekly HDEP%
25	5.58±0.35	39	52.88±1.35
26	21.26±1.13	40	48.82±0.83
27	43.09±1.60	41	55.04±0.92
28	63.34±0.91	42	62.71±0.98
29	44.87±1.12	43	70.75±1.43
30	34.73±2.18	44	70.75±1.12
31	52.11±1.30	45	68.96±2.07
32	53.47±1.72	46	64.03±1.54
33	33.61±1.56	47	63.62±2.38
34	30.81±0.97	48	63.69±5.36
35	43.53±1.78	49	33.33±2.38
36	54.43±1.12	50	46.59±7.46
37	58.14±1.13	51	52.38±4.76
38	55.51±0.97	52	43.33±5.24

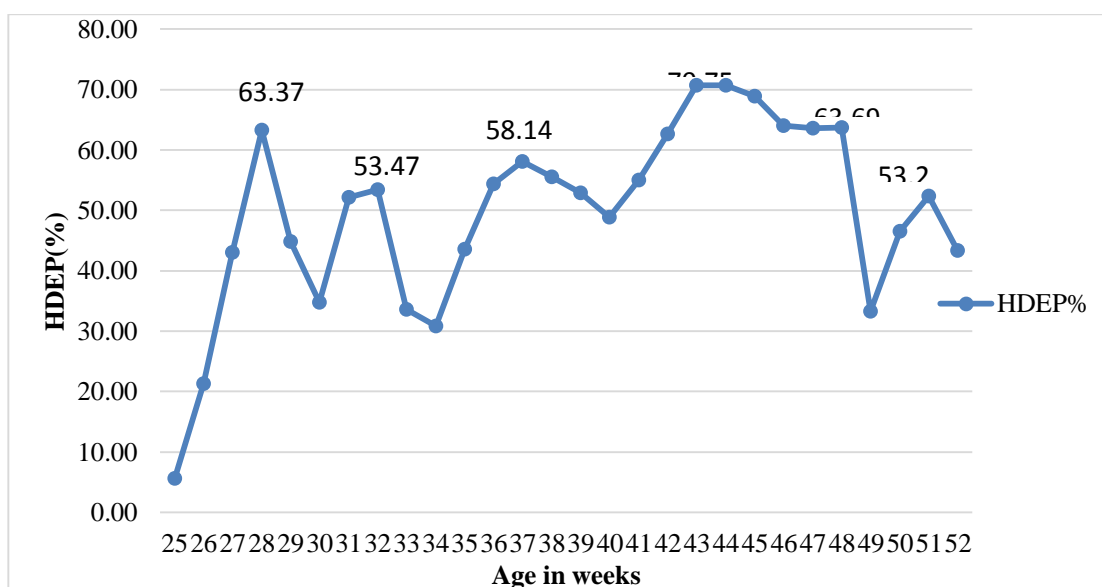


Fig 4.11: HDEP (%) of CSML x Hansli layers at different weeks of age

4.3.5 Summary of Production Performance of CSML x Hansli layers up to 52nd week of age

Age at sexual maturity

Laying performance parameters of CSML x Hansli birds up to 52nd week of age are presented in Table 4.15. The age at first lay was 170.00±0.27 days. Age at 10 %, 20 %, 30 %, 50% and peak production % were found to be 172.50±0.53 days, 178.88±0.64 days, 180.75±0.31 days, 186.62±0.65 days, 308.25±0.16 days respectively. Peak egg production % was 70.75±1.12 %.

The FCR per dozen of eggs from 25th to 52nd week of age was found to be 2.96 ± 0.03. and per kg of eggs mass was found to be 4.82 ± 1.23

Table 4.15 Summary of Production Performance of CSML x Hansli cross layers up to 52 weeks

Age at first lay	170.00±0.27 days
Age at 10% egg production (HDEP%)	172.50±0.53 days
Age at 20% egg production (HDEP%)	178.88±0.64 days
Age at 30% egg production (HDEP%)	180.75±0.31 days
Age at 50% egg production (HDEP%)	186.62±0.65 days
Age at peak egg production (HDEP%)	308.25±0.16 days
Peak egg production (HDEP %)	70.75±1.12
Avg. no. of eggs produced per hen (up to 40 weeks)	48.25±0.93
Avg. no. of eggs produced per hen (up to 52 weeks)	91.92±1.46
FCR (per dozen of eggs)	2.96 ± 0.03
FCR (per kg egg mass)	4.82 ± 1.23

4.3.6 External egg quality traits of experimental birds at different ages

The mean external egg quality parameters of CSML x Hansli cross birds at different age are represented on Table 4.16. The egg weight at 25th week of age was 43.29±1.23g which gradually increased to 53.00±1.73g at 52nd week of age. The egg weight significantly ($p \leq 0.05$) increased up to 52nd week of age. The shape index at 25th and 52nd week of age was 76.29±0.80 and 79.08±2.93 respectively. The shape index at 25, 30, 35, 40, 45 and 52 weeks of age were similar ($p > 0.05$).

Table 4.16 External egg quality traits of experimental birds

Age in weeks	Weight(g)	Length(mm)	Diameter(mm)	Shape index
25	43.29 ^d ±1.23	50.3 ^d ±0.23	38.39 ^e ±0.39	76.29 ^a ±0.80
30	45.28 ^{c,d} ±0.73	51.50 ^{c,d} ±0.47	39.56 ^{d,e} ±0.46	76.91 ^a ±0.83
35	47.57 ^{b,c} ±0.47	52.27 ^c ±0.24	40.54 ^{c,d} ±0.20	77.58 ^a ±0.37
40	49.70 ^{a,b} ±0.93	53.11 ^{b,c} ±0.40	41.59 ^{b,c} ±0.20	78.46 ^a ±0.57
45	51.45 ^a ±0.50	54.23 ^{a,b} ±0.34	42.81 ^{a,b} ±0.32	79.03 ^a ±0.77
52	53.00 ^a ±1.73	55.43 ^a ±0.81	43.85 ^a ±1.89	79.08 ^a ±2.93
P value	0.000**	0.000**	0.000**	0.193NS

^{a-c} Mean with different superscripts within a column differ significantly ($p \leq 0.05$). ** Mean values differ significantly ($p \leq 0.01$), NS-Non significant.

4.3.7 Internal egg quality traits of CSML x Hansli adult birds at different ages

The internal egg quality traits at different ages (30th, 40th, 45th, and 52nd weeks) are presented in Table 4.17. At 30th week of age the albumin weight was 27.15±0.84 g which gradually increased to 30.75±1.47g at 52nd week of age. The albumin weight was significantly ($p \leq 0.05$) increased up to 52nd week of age. Albumen weight at 30th and 40th week of age were not significantly different ($p \leq 0.05$). The yolk weight was increased gradually from 30th week of age (13.75±0.39 g) to 52nd week of age (16.80±0.36 g). At 30th week of age the shell weight was 4.38±0.21 g which gradually increased to 5.45±0.32 g at 52nd week of age. The shell weight was significantly ($p \leq 0.05$) increased up to 52nd week of age. The shell weight was not significantly different at 45th and 52nd weeks of age. Albumen ratio decrease significantly ($p \leq 0.05$) from 30th to 52nd week of age. Albumen ratio at 30th week of age was 59.52±1.07% decreased to

58.21±1.57% at 52nd week of age. The yolk ratio was increased gradually from 30th week of age (30.32±0.83 %) to 52nd week of age (32.10±1.03 %). The yolk ratio was significantly increased ($p \leq 0.05$) up to 52nd week of age. The shell ratio decreases significantly from 30th week to 52nd week of age. The albumin index was 0.0957±0.007 at 30th week of age. The yolk index at 30th week of age was 0.4392±0.017 which gradually increased to 0.4505±0.006 at 52nd weeks of age. The yolk index at 30th week was significantly ($p \leq 0.05$) increased up to 52nd week of age. The Haugh unit significantly ($p \leq 0.05$) increased from 30th week of age (81.99±1.82) to 52nd week of age (90.35±1.25). Shell thickness at 45th and 52nd weeks of age are not significantly different.

Table 4.17 Internal egg quality traits of CSML x Hansli layers

Age in week	Albumen wt.(gm)	Yolk wt.(gm)	Shell weight(gm)	Albumen ratio (%)	Yolk ratio (%)	Shell ratio (%)	Albumen Index	Yolk Index	Haugh Unit	Shell thickness (mm)
30	27.15 ^c ±0.84	13.75 ^d ±0.39	4.38 ^c ±0.21	59.52 ^a ±1.07	30.32 ^c ±0.83	10.15 ^a ±0.46	0.0957 ^b ±0.007	0.4392 ^c ±0.017	81.99 ^c ±1.82	0.15 ^c ±0.01
40	29.60 ^c ±1.08	15.50 ^c ±0.44	4.60 ^b ±0.17	58.90 ^b ±1.04	31.11 ^b ±0.79	9.99 ^{a,b} ±0.40	0.0990 ^b ±0.002	0.4421 ^c ±0.004	85.91 ^b ±0.78	0.24 ^b ±0.02
45	30.60 ^b ±1.50	15.85 ^b ±0.46	5.00 ^a ±0.18	58.86 ^{b,c} ±1.54	31.30 ^{a,b} ±1.34	9.84 ^b ±0.44	0.1002 ^a ±0.003	0.4452 ^b ±0.004	88.27 ^{a,b} ±0.99	0.29 ^a ±0.01
52	30.75 ^a ±1.47	16.80 ^a ±0.36	5.45 ^a ±0.32	58.21 ^c ±1.57	32.10 ^a ±1.03	9.69 ^c ±0.72	0.1026 ^a ±0.003	0.4505 ^a ±0.006	90.35 ^a ±1.25	0.32 ^a ±0.02
P value	0.000**	0.000**	0.000**	0.002**	0.001**	0.009**	0.036*	0.029*	0.001**	0.000**

^{a-d} Mean with different superscripts within a row differ significantly ($p \leq 0.05$). ** Mean values differ significantly ($p \leq 0.01$), * Mean values differs significantly ($p \leq 0.05$).

4.3.8 Mortality (%)

The mortality of CSML x Hansli cross layers from 21st to 52nd week of age recorded daily, and presented on weekly basis have been presented in Table 4.18. The mortality during the experimental period was 13.29%. The mortality was highest at 41st and 43rd weeks of age mostly due to cyclone Funy and post cyclonic effects.

Table 4.18 Mortality of CSML x Hansli adults

Age (Weeks)	No of birds died
21	1
22	1
26	1
28	1
29	1
37	1
41	4
43	5
44	2
47	2
Total	19
Mortality (21-52weeks)	13.29%

DISCUSSION

The prime objective of the present experiment was to evaluate the performance of CSML x Hansli crossbred chicken under intensive system of management. The main parameters studied are growth performance, feed conversion efficiency, mortality at different ages, linear body measurements, egg production and external and internal egg quality parameters. The results obtained from this investigation have been discussed in this chapter.

Body weight and body weight gain

The day-old body weight of CSML x Hansli crossbred chicken (34.49 ± 0.19 g) was higher than some native broiler crosses i.e. BN crosses (PB_2 x Indigenous) reported by different Rural Poultry Centers of AICRP on Poultry Breeding such as, Assam Agricultural University, Guwahati (32.43 ± 0.40 g) and Birsa Agricultural University, Ranchi (32.08 ± 0.24 g). The observed higher day-old body weight of chicks in present experiment as compared to BN crosses (PB_2 x Indigenous) could be due to higher egg weight of dam line which was used to develop the cross under study. Saadey *et al.* (2008) reported the day-old body weights of some broiler native crosses such as Fayoumi (F) x WL (31.73g), F x RIR (37.06g), (Sanai) S x WL (40.45g) and S x RIR (34.71g) which are higher than that of the cross under study. The measured day-old body weight of PD1 x PD4 cross (43.07 ± 0.042 g) was greater than that of CSML x Hansli crossbred chicken as observed by Padhi *et al.* (2014). The day-old body weight of above crosses is higher than that of the experimental chicks possibly due to the fact that the above cross was developed from two meat type chicken breeds.

The 8th week body weight of CSML x Hansli crossbred chicken (717.39 ± 5.68 g) was greater than that of other broiler native crosses (468 ± 33.1 g, Adedokun and Sonaiya 2002; 413 ± 8.12 g, Chaterjee *et al.*, 2002). The above body weight of the present experimental cross was more than that of BG1 (Local cocks (LC) x Exotic females (EF)) (702.0 ± 0.4 g), BG2 (exotic cocks (EC) x local females (LF)) (559 ± 0.26) as observed by Ndofor-Foleng *et al.* (2015). The above body weight of present experimental birds was greater than the various broiler native crosses of Fayoumi (F) x WL (362.57g), F x RIR (553.89g), (Sanai) S x WL (702.53g), S x RIR (430.09g), WL

× F(383.11g), RIR × F (537.57g), WL × S (610.57g) and RIR × S (400.68g) as evaluated by Saadey *et al.* (2008).

The 12th week body weight of CSML x Hansli crossbred chicken (1361.92±11.39g) was higher than BG1 (Local cocks (LC) × Exotic females (EF)) (1000±0.2g), BG2 (exotic cocks (EC) × local females (LF)) (920±0.0.1) as estimated by Ndofor- Foleng *et al.* (2015). The above body weight of present experimental cross was greater than the various broiler native crosses of Fayoumi (F) × WL (622.09g), F × RIR (821.81g), (Sanai) S × WL (757.90g), S × RIR (745.68g), WL × F(720.63g), RIR × F (819.69g), WL × S (632.18g) and RIR × S (680.36g) as measured by Saadey *et al.* (2008).

At16th week male and female birds of CSML x Hansli crossbred chicken attained a body weight of1894.75±49.54 g and1638.71±24.70g respectively and the body weight on combined sex basis was 1766.73±16.89g. The above body weight of the present experimental birds was greater than that of PD1 × PD4(1610.00 ± 18.16g), PD1 × PD3 (1515.00 ± 19.58g) and PD1 × IWI (1486.00 ± 14.71g) as observed by Padhi *et al.* (2015). The above body weight of CSML x Hansli crossbred chicken in present study was greater than the various exotic indigenous crosses of Fayoumi (F) × WL (916.18g), F × RIR (1005.14g), (Sanai) S × WL (1330.13g), S × RIR (1106.72g) as estimated by Saadey *et al.* (2008).

The 20th week body weight of the experimental birds were 2403.94±61.72 g (male) and 1900.95±27.29 g (female). The 20th week body weight of these birds were 2152.45±19.02 g on combined sex basis. The above body weight of birds was higher than that of Dahlem Red (1720± 33.22 g) and BN Cross (1590 ± 41.55 g) which were reared at ICAR Research Complex for NEH Region, Agartala (AICRP 2018). The 20th week body weight of experimental birds were lower than that of PD1 × PD4 (2534±44.17g), PD1 × PB2 (3093±65.61g), PD1 × PD3 (2404±57.20g) and PD1 × IWI (2323±46.81g) as reported by Padhi *et al.* (2015). The variations in body weight of CSML X Hansli cross growers as compared to other broiler native crosses could be due to the variations in the parents used to develop the crosses and the feeding managements followed. In the present experiment, restricted feeding was practiced during the grower phase (9 to 20 weeks).

The 40th week body weight of male and female of the experimental birds were 3379.55±34.96g and 2711.14±29.54g respectively. The above value of body weight was higher than that of Miri type chicken (male- 1507.00±44.70g, female- 1214.14±20.65g), Gramapriya (male- 2544.20±62.24g, female- 1810.42±60.38), Vanaraja (male-3323.00±64.08g, female- 2277.00±37.02g) as observed by Haunshi *et al.* (2009). The above body weight of experimental cross was higher than that of F1 cross (IWN x Native) (1468.39±19.05g) reared at Anand Agricultural University, Anand. The above body weight of CSML x Hansli was higher than that of Kadaknath (1530±17.3g), JBC (2067±19.5g) and CSML (2330 ±19.5 g) reared at Nanaji Deshmukh Veterinary Science University, Jabalpur. (AICRP 2018)

Growth is a polygenic inheritance. The difference in body weight of CSML x Hansli crossbred chicken as compared with other crosses possibly due to the gene pool of the lines/populations used to develop the crosses. The dam of the present experimental cross is a native breed Hansli, which exhibit a higher growth potential. This might be the reason for better growth in the present cross. The result in the present study is also tuned with the report of Hazel LN and Lamoreux WF (1947), who stated that the maternal genes had tremendous effect on variation in the body weight. The above comparison indicates that CSML x Hansli crossbred chicken have a good growth potential, which can lead to better commercial exploitation. The CSML (Coloured Synthetic Male Line) population used in the present study has an average weight of approximately 2250-2450 g at 20th week of age. The native Hansli breed, which was used as dam in the present study, has average body weight of approximately 1500-1600g (As maintained under AICRP breeding programme). The average body weight of the cross at 20th weeks (2152.45g) is higher than the mid parent data average body weight (around 2100-2200g), which indicates there is existence of heterosis in the body weight traits.

The 40th week body weight of this cross is also higher than other cross. This seems to be in a profitable direction and an economic trait of the cross when reared for meat purpose.

Feed conversion efficiency

The 8th week FCR of CSML x Hansli crossbred chicken was found to be 2.96 ± 0.02 , which was lower than that of Vanaraja (3.77) as reported by Debata *et al.* (2012). The above value of FCR was higher than that of Hansli \times CSML cross (2.26) as reported by Ekka *et al.* (2016) and is higher than that of PD1 \times PD4 (2.79) as observed by Padhi *et al.* (2015). The above value of FCR was lower than that of two Egyptian chicken strains such as MS (Mandarah x El-Salam) and SM (El-Salam \times Mandarah) whose FCR was 4.12 ± 0.06 and 4.45 ± 0.06 respectively as evaluated by Taha and AbdEl-Ghany (2013). The 8th week FCR of experimental birds was lower than that of RIFI (RIR male \times Fayoumi female) and FIRI (Fayoumi male \times RIR female) whose FCR was 4.68 ± 0.11 and 5.20 ± 0.10 , respectively as estimated by Khawaja *et al.* (2013).

From the above discussion, it is found that the FCR of CSML x Hansli crossbred chicks is lower than most other BN crosses.

Feed conversion efficiency is the ability to convert feed into body mass which is dependent on the nutrient content of the feed and the genotype. Therefore, the variation in FCR values of experimental birds as compared to other crosses could be attributed to those factors.

Mortality

In the present experiment, the mortality during chick phase (0-8 weeks) was 1.26% which was lower than that of Hansli (6.66%), CSML (8.88%) and Hansli \times CSML (7.77%) as reported by Ekka *et al.* (2016). The above value of mortality of CSML x Hansli crossbred chicken was lower than that of some crossbred such as E (Acre broiler) \times NL (normal local) and his reciprocal cross NL \times E whose mortality rate was found to be 10.55% and 15.40% respectively as studied by Nwachukwu *et al.* (2006).

Mortality during grower phase was 2.78% which was lower than the mortality during grower phase for Kadaknath, Jabalpur colour, CSFL, Kadaknath crosses, PD1 \times PD4 crosses have been reported as 6.80%, 8.4%, 16.9%, 4.1% and 8.55% (AICRP Annual Report, 2017- 2018). The above value of mortality of the experimental birds during grower phase was similar to the mortality of RIFI (RIRmale \times Fayoumi female)

($2.80 \pm 0.23\%$) and FIRI (Fayoumi male \times RIR female) ($2.69 \pm 0.13\%$) as reported by Khawaja *et al.* (2013). The above value of mortality was lower than that of some crossbred E \times NL (5.70 %) and it's reciprocal cross NL \times E N (8.51 %) as observed by Nwachukwu *et al.* (2006).

The mortality of the experimental cross during laying (20th – 52nd week) period was 13.29%. the above value of mortality was higher than that of Dahlem Red (6.5%), BN cross (5.1%) which was reared at ICAR Research Complex for NEH Region, Agartala. The above mortality of experimental birds was higher than Kadaknath (3.70%), Jabalpur colour line (2.88%), Kadaknath Crosses (4.16%) reared at Nanaji Deshmukh Veterinary Science University, Jabalpur. The experimental cross had higher mortality than RIR (6.75%), Mewari (2.50%) and CSFL (8.33%) which were reared at Maharana Pratap University of Agriculture & Technology, Udaipur. (AICRP 2018)

From the above study, it is found that the mortality rate of experimental birds at chick phase and grower phase was lower than that of other cross which could be due to higher disease resistance inherited from the Hansli population which was used to develop the experimental cross and better management. But the mortality rate at adult phase was higher than the other crosses due to heat stress and other climatic effects like cyclone.

Linear Body Measurements

The 8th week shank length of males and females of present experimental birds were 8.29 ± 0.05 cm and 7.85 ± 0.04 cm respectively. The above shank length (SL) of birds under present investigation was higher than that of the crossbred lines of two Egyptian chicken strains such as MS (Mandarah \times El-Salam) (6.64 ± 0.02 cm) and SM (El-Salam \times Mandarah) (6.69 ± 0.01 cm) as reported by A.E. Taha and AbdEl-Ghany (2013). The above shank length of birds under experiment was lower than that of PD1 \times PD4 crosses (8.62 ± 1.01 cm and 8.1 ± 0.87 cm), PD1 \times PB2 (8.58 ± 0.62 cm and 8.08 ± 0.68 cm) as reported by Padhi *et al.* (2015). The above shank length of experimental cross was lower than that of Normal Feather (9.98cm), Naked neck (9.63cm), Marshall broiler (8.02cm), Frizzle feather (9.62cm) as reported by Atansuyi *et al.* (2017).

At 8th week of age the keel length of CSML \times Hansli males was 11.20 ± 0.17 cm which was significantly ($p < 0.05$) higher than those of females (8.85 ± 0.23 cm). The

above keel length (KL) of the experimental cross was higher than that of two crossbred line of two Egyptian chicken strains such as MS (Mandarah x El-Salam) and SM crosses (El-Salam X Mandarah) as reported by Taha and AbdEl-Ghany (2013). They evaluated that the keel Length (KL) at 8th week of age of both male and female of MS (Mandarah x El-Salam) were 8.33 ± 0.02 cm and 8.31 ± 0.02 cm respectively, which were lower than that of present experimental birds. Shank Length (SL) of female of SM crosses (El-Salam X Mandarah) was 8.36 ± 0.01 cm which was lower than that of female under the study. The above keel length of present cross was higher than that of NM(Normal) X WL (White Leghorn) cross whose KL was 5.24 ± 0.04 cm as measured by Adedeji *et al.* (2006). Adedeji *et al.* (2015) conducted a study to assess the growth performance of (Giriraja) Gr male X Alpha female, reciprocal Alpha Male X Gr female and Alpha Male X White Leghorn (WL) female crosses. The 8th week keel length of CSML x Hansli crossbred chicken was lower than that of above birds whose KL were 14.77 ± 0.26 cm, 13.80 ± 0.66 cm and 12.13 ± 0.23 cm respectively.

The body length of males of CSML x Hansli crossbred chicken was 47.80 ± 1.50 cm, which was higher than those of female (36.63 ± 0.57 cm). The breast angle of males was found to be $45.33\pm 0.99^\circ$ which was higher than those of females with breast angle of $36.87\pm 1.16^\circ$.

The chest girth of the male (26.15 ± 0.43 cm) and female (24.21 ± 0.33 cm) of experimental birds at 8th week of age were higher than those of Normal Feather (20.92 ± 0.42 cm), Naked neck (27.22 ± 0.30 cm), Marshall broiler (20.12 ± 0.25 cm), Frizzle feather (23.05 ± 0.25 cm) as observed by Atansuyi *et al.* (2017).

At 12th week of age the Shank length (SL) in male and female of experimental birds were 8.72 ± 0.08 cm and 8.37 ± 0.04 cm respectively. The above shank length is higher than that of both male and female of MS (Mandarah x El-Salam) whose SL were 7.75 ± 0.02 cm and 7.71 ± 0.02 cm respectively as reported by Taha and AbdEl-Ghany (2013). The above SL of CSML x Hansli crossbred chicken was higher than that of female birds of SM crosses (El-Salam X Mandarah) (7.79 ± 0.01 cm).

At 12th week Keel lengths (KL) of male and female birds of present experimental birds were 11.50 ± 0.12 cm and 9.79 ± 0.17 cm respectively. The above value of KL was higher than that of males and female birds of MS (Mandarah x El-Salam) whose keel

length at 12th week were $8.98\pm 0.02\text{cm}$ and $8.97\pm 0.02\text{cm}$ respectively as observed by Taha and AbdEl-Ghany (2013). The above KL of present experimental cross was higher than that of NM(Normal) X WL (White Leghorn) ($7.23\pm 0.05\text{ cm}$) as reported by Adedeji *et al.* (2006). Adedeji *et al.* (2015) evaluated the growth performance of Gr male X Alpha female, reciprocal Alpha male X Gr female and Alpha male X White Leghorn (WL) female crosses. The 12th week KL of CSML x Hansli crossbred chicken was lower than that of the above birds whose keel length were $21.62\pm 0.41\text{cm}$, $21.90\pm 0.71\text{cm}$ and $16.87\pm 0.35\text{cm}$ respectively.

The 12th week Breast Angle in male and female birds of CSML x Hansli crossbred chicken were $50.40\pm 1.31^\circ$ and $41.80\pm 1.43^\circ$ respectively. The BA of males were significantly higher than those of females.

At 20th week of age, the Shank length (SL) in male and female birds ($9.85\pm 0.17\text{cm}$ and $9.11\pm 0.09\text{cm}$) of present experimental cross were lower than that of PD1 X PD4 crosses ($13.16 \pm 1.23\text{cm}$ and $10.73 \pm 0.48\text{cm}$) and PD1 X PB2 ($13.56 \pm 1.09\text{cm}$ and $11.27 \pm 0.98\text{cm}$) as estimated by Padhi *et al.* (2015).

The 20th week Keel length (KL) in male ($14.26\pm 0.09\text{ cm}$) and female birds ($12.70\pm 0.35\text{ cm}$) of CSML x Hansli crossbred chicken were lower than that of PD1 X PD4 crosses ($15.19 \pm 1.23\text{cm}$ and $13.99 \pm 0.94\text{cm}$) as evaluated by Padhi *et al.* (2015). The above KL of present experimental birds was higher than that of NM(Normal) X WL (White Leghorn) ($11.10\pm 0.08\text{ cm}$) as observed by Adedeji *et al.* (2006).

The above observation indicates that the shank length of different crosses at 8th week of age varies between 6.64cm to 9.98cm. according to the present finding, the shank length at 8th week of age is within this range. This could be due to the use of CSML population as sire, which has lower shank length. The keel length at 8th week of age is within the range of earlier data reported by different scientist. At 12th week, the keel length of different crosses varies between 7.23cm to 8.9 cm. The present experiment showed a higher keel length at 12th week. Hence the variations in the linear body parameters of the experimental cross, as compared to observed values in the other crosses are justified.

Age at sexual maturity of females (ASM)

The age at first lay of egg in CSML x Hansli crossbred chicken under present experiment was 170.00 ± 0.27 days. The above ASM value of experimental birds was higher than that of Fayoumi x RIR (151 days) and RIR x Fayoumi (147 days) as observed by Rahman *et al.* (2004). The above value of ASM of experimental birds was somewhat similar to the various crosses such as CB (Cool ecotype \times Broiler), BC (Broiler \times Cool ecotype), WB (Warm ecotype \times Broiler) and BW (Broiler \times Warm ecotype) whose ASM were 171 ± 11.6 , 175 ± 10.8 , 159 ± 15.5 and 140 ± 12.2 days respectively, as reported by Munisi *et al.* (2015). The above value of ASM of the experimental birds was lower than that of SL (Baladi Saudi X White leghorn) and LS (White leghorn X Baladi Saudi) whose ASM were 179.3 ± 12.8 days and 168.5 ± 12.7 days respectively as estimated by Khalil *et al.* (2004).

The ASM of broiler parent line CSML and native Hansli population are 182 days and 173 days respectively (AICRP, 2018). The ASM of 170.00 ± 0.27 days is less than the mid parent data *i.e.* 177.5 days (Calculated from seven generations of CSML flock and three generations of native Hansli maintained in this farm).

The ASM data of the cross being less than the mean ASM of parent lines, indicate negative heterosis of the character. This negative heterosis seems to be in a desirable direction and an important favorable character of the cross when maintained for egg laying.

Egg production

The 40th week egg production of the CSML x Hansli crossbred chicken was 48.82 ± 0.83 per hen which was lower than the 40th week egg production of PD1 X PD4 cross (70.50 ± 0.44) as estimated by Padhi *et al.* (2015). The 40th weeks egg production of the experimental birds was almost similar to BND (31.68), DBN (35.06), BN (41.27) crosses and Kamrupa (48.1) a dual purpose (AICRP 2018). The above value of egg production was higher than that of Miri Type chicken (33.59 ± 0.997), Gramapriya (26.82 ± 1.622), Vanaraja (13.37 ± 1.097) as observed by Haunshi *et al.* (2009).

The 52nd week hen day egg production of experimental birds were 43.33 ± 5.24 . This value was higher than that of Miri Type chicken (31.24 ± 0.72), Gramapriya

(32.35±1.09), Vanaraja (25.86±1.22) as observed by Haunshi *et al.* (2009). The above value of HDEP of experimental birds was higher than that of different generations of native breed of Himachal Pradesh i.e. G₁ (57.58), G₂ (63.58), G₄ (72.45), and lower than G₃ (83.33) as observed by Dinesh (2018).

The weekly hen day egg production (HDEP%) of CSML x Hansli crossbred chicken showed multiple peaks between 20th to 52nd week of age. But the peak egg production i.e. 70.75±1.12 % was observed at 44th week of age. The multiple peak of HDEP% was observed in some indigenous chicken of Kerala observed by Kumar *et al.* (2016). These type of multiple peaks in HDEP% was also observed in Aseel and Kadaknath breeds of chicken as observed by Haunshi *et al.* (2013). The above type of multiple peak is also observed in purebred Bresse-Gauloise and crossbred Bresse-Gauloise × New Hampshire by Lambertz *et al.* (2018).

The 40th week egg production of CSML and native Hansli are 52.24 and 20.18 respectively (AICRP 2018). The 40th week egg production of this cross was higher than that of the mid parent. The 52nd week egg production of the experimental cross also follows the same order. CSML is used for meat purpose and produces 107 eggs per annum under backyard rearing (AICRP 2018). As CSML males and Hansli females were used to develop the cross, the egg production was very high. The multiple peak in the HDEP% during their laying period of the experimental cross may be due to brooding, molting and temperature change such as heat stress and cold stress etc.

Production performance

The peak egg production of CSML x Hansli bird was 70.75±1.12 %. The peak egg production of experimental bird was higher than that of some pure breeds i.e. Delham red (58.78 %), Vanaraja (52.15%), and some crossbreeds like Giriraja x Delham Red (52.71%), Delham Red x White Leghorn (51.23%), Giriraja x Asselkala (52.17%), Delham Red x Giriraja(54.87%), Asselkala x Giriraja (53.25%) as estimated by Bharambe and Garud (2012). The above value of peak egg production was higher than that of Aseel(67.57%) and lower than that of Kadaknath (75.56%) as observed by Haunshi *et al.* (2013).

The peak egg production depends on the genotype and suitable environment. So, the difference in the peak egg production between different breeds is due to difference in the above characters.

The FCR per dozen egg of the CSML x Hansli cross was 2.96 ± 0.03 . The said value of FCR per dozen egg was higher than that of some pure breeds i.e. Delham red (1.40), Vanraja (1.42), and some crossbreeds like Giriraja x Delham Red (1.45), Delham Red x White Leghorn (1.32), Giriraja x Asselkala (1.44), Delham Red x Giriraja (1.33), Asselkala x Giriraja (1.35) as estimated by Bharambe and Garud (2012). The above FCR per dozen egg of the experimental bird was lower than that of the crossbreed like Dominant Red Barred(DR) (3.18), Dominant Sussex (DS) (3.39), Lohmann-Dual (LD) (3.45), NOVOgen Brown (NB) (3.08), NOVOgen Color (NC) (3.26), and local Koekoek (KK) (3.77). The ExpCb were (dams \times sires) DR \times KK (R \times K) (3.43), DS \times DR (S \times R), (3.06) and KK \times DS (K \times S) (3.45) as observed by Ibrahim *et al.* (2019).

The FCR per kg egg mass of CSML x Hansli crosses was 4.82 ± 1.23 . The above value of FCR was lower than that of Desi (8.70 ± 0.20), Fayoumi (6.79 ± 0.25), RIR (5.02 ± 0.26) as observed by Khawaja *et al.* (2012). The above value of FCR of the experimental birds was higher than that of Blue White Leghorn (2.20), Burgundy White Leghorn (2.44), Black White Leghorn (2.31), Columbia Plymouth Rock (2.54), Barred Plymouth Rock (2.36), Rhode Island Red (2.31), Babcock 300 (1.98), Shaver White (2.02), Shaver 2000 (1.94), Shaver 579 (2.07) as estimated by Silversides (2010).

Feed conversion efficiency during laying period is defined as the ability to convert feed into egg which is dependent on the nutrient content of the feed, the genotype, temperature humidity index and type of housing. Therefore, the variation in FCR values of experimental birds as compared to other crosses could be attributed to those factors.

Egg quality traits

The profitable egg quality traits are of immense importance to poultry breeding industries (Bain 2005). The embryonic development is dependent on some important traits like egg weight, yolk and albumen weights, generic line and age of hen (Finkler *et al* 1998; Onagbesan *et al* 2007).

Egg quality, reproductive fitness and body weight of chicken parents are dependent on the egg weight which is one of the most important phenotypic traits (Faruque *et al* 2013). The fact is that the egg weight is direct proportional to albumen weight, yolk weight and shell weight that it contains and this varies significantly between strains of hen (Pandey *et al.* 1986). The initial egg weight of CSML x Hansli crossbred chicken was 43.29 ± 1.10 g. The above egg weight of experimental birds was higher than that of RIR X Deshi Dwarf (32.08g) and Fayoumi X Deshi Normal (32.03g) as reported by Yeasmin *et al.* (2003). The above egg weight of experimental cross was higher than that of Fayoumi X Deshi Dwarf and WLH X Deshi Dwarf whose initial egg weight were 30.51g and 31.12g respectively as evaluated by Yeasmin *et al.* (2003).

The 40th week egg weight of CSML x Hansli crossbred chicken was 49.70 ± 0.93 g. The above egg weight of experimental birds was higher than that of the F1 cross (IWN x Native) (45.15 ± 0.43 g) which was evaluated at Anand Agricultural University, Anand (2018). The above 40th week egg weight of experimental birds was higher than that of BN cross (PB x Indigenous). Assam Agricultural University, Guwahati evaluated the performance of BN cross under farm condition and the weight of 40th week egg was found to be 47.50 ± 6.60 g. The above egg weight of CSML x Hansli crossbred chicken was somewhat similar to that of BN cross (50.89 ± 1.01 g) as reported by ICAR Research Complex for NEH Region, Agartala. However, the egg weight of present crossbred chicken at 40th week of age was lower than the egg weight of PD1 X PD4 cross (54.52 ± 0.59 g) as evaluated by Padhi *et al* (2015).

The initial egg weight of the birds under present investigation was 43.29 ± 1.23 g. The egg weight of birds at 52nd week of age was 53.00 ± 1.73 g. Padhi *et al.* (2014) recorded that the egg weight in Vanaraja Male Line increased with increase in age.

From the cited literature it is found that the egg weight of different crosses involving native and improved chicken populations at the start of lay ranges from 30.15g to 32.08g and at 40 weeks it ranges between 50.89g to 54.52g. The present investigation shows that the egg weight is much higher at initial stage as compared to other crosses. But with advancement of age, the egg weight becomes similar to the egg weight in different crosses.

The shape index (SI) at 25, 30, 35, 40, 45 and 52 weeks of age were 76.29 ± 0.80 , 76.91 ± 0.83 , 77.58 ± 0.37 , 78.46 ± 0.57 , 79.03 ± 0.77 , 79.08 ± 2.93 which were statistically similar ($p > 0.05$). The shape index of the egg of CSML x Hansli crossbred chicken at 40th week of age was 78.46 ± 0.57 . The above value of present experimental cross was higher than that of Vanaraja (75.6) and Gramapriya (76.9) as reported by Niranjana *et al* (2008). The above shape index of experimental bird was higher than that of CB (Cool ecotype X Broiler), BC (Broiler X Cool ecotype), WB (Warm ecotype X Broiler) whose shape index were 62.4 ± 8.2 , 74.03 ± 3.7 and 75.2 ± 4.7 respectively as evaluated by Munisi *et al.* (2015). From the cited literature it is found that the shape index of different chicken populations at 40th week ranges from 62.4 to 76.9. The shape index of egg of birds under present investigation were found to be within normal range (72-79). The normal shape index indicates a normal shaped egg which is of aesthetic value to the consumers and it can be properly set in setter and show good hatchability.

Shape index did not show any significant ($P < 0.05$) difference between different age of measurements. Age don't have any significant effect on shape index in broiler laying hen, as reported by Tumova and Gous (2012).

The Haugh unit (HU) value of eggs of CSML x Hansli crossbred chicken at 30th week of age was 81.99 ± 1.82 which was within normal range. The HU value obtained in the present experiment at 40th week of age (85.91 ± 0.78) was also within the normal range. However, the above value was higher to that of Vanaraja (77.1) and Gramapriya (75.4) as observed by Niranjana *et al* (2008). The above value of HU of experimental cross was higher than that of F1 progeny (Barred Plymouth Rock (BPR) X RIR) and Indigenous Chicken (IC) whose Haugh unit were 83 and 72.8 respectively as evaluated by Gikunju *et al.* (2018).

From the above cited literature, it is found that the Haugh unit of different chicken populations ranges from 75.4 to 83. The present investigation shows that the value of Haugh unit of CSML x Hansli crossbred chicken at 40th week of age is higher than the above value. The higher Haugh unit values indicates superior quality of albumen, this could be due to the Native genotype used to develop the cross in the present study.

Approximately 60% of an egg weight is contributed by Albumen and thus has a major influence on the internal quality of the egg. At 30th week of age the weight of albumin was 27.15 ± 0.84 g which gradually increased to 30.75 ± 1.47 g at 52nd week of age. The albumin weight was significantly ($p \leq 0.05$) increased up to 52 weeks of age. Albumen weight increases gradually with increase in age was observed by Silversides *et al.* (2006) and decrease in weight of albumen at 40th week compare to 28th week also reported by Rajkumar *et al.* (2009). The yolk weight of present experimental bird was 13.75 ± 0.39 g at 30th week and significantly ($p \leq 0.05$) increased to 16.80 ± 0.36 g at 52nd week. Yolk weight increases gradually with increase in age along with egg weight. Increase in yolk weight with increase in age in chickens were observed by (Suk and Park, 2001; Silversides *et al.*, 2006; Niranjana *et al.*, 2008; Rajkumar *et al.*, 2009).

The albumen index is a most important trait of egg which indicates the firmness and viscosity of the egg. The albumin indexes were 0.0957 ± 0.007 and 0.1026 ± 0.003 at 30th and 52nd week of age which did not vary with advancement of age. These findings are in tune with the results of Singh *et al.* (2009) in hill fowl. The yolk index at 30th week of age (0.4392 ± 0.017) was significantly ($p \leq 0.05$) increased up to 52nd week of age (0.4505 ± 0.006). The yolk index varied significantly among different age groups. Similar findings were recorded in some crosses like Vanaraja and Gramapriya by Niranjana *et al.* (2008) whereas lower indices were reported by other scientists.

Reproduction performances of some recently developed chicken varieties as compared to CSML X Hansli cross:

Data on the performance of some recently developed chicken varieties and the cross under study has been presented in a tabular form below. The ASM of CSML X Hansli is comparable with those of Jharsim, Narmadanidhi, Gramapriya varieties but higher than Kamarupa variety (151.30 days). However, the ASM of Vanaraja and Kaveri, were higher than the CSML X Hansli cross.

The 40-week egg production (no of eggs/hen) of Hansli X CSML cross was similar to those of Kamrupa (49.5), higher than Jharsim (41.17) and Vanaraja (38.41) varieties but lower than Kamarupa (49.5), Narmadanidhi (66) and Gramapriya (72.31). The 52 weeks egg production of CSML X Hansli is comparable with Jharsim and Kamarupa Varieties. The 40-week egg weight of CSML X Hansli cross was comparable with Narmadanidhi variety but lower than Kamarupa, Kaberi, Vanaraja and Gramapriya varieties.

PARAMETER	CSML x HANSLI	JHAR SIM	KAMA RUPA	KAB ERI	NARMAD ANIDHI	VANA RAJA	GRAMA PRIYA
ASM (days)	172.50 ±0.53	171	151.30 ± 5.30	183	169	187.8 ±0.06	176.02 ±0.05
40 wk. egg production (No. / hen	48.25 ±0.93	41.17	49.5	-	66 ±2.7	38.41 ±0.05	72.31 ±0.04
52 wk. egg production (No. / hen	91.92 ±1.46	96.98	90.3	-	-	-	-
40 wk. egg weight (g)	49.70 ±0.93	-	54.20 ± 2.60	56	49.5	58.5 ±0.01	57.17 ±0.01

SUMMARY AND CONCLUSION

The present experiment was conducted to evaluate the growth and reproductive performance of CSML x Hansli crossbred chicken. The research work was conducted in the Post Graduate Department of Poultry Science under the Faculty of Veterinary Science and Animal Husbandry, Odisha University of Agriculture and Technology, Bhubaneswar. Two hundred forty-day old CSML X Hansli cross bred chicks were randomly distributed in 3 replicate groups to have 80 chicks per replicate group. The chicks of each replicate group were housed in separate pens and reared under intensive system of management. The chicks were provided with ad-libitum feeding up to 8th week of age. Restricted feeding was being practiced from 9th week to 20th week of age. From 21st week to 52nd week the birds were provided @110g of feed per bird. Proper vaccination schedule and medication will be followed. Birds were reared up to 52 weeks of age. Growth, FCR, linear body measurements and egg production traits were recorded.

The mean day-old body weight of CSML x Hansli crosses was found to be 34.49±0.19 g. The mean 8th week body weight was 717.39±5.68g.

The 12th week body weight of the experimental cross were 1436.39±22.48g (male) and 1287.45±15.92 (female). The 16th week body weight of male and female of the cross under study was 1894.75±49.54g and 1638.71±24.70g respectively. At the end of the grower phase (20th week) the experimental cross attained a body weight of 2403.94±61.72g and 1900.95±27.29g for male and female respectively. The 40th week body weight of the cross under study was 3379.55±34.96g and 2711.14±29.54g for male and female respectively. The 8th week FCR of the cross under study were recorded as 2.96±0.02. In the present research the mortality during chick stage (0-8 weeks) was recorded as 1.26%. The mortality during grower phase at age of 9th to 20th week of CSML x Hansli cross was 2.78 %. During laying phase (21- 52 weeks) the mortality was recorded as 13.29%. The 8th week shank length of experimental cross was found to be 8.29±0.05 cm and 7.85±0.04cm for male and female birds respectively. The keel length of CSML x Hansli cross males (11.20±0.17 cm) was significantly ($p \leq 0.01$) higher than that of females (8.85±0.23 cm). The 20th week shank length was 9.85±0.17 cm and 9.11±0.09 cm for male and female respectively. The 20th week keel length of male and female of the experimental cross were 14.26±0.09 cm and 12.70±0.35 cm respectively. The shank length obtained in the experimental cross was higher than some other crosses.

The age at first lay of egg in the experimental cross was 170.00 ± 0.27 days. The average number of eggs produced per hen up to 40 and 52 weeks were 48.25 ± 0.93 and 91.92 ± 1.46 respectively. Weight of first egg laid $43.29^d \pm 1.23$ g. The peak egg production (HDEP) % was estimated as $70.75 \pm 1.12\%$ at the age of 308.25 ± 0.16 days in the present cross. The HDEP% of CSML x Hansli cross was comparable with other established dual-purpose bird, such as Vanaraja, Naked neck, Kamarupa and Srinidhi. The age at sexual maturity in females in the present research was found higher than other crosses. The 40th week HDEP of the cross under study was 48.82 ± 0.83 per hen.

The external egg quality traits of experimental birds were recorded. The mean egg weight gradually increased with age from 25th week (43.29 ± 1.23 g) to 52nd week (53.00 ± 1.73 g) of age. It was found that the egg weight significantly ($p \leq 0.05$) increased up to 52nd week of age.

The shape index of egg of the cross under study at 25th and 52nd week of age was 76.29 ± 0.80 and 79.08 ± 2.93 respectively. The shell weight of the present cross was increased gradually from 30th week (4.38 ± 0.21 g) to 52nd week (5.45 ± 0.32 g). At 30th week of age the albumen weight was 27.15 ± 0.84 g which gradually increased to 30.75 ± 1.47 g at 52nd week of age. The albumen weight significantly ($p \leq 0.05$) increased up to 52 weeks of age. The yolk weight of present cross was increased gradually from 30th week (13.75 ± 0.39 g) to 52nd week (16.80 ± 0.36 g). The Haugh unit (HU) value obtained in the present experiment increased gradually from 30th week (81.99 ± 1.82) to 52nd week (90.35 ± 1.25). Albumen index increased significantly ($p \leq 0.05$) from 30th week (0.0957 ± 0.007) to 52nd week (0.1026 ± 0.003) of age. The yolk index and shell thickness were increased gradually from 30th week to 52nd week of age.

Based on the available literature and the results obtained from the present investigation, it may be concluded that the CSML x Hansli crossbred chicken could be a potential dual type chicken variety with performance comparable with ruling varieties such as Kamarupa, Narmadanidhi and Jharsim.

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