Indian Journal of Animal Sciences **96** (4): 297–301, April 2026/Article
https://doi.org/10.56093/ijans.v96i4.171804

Heritability estimates for growth traits and response to selection on egg production in Desi chicken breed (Khukhri)

RAVINDRA KUMAR[1✉], DHAWAL KHANT YADAV[2], NISHANT PATEL[3], NANDANI KUMARI[4] and K T KRISHNAGUPTA[5]

Birsa Agricultural University, Kanke Ranchi Jharkhand 834 006 India

Received:16 September 2025; Accepted: 25 June 2026

ABSTRACT

This research aimed to assess heritability and selection response for body weight of Desi chickens at 0, 8, 12, 16, and 20 weeks of age, shank length at 8 and 16 weeks, and egg production up to 322 days, focusing on developing a dual-purpose breed. Data were gathered across five generations, and the response to selection was recorded. The heritability estimates for body weight were moderate up to 16 weeks of age but low at 20 weeks, indicating that body weight can be enhanced through selective breeding of the birds. The correlations between genotype and phenotype for growth traits were found to be high. A sex effect was noted, with males showing a greater response than females. Following five generations of selection, the pooled body weight of hens and cocks at 20 weeks increased by 148.94g. The increase in shank length was minimal. Heritability for shank length at 8 weeks was moderate. In the fifth generation, egg production showed an improvement of 20 eggs when compared to the first generation. The findings indicated that the desi chicken can be enhanced, making it a promising dual-purpose indigenous breed suitable for free-range and semi-intensive rearing systems.

Keywords: Body weight, Desi chicken, Egg production, Heritability, Selection response, Shank length

Enhancing chicken breeds for body weight in India involves a comprehensive strategy that combines selective breeding, optimal nutrition, and efficient management techniques. Numerous regions in India face challenges related to malnutrition and shortages of vital vitamins, minerals, and proteins. To address this issue, various improvement strategies are implemented, offering chicken varieties that grow more quickly and exhibit disease resistance. Selecting for body weight across generations is one effective strategy that has shown positive results (Larivière *et al*. 2009). The average market weight of indigenous chicken stands at only 625±10.9 g (Kumaresan *et al*. 2008). Crossbreeding with a commercial breed can lead to satisfactory improvements (Larivière and Leroy, 2003). Enhanced chicken varieties have demonstrated greater body weight (Haunshi *et al.* 2009). Following 34 generations of selection, Slovenian chickens recorded an increase in body weight of approximately 2,220 g for males and 1,860 g for females (Flisar *et al.* 2014). Heritability estimates for body weight in Indian conditions range from 0.37 to 0.39 (Haunshi *et al.* 2012) with a notable increase in body weight among Desi chickens in India (Haunshi *et al.* 2022).

Improving local chicken breeds for both body weight and productivity is vital for fostering sustainable poultry farming in India. Through selective breeding, genetic improvements, and optimized management methods, it becomes feasible to achieve significant productivity gains while maintaining the unique benefits of local breeds. This comprehensive approach will not only satisfy the rising demand for poultry meat but also bolster the livelihoods of rural farmers and enhance the overall resilience of the agricultural sector.

MATERIALS AND METHODS

The experiment was conducted following the approval of the Institutional Animal Ethics Committee of Ranchi Veterinary College as per CPCSEA guidelines. The research took place at the poultry farm within Ranchi Veterinary College, BAU, Jharkhand, situated at 23°22′N 85°20′E with humid subtropical climate.

A total of 1,000 chicks over five generations, averaging 100 chicks per generation, were assessed in this study. Identification was achieved by placing wing bands at the time of hatching, and vaccinations were administered

Present address: [1] Associate Professor and Head, Department of Livestock Production and Management, Ranchi College of Veterinary Sciences and Animal Husbandry, Kanke, Ranchi, Jharkhand 834 006.[2]Scientist. ICAR–National Research Centre on Camel (NRCC), Jorbeer, Bikaner, Rajasthan 334001, India. [3]Assistant Professor, Department of Livestock Production Management, [4] Head, Department of Animal Genetics Breeding, College of Veterinary Science, [5]M. V. Sc. Scholar, Department of Livestock Production Management, Birsa Agricultural University, Kanke, Ranchi, Jharkhand 834 006. ✉Corresponding author email: ravindrarvcbau@gmail.com

according to the layer birds' schedule. The chicks were housed in a deep litter system across brooder, grower, and layer facilities. Until they reached 20 weeks, the chicks were collectively housed in a brooder cum grower facility irrespective of sex, after which they were moved to designated layer houses. After this period, they were separated based on morphological characteristics and raised in open-sided cage houses. To shield them from rain, heat, and cold, protective curtains were installed.

Phase feeding was implemented for the birds. For the initial eight weeks, the chicks were fed a starter diet consisting of 2600 kcal/kg metabolizable energy (M.E.) and 18% crude protein (C.P.). From weeks nine to twenty, a grower diet providing 2500 kcal/kg M.E. and 16% C.P. was given, and a pre-layer diet (a blend of grower and layer rations in equal parts) was fed from day 21 until the flock laid its first egg. Afterwards, the layers received a layer feed that had 2600 kcal/kg M.E. and 16% C.P. The birds had free access to clean drinking water and feed at all times. The hens were exposed to light for sixteen hours daily. During the study period, standard medical protocols were followed. The mortality rates observed from the first to the fifth generations of the flock were 6.45, 9.38, 12.05, 8.27, and 11.13, respectively.

Initially, the population was bred randomly, but after the first generation, selection for higher body weight at 20 weeks was initiated through mass selection. Hens (ranging from 100 to 120) were housed in individual cages to monitor their laying and growth performance, while roosters (10 to 15), with greater body weight, were kept separately up to 20 weeks. Mating occurred at a ratio of 1:3 through artificial insemination to produce the next generation.

Growth traits: The body weight was measured at 0, 8, 12, 16, and 20 weeks, as well as shank lengths at 8 and 16 weeks of age, for all surviving birds with a pooled sex accuracy to a minimum of 0.1g and 0.01mm. At 20 weeks of age, body weight was recorded based on sex. An average of 100 birds from each generation were used to document body weight and shank length.

Production traits: A total of 100, 102, 110, 100, and 100 hens were individually housed from the first to the fifth generation. The production traits examined included age at first lay, egg production over 322 days, and egg weight. The weights of the eggs were recorded for those produced over three consecutive days.

Statistical analysis: Descriptive statistics were employed to calculate mean and standard error for each trait. Regression analysis, involving a plot of the average of each trait (generation means) against generation numbers, was conducted to investigate the performance trends across generations (MS Excel 2019). Least-squares means, heritability estimates, as well as genetic and phenotypic correlations for growth traits were determined through mixed model least squares and maximum likelihood methods using the computer program (PC-2 version) as previously described (Haunshi *et al*. 2021). Variance was divided into components attributable to sires, dams, and the combined sire and dam effects (Becker 1992). The Pearson correlation coefficient between growth and production traits was calculated utilizing SPSS.

RESULTS AND DISCUSSION

Reproductive traits: Improved fertility and hatchability were noted in the successive generations of the desi breed. The highest recorded fertility was 92.8%, while the lowest was 87.1%, resulting in an overall average of 90.1%. Similarly, enhanced hatchability was observed across generations. The highest hatchability recorded was 91%, and the lowest was 88.1%, yielding an average hatchability of 89.8% (FES). The hatchability across total egg sets ranged from 77.3% to 83.1%. Thus, the Desi breed consistently exhibited higher average fertility and hatchability rates with no noticeable generational variations in these metrics. From both economic and quality viewpoints, enhanced hatchability and fertility are advantageous for producing a greater number of chicks when compared to other indigenous breeds, such as Aseel, Kadaknath, and Nicobari, the Desi breed demonstrated superior fertility and hatchability (Chatterjee *et al*. 2007, Rajkumar *et al*. 2017, Haunshi *et al*. 2012).

Production traits: Selection for growth traits across

Table 1. Fertility and Hatchability of Desi chicks in five generations

Generation	Fertility (%)	Hatchability (%)		Chicks produced	Eggs produced
		FES	TES		
1	88.6	90.2	78.3	81	116.46
2	87.1	88.1	79.1	104	126.45
3	90.9	90.7	81.2	117	134.64
4	91.1	89.0	83.1	82	131.65
5	92.8	91.0	77.3	94	136.78
Average	90.1	89.8	79.8		
S.E.	0.27	0.23	0.29		
p value	NS	NS	NS		

NS = Non-significant ($p > 0.05$).

Table 2. Body weight and Shank lengths of birds in 5 generations

Generations	Body weight (g)		Shank length (mm) 8 weeks
	0 days	8 weeks	
1	27.2±0.13	361.4±3.52	64.2±0.46
2	28.1±0.12	378.8±4.64	65.0±0.69
3	29.4±0.13	398.7±4.83	65.5±0.35
4	31.1±0.23	428.2±5.39	67.0±1.25
5	32.4±0.25	470.3±6.45	68.1±1.16
Average	29.64	407.48	65.96
b±S.E.	0.64±0.14	17.18±3.49	0.44±0.04
p value	**	**	NS

NS = Non-significant (P > 0.05); ** indicates P < 0.01

generations has been widely reported to improve body weight and productivity in indigenous chicken populations (Flisar *et al*. 2014; Haunshi *et al*. 2012). Such genetic improvement programmes are essential for developing dual-purpose birds suitable for backyard and semi-intensive systems. In the 8th week, the average body weight in the first generation was 361.4 g, while in the 5th generation, it rose to an average of 470.3 g. By the 8th week, there was a difference of 109.8 g in body weight between the 1st and 5th generations. Additionally, shank length increased by approximately 3.9 mm at the 8th week. Both body weight and shank length reached their peak in the 5th generation.

Heritability estimates: Heritability assessments for growth characteristics were conducted for the third and fifth generations. The heritability values for body weight at the 8th and 16th weeks, as well as shank length at the 8th week, were high, while they were moderate at the 20th week. These values showed variation between the third and final generations. These findings suggested significant genetic diversity within the desi chicken population, indicating that selection for these traits is feasible. The relationships among the growth characteristics were analyzed in both the third and fifth generations. A strong positive correlations (0.87±0.13) were observed between body weight at the 8th week and shank length, and between body weight at the 4th and 8th week.

Growth characteristics in adult birds: Data on body weight indicated that at 12 weeks of age, the average body weight for the first generation was 846.47±7.12 g, whereas in the fifth generation, it increased to 917.57±7.23 g, showing a considerable improvement. By 16th week, there was a difference of 39.22 g, and by 20th week, body weight had risen by 149 g. The average body weight of cocks and hens combined over five generations at 20 weeks was 2231.48±39.28 g, while the overall shank length for cocks and hens at the 16th week was 127.00±0.48 mm and 99.65±0.46 mm, respectively.

Table 4. Genotypic and phenotypic correlations

Genetic/phenotypic	Fifth generation		
	4 weeks body weight	8 weeks body weight	8 weeks SL
4 weeks body weight	1	0.74±0.11	0.87±0.13
8 weeks body weight	0.72±0.11	1	0.85±0.12
8 weeks SL	0.70±0.12	0.83±0.20	1

Table 3. Heritability estimates of body weight and shank length in 5 generations

Components of variance	Third generation				Fifth generation			
	Body weight s			Shank length	Body weight			Shank length
	8 weeks	16 weeks	20 weeks	8 weeks	8 weeks	16 weeks	20 weeks	8 weeks
h^2 (sire)	0.39±0.14	0.35±0.13	0.22±0.13	0.30±0.15	0.33±0,13	0.37±0.14	0.30±0.11	0.26±0.12
h^2(dam)	0.47±0.17	0.55±0.15	0.50±0.21	0.48±0.20	0.60±0.23	0.57±0.18	0.49±0.17	0.41±0.17
h^2(sire+dam)	0.43±0.08	0.44±0.06	0.36±0.06	0.39±0.07	0.45±0.06	0.46±0.07	0.40±0.05	0.31±0.03

Table 5. Body weight and shank lengths of adult birds

Generation	Body weight (g)			SL (mm)	
	12wks	16wks	20wks	Males	females
1	846.47±7.12	1151.56±11.45	2138.67±36.78	125.60±0.47	98.45±0.41
2	855.37±8.21	1163.65±11.77	2191.84±37.57	126.70±0.52	99.43±0.43
3	905.67±9.34	1170.65±12.56	2259.84±38.56	128.20±0.55	99.54±0.46
4	908.54±8.17	1182.77±12.76	2280.46±40.56	127.10±0.42	100.55±0.52
5	917.57±7.23	1190.78±13.12	2287.67±46.75	127.40±0.51	100.30±0.44
Average	886.32±8.21	1171.48±12.12	2231.48±39.28	127.00±0.48	99.65±0.46
b±S.E.	19.54±4.37	9.76±0.45	38.66±7.30	0.40±0.26	0.48±0.12
p Value	NS	NS	NS	NS	NS

NS = Non-significant (p > 0.05).

The trends in development and production performance of the Desi breed revealed that body weight of both males and females increased across generations during the juvenile as well as adult stages. Growth characteristics were documented for each sex and at identical ages across generations. Therefore, the observed increase in body weight primarily resulted from both targeted and unintentional selection practices utilized over the past four generations. The growth characteristics of the desi breed were similar to those of the Aseel breed (Haunshi *et al*. 2012, Rajkumar *et al*. 2017). Nevertheless, when compared to breeds like Nicobari and Kadaknath, egg production over 40 weeks was lower. The reduced egg yield was largely attributed to a higher occurrence of broodiness during peak egg production periods. Over generations, egg production improved and the age at which the first egg was laid (AFE) also decreased significantly. Given the negative relationship between AFE and body weight, the increase in body weight was plausibly a primary factor behind this reduction. The AFE was highly variable and is generally influenced by various elements such as season, nutrition, and rearing conditions. Due to their positive correlation, egg weights measured at different ages have risen, particularly in the most recent generations. This increase was mainly driven by rises in body weight. Likewise, the egg weights of the Desi breed were found to be higher than those of the Kadaknath and Nicobari breeds, aligning with those of the Aseel breed (Haunshi *et al*. 2011, Haunshi *et al*. 2021, Dalal *et al*. 2022). Egg production in the fifth generation was nearly equivalent to that recorded in the third generation.

The findings suggested that the desi population possesses adequate genetic diversity, as indicated by higher heritability estimates for growth parameters observed in two distinct generations, and great potential for enhancing juvenile body weight in this breed. Other native breeds, including Aseel and Kadaknath, also exhibited elevated heritability estimates (Haunshi *et al*. 2012, Haunshi *et al*. 2021, Dalal *et al*. 2022). A higher genetic correlation between body weight and shank length implied that selecting for greater body weight would also improve shank length, benefiting birds in free-range or backyard systems by enabling quicker movement to evade predators. The results indicated a positive correlation between growth traits and egg production over 40 weeks. This may be due to the decreased AFE along with increasing body weight during the growth phase. A decrease in AFE corresponds to an increase in egg counts. Previous studies have also reported positive relationships between juvenile or grower body weights and egg production. Such correlations have been noted in Vanashree (Haunshi *et al*. 2021), between juvenile body weight at 4 and 16 weeks and 40- and 56-week egg production in two strains of White Leghorn (Reddy *et al*. 2001) and between juvenile body weight at 12 and 16 weeks and 40-week egg production in Aseel (Dalal *et al*. 2022). Similar relationships were observed in Ethiopian Horro chickens. Research indicated that early growth had a negative correlation with AFE in Thai native chickens, suggesting that a lower AFE could lead to improvement in both growth and egg production (Tongsiri *et al*. 2020).

The relationship between shank length and egg production was an indirect one, as body weight and shank length are genetically highly correlated. While this positive correlation between body weight and egg production may not apply universally across all chicken breeds or lines, it is often observed in slower-growing birds like IC (indigenous chicken), which have lower to moderate egg production capabilities. Consequently, this favorable link between body weights and egg yield could be leveraged to enhance both growth and egg production in IC simultaneously.

There was a notable increase ($P<0.01$) in body weight across generations, indicating a positive response to selection. The increase of 109.8 g in 8-week body weight between the first and fifth generations clearly reflected the effectiveness of selection for growth traits. Similar improvements in body weight due to long-term selection have been reported in chickens. The increase in shank length further supports the positive association between growth and skeletal development.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the Director Research, Birsa Agricultural University, for providing the necessary facilities and support to conduct this study. This work was aided financially by the ICAR- Directorate of Poultry Research (DPR), Hyderabad.

REFERENCES

Becker W A. 1992. *Manual of Quantitative Genetics*. 5th edn. Academic Enterprises, Pullman, Washington, USA.

Chatterjee R N, Sharma R P, Reddy M R, Niranjan M and Reddy B L N. 2007. Growth, body conformation and immune responsiveness in two Indian native chicken breeds. *Livestock Research for Rural Development* **19**(10): 151.

Dalal D S, Ratwan P and Yadav A S. 2022. Genetic evaluation of growth, production and reproduction traits in Aseel and Kadaknath chickens in agroclimatic conditions of northern India. *Biological Rhythm Research* **53**(1): 1621081.

Flisar T, Malovrh Š, Terčič D, Holcman A and Kovač M. 2014. Thirty-four generations of divergent selection for 8-week body weight in chickens. *Poultry Science* **93**(1): 16–23.

Haunshi S, Doley S and Shakuntala I. 2009. Production performance of indigenous chicken of northeastern region and improved varieties developed for backyard farming. *Indian Journal of Animal Sciences* **79**(9): 901.

Haunshi S, Niranjan M, Shanmugam M, Padhi M K, Reddy M R, Sunitha R, Rajkumar U and Panda A K. 2011. Characterization of two Indian native chicken breeds for production, egg and semen quality, and welfare traits. *Poultry Science* **90**(2): 314–320.

Haunshi S, Rajkumar U, Paswan C, Prince L L L and Chatterjee R N. 2021. Inheritance of growth traits and impact of selection on carcass and egg quality traits in Vanashree, an improved indigenous chicken. *Tropical Animal Health and Production* **53**(1): 128.

Haunshi S, Shanmugam M, Padhi M K, Niranjan M, Rajkumar U, Reddy M R and Panda A K. 2012. Evaluation of two Indian native chicken breeds for reproduction traits and heritability of juvenile growth traits. *Tropical Animal Health and Production* **44**(5): 969–973.

Haunshi S, Ullengala R, Prince L L, Ramasamy K, Gurunathan K, Devatkal S and Chatterjee R N. 2022. Genetic parameters of growth traits, trend of production and reproduction traits, and meat quality status of Ghagus, an indigenous chicken of India. *Tropical Animal Health and Production* **54**(3): 170.

Kumaresan A, Bujarbaruah K M, Pathak K A, Chhetri B, Ahmed S K and Haunshi S. 2008. Analysis of a village chicken production system and performance of improved dual purpose chickens under a subtropical hill agro-ecosystem in India. *Tropical Animal Health and Production* **40**: 395–402.

Lariviere J M, Michaux C and Leroy P. 2009. Genetic parameters of embryonic viability traits in a traditional chicken breed. *International Journal of Poultry Science* **8**(12): 1183–1188.

Lariviere J M and Leroy P. 2003. Genetics of growth in a slow growing broiler obtained from different crosses between the Ardennaise male and a "Label Rouge" breeder female. In: *Proceedings of the 3rd European Poultry Genetics Symposium*, Wageningen.

Rajkumar U, Haunshi S, Paswan C, Raju M V L N, Rama Rao S V and Chatterjee R N. 2017. Characterization of indigenous Aseel chicken breed for morphological, growth, production and meat composition traits from India. *Poultry Science* **96**(7): 2120–2126.

Reddy B L N, Panda A K, Reddy M R, Rama Rao S V and Praharaj N K. 2001. Studies on the influence of juvenile growth traits on laying performance in egg type chickens. *Indian Journal of Poultry Science* **36**(3): 290–293.

Tongsiri S, Van der Werf J H J, Li L, Jeyaruban M G, Wolcott M L, Hermesch S and Chormai T. 2020. Using random regression models to estimate genetic variation in growth pattern and its association with sexual maturity of Thai native chickens. *British Poultry Science* **61**(6): 615–623.