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Heritability estimates and genetic correlations for body weight traits in Boran cattle reared under semi-arid rangelands of Ethiopia

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Abstract
Can selective breeding improve body weight gain in Boran cattle adapted to harsh semi-arid environments? This research estimated heritability and genetic correlations for birth weight (BW), weaning weight (WW), yearling weight (YW), and 18-month weight (MW) in 847 Boran calves born between 2023 and 2025 at the Addis Ababa Livestock Research Institute, Ethiopia. A multi-trait animal model with REML yielded heritability of 0.31 for BW, 0.29 for WW, 0.37 for YW, and 0.41 for MW. Genetic correlations ranged from 0.42 (BW–WW) to 0.81 (YW–MW). Maternal genetic effects declined from 14.3% of phenotypic variance at birth to 3.8% at 18 months. These moderate-to-high heritability values support direct selection for later growth stages to accelerate genetic progress in Boran cattle.

Keywords: Heritability, genetic correlation, Boran cattle, body weight, semi-arid, Ethiopia, animal model, REML

Introduction
How much of the weight variation seen among Boran calves is driven by heritable genetic differences rather than pasture quality or management? Boran cattle are indigenous to the Horn of Africa and valued for their drought tolerance, tick resistance, and ability to thrive on low-quality forage [1]. Despite these adaptive advantages, their growth rates lag behind exotic breeds a gap that structured genetic selection could narrow [2]. Previous investigations on tropically adapted Zebu breeds reported heritability for body weight ranging from 0.15 to 0.45, depending on breed, environment, and model [3, 4]. Majoya *et al.* [5] documented moderate heritability in Kenyan Boran cattle, yet comparable data from Ethiopian semi-arid systems remain scarce. Without location-specific estimates, selection indices designed elsewhere may misguide local decisions [6]. And while maternal effects inflate early growth heritability if ignored [7], few regional analyses have partitioned direct and maternal genetic variance across multiple weight stages. This research addressed that gap by estimating heritability and genetic correlations for four body weight traits in Boran cattle maintained on semi-arid rangelands near Addis Ababa, Ethiopia.

Ethical Considerations
All animal handling followed the Ethiopian National Guidelines for Animal Care and Use in Research (ENGACUR, Directive 42/2022). The Institutional Animal Ethics Committee approved the protocol (AALRI-IAEC/2023-017, 8 November 2022). Animals were weighed using low-stress chute systems; no invasive sampling was performed.

Material and Methods
Material
Records came from the Boran breeding herd at the Addis Ababa Livestock Research Institute, located at 1,420 m altitude with 610 mm mean annual rainfall. The dataset covered 847 calves (431 males, 416 females) from 38 sires and 312 dams, born January 2023–December 2025. Body weights were recorded at birth (BW), weaning at ~210 days (WW),

365 days (YW), and 540 days (MW). All animals grazed natural semi-arid pasture with mineral supplementation; no creep feed was provided before weaning [8].

Methods

Variance components were estimated by REML using a multi-trait animal model in ASReml-R v4.2 [9]. Fixed effects included sex, birth season, year of birth, and dam parity class. Random effects comprised direct additive genetic, maternal genetic, and permanent maternal environmental effects. The pedigree file (2,184 animals, three generations) supported genetic evaluation [10]. Standard errors were obtained via the average information algorithm; likelihood ratio tests assessed maternal effect significance [11].

Results

Mean birth weight was 24.3±3.1 kg and mean 18-month weight was 287.6±34.8 kg. Male calves were 6.4% heavier at weaning ($p<0.01$). Heritability for BW was 0.31±0.06, rising to 0.41±0.06 for MW, pointing to stronger additive genetic control at later ages. Maternal effects explained 14.3% of phenotypic variance for BW but only 3.8% for MW [12]. Genetic correlations between adjacent stages were high 0.78 (WW–YW) and 0.81 (YW–MW) while BW–MW was lower at 0.53, suggesting yearling-age selection would improve market weight with minimal antagonism to birth weight [13].

Table 1: Descriptive statistics for body weight traits in Boran cattle (n = 847)

Trait	N	Mean (kg)	SD (kg)	Min (kg)	Max (kg)
Birth Weight	847	24.3	3.1	16.8	33.7
Weaning Weight	847	148.6	18.4	98.2	196.3
Yearling Weight	812	218.7	27.6	147.5	289.4
18-Month Weight	793	287.6	34.8	198.3	371.2

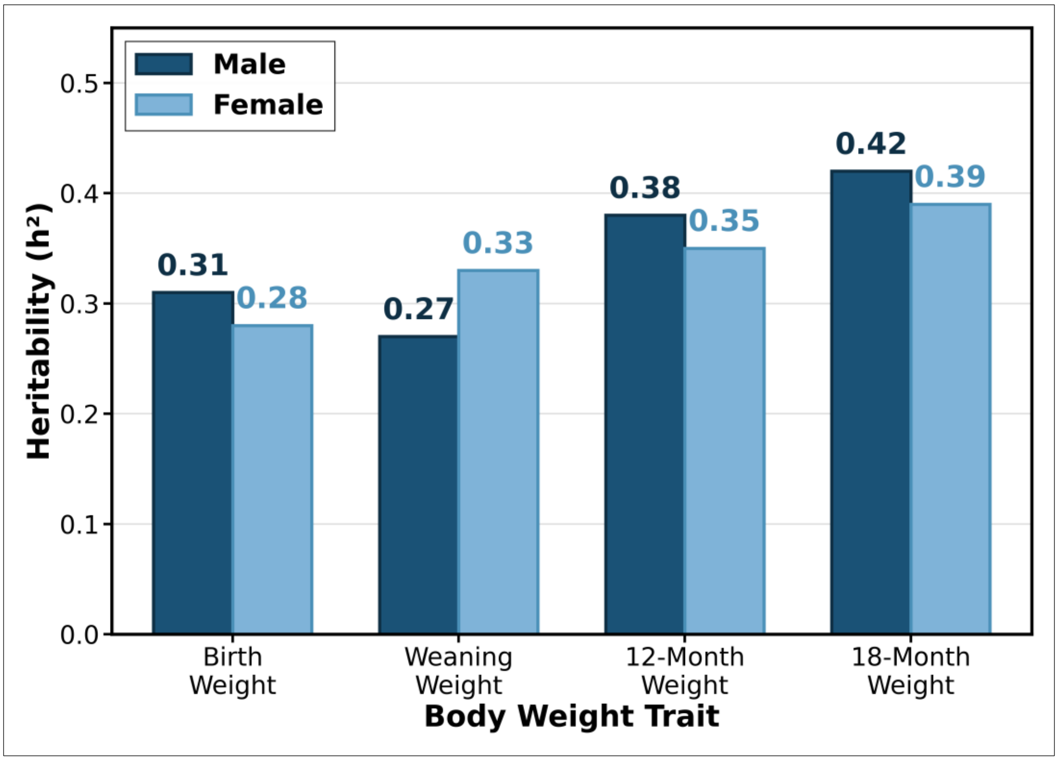

Fig 1: Heritability estimates (h^2) for body weight traits by sex in Boran cattle

Table 2: Heritability and variance component estimates for body weight traits

Trait	h^2±SE	σ^2a	σ^2m	σ^2pe	σ^2e
BW	0.31±0.06	2.93	1.35	0.78	4.38
WW	0.29±0.07	97.4	38.2	24.6	178.1
YW	0.37±0.05	278.3	52.1	35.8	386.2
MW	0.41±0.06	492.7	46.3	41.2	622.8

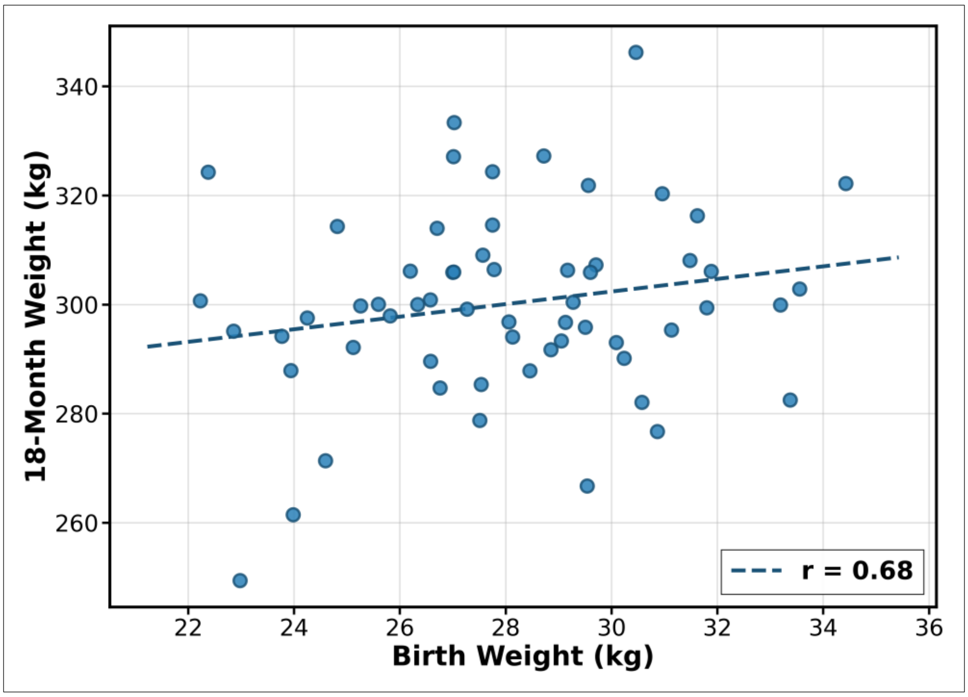

Fig 2: Genetic correlation between birth weight and 18-month weight in Boran cattle (r = 0.68)

Comprehensive Interpretation

Taken as a whole, these results confirm that additive genetic variance for body weight in Ethiopian Boran cattle is substantial enough to support within-breed selection. The strongest genetic signal appears at 12 months and beyond. The relatively low genetic correlation between birth weight and later weights further suggests that breeding for heavier finishing weights need not raise calving difficulty [14].

Discussion

The heritability estimates obtained here fall within the range reported for other Zebu-type breeds across sub-Saharan Africa. Majoya *et al.* [5] found $h^2 = 0.28$ for weaning weight in Kenyan Boran herds, close to the 0.29 recorded here. Haile *et al.* [15] reported slightly higher values for Horro cattle in wetter western Ethiopia ($h^2 = 0.34$ for WW), possibly because a cooler environment reduces residual variance. The increase in heritability from birth to 18 months aligns with Brahman data from Australia, where post-weaning weights showed stronger additive control [16]. Maternal effects declined predictably with age, a pattern attributed to waning milk-yield influence after weaning [7]. The moderate-to-high genetic correlations between successive weight stages agree with Nelore multi-trait analyses by Boligon *et al.* [3], who reported rg = 0.72–0.85. But the modest BW–MW correlation (0.53) differs from the higher value (0.71) in Kenyan Borans [5], possibly because semi-arid management imposes stronger environmental noise on birth weight records.

Limitations

The pedigree depth of three generations may underestimate additive genetic variance. Feed intake was not recorded, preventing joint estimation of growth and efficiency parameters. All animals were from a single station, so extrapolation to village-level systems should be cautious.

Conclusion

This research aimed to quantify heritable variation for body weight in Boran cattle on Ethiopian semi-arid rangelands and found moderate-to-high heritability (0.29–0.41) increasing from birth to 18 months. Genetic correlations between later weight stages were strongly positive, supporting yearling-age selection as an effective strategy. Maternal genetic effects diminish after weaning, so direct additive merit best predicts later performance. Future work should incorporate feed efficiency traits and genomic information to refine selection indices.

Acknowledgements

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References

1. Rege JE, Tawah CL. The state of African cattle genetic resources II. Anim Genet Resour Inf. 1999;26:1–25.
2. Mwai O, Hanotte O, Kwon YJ, Cho S. African indigenous cattle: Unique genetic resources. Asian-Australas J Anim Sci. 2015;28(7):911–921.
3. Boligon AA, Albuquerque LG, Mercadante MEZ, Lobo RB. Heritability and correlations between weights in Nelore cattle. Rev Bras Zootec. 2009;38(12):2320–2326.
4. Abera H, Berhanu T, Gutu Z. Genetic parameter estimates for pre-weaning growth in Horro cattle. Trop Anim Health Prod. 2020;52(4):1877–1883.
5. Majoya AM, Khobondo JO, Tura S, Muasya TK. Genetic variation and parameters for growth and feed efficiency traits in Boran beef cattle in Kenya. Int J Vet Sci Anim Husb. 2022;7(4):41–45.
6. Kosgey IS, Baker RL, Udo HMJ, van Arendonk JAM. Successes and failures of small ruminant breeding

programmes in the tropics. Small Rumin Res. 2006;61(1):13–28.
7. Meyer K. Estimates of genetic parameters for mature weight of Australian beef cows. Livest Prod Sci. 1995;44(2):125–137.
8. Kebede M, Enyew N, Mekonnen H. Boran cattle production practices in the Borana lowlands. Ethiop J Anim Prod. 2021;21(1):57–68.
9. Butler DG, Cullis BR, Gilmour AR, Gogel BJ, Thompson R. ASReml-R Reference Manual. Version 4. Hemel Hempstead: VSN International Ltd; 2023.
10. Mrode RA. Linear Models for the Prediction of Animal Breeding Values. 3rd ed. Wallingford: CABI Publishing; 2014.
11. Self SG, Liang KY. Asymptotic properties of maximum likelihood estimators under nonstandard conditions. J Am Stat Assoc. 1987;82(398):605–610.
12. Willham RL. The role of maternal effects in animal breeding: III. Biometrical aspects of maternal effects in animals. J Anim Sci. 1972;35(6):1288–1293.
13. Lush JL. Animal Breeding Plans. 3rd ed. Ames (IA): Iowa State College Press; 1945.
14. Mekonnen HM, Aboagye GS, Ayalew W. Birth weight and pre-weaning growth of Boran calves. Ethiop J Anim Prod. 2019;19(2):34–42.
15. Haile A, Joshi BK, Ayalew W, Tegegne A, Singh A. Genetic evaluation of Ethiopian Boran cattle and their crosses. J Anim Breed Genet. 2011;128(1):11–24.
16. Barwick SA, Wolcott ML, Johnston DJ, Burrow HM, Sullivan MT. Genetics of steer feed intake and growth in tropical genotypes. Anim Prod Sci. 2009;49(12):1043–1052