

nutrients, along with more favorable rumen fermentation and blood profiles (Dutta et al., 2025). Similar benefits of higher-quality or better-balanced forage-concentrate combinations were reported when guinea grass was mixed with protein-rich Indigofera, which produced the highest crude protein intake, total weight gain, and average daily gain among several forage legume mixtures. These findings support the principle that growth optimization requires both adequate energy density and sufficient rumen-degradable and bypass protein in the ration.

Feeding frequency is another key management lever for improving growth in goats. In Sirohi kids, offering a fixed amount of concentrate three times daily significantly increased total daily feed intake and average daily gain relative to once- or twice-daily feeding, with little effect on feed conversion ratio, suggesting improved utilization of nutrients rather than increased efficiency per se. Studies in Beetal kids and in goats receiving turmeric-supplemented diets likewise showed that more frequent or daily provision of the ration enhanced dry matter intake, weight gain, and body measurements compared with less frequent feeding schedules (Ahmad et al., 2014; Omotoso, 2022). Collectively, this evidence indicates that dividing the daily ration into multiple meals better matches the high metabolic rate and limited rumen capacity of young goats, stabilizing rumen conditions and supporting faster growth.

4.3 Water management and environmental control

Water availability and quality interact strongly with feed intake to determine growth performance in goats. Experiments with Nguni does showed that moderate water restriction (around 70%-80% of ad libitum) can temporarily coincide with peak dry matter intake and average daily gain, but more severe or prolonged restriction reduces gain and worsens gain-to-feed ratio, especially when combined with saline drinking water (Mpendulo et al., 2017). In related work, increasing the period of water deprivation from 0 to 48 hours led to higher compensatory water and feed intake after rehydration but significantly decreased average daily gain, final body weight, and body condition score, and increased parasite burden, underscoring the cumulative negative impact of hydric stress on productivity and health (Mpendulo et al., 2020). These results emphasize that any short-term adaptation to reduced water supply is quickly offset by losses in growth and condition when restriction is extended.

Environmental conditions, particularly heat and humidity, further modify water needs and growth responses. Under hot-humid tropical conditions, providing drinking water with pH as low as 3.8 did not adversely affect nutrient intake, water balance, or growth, and in some cases was associated with higher metabolizable energy use and daily gain compared with mildly acid water, suggesting considerable tolerance to naturally acidic sources where microbial safety is adequate (Ali et al., 2022). In tropical and semi-arid settings, higher temperature-humidity indices drive increased water intake, highlighting the importance of continuous access to clean water to maintain thermoregulation and feed intake (Mpendulo et al., 2017). From a systems perspective, integrating robust water supply, shade, and ventilation into intensive housing, and ensuring accessible watering points and microclimate refuges in grazing systems, is essential to protect growth performance as climate variability and heat stress intensify (Mugoti et al., 2025).

5 Genetic Factors and Breeding Improvement Strategies

5.1 Selection of superior breeds and utilization of hybrid vigor

Breed choice is a foundational decision for improving growth performance, because heritability estimates for body weights and average daily gain are generally moderate, allowing sustained response to selection in meat-type goats (Ofori and Hagan, 2020; Tesema et al., 2020). Crossbreeding indigenous does with specialized meat breeds such as Boer has been widely used to combine adaptation with superior growth, as shown in Boer × Central Highland goats where F₁ progeny raised semi-intensively achieved substantial gains from birth to yearling age under moderate inputs (Tesema et al., 2021). Within indigenous populations such as West African Dwarf goats, relatively high heritability for birth and weaning weights indicates that systematic selection among local animals can also deliver progress when crossbreeding options are limited.

Exploiting heterosis (hybrid vigor) can accelerate improvement, but the level of exotic blood must be carefully managed under low-input systems. In Boer × Central Highland goats, F₂ and F₃ generations did not outperform F₁ for growth and efficiency traits, and increasing Boer inheritance beyond 50% was considered uneconomical under