



A Monthly e Magazine
ISSN:2583-2212

Popular Article

October 2024 Vol.4(10), 3975–3881

Design & Management of Housing System for Promoting Animal Welfare, Productivity & Ease of Management in Small Ruminants

Dr. Dhrumilkumar Panchal^{1*}, Dr. Nayan Raval¹, Dr. Abhishek Singh Tomar²,
Dr. Dileep Singh², Dr. Akashkumar Sutariya¹, Dr. M. M. Islam³

¹M.V.Sc. Scholar, Department of Animal Nutrition, College of Veterinary Science & A. H.,
Kamdhenu University, Anand, Gujarat, India

²M.V.Sc. Scholar, Department of Livestock Production Management, College of Veterinary
Science & A. H., Kamdhenu University, Anand, Gujarat, India

³Associate Research Scientist and Head, Pashupalan Sanshodhan Kendra, VASREU,
Kamdhenu University, Ramna Muvada, Gujarat, India

<https://doi.org/10.5281/zenodo.14003504>

Abstract

This review explores innovative housing models and key factors influencing small ruminant welfare, productivity, and management. Various housing designs, such as the plastic-based 2-tier model, Yagya-type shed, bamboo dome, thermocol-based shed, and grass mat modified shed, have been developed to address the unique needs of goats and sheep in different climates. Key factors like space allowance, stocking density, ventilation, flooring, roofing, and lighting are crucial for optimizing animal welfare and productivity. Adequate space improves growth and feed efficiency, while proper stocking density, ventilation, and flooring enhance health and performance. The study highlights the importance of adapting housing systems to meet the specific needs of small ruminants, ensuring improved health, welfare, and productivity.

Keyword: Welfare, productivity, housing, health, kachcha flooring, elevated slatted flooring

Introduction

The transition from extensive to intensive goat rearing has made housing design a pivotal factor in enhancing livestock productivity (Tosawada *et al.*, 2021). Livestock rearing based on grazing and mixed farming system likely to be affected by global warming than industrialized system. Because they have negative effect on rainfall and generate the drought like condition which lower the crop production and of the direct effects of high temperature and solar radiation on the animals. So due to this changing climatic condition requirement of appropriate housing is necessary to improve the production potential of small ruminants. Hence, there is less sophisticated housing involved for small ruminants (Sharma *et al.*, 2024). India, being a tropical country, experiences hot and humid summers, while the winters are

relatively mild. One of the best ways to protect goats from harsh weather conditions is by providing them with suitable housing (Wadhvani *et al.*, 2016).

The design and space allowance in goat and sheep shelters are key factors that can cause discomfort for the animals. In both semi-intensive and intensive sheep production systems, stocking density is a crucial factor influencing animal welfare and productivity. Proper ventilation also important which mitigates excessive humidity, controls the levels of noxious gases and airborne particles, and ensures an overall healthier living environment. Floor is an important aspect in housing management of goats, which provides both comfort and cleanliness with minimal risk of injury. It improves their growth rate, productivity and provides better health. The roof is an important part of housing systems, which protects animals from direct heat and rainwater. The material used for the roof of a goat shed plays a key role in both the construction cost and the internal environment of the shed.

Shelter Design

- **Conceptual Design of a Plastic-Based 2-Tier Housing Model for Goats:** The Central Institute for Research on Goats (CIRG) developed this innovative housing system to help landless farmers increase their goat-rearing capacity and enhance their livelihoods. In this model, adult goats are housed on the ground level, while newborn and young goats are kept on the first tier. The upper floor is constructed with a perforated plastic slatted design, angled at a 1:40 gradient to allow for efficient drainage and waste management.
- **Yagya-Type Shed:** Developed under the ICAR-NICRA (National Initiative on Climate Resilient Agriculture) project, this shed is designed for effective summer management in tropical and subtropical regions. The structure promotes heat dissipation and helps maintain cooler temperatures at ground level. Constructed after the traditional "Yagya" used in Hindu rituals, the shed is built from bamboo and having a three-tier design. Its walls consist of two brick layers with a hollow middle, filled with sand. Water is dripped onto the sand layer, cooling the walls and reducing heat stress for the animals.
- **Bamboo Dome:** As part of the NICRA project, the bamboo dome shed is recommended for protecting lambs from cold stress by maintaining a higher minimum temperature during extreme cold conditions. Its lightweight and portable design make it an ideal solution for migratory flocks, offering both convenience and effective thermal insulation.
- **Thermocol-Based Shed:** Recommended by the ICAR-NICRA project, this modified housing system offers a floor positioned lower than the outside ground level to regulate



temperature. The roof is constructed from thermocol cover in polyvinyl (PV) sheets, which helps maintain a cooler maximum temperature during the day and a warmer minimum temperature at night, providing better temperature control compared to traditional sheds.

- **Grass Mat Modified Shed:** The Central Sheep and Wool Research Institute (CSWRI) give this concept using a modified shed with grass mats to provide evaporative cooling for growing lambs during the summer in semi-arid tropical regions. The shed's walls are constructed from locally sourced water grass mats, which are sprinkled with water 3-4 times a day to enhance the cooling effect through evaporation, creating a more comfortable environment for the lambs.

Some of the key factors which enhance the welfare, productivity & management in small ruminant housing:

- **Space Allowance:** One of the most significant aspects of housing is floor space allowance, which plays a key role in determining growth performance from the weaning to finishing stages. Adequate space allowance not only enhances growth rates but also improves feed efficiency and reduces morbidity and mortality rates, thereby offering substantial economic advantages to producers (Cook, 2003). Space allowance, defined as the average area allocated per animal, is a distinguishing feature of all animal production systems due to its direct impact on animal welfare and farm profitability. Therefore, optimizing space allowance is crucial not only for improving animal well-being but also for maximizing economic returns.

Adequate space allowance significantly impacts the growth and feed intake of goats. Adult Surti non-lactating goats also showed higher dry matter intake DMI (g/KgW^{0.75}), digestible crude protein DCP (g/d, % body weight and g/Kg W^{0.75}), and total digestible nutrients TDN (g/d and % body weight) when provided with ample space (Sheikh *et al*, 2022). Additionally, Beetal kids with more covered space experienced higher feed and fodder intake and total weight gain, whereas limited space was associated with increased coccidian oocyst counts. These findings highlight the importance of adequate space in optimizing growth performance and health in goats (Thakur *et al.*, 2016).

Minimum floor space requirements for sheep and goats as per BIS (2024)

Sl. No.	Age / Category of goats	Covered area (m ² /animal)	Open paddock (m ² /animal)
1	0 - 3 months	0.2-0.25	0.4 - 0.5



2	3 - 6 months	0.5 - 0.75	1.0 – 1.5
3	6 - 12 months	0.75 - 1.0	1.5 – 2.0
4	Yearling sheep and goats	1.00	2.00
5	Adult sheep and goats	1.5	3.0
6	Pregnant and lactating sheep and goats	1.5 - 2.0	3.0 - 4.0
7	Rams/Bucks	1.5 - 2.0	3.0 - 4.0

(Source: BIS (2024) Housing of sheep and goats)

- Stocking Density:** In both semi-intensive and intensive sheep production systems, stocking density (measured as animals per unit area) is a crucial factor influencing animal welfare and productivity. Adequate space allowance, particularly when combined with access to outdoor areas, has been shown to enhance social interactions, improve feeding behaviours, and positively affect meat, milk, and wool production. Ewes, in particular, are highly sensitive to variations in stocking density, requiring sufficient space at each stage of development to avoid stress and maintain optimal performance. Variations in behavioural responses among sheep breeds emphasize the necessity of adjusting stocking density to accommodate the specific needs of each breed.
- Ventilation:** Ventilation plays a critical role in maintaining the welfare and productivity of housed sheep and goats by regulating thermal exchanges between the animals and their environment. Proper ventilation mitigates excessive humidity, controls the levels of noxious gases and airborne particles, and ensures an overall healthier living environment (Sevi, 2005). Effective ventilation systems prevent respiratory issues and promote better health outcomes, which directly contribute to improved performance and productivity. Therefore, maintaining an optimal ventilation rate is essential to creating a conducive environment for the health and welfare of small ruminants.
- Floor:** Scientific data on goat floor preferences remains limited, yet flooring is critical in goat housing, impacting comfort, cleanliness, and safety. Ideal flooring should be hygienic, dry, resilient, and temperature-resistant to enhance growth and health. Characteristics such as low thermal conductivity, softness, and cleanliness influence goats' preferences and thermoregulatory behaviour in varying climates (Wadhvani *et*



al., 2016). Thus, effective flooring must balance durability with comfort to optimize animal welfare and productivity.

Different types of flooring

- **Kachcha flooring:** Mostly kachcha flooring preferred because it is cost-effective option. It has low thermal conductivity so provides better comfort to goats resulted in increased feed and nutrient intake of goats irrespective of season under stall-feeding in semi-arid regions (Modi *et al.*, 2021). But there is more chances occurrence of parasitic infestation in kachcha flooring.
- **Cement flooring:** It has gained popularity due to its ease of cleaning and ability to prevent the presence of parasites commonly found in mud beds (Modi *et al.*, 2021). In cement flooring there is less chances of hoof problem.
- **Elevated flooring:** It is beneficial for labour efficiency and cleanliness but it is expensive as compare to cement flooring. Goats can be kept relatively clean without any bedding materials at a low space allowance and with a minimum of work input on slatted floor. But inadequate gap width or poor maintenance of existing slatted floors can lead to leg and foot problems in goats. However, it is worth mentioning that the main drawback of raised, slatted floors is their high construction cost.

Studies show that no significant differences were found in growth performance, feed conversion, disease incidence, or parasitic infestation in Mehsana kids reared on different floor types viz. kachcha, brick, concrete (Patel *et al.*, 2020). However, earthen and cement concrete floors improved dry matter intake (DMI) and comfort viz. lying and feeding time (Modi *et al.*, 2021).

- **Roof:** In India, many goats are housed in open areas with inadequate shelters, characterized by low light, poor ventilation, and insufficient roof height, leading to reduced growth performance in kids. The roof plays a vital role in shielding animals from direct solar radiation and rain. Roof type, including shed, gable, or modified gable, influences microclimate and drainage. Roofing materials, such as thatched roofs, cement asbestos sheets, fibre-reinforced plastic sheets, tiles, corrugated iron sheets, galvanized iron sheets, PVC sheets, and concrete roofs, affect construction costs and micro-environment quality. Inadequate roofing can lead to significant health and performance losses in goats (Bankar *et al.*, 2024). According to BIS standards, roof height should be 2.7 meters at the eaves and 3.5 meters at the centre, with an overhang of 0.75-1 meter on both sides (BIS 2024).

Proper roof insulation is crucial for maintaining a stable temperature within goat



housing, particularly in regions with extreme temperatures. Research indicates that thatched roofs effectively regulate temperature and humidity, keeping the physiological parameters of Osmanabadi kids within normal ranges (Bankar *et al.*, 2024). Elevated slatted flooring with galvalume roofing has proven effective in mitigating heat stress and maintaining normal hematological parameters, thus improving growth performance in Nellore ram lambs (Kasala *et al.*, 2023). Conversely, fiber-reinforced plastic (FRP) sheet roofing in Jakhrana goat shelters in semi-arid areas has been shown to be less effective in enhancing the production of lactating goats during winter (Ramachandran *et al.*, 2021).

- **Lighting:** Lighting is a critical factor in goat housing, significantly impacting health and well-being. Proper lighting regulates circadian rhythms, ensuring a consistent day-night cycle and influencing reproductive performance through photoperiodic effects on hormone secretion. Adequate illumination supports growth, bone development, and milk production, while also promoting normal behaviour, reducing stress, and enhancing overall welfare. Optimizing lighting conditions is therefore essential for maximizing physiological processes, reproductive efficiency, and overall health in goats.

Conclusion

Effective shelter design and housing systems are essential for improving the welfare, productivity, and management of small ruminants, especially goats, in tropical and semi-arid regions like India. Innovations such as plastic-based 2-tier housing, Yagya-type sheds, bamboo domes, and thermocol-based sheds provide sustainable solutions for protecting livestock from environmental stressors. Key factors like space allowance, stocking density, ventilation, flooring, roofing, and lighting directly impact animal health, feed efficiency, and growth performance. Optimizing these housing components not only enhances animal welfare but also boosts farm productivity and economic efficiency.

References

- Bankar, A. S., Siddiqui, M. B. A., Kharwadkar, M. D., Ali, S. S., & Wankar, A. K. (2024). Effect of various roofing materials on physiological response of Osmanabadi kids. *Indian Journal of Animal Production and Management*, 40(3), 174–179.
- BIS (2024). Housing of sheep and goats – code of practice (Second Revision of IS 2733). Animal Husbandry and Equipment Sectional Committee.
- Cook, N. B. (2003). Prevalence of lameness among dairy cattle in Wisconsin as a function of housing type and stall surface. *Journal of the American Veterinary Medical Association*, 223(9), 1324–1328.
- ICAR-CIRG. (2019). *Annual Report 2019*.
- Indian Standards Institution. 1986 June. *Indian Standard Code of Practice for Sheep and Goat Housing* (IS: 273=1985).
- Kasala, V. T., Sreedhar, S., & Chakravarthy, K. (2023). A Study on the Effect of Housing on Haematological Parameters of Nellore Lambs. *Indian Journal of Animal Production*



- and Management, 37(4), 342–349.
- Modi, R. J., Patel, N. R., & Wadhvani, K. N. (2021). Effect of floor types and seasons on behavioural activities of Surti goats. *The Indian Journal of Animal Sciences*, 91(9), 750–753.
- Patel, J. V., Chauhan, H. D., Srivastava, A. K., Pawar, M. M., & Patel, V. K. (2020). Effect of different floor types on growth performance and feed conversion ratio of Mehsana goat kids. *The Indian Journal of Veterinary Sciences and Biotechnology*, 16(01), 37–40.
- Patel, R., Wadhvani, K., Modi, R., & Patel, N. (2020). Effect of different floor types on body weight of Surti goats under asbestos roofed house. *Indian Journal of Animal Production & Management*, 35 (1-2), 40-44.
- Ramachandran, N., Singh, S. P., Dwivedi, D., Kharche, S. D., Kumar, A., & Rai, B. (2021). Effect of fibre reinforced plastic (FRP) roof on performance of lactating Jakhrana does. *The Indian Journal of Animal Sciences*, 91(9), 744–749.
- Sevi, A. (2005). Influence of sunlight, temperature and environment on the fatty acid composition and coagulating properties of sheep milk. *International Dairy Federation Special Issue*, 5, 305–311.
- Sharma, M., & Gupta, A. (2024). Housing of Sheep and Goat Under Different Management Systems. *Bio Vet Innovator Magazine*, 1, 42–49.
- Sheikh, N. A., Islam, M. M., Modi, R. J., Wadhvani, K. N. (2022). Effect of different floor space allowances on feed, water and nutrient intake of adult Surti goat under intensive housing system. *International Journal of Agriculture Sciences*, 14(10), 11749-11751.
- Thakur, A., Malik, D. S., Kaswan, S., & Saini, A. L. (2016). Effect of floor space allowances on growth, coccidiosis and economics of beetal kids under stall feeding. *Indian Journal of Small Ruminants*, 22(2), 264.
- Tosawada, K., Waiz, H. A., Shende, K. A., Gurjar, M. L., & Joshi, M. (2021). Impact of space allowance on growth performance and physiological responses of Sirohi kids under intensive management system. *The Pharma Innovation Journal*, 10(9), 333-337.
- Wadhvani, K. N., Modi, R. J., Islam, M. M., & Patel, Y. G. (2016). Role of housing in welfare of small ruminants. *Indian Journal of Animal Production and Management*, 32(3–4), 130–139.

