

Design and Construction of Sheep and Goat Shelter using Bamboo Architecture in Bauchi

Odetoye Sunday Adeola¹; Shuaibu Nuru Mamman²; Ogwuche Henry Audu³; and Osunkunle Abdulmageed Abiodun⁴

¹Department of Architecture, Ladoke Akintola University, Ogbomoso, Nigeria. ²Department of Building Technology, Federal Polytechnic, Bauchi, Nigeria. ^{3&4}Department of Architectural Technology, Federal Polytechnic, Bauchi, Nigeria.

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Abstract

Livestock farming, particularly sheep and goat rearing, is crucial to rural economies worldwide, especially in the North Eastern Nigeria of Bauchi metropolis. However, inadequate shelter remains a significant challenge, affecting animal health, productivity, and farmer livelihoods. This study investigates the feasibility of using bamboo architecture to improve sheep and goat shelters. Bamboo's sustainability, strength, flexibility, accessibility durability, cost-effective, environmentally friendly and affordability make it an attractive alternative to other traditional materials. This paper explores the innovative use of bamboo architecture to improve sheep and goat shelters, emphasizing sustainability, efficiency, and welfare in livestock farming. As the demand for small ruminants continues to rise in many regions, traditional shelter designs often fail to meet the needs of these animals, leading to health issues and decreased productivity. The methodology focused on step-by-step design and construction based on field work, expert interviews, and analysis to assess existing shelters and design innovative bamboo-based alternatives. Results show that bamboo shelters can reduce construction costs by 30%, increase thermal comfort by 25% and enhance durability by 50%. By integrating local knowledge and practices with modern architectural techniques, the findings suggest that bamboo shelters can significantly improve the overall health and productivity of sheep and goat populations. It was recommended that sustainable livestock practices will grow tremendously by advocating for bamboo as a primary building material in the design of animal shelters.

Keywords: Bamboo Architecture, Cost-Effective, Livestock Welfare, Sustainable Design, Sheep and Goat Shelters.

Introduction

Smallholder sheep and goat farming in Nigeria faces significant challenges, including inadequate housing, poor nutrition, and high disease incidence (Sanusi et al., 2010; Enwelu et al., 2015). Many farmers use extensive or semi-intensive rearing systems with limited shelter, exposing animals to environmental stresses and parasites (Sanusi et al., 2010). The main obstacles to efficient production include lack of veterinary services, feed shortages, and disease outbreaks (Enwelu et al., 2015; Aldridge et al., 2018). These issues result in low productivity and income for farmers (Enwelu et al., 2015).

To address these challenges, innovative and sustainable solutions are needed (Aldridge et al., 2018). Bamboo emerges as a promising material for constructing animal shelters due to its rapid growth, affordability, and adaptability to various climates (Auwalu & Dickson, 2019). Implementing improved housing, nutrition, and disease prevention strategies could significantly enhance animal welfare and productivity in Nigerian smallholder sheep and goat farming systems (Sanusi et al., 2010; Aldridge et al., 2018). Bamboo has emerged as a viable alternative building material due to its numerous advantages. It is not only sustainable but also possesses exceptional strength and flexibility, making it suitable for various construction applications. Bamboo grows rapidly and can be harvested sustainably without causing significant environmental degradation (Silva et al., 2022).

This characteristic aligns well with the principles of sustainable development, which emphasize minimizing ecological footprints while maximizing resource efficiency. Furthermore, bamboo structures can be constructed at a significantly lower cost—up to 30% less than traditional materials—making them accessible to small-scale farmers who may have limited financial resources (Cesar, 2021). Proper housing systems are crucial for maintaining the health and productivity of sheep and goats. A well-designed shelter protects animals from adverse weather conditions, predators, and diseases. It also facilitates easier management practices such as feeding, cleaning, and health monitoring (Osunkunle et al., 2024). The welfare of livestock directly correlates with their housing conditions; inadequate shelter can lead to stress, increased susceptibility to disease, and decreased productivity. Research indicates that improving shelter conditions can enhance livestock productivity by up to 25%, highlighting the importance of investing in appropriate housing solutions (IFAD Agric Hub, 2022).

Statement of the Problem

The design and construction of sheep and goat shelters using bamboo architecture in Bauchi face challenges such as inadequate knowledge of sustainable building practices and limited access to eco-friendly materials. Additionally, traditional livestock housing often lacks resilience against environmental factors, compromising animal welfare and productivity in the region.

Literature Review

Smallholder sheep and goat farming in Bauchi, Nigeria faces challenges including inadequate housing, with many farmers using basic shelters or no housing at all (Sanusi et al., 2010). This contributes to health issues and decreased productivity in livestock. Major diseases affecting these animals include enteritis, foot rot, and helminthosis, with most occurring in both dry and wet seasons (Sanusi et al., 2010). Sustainable solutions are needed to address these challenges in small ruminant production (Aldridge et al., 2018). Indigenous

plant-based treatments have shown promise in managing diseases like Pestes Des Petits Ruminants in sheep and goats (Ayoola & Josephine, 2007).

Bamboo emerges as a sustainable building material for Nigeria, offering rapid growth, affordability, and versatility in construction applications (Auwalu & Dickson, 2019). Its use in livestock shelters could potentially address housing inadequacies while promoting environmental and economic sustainability in rural farming communities. In addition to enhancing animal welfare, the adoption of bamboo architecture in livestock housing can contribute positively to local economies. By utilizing locally sourced materials and skilled labor for construction, this initiative can stimulate job creation and promote economic development within the community (Osunkunle et al., 2024).

Moreover, shelters designed with sustainability in mind can help mitigate the impacts of climate change on livestock farming by providing resilient structures capable of withstanding extreme weather conditions. Bamboo is increasingly recognized as a sustainable building material due to its rapid growth, renewability, and environmental friendliness (Boity et al., 2022; Sharma et al., 2014). It offers high strength-to-weight ratio, flexibility in design, and cost-effectiveness compared to conventional materials (Kumar et al., 2017). Bamboo's versatility allows for its use in various construction applications, including foundations, walls, roofs, and scaffolding (Auwalu & Dickson, 2019). When properly treated, bamboo structures can be durable and long-lasting (Sharma et al., 2014). The material's abundance and low production costs make it an economical choice for construction, particularly in developing regions (Kumar et al., 2017). However, challenges such as susceptibility to insect and fungal attacks need to be addressed through chemical and non-chemical preservation techniques to enhance durability (Auwalu & Dickson, 2019). As timber resources diminish, bamboo emerges as a promising alternative that can meet the growing demand for sustainable building materials (Kumar et al., 2017).

Methodology

The design process for the bamboo-based sheep and goat shelters involved several key steps:

1. **Field Research:** Conducting surveys and interviews with local farmers to understand their needs and existing challenges with current shelter designs.
2. **Site Analysis:** Evaluating potential locations for shelter construction, considering factors such as drainage, sunlight exposure, and wind direction.
3. **Design Development:** Utilizing computer-aided design (CAD) software to create detailed plans that incorporate local knowledge with modern architectural techniques.
4. **Construction Techniques:** Employing hybrid construction methods that combine traditional practices with innovative techniques to ensure structural integrity and longevity.

5. **Material Selection:** Choosing locally sourced bamboo along with other materials (e.g., thatch for roofing) to create cost-effective and efficient shelters.

Construction methods are based on the following steps outline processes:

1. Design Planning: Assessing shelter requirements using CAD software for precise planning.
2. Site Preparation: Clearing debris and leveling the ground to create a solid foundation.
3. Structural Frame Construction: Erecting the bamboo framework with proper bracing for stability.
4. Flooring Options: Using elevated flooring to prevent water stagnation; options include compacted earth or wooden battens.
5. Wall Enclosures: Installing bamboo walls with ventilation openings for airflow.
6. Roof Installation: Using thatch or metal sheets based on durability needs.
7. Finishing Touches: Adding doors, windows, feeders, and water troughs.

Design considerations must accommodate specific needs:

1. Space Requirements: Each sheep or goat requires approximately 1.3 square meters for comfortable feeding (Cesar, 2021).
2. Ventilation: Open-sided designs enhance airflow while providing shade.
3. Safety Measures: Ensuring structures are free from sharp edges or hazards.

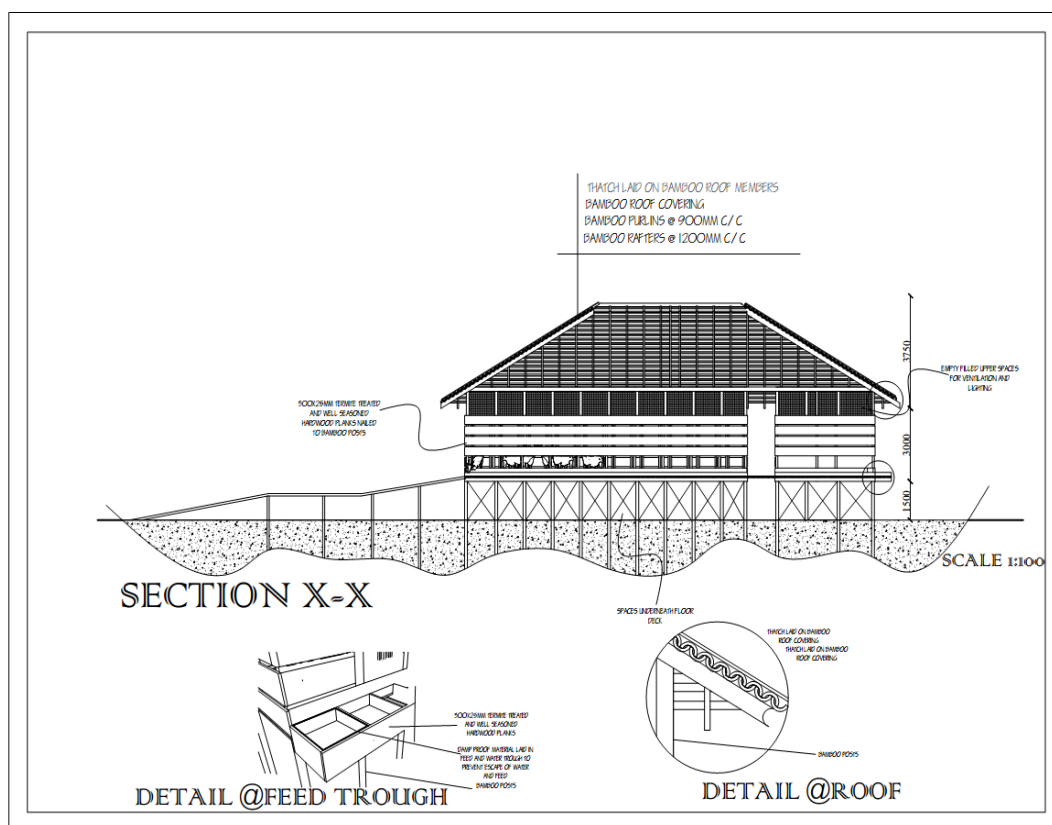


Figure 1: Typical section of the sheep and goat bamboo shelter

Results and Discussion

Bamboo architecture offers numerous benefits for sheep and goat shelters, aligning with sustainability goals and animal welfare concerns. As a renewable and cost-effective material, bamboo can significantly reduce construction expenses while minimizing environmental impact (Rao, 2014; Manandhar et al., 2019). Its versatility and strength make it suitable for creating comfortable living spaces for livestock, potentially improving animal welfare (Silva et al., 2022). This is particularly important as research has shown that inadequate housing structures and poor environmental control can negatively affect the well-being of sheep and goats (Sevi et al., 2009).

By providing proper shelter using bamboo, farmers can address issues such as thermal stress and overcrowding, which are known to impact animal health and productivity (Sevi et al., 2009). Additionally, the use of bamboo in construction aligns with the growing interest in sustainable and welfare-oriented farming practices (Silva et al., 2022; Manandhar et al., 2019). Bamboo is gaining recognition as a sustainable building material with environmental, social, and economic benefits (Manandhar et al., 2019). Its use in housing construction can significantly reduce costs, making it accessible to low-income groups (Atamewan, 2020). Integrating bamboo into contemporary vernacular architecture offers structural and sustainability advantages, potentially improving the financial stability of low-income families (Habibi, 2019).

However, the adoption of modern bamboo construction techniques is hindered by a lack of technological know-how, necessitating advocacy, training, and a shift in perception towards locally available materials (Atamewan, 2020). The successful implementation of modern technologies in agriculture and construction requires consideration of local and indigenous knowledge systems (Adedipe & Ayinde, 2004). A balanced approach that combines traditional practices with modern techniques is crucial for sustainable development, particularly in developing countries facing rapid population growth and increasing domestic demands (Adedipe & Ayinde, 2004).

Conclusion

In conclusion, the design and construction of sheep and goat shelters using bamboo architecture represent a transformative approach to addressing the challenges faced by livestock farmers in Bauchi, Nigeria. This innovative solution not only meets the specific needs of small ruminants but also promotes sustainable agricultural practices that are crucial for the region's economic viability. By leveraging bamboo's unique properties—such as its strength, flexibility, and sustainability—farmers can construct cost-effective and durable shelters that significantly enhance animal welfare.

The implementation of bamboo architecture in livestock farming has the potential to improve overall health and productivity among sheep and goat populations. Research indicates that well-designed shelters can lead to increased productivity by providing protection from adverse weather conditions, predators, and diseases. Moreover, these shelters can facilitate better management practices, making it easier for farmers to monitor animal health and wellbeing. Furthermore, this approach aligns with broader environmental goals by utilizing locally sourced materials and reducing reliance on conventional building resources that may have a higher ecological impact.

The use of bamboo not only supports sustainable development but also fosters community engagement by creating jobs and stimulating local economies through the construction process. As climate change continues to pose significant challenges to agriculture, adopting resilient building practices like bamboo architecture becomes increasingly essential. By promoting environmentally friendly solutions in livestock housing, this study advocates for a future where livestock farming can thrive sustainably while enhancing food security and economic stability in Bauchi.

References

- Adedipe, N., & Ayinde, I.A. (2004). The Relevance Of Local And Indigenous Knowledge For Nigerian Agriculture.
- Aldridge, M.E., Fearon, J.E., Haynes, B.P., Miller, H., Sanford, K.Y., Scott, R.R., Anglin, W.W., Blalock, L.S., Burkes, B.L., Cohn-White, O.L., Franks, B.R., Giles, H.M., Greene, A.L., Hanby, R.D., Holliman, A.G., Kirby, J.M., Klein, A.W., Lehmann, C., Llyod, G.J., Lore, C.T., McMurray, T.B., Moody, Z.V., Palmer, B.N., Pansano, L.V., Pickle, R.M., Schaeffer, L., Seidl, J.R., Smith, J.D., Stepp, H., Satrio, F.A., Kutchy, N.A.,

- Dechert, E., Rutherford, C., Brown, K., Purwantara, B., & Memili, E. (2018). SOLUTIONS FOR GRAND CHALLENGES IN GOAT AND SHEEP PRODUCTION. *BIOTROPIA*.
- Atamewan, E.E. (2020). Use of Bamboo for Sustainable Housing Construction in Developing Countries.
- Auwalu, F.K., & Dickson, P.D. (2019). Bamboo as a Sustainable Material for Building Construction in Nigeria. *Civil and Environmental Research*.
- Ayoola J, B., Ofukwu, R.A., Teryila, A., & Ayoola, G.B. (2007). Use of indigenous plants for sustainable management of livestock diseases in rural Nigeria.
- Cesar, "Considerations for Goats and Sheep Shelter Fabrication," Journal of Agricultural Sciences (2021).
- Enwelu, I.A., Ezeuko, E.L., & Machebe, N.S. (2015). Challenges of smallholder sheep and goat keeping in rural communities of Aguata Agricultural Zone of Anambra State, Nigeria. *Indian Journal of Animal Research*, 49, 373-377.
- Habibi, S. (2019). Design concepts for the integration of bamboo in contemporary vernacular architecture. *Architectural Engineering and Design Management*, 15, 475 - 489.
- Kumar Boity, A., Bhandari, H., & Shukla, S.K. (2022). Bamboo as a sustainable building construction material. *Materials Today: Proceedings*.
- Kumar, N., Mathur, U., Phulwari, B., & Choudhary, A. (2017). BAMBOO AS A CONSTRUCTION MATERIAL. *International Journal of Advance Research and Innovative Ideas in Education*, 3, 343-349.
- Manandhar, R., Kim, J., & Kim, J. (2019). Environmental, social and economic sustainability of bamboo and bamboo-based construction materials in buildings. *Journal of Asian Architecture and Building Engineering*, 18, 49 - 59.
- Osunkunle Abdulmageed A., et al., "Design and Fabrication of Goats and Sheep Shelter," Federal Polytechnic, Bauchi (2024).
- Sanusi, M., Zahraddeen, D., & Mahmood, A. (2010). Characterization of Smallholder Sheep and Goat Farming in Bauchi, Northeastern Nigeria. *Animal Production Research Advances*, 6.
- Sevi, A., Casamassima, D.V., Pulina, G., & Pazzona, A.L. (2009). Factors of welfare reduction in dairy sheep and goats. *Italian Journal of Animal Science*, 8, 101 - 81.
- Sharma, P., Dhanwantri, K., & Mehta, S. (2014). Bamboo as a Building Material.
- Silva et al., "Technological Developments in Extensive Farming Systems," IFAD Agric Hub (2022).
- Silva, S.R., Sacarrão-Birrento, L., Almeida, M., Ribeiro, D.M., Guedes, C., González Montaña, J.R., Pereira, A.F., Zaralis, K., Geraldo, A.C., Tzamaloukas, O., Cabrera, M.G., Castro, N., Argüello, A., Hernández-Castellano, L.E., Alonso-Diez, Á.J., Martín, M.J., Cal-Pereyra, L.G., Stilwell, G., & de Almeida, A.M. (2022). Extensive Sheep and Goat Production: The Role of Novel Technologies towards Sustainability and Animal Welfare. *Animals: an Open Access Journal from MDPI*, 12.