**HOUSING OF SMALL RUMINANTS: PROSPECTS AND CHALLANGES**

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**ABSTRACT**

The key management systems in ruminant animal production, including housing, nutrition, health, reproduction, and environmental considerations. Small ruminants, such as sheep and goats, have been domesticated for thousands of years and have played a crucial role in the lives of human populations worldwide. These animals provide a wide range of benefits, making them invaluable to agricultural systems and rural economies. Housing systems play a crucial role in small ruminant animal production by providing a suitable environment for the animals to thrive and maximizing their productivity. Hence, this work evaluated the roles and challenges facing small ruminant housing.

**INTRODUCTION**

Ruminant animal production involves the rearing and management of animals such as; cattle, sheep, and goats. These livestock species possess a unique digestive system called the rumen, which allows them to efficiently utilize fibrous plant materials. To ensure successful ruminant production, various management systems are employed to optimize animal health, nutrition, reproduction, and overall productivity. The key management systems in ruminant animal production, including housing, nutrition, health, reproduction, and environmental considerations (Mee & Prendiville, 2016). Small ruminants, such as sheep and goats, have been domesticated for thousands of years and have played a crucial role in the lives of human populations worldwide. These animals provide a wide range of benefits, making them invaluable to agricultural systems and rural economies (Dubeuf *et al.,* 2009). Small ruminant consist a large percentage of meat consumed and it also a source of income for the producers (Dubeuf *et al.,* 2009). Housing systems play a crucial role in small ruminant animal production by providing a suitable environment for the animals to thrive and maximizing their productivity. The housing systems for small ruminants vary across regions and depend on multiple factors such as; climate, available resources, farm size, and management practices. Housing systems for small ruminants, their design considerations impact the overall well-being and productivity of the animals (Ndagurwa, 2021). However, there are several challenges associated with these housing systems that need to be addressed to ensure optimal management and well-being of the animals and some of these challenges include; space limitation, inadequate ventilation, poor feeding and watering system, among others (Solomon *et al.*, (2016). To mitigate this challenges, it is importance to note that housing systems provide shelter and protection from adverse weather conditions, predators, and diseases. Additionally, they allow for efficient management practices and promote optimal growth and reproduction (Gipson, 2019). Conclusively, this work reviews the challenges and prospects of small ruminants.

**IMPORTANCE OF SMALL RUMINANTS**

These animals provide a wide range of benefits, making them invaluable to agricultural systems and rural economies. This section will explore the importance of small ruminants in various aspects:

**Livelihood Support:** Small ruminants are often kept in rural and resource-poor areas where other livestock species may not thrive. They play a vital role in supporting the livelihoods of millions of small-scale farmers and pastoralists globally. Sheep and goats are versatile, adaptable, and capable of thriving in diverse environments, even in marginal lands with limited vegetation. They provide an important source of income, food security, and nutrition for communities in developing countries (Dubeuf *et al.,* 2009).

**Meat and Dairy Production:** Small ruminants are an excellent source of high-quality protein through meat and milk production. The meat from small ruminants is considered a valuable protein source, especially in regions with limited access to other animal protein sources (Tesfaye *et al.,* 2019). Similarly, goat and sheep milk are highly nutritious, easily digestible, and contribute to human nutrition, especially in areas with lactose intolerance where consumption of cow's milk may be limited (Morand-Fehr, 2005).

**Biodiversity and Sustainable Land Management:** Small ruminants play a significant role in maintaining biodiversity and promoting sustainable land management practices. Through their selective browsing habits, goats and sheep help control invasive plant species and reduce the risk of wildfires. They also contribute to maintaining grasslands, preventing desertification, and improving soil fertility through their grazing behaviors (Moghaddam *et al.,* 2019; Shabtay *et al.*, 2008).

**Utilization of Marginal Lands:** Small ruminants are well-suited to graze on marginal lands that are unsuitable for crop cultivation. These lands often have limited productivity due to restrictions such as steep slopes, poor soil fertility, or water scarcity. By utilizing these marginal lands, small ruminants can convert low-quality forage into high-quality protein and make productive use of otherwise underutilized resources (Belanche *et al.,* 2012; Smit *et al.,* 2017).

**Cultural and Socioeconomic Significance:** Small ruminants have deep cultural and socio-economic importance in many societies. They are often integral to traditional customs, festivals, and religious celebrations. The ownership of small ruminants can also enhance social status and provide economic security, particularly for women and marginalized groups who rely on these animals for income generation (Fizzani *et al.,* 2019; Janssen *et al.,* 2007).

**Environmental Sustainability:** Compared to larger ruminant species, small ruminants have a lower environmental impact in terms of greenhouse gas emissions, land usage, and water consumption. The efficient digestion system and smaller body mass of sheep and goats make them less environmentally demanding, making their production more sustainable than larger livestock (Herrero *et al.,* 2013).

In conclusion, small ruminants, including goats and sheep, are of paramount importance in various aspects. Their contribution to livelihood support, meat and dairy production, biodiversity conservation, sustainable land management, utilization of marginal lands, cultural significance, socioeconomic benefits, and environmental sustainability cannot be overstated. Recognizing and investing in the development of small ruminant production systems can lead to enhanced food security, poverty alleviation, and environmental conservation.

**MANAGEMENT SYSTEMS IN RUMINANT ANIMAL PRODUCTION**

This section provides an overview of the key management systems in ruminant animal production, including housing, nutrition, health, reproduction, and environmental considerations.

1. **Housing Systems:** Housing systems for ruminants primarily aim to provide shelter, protection from adverse weather conditions, and promote animal well-being. The choice of housing system depends on factors such as climate, available resources, and production objectives. Common housing systems include pasture-based systems, barns, free-stall systems, and feedlots (Dwyer, 2008). Each system has advantages and disadvantages in terms of animal comfort, health, and production efficiency (Mee & Prendiville, 2016).
2. **Nutrition Management:** Proper nutrition is crucial for the growth, reproduction, and overall health of ruminant animals. The nutrition management system includes formulating balanced diets, providing adequate forage, supplementation, and rationing. It involves considerations such as dietary energy, protein, minerals, vitamins, and water requirements. Ruminant animals have specific nutrient requirements due to their unique rumen fermentation process, which includes the breakdown of complex carbohydrates and production of volatile fatty acids essential for their energy supply (NRC, 2007).
3. **Health Management:** Effective health management is vital for the prevention and control of diseases in ruminant animal production. This system includes regular vaccinations, parasite control, preventive medicine, and prompt diagnosis and treatment of illnesses (Smith & Sherman, 2019). Additionally, practices such as proper biosecurity measures, hygiene, herd health monitoring, and quarantining new animals are essential for minimizing disease outbreaks and optimizing production efficiency (Radostits *et al.,* 2018).
4. **Reproduction Management:** Reproduction management systems aim to optimize fertility, reproduction efficiency, and genetic improvement in ruminant animals (Kasimanickam *et al.,* 2005). This includes practices such as estrous synchronization, artificial insemination, proper mating and breeding strategies, pregnancy diagnosis, and management of parturition. Ensuring adequate nutrition, minimizing stress, and proper timing of reproductive interventions are critical for successful reproductive performance (Lucy, 2001).
5. **Environmental Considerations:** There is a growing emphasis on sustainable and environmentally friendly practices in ruminant animal production. This includes managing waste and effluents, minimizing greenhouse gas emissions, and adopting practices that reduce environmental impact, such as pasture rotation and utilizing renewable energy sources (Capper *et al.,* 2009). Environmental management systems aim to minimize the ecological footprint of ruminant production while maximizing productivity (Montes *et al.,* 2013).

In conclusion, successful management systems are crucial for efficient and sustainable ruminant animal production. Housing, nutrition, health, reproduction, and environmental considerations all play significant roles in optimizing productivity and animal welfare. Adequate knowledge and implementation of these management systems contribute to the overall success and viability of ruminant farming operations.

**HOUSING SYSTEMS FOR SMALL RUMINANTS**

In this comprehensive overview, the common housing systems for small ruminants, their design considerations, and their impact on the overall well-being and productivity of the animals will be discussed.

1. **Traditional Extensive Systems:** The traditional extensive housing systems are prevalent in many pastoral and nomadic regions worldwide. In these systems, small ruminants, including sheep and goats, are left to graze on communal lands during the day and are brought back to a centralized shelter during the night. The shelter, commonly known as a kraal, pen, or corral, provides protection from predators and adverse weather conditions (Ndagurwa, 2021).
2. **Open Grazing Systems:**

Open grazing refers to allowing small ruminants to roam freely in pastures or extensive rangelands. Animals have access to natural forage, and grazing allows them to exercise and exhibit natural behaviors. However, open grazing may become challenging in areas with limited land resources, predator issues, or climate constraints (hot or cold temperatures, extreme weather events) (Squires *et al.,* 2013)

1. **Semi-Intensive Systems:** Semi-intensive housing systems involve a combination of grazing and provision of supplementary feeding. The animals are allowed outdoor access during the day and are housed in enclosures or sheds during the night. These enclosures are designed to prevent predators and provide shelter from extreme weather conditions. Additionally, some semi-intensive systems include exercise yards or paddocks to allow for increased movement and exercise (Taye, 2020).
2. **Intensive Systems:** Intensive housing systems are typically implemented in commercial small ruminant production settings. These systems prioritize intensive management, productivity, and controlled environmental conditions. Intensively housed small ruminants are generally confined indoors, either in purpose-built buildings or converted barns, away from external grazing. These systems provide precise control over diet, climate, and disease prevention, ensuring optimal growth and productivity (Ademosun, 2018).
3. **Conventional Intensive Systems:** Conventional intensive systems often involve fully enclosed barns where small ruminants are confined to individual stalls or group pens. These barns are equipped with ventilation systems, temperature controls, and feeding and watering systems. The animals receive a formulated diet, and waste management systems are implemented for efficient removal of manure (Altuntas and Yilmaz, 2017).
4. **Traditional Barn Systems:** Traditional barns provide indoor housing for small ruminants and are widely used globally. Barns protect animals from adverse weather conditions, predators, and diseases while offering controlled feeding and management. The barns should provide adequate ventilation, lighting, and space per animal to ensure proper air quality, reduce moisture buildup, and prevent overcrowding (Zhao *et al.,* 2020)
5. **Deep-Litter Systems:** Deep-litter systems involve the use of bedding materials, such as straw, sawdust, or wood shavings, which are regularly added to the floor of the housing area. The bedding helps absorb moisture, provides insulation, and promotes microbial activity. Small ruminants are free to move and interact within this bedding, resulting in increased activity levels and enhanced animal welfare (Martínez and González, 2020).
6. **Slatted/Slatted-Floor Systems:** Slatted or slatted-floor systems are popular in intensive sheep and goat production units. The floors consist of slats or grids with gaps that allow urine and feces to pass through, enhancing hygiene, air circulation, and manure management. These systems can be equipped with manure collection systems for improved waste management (Wasike, 2020).

Housing systems for small ruminants should consider several design considerations, including proper ventilation, adequate space allocation, temperature control, lighting, and biosecurity measures. Additionally, access to clean water, feed storage, and handling facilities should be integrated into the housing design to optimize management practices. When implementing any housing system, it is essential to prioritize animal welfare, account for regional regulations, and ensure the sustainability of the production system. Furthermore, periodic assessments, such as monitoring growth rates, reproduction performance, disease prevalence, and behavior, can help evaluate the efficiency and efficacy of the chosen housing system. It is important to note that specific housing recommendations may vary depending on the geographic location, production goals, and animal and economic considerations.

**CHALLENGES OF HOUSING FOR SMALL RUMINANTS**

Housing systems for small ruminants, such as sheep and goats, play a crucial role in their overall health, productivity, and welfare. However, there are several challenges associated with these housing systems that need to be addressed to ensure optimal management and well-being of the animals. In this response, below are key challenges faced by small ruminant housing systems:

1. **Space limitation:** One of the primary challenges is the limited space available for small ruminants. Overcrowding can lead to stress, increased disease transmission, and decreased productivity. Adequate space allocation is essential to allow animals to move freely, exhibit normal social behaviors, and access feed and water without competition. Research by Huzzey *et al.* (2005) on small ruminant highlighted the negative impacts of overcrowding on behavior and welfare. They observe severe vices among the animals.
2. **Inadequate ventilation and air quality:** Proper ventilation is crucial in small ruminant housing systems to control temperature, humidity, and air quality. Inadequate ventilation can lead to poor air quality, accumulation of harmful gases like ammonia and carbon dioxide, and increased susceptibility to respiratory diseases. Studies by Solomon *et al.*, (2016) emphasized the importance of adequate ventilation for the well-being of housed livestock.
3. **Improper Structural design and materials:** The design and construction of small ruminant housing should provide protection against adverse weather conditions, predators, and facilitate ease of management. The choice of suitable building materials and their maintenance is also vital. Improper design or usage of inappropriate materials can compromise the structural integrity, thermal comfort, and safety of the animals. Dwyer *et al.,* (2015) conducted research on sheep housing, highlighting the effect of design on animal behavior and welfare. The finding was significant.
4. **Improper drainage and waste management:** Effective drainage systems are needed to prevent accumulation of water and subsequent health issues like foot rot and mud-related infections in small ruminants. Additionally, proper waste management practices, such as regular cleaning, composting, or proper disposal of manure, are essential for maintaining a healthy environment and preventing the spread of diseases. Studies by Leymaster *et al.,* (2009) on sheep housing emphasized the importance of appropriate waste management strategies.
5. **Improper Lighting and photoperiod management:** Light plays a significant role in regulating the biological functions and behavior of small ruminants. Inadequate or improper lighting can lead to disrupted circadian rhythms, poor performance, and reproductive problems. Proper artificial lighting systems and management techniques need to be implemented to mimic natural light conditions. Napolitano and De Rosa (2009) discussed the impact of lighting on the welfare and production of small ruminants.
6. **Inadequate biosecurity and disease control:** Small ruminant housing systems need to address biosecurity concerns to prevent the entry and spread of infectious diseases. Measures such as quarantine protocols, vaccination programs, and hygiene practices are critical in minimizing disease transmission. Studies by Hegde *et al.,* (2021) highlighted the significance of biosecurity measures in small ruminant production systems.
7. **Poor feeding and watering systems:** Some housing does not incorporate convenient and easily access feeding and watering systems which ensure animals receive proper nutrition and hydration. Feed and water should be protected from contamination and wastage (DGCRC, 2002).
8. **Inadequate temperature and insulation:** Small ruminants are susceptible to extreme temperatures, and housing should provide insulation to maintain a comfortable environment. In cold climates, inadequate insulation can lead to hypothermia, decreased feed intake, and reduced productivity. Similarly, in hot climates, inadequate cooling mechanisms can cause heat stress and reduced fertility (Landau & Berman, 2011).
9. **Lack of Social and environmental enrichment:** Small ruminants are social animals and require opportunities for social interaction and environmental enrichment. Lack of appropriate enrichment can lead to stress, abnormal behaviors, and reduced welfare. Providing features like hiding spots, elevated platforms, and toys can help promote natural behaviors. Research by Villalba *et al*., (2006) explored the behavioral and physiological benefits of environmental enrichment for sheep.

It is important to note that the challenges faced by small ruminant housing systems can vary depending on geographical locations, management systems, and specific animal needs.

**PROSPECTS OF HOUSING FOR SMALL RUMINANTS**

Housing systems for small ruminants play a crucial role in ensuring their health, welfare, and productivity. These systems provide shelter and protection from adverse weather conditions, predators, and diseases. Additionally, they allow for efficient management practices and promote optimal growth and reproduction.

This section discusses the prospects related to housing systems by consideration of different key component for small ruminants.

1. **Choice of Housing Systems:**

According to Mekasha & Gebremedhin, (2017), there are different types of housing systems suitable for small ruminants. A suitable housing system will benefit the animals in the following areas;

* Protection from Harsh Weather: Adequate housing protects small ruminants from extreme temperatures, high humidity, wind, rain, and snow, preventing stress and related health issues.
* Disease Prevention: Proper housing reduces the risk of infectious diseases and parasitic infections by minimizing contact with pathogens or vectors.
* Improved Reproductive Performance: Well-designed housing systems facilitate controlled breeding, estrus detection, and provide a stress-free environment, leading to improved reproductive efficiency.
* Enhanced Nutrition Management: Housing systems enable precise feeding and monitoring of small ruminants' nutritional intake, contributing to optimal growth and production.
* Predator Control: Enclosed housing systems offer protection from predators, reducing loss due to predation.
* Easy Management and Handling: Well-planned housing systems simplify animal handling, health checks, and administration of treatments.

Hence, for enhanced productivity and protection of the animals, the most suitable types pf housing systems for small ruminants includes;

1. Barns or Sheds: These structures provide enclosed spaces for animals, protecting them from extreme weather conditions.
2. Pasture-based Systems: These systems allow small ruminants to graze on pasture, offering open-air environments. Fencing and shelters may still be necessary.
3. Feedlots: Feedlots are intensive housing systems where animals are confined and provided with a controlled diet (Zobel & Lensink, 2021).
4. **Improved housing design**: Advancements in architectural and engineering practices offer opportunities to develop innovative and efficient housing systems. These systems can improve ventilation, lighting, space utilization, and waste management, leading to enhanced animal welfare and productivity (Salami, 2018; Boopathy, 2020). According to Thornton, (2010), housing systems for small ruminant should be anchored on the following aspects;

* **Space Requirements**: Sufficient space per animal is essential to avoid overcrowding, facilitate movement, resting, and social interaction.
* **Ventilation**: Proper ventilation is critical to remove moisture, odors, and airborne pathogens, preventing respiratory issues.
* **Lighting**: Adequate natural or artificial lighting is necessary to maintain normal circadian rhythms and encourage feeding and activity.
* **Flooring**: Flooring surfaces should be well-drained, slip-resistant, and comfortable for the animals, avoiding injury or hoof-related problems.
* **Bedding**: Clean and comfortable bedding materials, such as straw or wood shavings, promote animal welfare and prevent injuries.
* **Water Provision:** Easy access to clean and fresh water sources is vital for maintaining hydration and preventing dehydration.
* Proper feeding watering systems which should be accessible to the animals without stress.

1. **Sustainable housing solutions**: There is an increasing awareness of the need for sustainable practices in agriculture. Energy-efficient housing design, use of renewable resources, and waste recycling can reduce the environmental footprint of small ruminant housing systems (Ruiz-Mirazo, 2021).
2. **Technological advancements**: Integrating smart technologies in housing systems can provide real-time monitoring of animal behavior, health status, and environmental parameters. Such systems can help in early disease detection, optimized feeding, and improved overall management (Gipson, 2019).

**CONCLUSION**

In conclusion, housing systems for small ruminants are essential for their well-being and efficient management. By providing protection, disease prevention, and controlled environments, these systems contribute significantly to the overall productivity and health of small ruminants. Adequate housing design, considering space, ventilation, lighting, flooring, bedding, and water provision, is crucial for optimal results. Addressing these challenges requires an integrated approach that incorporates scientific research, innovation, and practical knowledge to ensure the well-being and productivity of small ruminants.

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