



ISSN: 2456-2912

VET 2024; 9(6): 376-379

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www.veterinarypaper.com

Received: 04-09-2024

Accepted: 13-10-2024

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Biosecurity and waste management: Neglected but the most vital aspects in livestock farms

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Abstract

Indian livestock is inextricably linked with the rural economy, aiding masses in generating livelihoods and nutritional security. Over the years, a transitional change has been witnessed both in livestock productivity and production. Contrarily, in absolute numbers, the livestock has witnessed consolidation. The livestock farmers have delved into better husbandry practices which has led to a paradigm shift in production but deficits have been observed in the elemental aspects of biosecurity and waste management in livestock farms. Biosecurity curtails the influx of pathogens in the farm and waste management ensures the efflux of the same. The farmers have readily adopted many contemporary technologies for augmenting farm economy, howsoever, there is a need to adopt the biosecurity measures and waste management practices in principality for ensuring maximum profit realization.

Keywords: Adoption, biosecurity, economy, pathogens, waste management

Introduction

India stands at zenith in livestock population, milk production, cattle population, goat population, and total bovine population. The standing of the country is second in aquaculture, third in egg production, fifth in poultry production (Kour *et al.*, 2018; Singh A, 2023) ^[2, 30]. Over the years, livestock population and livestock produce *viz.* milk, meat, eggs and wool has witnessed a substantial increase which can be attributed to better germplasm in the country, better husbandry practices and various extension efforts at grassroots (Ahmad *et al.*, 2019; Kour *et al.*, 2020) ^[1, 3].

Biosecurity and waste management are critical components of modern livestock farming, ensuring the health of animals, the safety of farm products, and the sustainability of farming practices. As livestock farms grow larger and more complex, the risks of disease outbreaks and environmental degradation also increase, making biosecurity and waste management essential for maintaining farm productivity, public health, and environmental integrity.

Biosecurity refers to a set of management practices aimed at preventing the introduction and spread of infectious diseases within and between livestock farms (woah.org). Effective biosecurity measures help safeguard the health of animals by controlling the movement of people, animals, equipment, and vehicles, minimizing the risk of contamination. By preventing the outbreak of diseases such as foot-and-mouth disease, avian influenza, and swine fever, biosecurity measures not only protect animal welfare but also reduce economic losses and maintain consumer confidence in livestock products.

Waste management, on the other hand, involves the responsible disposal and treatment of waste generated on livestock farms, such as manure, bedding, and dead animals. Improper waste management can lead to soil, air, and water pollution, contributing to environmental degradation and public health issues (Singh *et al.*, 2020a) ^[23]. To mitigate these risks, farms employ waste treatment methods like composting, anaerobic digestion, and proper disposal of carcasses. Manure management is particularly important, as it can be a valuable resource when handled properly, serving as fertilizer or bioenergy (Singh *et al.*, 2019) ^[22]. However, mismanagement can result in nutrient runoff, greenhouse gas emissions, and the spread of pathogens (Kumar *et al.*, 2021) ^[6].

Incorporating effective biosecurity and waste management strategies is essential for sustainable livestock farming (Panda *et al.*, 2023a) ^[9]. These practices not only improve animal

health and productivity but also minimize the environmental impact of farming, reduce the risk of disease transmission, and contribute to a safer food supply chain. Proper waste management, including the treatment and disposal of manure and farm waste, reduces the risk of water and soil contamination, minimizes odor, and controls pests (Singh and Rashid, 2017)^[19]. Together, these practices promote healthier livestock, safeguard public health, and support sustainable farming operations.

The cognitive domain of biosecurity and waste management

In India, livestock farming plays a crucial role in the livelihoods of millions, but the awareness and implementation of biosecurity and waste management practices among farmers vary significantly (Singh *et al.*, 2018; Panda *et al.*, 2024)^[1, 13]. Many small-scale and traditional farmers have limited knowledge about modern biosecurity protocols, relying more on traditional practices for disease control. In developing countries, where livestock is essential for livelihoods by providing food, income, and fulfilling various social roles, the challenges posed by animal diseases and their impact on poverty can be substantial (Randolph *et al.*, 2007; Perry and Rich, 2007; Perry and Grace, 2009)^[17, 16, 15]. While some progressive farmers adopt preventive measures like vaccination and isolation of sick animals, a large portion still lacks comprehensive knowledge of biosecurity practices such as controlled farm access, regular disinfection, isolation & quarantine and proper disposal of carcass and farm waste (Panda *et al.*, 2023a)^[9]. It was also seen that poultry farmers have more knowledge regarding biosecurity than other livestock farmers which may be because of the species wise differences in vulnerability due to any disease outbreak.

In terms of waste management, Indian livestock farmers, especially in rural areas, often handle waste traditionally by using manure for biogas production or as organic fertilizer. However, many still do not employ advanced waste treatment techniques like composting or anaerobic digestion on a large scale (Singh *et al.*, 2023). Poor waste management practices, including open dumping of manure, can lead to environmental pollution, water contamination, and health risks. Kumari *et al.* (2020)^[8] and Singh *et al.* (2024)^[31] also reported that maximum gap in knowledge among the dairy farmers is found in utilization of livestock waste followed by household waste and agriculture waste. Efforts from government programs and agricultural extension services are increasingly focused on educating farmers about sustainable waste management and biosecurity measures, but challenges remain due to resource limitations, lack of infrastructure, and gaps in knowledge dissemination. Hence, by enhancing farmers' educational levels, improving their ability to utilize information sources effectively, and building their capacity for the sustainable management of organic waste, their knowledge of organic waste management can be significantly improved. Improved training and extension services, along with the promotion of cost-effective solutions, are essential to raise awareness and adoption of these practices among Indian livestock farmers (Singh *et al.*, 2016)^[18].

Sustainable management of livestock waste

Sustainable management of livestock waste involves strategies that minimize environmental impact while maximizing resource recovery. Key approaches include composting, vermicomposting and anaerobic digestion, which convert manure into valuable products like organic fertilizer

and biogas for energy. Proper manure storage systems, such as covered lagoons or tanks, prevent nutrient runoff and greenhouse gas emissions. Integrating waste management with crop production allows for nutrient recycling, where treated manure is used as a natural fertilizer for crops, reducing reliance on chemical inputs. Additionally, controlled grazing and precision feeding techniques can help reduce the overall volume of waste (Singh *et al.*, 2024a; Singh *et al.*, 2024b)^[32, 33]. These strategies not only mitigate environmental risks but also create opportunities for renewable energy generation and soil health improvement (Yadav *et al.*, 2024)^[36].

Current scenario

Indian livestock farmers employ a range of practices for waste management and biosecurity, though the extent and sophistication of these practices often depend on the size of the farm, region, and farmer awareness. As far as waste management is concerned, a majority of Indian farmers utilize animal manure as organic fertilizer for crops. Manure is often collected and stored in open heaps or pits before being applied to fields, although this method can lead to nutrient loss and environmental pollution (Singh *et al.*, 2018a)^[20]. In some rural areas, manure is used for biogas generation. This provides a renewable source of energy for cooking and lighting while reducing waste accumulation. Farmers are increasingly adopting composting methods to treat manure, converting it into nutrient-rich organic matter for soil health improvement. Few farmers have also been seen to be using untreated manure directly to fields, but this can pose risks of contamination if not managed properly. In areas with limited knowledge or infrastructure, open dumping of manure is still practiced, leading to water contamination, bad odor, and health risks (Singh *et al.*, 2023a)^[29].

The biosecurity practices have also been varied from farm to farm based on the knowledge and awareness of the farmers. Majority of farmers have been observed to be vaccinating the livestock against common diseases like Foot and Mouth Disease (FMD), Peste des petites ruminants (PPR), Black Quarter (BQ), Hemorrhagic Septicemia (HS), etc., especially in government-led health campaigns. Some farmers isolate sick animals to prevent disease spread, though this is often done informally without strict protocols (Panda *et al.*, 2021; Panda *et al.*, 2023b)^[10, 12]. Basic hygiene practices, such as cleaning animal sheds and ensuring fresh drinking water, are followed to some extent, though regular disinfection is less common. Larger or more commercial farms may restrict entry to limit disease exposure, but smaller farms often have open access, increasing the risk of infection. Quarantining new or sick animals is not widely practiced due to lack of awareness, space, or resources on small farms. Larger commercial farms may conduct regular health checks, while smaller farmers rely on local veterinarians during outbreaks or visible signs of illness. The most significant factor influencing the adoption of biosecurity measures is the farmers' level of knowledge. Additionally, factors such as education, income, herd or flock size, utilization of Information and Communication Technology, and the number of training sessions attended also play a significant role in the practical implementation of biosecurity measures (Panda *et al.*, 2024)^[13]. While these practices represent efforts to manage waste and biosecurity, there is still room for improvement in knowledge dissemination and access to modern techniques. Government extension services and programs are working to educate farmers about better waste

management and biosecurity practices to improve both farm productivity and environmental sustainability (Soodan *et al.* 2023)^[35].

Economics of waste management

Waste management can prove to be profitable venture for the livestock farmers. The waste generated at livestock farms is generally discarded by the farmers (Singh *et al.*, 2020c)^[25]. Few farmers also pay the local transporters and vendors to discard waste for them which is a net loss of the organic matter as well as economy (Singh *et al.*, 2021b)^[27]. Researchers have conducted comparative economic analysis to determine the expenses associated with vermicomposting, composting, and producing biogas. After study, it was discovered that vermicomposting (INR 2224.72) had the highest net returns per metric tonne of manure, followed by biogas production (INR 536.66) and composting (INR 45.59). The study places a strong emphasis on using waste materials for vermicomposting in conjunction with biogas production to increase farmers' revenue (Singh *et al.*, 2021a)^[26].

Online tools in practice

When it comes to building capacity of the people, digital tools can play a tremendous role in the same (Kumar and Singh, 2017; Panda *et al.*, 2018; Joshi *et al.*, 2021)^[7, 11, 5]. With high internet penetration and reduction in the price of the smart phones, the technology has traversed every palm top and made information dissemination easier (Singh *et al.*, 2020b; Panda *et al.*, 2021a; Panda *et al.*, 2021b)^[24, 10, 14]. It has been observed that farmers are also using smart phones to watch videos, use mobile apps and social media (Jadoun *et al.*, 2023)^[4]. Utilization of various information sources by farmers is found to be of medium level whereas ICT utilization is reported to be high for obtaining information related to waste management (Singh *et al.*, 2023b)^[30]. Mobile apps have contributed significantly in outreach services and in building capacities of the farmers (Sood *et al.*, 2020)^[34]. There are many mobile apps which are in practice and available on Google Play Store for livestock farming in general, and biosecurity and waste management in particular (Singh *et al.*, 2018b; Panda *et al.*, 2023b; Singh *et al.*, 2022)^[21, 12, 28].

Conclusion

Biosecurity and waste management are critical components of modern livestock farming, aimed at safeguarding animal health, protecting public health, and minimizing environmental impact. As the global demand for animal products increases, so does the need to manage livestock in a way that prevents disease outbreaks and ensures sustainable agricultural practices. Biosecurity refers to a set of preventive measures designed to reduce the risk of infectious diseases entering or spreading within a farm. This involves practices like limiting farm access, maintaining hygiene, and monitoring animal health closely. On the other hand, waste management focuses on the proper handling, treatment, and disposal of farm waste, such as manure and feed residue, to reduce environmental pollution and enhance farm hygiene. Together, biosecurity and waste management help promote a more sustainable, efficient, and safe livestock farming system, ultimately supporting both animal welfare and human food security.

Conflict of Interest

Not available

Financial Support

Not available

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How to Cite This Article

Singh A, Panda P. Biosecurity and waste management: Neglected but the most vital aspects in livestock farms. *International Journal of Veterinary Sciences and Animal Husbandry.* 2024;9(6):376-379.

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