

An Overview of Precision Livestock Farming: Innovations in Livestock Farming

Naresh M^{1*}, Hariharan R², Banoth Sai Nehru³, Gongale Tushar Surendra⁴, Shashikiran S Doddannavar⁵

¹M.V.Sc. Scholar, Department of Animal Nutrition, CVAS, Pookode, KVASU, Kerala - 673576.

²Ph.D. Scholar, Department of Veterinary Public Health, CVAS, Pookode, KVASU, Kerala - 673576.

³Ph.D. Scholar, Department of Veterinary Microbiology, CVAS, Pookode, KVASU, Kerala - 673576.

⁴M.V.Sc. Scholar, Department of Animal Nutrition, CVAS, Pookode, KVASU, Kerala - 673576.

⁵M.V.Sc. Scholar, Department of Animal Genetics and Breeding, CVAS, Pookode, KVASU, Kerala - 673576

[DOI:10.5281/Vettoday.15025292](https://doi.org/10.5281/Vettoday.15025292)

Introduction:

Precision Livestock Farming (PLF) is an innovative approach that enables real-time monitoring of livestock by equipping animals with sensors to collect and transmit data on their health and behavior. This data helps farmers make informed decisions regarding animal welfare and productivity. The strategic goal of PLF is to promote sustainability in livestock farming, improving efficiency, reducing environmental impact and ensuring both animal and human health. PLF provides a solution for the growing challenges of a decreasing number of farmers and increasing herd sizes by maintaining health monitoring, reducing antibiotic use and ensuring food safety and feed quality. Animal welfare is central to this technological revolution, driving innovation that enhances farm sustainability, reduces greenhouse gas emissions and improves environmental outcomes. PLF can enhance animal welfare by providing objective documentation of farm conditions, improving the marketing of livestock products, reducing illegal trade and stabilizing the economic well-being of rural communities when effectively implemented in the field or on farms. PLF integrates a wide range of technologies, such as real-time image analysis, sound detection, sensor systems, microfluidics,

saliva sensing and sero-diagnosis to enhance better health monitoring and disease prevention by alerting farmers to potential issues and enabling prompt intervention. These innovations support not only the well-being of animals but also contribute to environmental sustainability through precision nutrient management, reduced feed waste and optimized feed efficiency, boosting both productivity and profitability. The high initial investment cost of advanced technologies is often a barrier for small-scale farmers. The need for specialized knowledge to operate and maintain these systems, along with the complexities of managing and analyzing large datasets, can overwhelm farmers. Furthermore, internet connectivity issues in remote areas and a lack of technical support can hinder successful implementation. Addressing these challenges is essential for ensuring the widespread adoption and success of PLF, ultimately enhancing the sustainability and profitability of livestock farming.

Key Technologies:

Key technologies in Precision Livestock Farming (PLF) play a crucial role in improving farm management and animal welfare. **Electronic identification systems** such as RFID systems, advanced ear tags, ruminal boluses and injectable

subcutaneous electronic identifiers enable the independent identification of animals, ensuring individual animal records are maintained separately and allowing data storage for informed decision-making. **Sensor systems** which include chips, accelerometers, temperature sensors and pressure sensors form an Internet of Things (IoT) network crucial for monitoring animal health and behavior. Tools like pedometers, GPS and rumination tags which are all specific sensor-based technologies provide real-time data on movement, feeding behavior, estrus, calving and physiological conditions such as body temperature, enabling effective farm management. These sensors translate data into actionable insights, such as detecting ovulation or lameness, to support timely interventions by livestock farmers, enabling better health management and improved farm efficiency. **Automated weighing systems** such as walk-over weighers, step-on scales and machine learning-enabled cameras, provide accurate individual weight measurements with minimal intrusion. **Feed and water intake recording systems** use water meters and feed sensors to monitor consumption patterns, creating historical trends that can activate early warning systems in case of deviations, indicating potential health issues. **Imaging solutions**, like 3D cameras and thermal imaging, analyze behavioral patterns such as mounting and lameness, as well as physiological conditions like respiration and temperature, growth trends and carcass quality. **Microphones** are also utilized to record and analyze animal vocalizations, helping detect abnormal behavior, distress, respiratory problems and feed intake. Innovative technologies such as **virtual fencing and the Grass Hopper system** enhance efficiency of pasture management. Additionally, systems like **automatic drafters (AD)** use electronic identification (EID) to selectively guide animals through gates. For tracking **methane emissions**, advanced techniques like chamber systems, SF₆ tracer techniques, laser-methane detection and spectroscopy are being utilized to monitor and mitigate environmental impacts effectively. These technologies collectively advance livestock farming by optimizing health, productivity, and environmental sustainability.

Benefits of PLF:

Precision Livestock Farming (PLF) offers numerous advantages by integrating advanced technologies to enhance farm management by enabling efficient input management through precise

feeding strategies tailored to individual animals' requirements, optimizing feed efficiency using automated feeding systems. This ensures the efficient use of limited resources, lowering costs while increasing animal product yield and farm profitability. By improving resource efficiency, it reduces the consumption of water, feed and energy, contributing to sustainable farming practices. Moreover, it minimizes greenhouse gas emissions, particularly methane emissions from dairy farms, positively impacting the environment. PLF also improves animal welfare by enabling continuous monitoring of animal health, such as real-time tracking of vital signs, early disease detection and enhanced disease prevention. This leads to better management of animal behavior, reduced treatment expenses and improved overall welfare. Tools like wearable sensors and field technologies provide valuable data for herd management, including pedigree reconstruction, scheduling medical treatments and planning feeding supplements based on pasture availability. It helps in recording the feed consumption, body condition and growth rates of the livestock and enabling farmers to make informed decisions about breeding strategies and reproductive performance. Additionally, by reducing farm labor and providing easy access to reliable information, it enhances farmers efficiency and profitability, enabling them to manage larger herds effectively. These advancements empower livestock farmers to improve their operations, reduce workloads and achieve greater economic and environmental sustainability.

Challenges:

Although Precision Livestock Farming (PLF) offers numerous benefits, its implementation in livestock systems is associated with several technical, economic and operational challenges. The high initial cost of installation, including specialized equipment such as sensors, monitoring devices and automated feeding systems can be a significant barrier for farmers. Additionally, farmers with limited experience in data analysis may struggle to interpret and utilize the data effectively, reducing the potential benefits of PLF. Ethical concerns have also been raised about the potential decline in human-animal interaction due to digital animal husbandry technologies, which could negatively impact animal welfare. Over-reliance on technology increases the risk of technical failures, outdated systems and the loss of traditional animal husbandry skills. A major risk of PLF is that system failures in highly

integrated and automated setups can lead to severe consequences, especially in farms relying entirely on automation. Other challenges include hardware wear and tear, inaccurate predictions due to insufficient validation, and data security risks, such as unauthorized access and privacy breaches, which could compromise both farmers and livestock data.

Conclusion:

Precision livestock farming is a cutting-edge technique that utilizes advanced technologies that enables the real-time observation of livestock and optimize their health, welfare and productivity which leads to achieve sustainable livestock production with greater efficiency. It also integrates advanced technologies such as electronic identification systems, sensor systems for monitoring vital signs and behaviors, automated weighing systems, imaging solutions for analyzing health and conditions, Wearable sensors and automated feeding systems for further improving the herd management by providing precise data and optimizing feeding strategies. Innovative tools like virtual fencing and the Grass Hopper system enhance pasture management, while methane-tracking technologies contribute to environmental sustainability. These technologies enable farmers to make informed decisions, reduce labor requirements, increase productivity and maximize profitability. By ensuring sustainable resource utilization and minimizing deforestation, PLF also contributes to environmental conservation and long-term agricultural sustainability. Despite its numerous benefits livestock farmers are also facing various challenges in adopting and implementing precision livestock farming due to its high initial cost, lack of technical knowledge to use the specialized equipments, technical failure may struggle to understand the data and use it effectively, decline in human-animal interaction, loss of animal-oriented husbandry skills. Since only few research studies have been conducted with these advanced technologies and shown results that they have helped the farmers by enhancing the efficiency, reducing environmental impact, ensuring livelihoods, and support animal health, welfare and also some difficulties faced by them, further research studies are the need of the hour in both developed and developing countries like India also to explore its advantages, techniques to overcome the drawbacks and profitability to the livestock farmers.

References:

- Parisa Niloofar, Deena P. Francis, Sanja Lazarova-Molnar, Alexandru Vulpe, Marius-Constantin Vochin, George Suciu, Mihaela Balanescu, Vasileios Anestis, Thomas Bartzanas (2021). Data-driven decision support in livestock farming for improved animal health, welfare and greenhouse gas emissions: Overview and challenges, *Computers and Electronics in Agriculture*, Volume 190, 106406. <https://doi.org/10.1016/j.compag.2021.106406>.
- Papakonstantinou, G.I.; Voulgarakis, N.; Terzidou, G.; Fotos, L.; Giamouri, E.; Papatsiros, V.G. Precision Livestock Farming Technology: Applications and Challenges of Animal Welfare and Climate Change. *Agriculture* **2024**, *14*, 620. <https://doi.org/10.3390/agriculture14040620>.
- Banhazi, Thomas & Lehr, Heiner & Black, J. & Crabtree, H. & Schofield, Charles & Tschärke, M. & Berckmans, Daniel. (2012). Precision Livestock Farming: An international review of scientific and commercial aspects. *International Journal of Agricultural and Biological Engineering*. 5. 1-9. 10.3965/j.ijabe.20120503.00?
- D. Berckmans, General introduction to precision livestock farming, *Animal Frontiers*, Volume 7, Issue 1, January 2017, Pages 6–11, <https://doi.org/10.2527/af.2017.0102>
- Neethirajan, Suresh (2016). Recent advances in wearable sensors for animal health management. *Sensing and Bio-Sensing Research*. 12. 10.1016/j.sbsr.2016.11.004.
- Kleen, J.L.; Guatteo, R. Precision Livestock Farming: What Does It Contain and What Are the Perspectives? *Animals* **2023**, *13*, 779. <https://doi.org/10.3390/ani13050779>
- Odintsov Vaintrub M, Levit H, Chincari M, Fusaro I, Giammarco M, Vignola G. Review: Precision livestock farming, automats and new technologies: possible applications in extensive dairy sheep farming. *Animal*. 2021 Mar;15(3):100143. doi: 10.1016/j.animal.2020.100143.
- C. Aquilani, A. Confessore, R. Bozzi, F. Sirtori, C. Pugliese, Review: Precision Livestock

Farming technologies in pasture-based livestock systems, *Animal*, Volume 16, Issue 1, 2022, 100429, <https://doi.org/10.1016/j.animal.2021.100429>.

Geopard Agriculture. Blog: Precision Livestock Farming- technologies, benefits and risks. <https://geopard.tech/blog/precision-livestock-farming-technologies-benefits-and-risks/>

Tuytens FAM, Molento CFM, Benaissa S. Twelve Threats of Precision Livestock Farming (PLF) for Animal Welfare. *Front Vet Sci.* 2022 May 27;9:889623. doi: 10.3389/fvets.2022.889623.

Sheeda Cheng (2024), MAIA Grazing, blog: Precision Livestock Farming: Advantages, Disadvantages and Tech. <https://www.maiagrazing.com/blog/precision-livestock-farming>