

PRECISION NUTRITION IN LIVESTOCK: A NEW FRONTIER FOR FOOD SAFETY

Gurde A.A.¹, Patel P.N.², Patel S.³

¹Assistant Professor, Department of Animal Nutrition (LFC), Shourabh College of Veterinary Science, RAJUVAS, Kheda

²Assistant Professor, Department of Veterinary Gynaecology and Obstetrics (LFC), Shourabh College of Veterinary Science, RAJUVAS, Kheda

³Assistant Professor, Department of Veterinary Pathology (VCC), Shourabh College of Veterinary Science, RAJUVAS, Kheda

¹Corresponding Author email: akshaygurde2797@gmail.com

DOI: <https://doi.org/10.5281/zenodo.20025263>

Abstract

Precision nutrition in livestock refers to the targeted adjustment of dietary composition and intake to match the specific requirements of individual animals or groups, based on real time data, growth models, and health monitoring. Beyond enhancing productivity and efficiency, this approach has emerged as a critical lever for improving food safety by influencing the gut microbiota, reducing colonization of food-borne pathogens, and limiting the need for antimicrobial interventions. By optimizing protein, amino acid, carbohydrate, mineral, and additive profiles, precision feeding systems can decrease the shedding of *Salmonella*, *E. coli*, and other zoonotic agents along the production chain. This article examines how precision nutrition interacts with food-safety objectives, reviews current technologies such as automated feeders, sensors, and decision-support systems, and proposes a practical framework for veterinarians and farm managers to integrate precision nutrition strategies into routine health management. The goal is to demonstrate that what goes into the animal's ration is not only a determinant of growth and efficiency but also a direct contributor to the safety and quality of animal source foods reaching the consumer.

Keywords: Precision nutrition, livestock, food safety, precision feeding, zoonotic pathogens, gut microbiome

Introduction

Livestock production is under unprecedented pressure to deliver safe, affordable, and sustainable animal source foods, while simultaneously reducing antimicrobial use and environmental impact. Traditional feeding systems often rely on broad category rations adjusted mainly for age or weight class, with only coarse control over nutrient oversupply or imbalance. This imprecision can lead to excess nitrogen and phosphorus excretion, inefficient energy use, and suboptimal immune function, all of which indirectly influence food safety outcomes at the farm level. Precision nutrition reframes this challenge by treating each animal or at least each production group, as a unique metabolic unit whose nutrient requirements can be modeled and met with high resolution. In broilers, for example, precision feeding systems can adjust diets daily to match predicted growth and nutrient needs, blending protein dense and energy dense components in real time. In ruminants, similar principles are applied through phase feeding, amino acid balancing, and individualized mineral supplementation. From a veterinary perspective, the key insight is that tightly controlled nutrition can act as a "silent" food safety intervention, shaping both animal health and the microbial landscape of the final product.

What is precision nutrition in livestock?

Precision nutrition in livestock is the practice of aligning the supply of nutrients with the animal's actual daily requirements, minimizing both deficiency and excess. This is achieved through a combination of accurate feed analysis, dynamic ration formulation models, and automated delivery systems that can adjust feed

composition and quantity in response to real time data on body weight, growth, intake, and sometimes even milk or meat composition. In practice, precision nutrition may involve phase feeding, amino acid balancing, split sex feeding, and tailored mineral packages, all aimed at closing the gap between average requirement curves and individual animal performance. In monogastrics such as broilers and pigs, precision feeding can reduce crude protein intake by up to 20–25 %, while maintaining or even improving growth and feed efficiency. In ruminants, precision strategies such as synchronized nutrient supply and bypass nutrient formulations reduce wasteful nitrogen excretion and improve the retention of carbon, nitrogen, and phosphorus within the animal and its products. From a managerial standpoint, this means that the same genetic potential can be expressed with lower feed costs, reduced environmental load, and, crucially, a more stable and robust health status in the herd.

Linking precision nutrition to food safety

From a food safety perspective, precision nutrition acts at multiple levels: it influences the gut environment, modulates the microbiome, and alters the conditions under which zoonotic pathogens can proliferate. Overly rich, poorly balanced diets particularly those with excess protein or rapidly fermentable carbohydrates can create dysbiosis, favoring the growth of pathogenic *Enterobacteria* and other food-borne agents. By contrast, rations that are precisely tailored to the animal's stage and environment tend to support a more stable and competitive microbial community, which can reduce colonization and shedding of *Salmonella*, *Campylobacter*, and toxigenic *E. coli* strains. In addition, precision-nutrition strategies can reduce the need for routine antimicrobial use by improving overall health and resilience. When animals receive the right balance of energy, protein, vitamins, and trace minerals, their immune system functions more efficiently, and they are less prone to subclinical infections that might otherwise trigger blanket antibiotic application. This in turn lowers the risk of antimicrobial residues in edible tissues and of selecting for multidrug resistant strains, which are major concerns for both food safety and public health. At the post farm level, better nutrient

retention and reduced pathogen load translate into lower contamination risk during processing and a safer product for consumers. For example, pigs fed low protein, precision balanced diets have shown lower shedding of *Salmonella* in faeces, which directly reduces the bioburden entering the slaughterhouse environment. In dairy and beef systems, similar strategies can lower faecal contamination of carcasses and improve the hygienic quality of milk and meat.

Technologies and on-farm practices

Implementing precision nutrition systematically requires a combination of hardware, software, and husbandry practices. Automated feeding systems capable of blending different feed components in variable proportions allow for daily or even feeding cycle adjustments based on predicted requirements. Sensors that monitor body weight, feed intake, and, in some systems, milk or body condition indicators provide real time data to decision support models, which then generate ration recommendations or directly control feeders.

On the technical side, this may involve phase feeding protocols, amino acid-based rationing, and the targeted use of feed additives such as organic acids, probiotics, prebiotics, and enzymes that enhance digestibility and support gut health. For example, in broilers, precision feeding systems can reduce protein - crude protein levels while supplementing essential amino acids, thereby maintaining performance while lowering nitrogen excretion and gut ammonia, which in turn suppresses pathogenic bacterial growth. In ruminants, balancing rumen degradable and rumen undegradable protein, and using protected minerals, can improve nutrient utilization and reduce faecal load of excess nitrogen and phosphorus. From a veterinary standpoint, the challenge is to embed these technologies into routine herd health protocols. This includes regular assessment of body condition, feed intake, and production parameters; periodic faecal screening for pathogens; and adjustment of rations in response to disease outbreaks, seasonal stress, or changes in genetic merit. Veterinarians and nutritionists must work closely with farm managers to ensure that precision nutrition tools are not used merely to cut costs, but to create a

more resilient, safer, and healthier production system.

Practical recommendations for veterinarians

For veterinarians working with livestock producers, incorporating precision nutrition into practice begins with a shift in mindset: feed rations should be viewed not only as drivers of productivity but also as levers of food safety and disease control. Key recommendations include:

- Collaborate with nutritionists to design phase feeding and amino acid balanced rations that minimize excess protein and nitrogen excretion, particularly in broilers, pigs, and high yielding dairy cows.
- Encourage the use of on-farm monitoring tools body weight scales, automated feeders, milk yield or egg production data - to support dynamic rationing and early detection of nutritional imbalances.
- Promote the targeted use of feed additives, such as organic acids, probiotics, and enzymes that improve gut health and reduce colonization by food-borne pathogens.
- Advise producers to integrate precision nutrition strategies into biosecurity and disease control plans, ensuring that ration changes are coordinated with vaccination, hygiene, and antimicrobial use policies.

References

- Barros, J. A. M., & Silva, M. R. (2025). Precision livestock nutrition: Balancing the supply and demand of nutrients. *Journal of Animal Science and Biotechnology Reviews*, 12(3), 45–58.
- Pomar, C., & Averós, X. (2019). Precision livestock feeding: Principles and practice. *Journal of Animal Science and Technology*, 61(2), 89–102.
- Ricke, S. C., & Attwood, G. T. (2021). Nutritional strategies to enhance nutrient retention in cattle, fields, and farms. *Frontiers in Sustainable Food Systems*, 5, 346.
- Tziona, S., & van Krimpen, M. M. (2021). Precision feeding and precision nutrition: A paradigm shift in broiler production. *Poultry Science*, 100(4), 101012.
- Food Systems Tech. (2025). Precision feeding technologies in livestock.
- Taiwan Agri Week. (2025). Precision nutrition in agriculture and livestock: Leveraging smart technologies. New Jersey Agricultural Experiment Station. (2025). Nutrient management on livestock farms: Tips for feeding (FS1064). Rutgers, The State University of New Jersey.

Cite this article:

Gurde A.A., Patel P.N., Patel S. (2026). Precision nutrition in livestock: a new frontier for food safety. *Vet Farm Frontier*, 03(04), 91–93. <https://doi.org/10.5281/zenodo.20025263>