GUT GUARDIANS: HOW LIVESTOCK MICROBIOTA SUPPORTS HEALTH AND HOW SMART FODDER ENHANCES IT

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ABSTRACT

Trillions of gut microbes in livestock act as a functional biological system that supports immunity, strengths the gut barrier, protects against infections, and improves nutrient utilization from fodder. In cattle, pigs, and poultry, good gut health can raise daily yield, weight gain, and fat and protein content by approximately 10-20%, leading to better productivity, improved meat quality, and improved economic returns for farmers. A healthy gut not only boosts output but also shields animals from disease by outcompeting harmful microbes competing for colonization. Yet factory feeds, stress, and the overuse or misuse of antibiotics can disrupt these beneficial microbial populations, causing disease, lost yields, and even death from opportunistic infections. The solution lies in understanding the importance of gut health and using fodder enriched with probiotics, prebiotics, and local herbal ingredients that support these microbial allies. This article shows how simple feed changes can improve animal health, reduce veterinary costs, and contribute to safer animal-derived food products.

INTRODUCTION

A healthy gut is a state in which a symbiotic balance exists between the gastrointestinal (GI) tract and the microbes living within it, with both partners coexisting in a mutually beneficial relationship that does not compromise the animal's health or welfare (Chowdhury et al., 2025). It is considered one of the most important factors influencing overall livestock performance. The animal gastrointestinal tract is a major habitat for diverse microbial communities. A healthy gut microbiota consists of a balanced population of microorganisms viz., viruses, bacteria, fungi, protozoa and other microbes. This communities comprises trillions of microbes, the majority of which are anaerobic bacteria(Costello et al., 2012).

Gut microbes play a critical role in the animal gastrointestinal tract during food digestion, efficient energy utilization, and supporting overall growth and health. They work together with the host animal in a beneficial relationship, by breaking down feed, enhancing nutrient absorption, and interacting with the immune system, thereby improving overall livestock performance. In cattle, for example, the rumen microbes break down plant fiber into volatile fatty acids that supply much of the animal's energy, while also influencing feed efficiency, milk yield, growth, and methane production (O'hara et al., 2020). In poultry, a healthy gut microbiome helps chicks digest feed better, absorb more nutrients, and stay protected from harmful bacteria like Salmonella and Clostridium, which can improve growth, feed efficiency, and overall flock health.

GUT MICROBIOME DYSBIOSIS AND ITS IMPACT ON LIVESTOCK PRODUCTIVITY

The gut microbiota in livestock is considered in a state of eubiosis when it maintains a stable, functionally balanced, and mutually beneficial relationship with the host

(figure 1). Any disruption in microbial diversity, abundance, or activity due to intrinsic factors, such as animal genetics, age, physiological stage, and species-specific anatomy, or extrinsic factors such as diet, management, environment, and treatments like antibiotics or feed additives, is termed dysbiosis. Excessive or improper use of antibiotics can disturb the gut microbiota by eliminating beneficial microbes along with pathogenic ones, thereby triggering dysbiosis. Similarly, stress conditions in livestock, including heat stress, overcrowding, transport, weaning, feed restriction, social or handling stress, and disease-related stress, can also disrupt the microbiota. Poor-quality silage, especially spoiled or badly fermented silage, may contain excess yeast, molds, and unwanted bacteria, along with high levels of organic acids or amines, which can irritate the gut, disturb microbial balance and gut pH, and favor harmful microbes over beneficial ones.

In livestock, the gut microbiome plays an important role in digesting fiber, produces volatile fatty acids and supports intestinal health. When this balance is disturbed for any reason, feed utilization and overall performance in livestock decline (O'hara et al., 2020). Dysbiosis can lead to: (i) Reduced feed efficiency: It weakens fermentation and nutrient absorption in the animal gut. As a result, the feed conversion ratio may worsen to around 2.5 instead of 1.8, meaning animals need more feed to gain the same body weight. This reflects poor nutrient utilization and reduced growth efficiency; (ii) Impaired gut health: It can damage the intestinal barrier, disturb gut pH, and promote inflammation or acidosis-like conditions; (iii) Weakened immunity: A disturbed microbiome interferes with immune system development and host defense, making animals more vulnerable to other diseases; (iv) Altered production traits: In cattle, gut microbial shifts are linked with changes in milk composition and methane emission; (v) Poor growth and health in young animals: Early-life dysbiosis is especially harmful because the microbiome is still developing and may affect long-term performance; (vi) Reduced muscle deposition: Disrupted gut function can limit the energy and protein supply needed for muscle synthesis; and (vii) Lower carcass quality: Shifts in gut microbiota can alter fat deposition and meat quality traits in livestock.

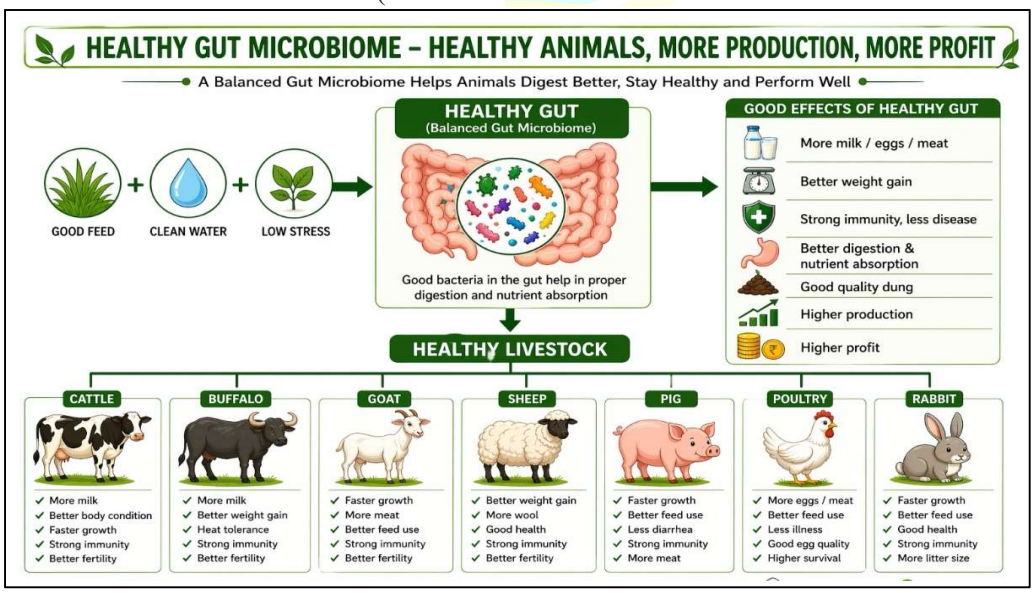

Fig. 1: Gut Microbiome Dynamics in Livestock

FODDER AS MICROBIOTA MEDICINE: NATURE'S TOOLBOX

Diet, age, species, and seasonal changes all influence the gut microbiota, with diet being the most significant factor. In

livestock, microbial efficiency and community composition are strongly linked to diet and feeding patterns. Multiple studies have evaluated the effects of different feeds and fodders on the natural microbiome of animals and birds. These studies consistently demonstrate that feed directly influences on the microbiome and animal health. Animals with poor gut health are more likely to exhibit reduced growth and increased susceptibility to diseases and infections.

Modulating gut health may help reduce reliance on antimicrobials for disease prevention and the maintenance of animal production. Currently, several approaches are being investigated to directly or indirectly improve the gut microbiome, including dietary interventions, prebiotics, probiotics, and synbiotics (Silvestro et al., 2025; Yue et al., 2025).

Probiotics are beneficial live microorganisms that, when provided in adequate amounts, confer health benefits to the host. Common probiotic microbes associated with livestock gut health include species of *Lactobacillus*, *Bifidobacterium*, *Enterococcus*, *Bacillus subtilis*, and *Saccharomyces boulardii*. These microorganisms produce metabolites that promote beneficial bacterial growth, suppress pathogens, maintain gut pH, stimulate mucus secretion, modulating immunity, and support intestinal epithelial integrity for improved nutrient absorption. Probiotics can be administered to livestock under veterinary guidance by incorporating them into their feed or fodder. For example, supplementation with *Lactobacillus plantarum* has been shown to improve silage quality and enhance growth performance and weight gain in livestock. Probiotic requirements can also be supported through fodder fermentation, which promotes the growth of beneficial microorganisms in it such as lactic acid bacteria and yeasts. The resulting fermented feed provides viable microbes and bioactive metabolites that help maintain a balanced gut microbiota, suppress pathogenic organisms, and improve nutrient utilization in animals.

Prebiotics are non-digestible substrates, such as non-starch polysaccharides and oligosaccharides, that are fermented by the gut microbiota and selectively stimulate the growth of beneficial bacteria. Their inclusion in animal diets has been associated with improved weight gain, feed efficiency, and overall animal welfare. For example, fructooligosaccharides and galactosyl-lactose have been reported to reduce enteric disorders and support growth in calves. When fermented in the large intestine by beneficial microbes, these compounds contribute to improved gut health, microbial balance, fecal quality, immune function, and intestinal mucosal integrity.

Synbiotics are combinations of prebiotics and probiotics designed to work together for a greater biological effect than either component alone. By supporting the growth and activity of beneficial microbes, they can improve colonization of the gastrointestinal tract and enhance gut function. For example, the combination of inulin and *Enterococcus faecium* has been reported to support postnatal rumen development and improve rumen functionality. Similarly, the commercial synbiotic Kormomix® Rumin has been shown to improve rumen fermentation and feed utilization in nursing cows without adversely affecting blood parameters. In another study, synbiotic supplementation containing *Lactobacillus acidophilus*, *Bifidobacterium lactis*, and *Bifidobacterium longum* with galactose increased beneficial gut bacteria and helped restore microbiota balance in obese animals.

In India, several commercially available fodder resources and feed-based forages are widely used to support gut function and gut microbiome, particularly in livestock. Among these, Napier grass (*Pennisetum purpureum*) is valued for its high biomass yield, rapid regrowth, and suitability for cut-and-carry systems; its fibrous structure supports rumen fermentation and gut

microbial activity. Berseem (*Trifolium alexandrinum*), a highly digestible leguminous fodder, is rich in protein and minerals and is associated with improved feed intake and nutrient digestibility. Lucerne/alfalfa (*Medicago sativa*) is another important commercial fodder, valued for its high protein content and favourable effects on gut microbial balance. Maize fodder and maize silage are also extensively used because of their palatability, energy density, and ability to support stable fermentation patterns in the gut. In addition, hydroponic maize fodder has emerged as a practical supplement in some livestock systems, with studies indicating improved digestibility when combined with probiotics. Fermented fodder and silage prepared from these crops may further enhance gut health by increasing beneficial microbial populations and improving feed safety and digestibility. Together, these fodder resources represent cost-effective, locally adaptable nutritional strategies that can promote healthier gut microbiota, better feed conversion, and improved growth and production performance in livestock.

DIY FODDER HACKS FOR INDIAN FARMERS

Herbal feed additives are widely available, easy to process, and cost-effective. They generally leave minimal residues, are generally considered safe when used appropriately, and are associated with few adverse effects in animals, while also being regarded as safe for human consumption. Plant extracts contain a diverse array of bioactive compounds with antimicrobial, immunomodulatory, antioxidant, and gut microbiota-modulating properties (Wang et al., 2024). As feed additives, herbal products can be administered in dried and crushed form, offered fresh during the growing season, or extracted as crude preparations containing the principal active constituents. In addition, different plant-derived products or extracts can be combined to achieve complementary effects and provide broader benefits to livestock gut health.

Plant essential oils, particularly eugenol, thymol, and cinnamaldehyde, can beneficially modulate the gut microbiota and improve livestock performance when incorporated into feed, thereby reducing reliance on antibiotics. Azolla is a sustainable, protein-rich feed supplement with prebiotic potential that supports gut health, enhances nutrient digestibility, and promotes beneficial microbial populations such as *Lactobacillus* and *Bifidobacterium* while reducing enteric pathogens like *E. coli*. Similarly, garlic peel, onion peel, banana peel, chicory root, Jerusalem artichoke, apple pomace, sugar beet pulp, mango peel, and rice bran may serve as prebiotic or fiber-rich substrates that help maintain a healthy gut microbiome in livestock.

CONCLUSION

The future of livestock production will increasingly depend on effective strategies to maintain animal health, enhance immune competence, and protect against infectious diseases. A key approach is the modulation of the gut microbiome through dietary interventions. Across the strategies discussed—including probiotics, prebiotics, synbiotics, fermented fodder, silage, essential oils, herbal products, Azolla, and fiber-rich plant materials—the underlying principle is to optimize microbial balance in the gastrointestinal tract to improve digestion, immune function, and overall animal performance.

This feed-based approach also provides a practical and sustainable alternative to the routine use of antimicrobials. By promoting beneficial microorganisms such as *Lactobacillus* and *Bifidobacterium* while limiting the proliferation of opportunistic pathogens such as *E. coli* and *Salmonella*, these interventions can enhance nutrient utilization, reduce enteric disorders, and improve growth, milk production, and overall animal welfare.

In India and other livestock-producing regions, the greatest potential lies in the use of locally available, low-cost feed resources. Green fodders, silage, fermented feeds, herbal supplements, and agro-industrial by-products can be incorporated into ration formulations to improve gut health in a cost-effective and sustainable manner. Thus, microbiome-targeted feeding represents not only a nutritional intervention but also a practical pathway to healthier animals, safer food production, and more resilient livestock systems.

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