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ROLE OF ANIMAL NUTRITION IN IMPROVING LIVESTOCK HEALTH AND WELFARE

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ABSTRACT

Animal nutrition plays a fundamental role in maintaining livestock health, improving animal welfare, and supporting sustainable agricultural production. Adequate nutrition provides animals with essential nutrients, including carbohydrates, proteins, fats, vitamins, minerals, and water, which are necessary for normal growth, reproduction, immunity, and physiological functions. Nutritional deficiencies and imbalanced feeding practices can negatively affect animal health, reduce productivity, weaken immune responses, and increase susceptibility to infectious and metabolic diseases. Proper nutritional management is therefore essential for maintaining healthy livestock populations and improving the quality of animal-derived products. Recent developments in animal nutrition have introduced improved feeding strategies, precision nutrition, probiotics, prebiotics, enzymes, functional feed additives, and alternative feed resources. These approaches can improve nutrient digestion, maintain gastrointestinal health, support immune function, and reduce nutritional stress. This research examines the role of animal nutrition in improving livestock health and welfare, with particular attention to dietary requirements, feed quality, digestive health, immune function, reproductive performance, and sustainable feeding practices. It also explores the relationship between balanced nutrition and animal welfare in cattle, buffaloes, sheep, goats, and poultry. Furthermore, the research considers nutritional challenges in developing countries, particularly Pakistan, where seasonal feed shortages, poor-quality fodder, inadequate supplementation, and rising feeding costs may affect livestock production. The study highlights that appropriate nutritional management, high-quality feed resources, clean drinking water, and scientifically balanced diets are essential for improving livestock performance. Overall, effective animal nutrition contributes to healthier animals, improved productivity, better welfare, reduced disease risks, and sustainable livestock production.

KEYWORDS:*Animal nutrition, livestock health, animal welfare, balanced diet, nutritional management, feed quality, protein requirements, vitamins, minerals, probiotics, prebiotics, gut health, feed efficiency, immune function, sustainable livestock production.*

INTRODUCTION

Animal nutrition is one of the most important factors influencing livestock health, productivity, and welfare. Animals require a balanced supply of nutrients to maintain normal physiological functions, support growth, reproduce successfully, and resist diseases. Proper nutrition provides energy for daily activities and supplies essential nutrients for the development and maintenance of body tissues. When animals receive adequate and balanced diets, their overall health and productive performance can improve. Biswas, S., Kim, M. H., Cho, S., & Kim, I. H. (2026). found that However, insufficient or imbalanced feeding can cause nutritional deficiencies, metabolic disorders, poor growth, reproductive problems, and reduced resistance to infectious diseases.Livestock animals, including cattle, buffaloes, sheep, goats, and poultry, contribute significantly to agricultural development, food security, and rural livelihoods. These animals provide milk, meat, eggs, hides, and other valuable products. Their productivity depends on several factors, including genetic characteristics, environmental conditions, housing, disease prevention, and nutritional management. Among these factors, nutrition has a particularly important role because it directly influences metabolism, body condition, immune responses, and reproductive performance. Therefore, appropriate feeding practices are essential for maintaining healthy and productive livestock populations.Balanced nutrition requires an appropriate combination of carbohydrates,

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proteins, fats, vitamins, minerals, and water. Carbohydrates and fats provide energy, while proteins supply amino acids required for tissue development, muscle growth, enzyme production, and immune functions. Vitamins and minerals participate in numerous metabolic processes, including bone development, blood formation, nerve function, and immune regulation. Water is equally essential because it supports digestion, nutrient transportation, temperature regulation, and waste removal. Deficiencies in any of these nutrients can negatively influence animal health and welfare.Recent developments in veterinary science and animal nutrition have increased understanding of the relationship between diet, digestive health, and immune function. Researchers are investigating probiotics, prebiotics, synbiotics, enzymes, organic acids, essential fatty acids, and plant-derived feed additives to improve nutrient utilization and gastrointestinal health. Kotsampasi et al. (2024) explain that functional nutritional components can support dairy ruminants during stressful physiological periods, including heat stress and the transition period. Such nutritional approaches may contribute to improved metabolism, antioxidant status, immune function, and productive performance.

Animal welfare is closely connected with nutritional status because animals experiencing inadequate feeding may suffer from hunger, weakness, poor body condition, reduced activity, and increased susceptibility to disease. Chen, L., Thorup, V. M., & Østergaard, S. (2025). Explained that Nutritional deficiencies can also interfere with natural behaviour and reproductive processes. Providing suitable feed, clean drinking water, and appropriate feeding conditions is therefore necessary for maintaining physical health and supporting positive welfare. Nutrition should not be considered only a method of increasing production but also an essential component of responsible animal care.In developing countries, including Pakistan, livestock farmers frequently face challenges associated with poor-quality fodder, seasonal feed shortages, increasing feed costs, and limited access to scientific nutritional advice. These problems can negatively affect milk production, animal growth, reproductive performance, and overall livestock welfare. Smallholder farmers may depend on traditional feeding practices that do not always provide sufficient nutrients for different animal species and production stages. Therefore, improving farmer awareness, feed quality, balanced ration preparation, and access to veterinary nutritional services is essential. This research examines the role of animal nutrition in improving livestock health and welfare and identifies practical nutritional strategies for supporting sustainable livestock production.

RESEARCH QUESTION

1. How does balanced animal nutrition influence livestock health, immune function, productivity, and overall animal welfare?

RESEARCH OBJECTIVES

1. To examine the importance of balanced nutrition in maintaining livestock health and physiological functions.

LITERATURE REVIEW

Animal nutrition is a fundamental component of livestock management because it determines the availability of essential nutrients required for normal body functions. Animals need

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balanced diets to support metabolism, tissue development, immune activity, reproduction, and daily physiological processes. Chowdhury, M. R., Hassan, M., & Shimosato, T. (2025). Explains that Proper nutritional management helps maintain body condition, improve feed utilization, and reduce the risk of nutrition-related diseases. When animals receive sufficient nutrients according to their species, age, body weight, and production requirements, they are more likely to maintain good health and productive performance.Nutrition also influences the ability of animals to respond to environmental and physiological challenges. Animals experiencing inadequate feeding may develop nutritional deficiencies, reduced immunity, poor growth, and reproductive disturbances. In contrast, balanced diets provide the nutrients necessary for maintaining body tissues and supporting normal immune responses.Alem (2025) discusses recent developments in livestock nutrition, particularly precision feeding, microbiome management, and sustainable feed resources. The review emphasizes that modern nutritional management can improve animal productivity while supporting environmental sustainability. This demonstrates that nutrition should be considered an essential component of veterinary healthcare rather than simply a method of increasing animal production.Proper nutritional management also reduces the economic losses associated with poor animal health. Farmers can improve production efficiency by providing appropriate feed ingredients, monitoring body condition, and adjusting diets according to the physiological requirements of different livestock species.Proteins are essential nutrients required for the growth, maintenance, and repair of animal body tissues. They are composed of amino acids that participate in muscle development, enzyme production, hormone synthesis, and immune system functions. Adequate protein intake is particularly important for young animals because their bodies require sufficient amino acids for rapid growth and tissue development.

Protein requirements vary according to animal species, age, body weight, pregnancy, lactation, and production level. Dairy animals require sufficient protein to support milk synthesis, while growing cattle, sheep, and goats need adequate protein for muscle development. Poultry birds also require suitable protein levels for growth, feather development, and egg production.Protein deficiency can result in reduced growth, poor body condition, decreased milk production, and impaired reproductive performance. Severe deficiencies may also affect immune function and reduce the ability of animals to recover from disease. However, excessive protein supplementation may increase feeding costs and result in unnecessary nitrogen excretion. Therefore, protein should be supplied according to the nutritional requirements of individual animal groups.Precision feeding approaches can help improve protein utilization by matching dietary amino acids with the animal's requirements. Cooke, A. S., Machekano, H., Gwiriri, L. C., Tinsley, J. H., Silva, G. M., Nyamukondiwa, C., ... & Lee, M. R. (2025). revealed that Pomar and Remus (2023) discuss the importance of precision nutrition in livestock production and explain how individualized feeding approaches can improve nutrient utilization and production efficiency.Carbohydrates are important energy sources in animal diets. They are supplied through grains, grasses, forage crops, and other feed ingredients. Energy is necessary for maintaining body temperature, movement, metabolism, growth, reproduction, and milk production. Animals that do not receive adequate energy may experience weight loss, poor body condition, reduced productivity, and reproductive difficulties.Ruminant animals, including cattle, buffaloes, sheep, and goats, obtain a substantial proportion of their energy through microbial fermentation in the rumen. Rumen microorganisms break down dietary carbohydrates and

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produce volatile fatty acids, which provide an important source of energy for the animal. Therefore, maintaining appropriate rumen function is essential for good nutritional health.

Inadequate dietary fibre or excessive rapidly fermentable carbohydrates can disturb normal rumen function and increase the risk of digestive disorders. One example is ruminal acidosis, which can occur when highly fermentable carbohydrates are supplied inappropriately. Such conditions can reduce feed intake, affect animal comfort, and negatively influence production.Appropriate forage-to-concentrate ratios and gradual dietary changes are important for maintaining digestive health. Providing sufficient good-quality roughage supports rumination, saliva production, and normal digestive activity. Balanced energy intake is therefore essential for maintaining both livestock health and welfare.Vitamins are essential organic nutrients that participate in numerous metabolic and physiological processes. They support immunity, reproduction, bone development, vision, blood formation, and antioxidant protection. Vitamins are generally classified into fat-soluble vitamins and water-soluble vitamins.Fat-soluble vitamins include vitamins A, D, E, and K. Vitamin A supports vision, epithelial tissue health, reproduction, and immune function. Vitamin D is important for calcium and phosphorus metabolism and bone development. Vitamin E acts as an antioxidant and helps protect cells from oxidative damage, while vitamin K contributes to normal blood clotting.Water-soluble vitamins include the B-complex vitamins and vitamin C. B vitamins participate in energy metabolism, nervous system function, and other important biochemical processes. Their dietary requirements differ according to animal species and digestive physiology.Vitamin deficiencies may result in poor growth, reduced fertility, impaired immunity, and other health problems. Kholif, A. E., Olafadehan, O. A., & Anele, U. Y. (2025). Elaborated on However, excessive supplementation of certain vitamins can also create adverse effects. Therefore, vitamin supplementation should be based on feed composition, animal requirements, and veterinary or nutritional advice.Kotsampasi et al. (2024) discuss the importance of nutritional components, including functional fatty acids, amino acids, and micronutrients, in supporting the physiological health and welfare of dairy ruminants. Their work emphasizes the importance of appropriate nutritional management during periods of increased metabolic demand.

Minerals are essential nutrients required for the development and maintenance of bones, muscles, blood, nerves, and other body tissues. They also participate in enzyme activity, fluid balance, hormone regulation, and immune function. Minerals are commonly divided into macrominerals and microminerals according to the quantities required by animals.Macrominerals include calcium, phosphorus, magnesium, sodium, potassium, chlorine, and sulfur. Calcium and phosphorus are especially important for skeletal development, bone strength, and reproductive health. Magnesium supports muscle and nerve functions, while sodium and potassium help maintain fluid and electrolyte balance.Microminerals include zinc, copper, iron, selenium, iodine, manganese, and cobalt. Although animals require these minerals in smaller quantities, they perform important biological functions. Zinc contributes to skin integrity, tissue repair, and immune activity. Iron is required for haemoglobin production, while selenium contributes to antioxidant protection.Mineral deficiencies may result in weak bones, poor growth, reproductive disorders, reduced immunity, and metabolic diseases. For example, inadequate calcium availability around the beginning of lactation can increase the risk of hypocalcaemia in dairy cows. Therefore, mineral requirements should be carefully considered when preparing livestock diets.Water is one of the most important components of animal nutrition because it is essential for almost every physiological process. It supports digestion, nutrient

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transportation, metabolism, temperature regulation, circulation, and waste removal. Animals cannot maintain normal health and productivity without sufficient clean drinking water.Water requirements vary according to species, body weight, environmental temperature, diet composition, pregnancy, and production level. Lactating dairy cows generally require substantial quantities of water because milk contains a high proportion of water. Animals consuming dry feed or experiencing high environmental temperatures may also require increased water intake.

METHODOLOGY

The present research adopts a systematic literature-based methodology to investigate the role of animal nutrition in improving livestock health and welfare. The study is based on secondary information collected from scientific research articles, review papers, veterinary journals, academic publications, and relevant reports published between 2023 and 2025. Scientific information is obtained from academic databases and research platforms, including Google Scholar, PubMed, ScienceDirect, MDPI, SpringerLink, and Frontiers. The selected publications are evaluated according to their relevance to animal nutrition, livestock health, nutritional management, digestive functions, immune responses, and animal welfare. Particular attention is given to the nutritional requirements of cattle, buffaloes, sheep, goats, and poultry. The research examines the importance of carbohydrates, proteins, fats, vitamins, minerals, and water in maintaining normal physiological functions and supporting animal production. It also investigates modern nutritional approaches, including precision feeding, probiotics, prebiotics, synbiotics, phytogenic feed additives, enzymes, and alternative feed resources. Information related to nutritional deficiencies, metabolic disorders, digestive health, reproductive performance, heat stress, and disease resistance is also considered. Furthermore, the study examines the challenges experienced by livestock farmers in developing countries, particularly Pakistan, where poor-quality fodder, seasonal feed shortages, limited nutritional awareness, and increasing feed costs may affect animal health and productivity. The collected information is classified into different thematic categories and compared to identify common findings, scientific developments, nutritional challenges, and practical recommendations. Particular attention is given to the reliability of published findings and the differences between animal species and production systems. The research also considers the importance of veterinary supervision, feed quality assessment, body-condition monitoring, and appropriate ration formulation. Since this research uses secondary information, no experimental animals are subjected to treatment, and no biological samples or primary field data are collected.

DATA ANALYSIS

The data analysis is conducted through a descriptive and qualitative examination of scientific publications related to animal nutrition and livestock welfare. The information obtained from the selected literature is organized into major categories, including protein requirements, energy intake, vitamins, minerals, water availability, digestive health, immune function, reproductive performance, and nutritional deficiencies. Each category is examined to identify the nutritional factors that influence livestock health and productive performance. The analysis compares findings from different researchers to understand how balanced diets and appropriate feeding practices contribute to normal physiological functions and animal welfare. Particular attention is given to the relationship between protein and energy intake and animal growth, milk production, and reproductive performance. Research concerning

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vitamins and minerals is evaluated to identify their importance in maintaining bone development, metabolism, immunity, and tissue repair. Furthermore, studies discussing probiotics, prebiotics, synbiotics, and other functional feed additives are examined to understand their potential effects on gastrointestinal health, nutrient absorption, and immune responses. The analysis also considers precision feeding and alternative feed resources as modern approaches to improving nutritional efficiency and reducing feed wastage. Literature concerning heat stress and nutritional management is reviewed to identify the relationship between environmental conditions, feed intake, and animal welfare. Where quantitative findings are available, they are interpreted according to the original research methods, animal species, dietary composition, and environmental conditions. Results from different studies are not treated as directly comparable when their experimental conditions differ. The research also examines nutritional problems affecting smallholder livestock farmers, particularly those related to seasonal fodder shortages, inadequate supplementation, poor feed quality, and limited access to scientific nutritional advice. The findings are organized according to the research objectives and interpreted to identify the major contributions of balanced nutrition to livestock health and welfare.

RESEARCH DESIGN

The research follows a descriptive, exploratory, and literature-based research design to examine the role of animal nutrition in improving livestock health and welfare. The descriptive component identifies the major nutrients required by farm animals and explains their functions in growth, metabolism, reproduction, immunity, and general health. The exploratory component investigates modern nutritional strategies and their potential applications in improving animal welfare and sustainable livestock production. The research uses a non-experimental approach because it does not involve direct manipulation of animal diets, laboratory investigations, or experimental feeding trials. Instead, it examines previously published scientific evidence to develop a comprehensive understanding of the research topic. The main units of analysis include cattle, buffaloes, sheep, goats, and poultry, with particular attention to their nutritional requirements and responses to different feeding practices. The study considers different livestock production systems, including intensive, semi-intensive, and traditional farming systems. Scientific publications from 2023 to 2025 are selected according to their relevance, quality, and contribution to the research objectives. The collected information is classified into thematic areas to facilitate comparison and interpretation. The research design also considers practical and economic factors affecting nutritional management, including feed availability, feed quality, supplementation costs, water resources, farmer awareness, and veterinary nutritional services. A regional perspective is included by considering nutritional challenges experienced by livestock farmers in Pakistan and other developing countries. The findings are synthesized to identify important nutritional practices, existing management problems, and opportunities for improving animal health and welfare. This research design is appropriate because livestock nutrition involves interconnected biological, environmental, economic, and management factors that require examination from veterinary and agricultural perspectives.

FINDINGS

The findings synthesized from the reviewed literature indicate that balanced animal nutrition plays a fundamental role in maintaining livestock health, improving productive performance, and supporting animal welfare. Adequate supplies of proteins, carbohydrates, fats, vitamins,

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minerals, and water are essential for maintaining normal physiological functions and supporting growth and reproduction. The reviewed studies indicate that nutritional deficiencies and imbalanced diets can negatively affect body condition, digestive health, immunity, milk production, and reproductive efficiency. Proper protein and energy intake is particularly important for growing and lactating animals because their nutritional requirements increase during periods of rapid growth and milk production. The literature also demonstrates that vitamins and minerals contribute to immune regulation, skeletal development, metabolic functions, and tissue maintenance. Another important finding concerns the relationship between nutrition and gastrointestinal health. Research suggests that probiotics, prebiotics, synbiotics, and other functional feed additives may support beneficial gut microorganisms, improve nutrient absorption, and strengthen intestinal health. Chowdhury et al. (2025) and Yue et al. (2025) highlight the potential contribution of these nutritional approaches to animal immunity, growth, and digestive health. The reviewed literature also indicates that precision feeding can improve nutrient utilization by matching dietary supply with the requirements of individual animals or production groups. Furthermore, nutritional management can help dairy animals cope with physiological challenges associated with heat stress and the transition period. Chen et al. (2024) reported that heat stress is associated with reduced feed intake and milk production in dairy cows, emphasizing the importance of appropriate feeding and environmental management. The findings also suggest that good-quality fodder, sufficient clean drinking water, and suitable mineral supplementation are essential for maintaining livestock welfare. In developing countries, particularly Pakistan, poor-quality feed, seasonal fodder shortages, increasing feeding expenses, and limited access to nutritional advice remain important challenges.

CONCLUSION

Animal nutrition is a fundamental component of veterinary healthcare and sustainable livestock production because it directly influences animal growth, health, immunity, reproduction, and welfare. The present research highlights that balanced feeding practices provide the essential nutrients required for normal physiological functions and productive performance. Adequate proteins, carbohydrates, fats, vitamins, minerals, and clean drinking water are necessary for maintaining healthy body tissues, supporting metabolism, strengthening immune responses, and preventing nutritional deficiencies. The reviewed literature also demonstrates that poor-quality feed and imbalanced diets can result in reduced growth, low milk production, reproductive difficulties, digestive disorders, and increased susceptibility to diseases. Modern nutritional approaches, including precision feeding, probiotics, prebiotics, synbiotics, enzymes, and phytogenic feed additives, provide additional opportunities for improving digestive health and nutrient utilization. These strategies may also contribute to improved animal welfare by supporting normal physiological functions and reducing certain nutritional stressors. However, their effectiveness depends on animal species, dietary composition, product quality, and management conditions. In developing countries, particularly Pakistan, improving livestock nutrition requires greater attention to fodder availability, balanced ration preparation, mineral supplementation, clean drinking water, and farmer education. Veterinary professionals, animal nutritionists, agricultural institutions, and livestock farmers should work together to promote scientifically appropriate and affordable feeding practices. Government support and agricultural extension programmes can also help smallholder farmers improve access to nutritional resources and technical guidance. Future research should focus on precision nutrition, sustainable feed ingredients,

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gut microbiome management, and cost-effective nutritional interventions suitable for different livestock production systems.

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