EFFECT OF HEAT STRESS ON GENETIC AND PHYSICAL HEALTH OF BREEDING CATTLE

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ABSTRACT

Heat stress presents a significant challenge to the genetic and physical health of breeding cattle. It affects physiological functions, reproductive efficiency, and genetic adaptation, leading to substantial economic losses. Implementing effective mitigation strategies, including environmental management, nutritional adjustments, and genetic selection, is essential to enhance cattle resilience against heat stress. Future research should focus on genetic markers associated with heat tolerance to improve breeding programs and sustain cattle production in changing climatic conditions.

Key words: Heat stress, Physical health, Genetic, Breeding

I. INTRODUCTION

Heat stress is a critical environmental factor affecting the productivity and health of breeding cattle worldwide. Climate change has led to rising global temperatures, exacerbating the impact of heat stress on livestock. Heat stress negatively influences genetic expression, reproductive efficiency, and overall physical health, ultimately reducing productivity and profitability in the cattle industry. This review explores the physiological and genetic consequences of heat stress on breeding cattle and discusses potential mitigation strategies.

II. PHYSIOLOGICAL EFFECTS OF HEAT STRESS

Heat stress leads to a series of physiological alterations in cattle, including increased body temperature, elevated respiration rate, and excessive sweating (Hansen, 2019). These changes disrupt homeostasis, leading to oxidative stress and metabolic imbalances. Prolonged exposure to high temperatures can cause dehydration, reduced feed intake, and impaired nutrient absorption, which significantly impact growth and reproductive performance (West, 2003).

III. IMPACT ON REPRODUCTIVE HEALTH

Reproductive efficiency is crucial for breeding cattle, and heat stress severely impairs fertility in both male and female animals. In females, heat stress disrupts estrous cycles, reduces oocyte quality, and leads to early embryonic mortality (Roth, 2020). In males, high temperatures negatively affect sperm production, motility, and morphology, reducing overall fertility rates (Das et al., 2016). The cumulative effect of heat stress on reproduction results in decreased calving rates and economic losses for cattle producers.

IV. GENETIC CONSEQUENCES OF HEAT STRESS

Heat stress also influences gene expression related to thermoregulation and adaptation. Specific genes, such as HSP70 and HSP90, play essential roles in heat shock responses, helping cattle cope with thermal stress (Collier et al., 2008). However, prolonged heat exposure can lead to genetic mutations, altering cattle's ability to adapt to heat stress over generations (Bernabucci et al., 2010).

V. STRATEGIES FOR MITIGATING HEAT STRESS

To minimize the adverse effects of heat stress, several management strategies can be implemented:

Environmental Modifications

Providing shade, ventilation, and cooling systems (e.g., sprinklers, fans) can help regulate body temperature (Armstrong, 1994).

Nutritional Interventions

Adjusting diets to include antioxidants, electrolytes, and high-energy feed can mitigate metabolic imbalances (Kadzere et al., 2002).

Genetic Selection

Breeding programs focusing on heat-tolerant traits, such as coat color, skin properties, and heat shock protein expression, can improve resilience (Hoffmann, 2010).

Behavioral Adaptations

Modifying grazing patterns to avoid peak heat hours and ensuring access to adequate water sources can reduce heat stress impacts (Vitali et al., 2009).

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ENHANCING LIVESTOCK HEALTH AND PRODUCTIVITY WITH PROBIOTICS

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ABSTRACT

Probiotics offer a sustainable alternative to antibiotics in livestock, boosting animal immunity and productivity. Their ability to enhance animal immunity and improve productivity, while reducing the reliance on traditional antibiotics, offers numerous benefits both from a health and economic standpoint. They help prevent diseases, reducing the need for antibiotics and improving economic outcomes through lower treatment costs and better efficiency. Probiotics represent a promising and sustainable solution for the livestock industry, not just from a health perspective but also from an economic standpoint. With ongoing research and development, we can expect probiotics to become an even more integral part of the future of animal agriculture.

Keywords: Livestock, health, probiotics, management, gut

I. INTRODUCTION

Live microorganisms added to livestock diets called probiotics have the potential to completely transform livestock management. These "friendly" bacteria have been found to be a good substitute for antibiotics, providing a means of preventing harmful infections and preserving the delicate balance of the gut microbiota. The use of probiotics, prebiotics, and symbiotics in animal nutrition has grown in popularity due to their potential to act as immunomodulators that can alter the immune system to support balance and health, as well as their capacity to enhance feed absorption and the quality of meat, milk, and eggs. Both innate and adaptive immune responses are influenced by the intricate interactions these microbes have with the host's immune system.

II. OPTIMIZING LIVESTOCK NUTRITION AND GROWTH THROUGH PROBIOTIC SUPPLEMENTATION

Probiotics, when given in the right amounts, these good bacteria and their host develop a symbiotic partnership that outcompetes harmful pathogens for resources and attachment sites in the gut. Their presence not only strengthens the intestinal barrier but also creates compounds that directly impede the growth of potential invaders and modifies the immune system (Ullah *et al*., 2024). (Probiotics have a significant impact on the immune system; they boost innate defenses and adaptive immunological responses, which increases resistance to disease. Numerous case studies that have connected probiotics to better feed conversion rates, enhanced nutrient intake, and higher-quality animal products demonstrate this immunomodulatory activity. Probiotic supplementation has been linked to lower rates of intestinal problems and pathogen shedding in poultry, while it has increased milk and meat output and enhanced feed efficiency in ruminants. The use of probiotics in animal nutrition leads to balance in the beneficial gut microbiome and eradicate harmful gut pathogens, leading to a number of benefits like improved gastrointestinal tract function, increased systemic and gut immunity, and improved health status for both ruminants and non-ruminants.

Enhancing ruminal fermentation efficiency, such as stabilizing pH-enhanced fiber digestion and lowering methane production in the rumen, has been the main goal of probiotic use in ruminants, which has an effect on production performance. When it comes to enhancing performance metrics in non-ruminants, bacterial probiotics outperform yeast. Probiotics have also been demonstrated to enhance the quality of meat and milk in food animals, lower the incidence of intestinal illnesses, and decrease the shedding of gut pathogens in feces.

III. PROBIOTICS IN ENHANCING ANIMAL PRODUCTIVITY

Probiotic usage has been shown to increase feed efficiency and average daily gain (ADG) in a variety of species, indicating a clear link between probiotic use and improved growth performance. Probiotics have been shown in studies to enhance the fatty acid profile of meat, which may benefit consumers' health by reducing harmful cholesterol levels. Probiotics have been shown to improve milk composition and yield in the dairy industry by promoting a healthy rumen environment, which in turn improves nitrogen flow and the generation of volatile fatty acids. Furthermore, probiotics improve growth performance and nutrient synthesis, which eventually improves muscle production and carcass weight. The proof that probiotics are beneficial There is strong evidence to support the use of probiotics in animal feeding, with studies showing steady improvements in output and product quality. Probiotics are becoming more and more crucial in promoting ethical and effective livestock production as the demand for animal feed rises worldwide.

IV. PROBIOTICS IN DISEASE PREVENTION

As a first line of defence, probiotics strengthen the animals' innate immunity and act as a barrier to keep harmful germs out. It has been demonstrated that probiotics are essential for preventing illnesses such bovine mastitis, a prevalent and expensive condition affecting dairy animals. Probiotics support animal health and wellbeing by boosting the immune system and making the environment unfavourable for infections. Probiotic supplementation has been linked to a decrease in the prevalence of respiratory ailments, gastrointestinal disorders, and other infections that frequently affect livestock. The process of competitive exclusion is one of the main ways that probiotics prevent illness. Probiotics successfully prevent the growth and colonization of harmful bacteria by competing with them for resources and attachment sites. This procedure is essential for preserving a healthy gut flora and delaying the onset of illness. Probiotics can also generate antimicrobial compounds that directly target pathogens, which lowers the risk of infection even more. Probiotics save cattle producers money by decreasing the incidence of sickness and the requirement for antibiotics and medical treatments. Additionally, healthier animals result in higher output and higher-quality products, both of which can boost livestock businesses' profitability. Research has indicated that the use of probiotics can result in significant healthcare cost savings as well as increased productivity by lowering absence from illness. Livestock illness prevention can be achieved in a variety of ways with probiotics. Livestock illness prevention can be achieved in a variety of ways with probiotics. They have the potential to be a sustainable substitute for conventional antibiotics because of their capacity to strengthen the immune system, competitively exclude harmful microorganisms, and provide economic benefits.

V. CHALLENGES IN PROBIOTIC APPLICATION

A number of variables can affect the viability of probiotics while they are being processed and stored. One important consideration is temperature; probiotics need to be maintained within particular temperature ranges in order to stay active. Lactic acid bacteria, for example, which are frequently found in probiotics, are susceptible to high temperatures, which can denature their proteins and cause cell death.

According to a study by Champagne et al. (2005), probiotics' survival rate throughout storage and gastrointestinal transit was considerably raised by microencapsulation. The full potential of probiotics can be realized, leading to better health outcomes, by addressing the variables that affect probiotic survival and using strategies to increase stability.

Because of the wide variety of microbial strains and their distinct interactions with the host's microbiome, figuring out the ideal probiotic dosage is a complex task. Every strain has unique qualities and health advantages that call for a customized dose strategy. The microbiome's dynamic nature, which might change the probiotic's effectiveness and dosage requirements, adds to the complexity.

Larger and better-designed clinical studies are needed to offer the solid proof needed for therapeutic claims. More investigation is required to determine the best strains for particular illnesses and to comprehend the mechanisms of action. Although probiotic therapy is still in its early stages, the current status of applications is encouraging. Research on probiotics' potential applications for other illnesses is lacking, despite the fact that some of them are successful in treating ailments like irritable bowel syndrome and diarrhoea. To investigate the therapeutic potential of probiotics in a broader range of illnesses and to identify the best strains, doses, and treatment durations, further study is required.

VI. CONCLUSION

Probiotics have emerged as a promising and sustainable alternative to traditional antibiotics in livestock management. By enhancing animal immunity, improving feed efficiency, and promoting overall health, probiotics offer significant economic and health benefits to the livestock industry. However, challenges remain in optimizing probiotic use, particularly regarding strain selection, dosage, and ensuring stability during storage and transit. The dynamic nature of the microbiome and the complex interactions between probiotics and host organisms require further investigation. While current research shows promising results, more large-scale clinical studies are needed to solidify the therapeutic claims and explore the full potential of probiotics for various animal diseases. With continued research and development, probiotics have the potential to revolutionize livestock nutrition and disease prevention, contributing to more sustainable, ethical, and efficient farming practices in the future.

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IMPORTANCE OF GENETICS IN ANIMAL HUSBANDRY FOR ECONOMIC GROWTH

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ABSTRACT

Genetic advancements have transformed animal husbandry, improving productivity, disease resistance, and economic sustainability. By adopting modern breeding techniques and genomic selection, livestock producers can optimize efficiency and maximize profits. As global demand for high-quality animal products continues to rise, genetics will remain a fundamental driver of economic growth in the livestock sector.

Keywords: Animal husbandry, Breeding techniques, Genomic selection, Economic growth.

I. INTRODUCTION

Animal husbandry is a vital sector of agriculture that contributes significantly to global food production and rural livelihoods. The application of genetics in animal breeding has revolutionized livestock production by improving productivity, disease resistance, and adaptation to environmental challenges. Genetic advancements have not only enhanced the quantity and quality of animal products but also played a crucial role in the economic growth of the livestock sector. By implementing selective breeding, artificial insemination (AI), genomic selection, and biotechnology, farmers can optimize production efficiency and increase profitability.

II. GENETIC IMPROVEMENT IN LIVESTOCK

1. Enhancing Productivity through Selective Breeding

Selective breeding has been a cornerstone of genetic improvement in livestock. By choosing animals with desirable traits, farmers can enhance milk yield, meat quality, growth rate, and reproductive efficiency. For example, crossbreeding between indigenous and exotic dairy breeds, such as Holstein-Friesian and Jersey, has significantly improved milk production in countries like India and Brazil (Singh et al., 2022).

2. Genetic Selection for Disease Resistance

Genetic resistance to diseases reduces veterinary costs and increases the lifespan and productivity of livestock. Advances in genomics have identified genes responsible for resistance to major livestock diseases such as mastitis in dairy cattle, Newcastle disease in poultry, and African swine fever in pigs (Bishop & Woolliams, 2014). The selection of disease-resistant breeds reduces economic losses due to mortality and treatment expenses.

3. Feed Efficiency and Growth Performance

Feed accounts for nearly 70% of the total cost of animal production. Genetic improvements have led to the development of livestock with better feed conversion ratios (FCR), reducing the overall cost of production. For instance, genetically improved broiler chickens reach market weight within six weeks due to enhanced growth rates and feed efficiency (Havenstein et al., 2003).

4. Reproductive Efficiency and Genetic Technologies

Reproductive technologies such as artificial insemination (AI), embryo transfer (ET), and in-vitro fertilization (IVF) have revolutionized animal breeding. AI has significantly improved reproductive efficiency in cattle, leading to higher conception rates and better genetic gains (Lucy, 2001). Additionally, genomic selection helps in identifying superior breeding animals at an early stage, accelerating genetic progress.

5. Quality Enhancement of Animal Products

Genetic selection has improved the composition of animal-derived products, leading to higher nutritional value and better consumer acceptance. For example, genetic modifications in dairy cattle have increased the beta-casein A2 protein content in milk, which is considered beneficial for human health (Kumar et al., 2022). Similarly, marbling genes in beef cattle, such as Wagyu, enhance meat tenderness and flavor, increasing market value.

6. Climate Resilience and Sustainability

Climate change poses a significant threat to livestock farming, affecting animal health, reproduction, and productivity. Genetic advancements have facilitated the development of heat-tolerant breeds, such as the Sahiwal and Gir cattle, which perform well under hot and humid conditions (Rashamol et al., 2020). By selecting climate-resilient livestock, farmers can ensure sustainable production and economic stability.

III. ECONOMIC BENEFITS OF GENETIC IMPROVEMENTS

1. Increased Farm Income and Productivity

Genetic improvements lead to higher yields and better-quality products, directly increasing farmers' income. For instance, dairy farmers using genetically superior breeds reported a 30–40% increase in milk production, leading to higher profits (FAO, 2021).

2. Lower Veterinary and Feed Costs

Healthier, genetically improved livestock require fewer veterinary interventions and consume feed more efficiently, reducing overall production costs. Disease-resistant breeds, such as those resistant to foot-and-mouth disease, have significantly lowered veterinary expenditures.

3. Expansion of International Trade and Exports

Genetically superior livestock products meet international quality and safety standards, making them competitive in global markets. Countries such as the Netherlands and New Zealand have successfully leveraged genetics to become leading exporters of dairy and meat products (OECD, 2022).

4. Sustainable and Environment-Friendly Livestock Farming

Genetic selection reduces greenhouse gas emissions by enhancing feed efficiency and reducing methane production in ruminants. Sustainable breeding practices contribute to environmental conservation while ensuring long-term economic viability (Garnsworthy, 2004).

IV. CHALLENGES AND FUTURE PROSPECTS

Despite the numerous benefits, genetic improvement in animal husbandry faces challenges such as high initial investment costs, ethical concerns regarding genetic modification, and limited access to advanced technologies in developing countries. However, advancements in genomics, biotechnology, and artificial intelligence are expected to further enhance genetic selection and precision breeding in the future (Dekkers, 2012).

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MULTIDRUG RESISTANCE *ACINETOBACTER BAUMANNII*: AN EMERGING THREAT

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ABSTRACT

Acinetobacter baumannii is a Gram-negative bacillus that is a common pathogen among immunocompromised individuals and is associated with aquatic environments. It has been designated as a "red alert" human pathogen due to its broad antibiotic resistance spectrum. *A. baumannii* is one of the ESKAPE organisms that pose a global threat to human health and a therapeutic challenge due to its emerging and constantly growing resistance. In 2018, WHO ranked carbapenem-resistant *A. baumannii* (CRAB) as the top priority for antibiotic research and development. The virulence potential of *A. baumannii* is based on a "persist and resist" strategy, with the bacteria also resisting oxidative stress and complement-mediated killing. The most significant virulence factors include protein secretion systems, iron-chelating systems, capsular polysaccharides, lipopolysaccharides (LPS), proteases, outer membrane porins, and phospholipases. The pathogen is a common cause of biofilm-related infections, especially ventilator-associated pneumonia and catheter-related infections, making clinical management of these infections extremely difficult.

Keywords: *Acinetobacter baumannii, A. baumannii,* Multidrug resistance, XDR, Nosocomial infections, Biofilm

I. INTRODUCTION

Acinetobacter baumannii is a Gram-negative bacillus that is aerobic, pleomorphic and nonmotile. *A. baumannii*, an opportunistic pathogen, is common among immunocompromised people, especially those who have been in the hospital for more than three months. It is commonly associated with aquatic environments and has been shown to colonize the skin in addition to being isolated in large numbers from infected individuals' respiratory and oropharyngeal secretions. In recent years, it has been designated as a "red alert" human pathogen, causing concern among the medical community, owing to its broad antibiotic resistance spectrum. The genus *Acinetobacter* originated in the twentieth century, when the Dutch microbiologist Beijernick described an organism known as *Micrococcus calcoaceticus*, which was isolated from soil using a medium enriched with calcium acetate. *A. baumannii* is one of the ESKAPE organisms (*Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, A. baumannii, Pseudomonas aeruginosa*, and *Enterobacter* spp.) that pose a global threat to human health and a therapeutic challenge as a result of emerging and constantly growing resistance. In 2018, WHO ranked carbapenem-resistant *A. baumannii* (CRAB) as the top priority for antibiotic research and development. Carbapenem was selected as a marker because carbapenem resistance is typically associated with a wide range of co-resistance to other antibiotic classes. Its capacity to create biofilms and withstand desiccation and disinfectants is particularly concerning because these traits enable *A. baumannii* to flourish in hospital environments. The virulence potential of *A. baumannii* is based on a "persist and resist" strategy, in which the bacteria also resist oxidative stress and complement-mediated killing. This is supported by the antibiotic resistance, environmental persistence, and lack of known host-damaging toxins in its genome. According to genomic and phenotypic studies, the most significant virulence factors are protein secretion systems, iron-chelating systems, capsular polysaccharides, lipopolysaccharides (LPS), proteases, outer membrane porins, and phospholipases. *A. baumannii* is a common cause of biofilm-related infections, especially ventilator-associated pneumonia and catheter-related infections. These infections can be extremely resistant to antibiotic therapy, making clinical management of *A. baumannii*-related biofilm infections extremely difficult. Because of the fast spread of infections linked to medical devices and antibiotic resistance, *A. baumannii* biofilms have emerged as one of the most significant worldwide problems.

II. MULTIDRUG RESISTANCE IN *ACINETOBACTER BAUMANNII*

Amnioglycosides

Amnioglycosides interact with the RNA 16S of the ribosomal 30S subunit. The production of aminoglycoside modifier enzymes is the well-studied mechanism of antibiotic resistance in *A. baumannii* strains. There are three types of modifier enzymes: aminoglycoside acetyltransferases (AAC), such as AAC (6′)-Ih (which also confers resistance to gentamicin and amikacin), aminoglycoside phosphotransferases (APH), such as APH (3′)-IA (which confers resistance to gentamicin), and aminoglycoside adeniliItransferases (ANT), such as ANT (2″)-IA. The production of RNA 16S ribosomal methyltransferase, particularly ArmA, the first of its kind found in a clinical isolate, appears to be an emerging mechanism of aminoglycoside resistance. *A. baumannii* strains producing ArmA are highly resistant to tobramycin, amikacin & gentamicin.

Carbapenems

Among all β-lactam antibiotics, carbapenems have the widest spectrum and are primarily used to treat infections brought on by Gram-negative bacteria. Among the mechanisms that give *A. baumannii* strains resistance to carbapenems are over expression of the carbapenem-hydrolyzing oxacillinase (OXA)-51-like-B-lactammase and ArmA RNA 16S ribosomal methyltransferase. Clinical repercussions have been linked to increased carbapenem resistance production and dissemination when OXA-23 is present. OXA-24 has been shown to exhibit moderate hydrolytic activity against carbapenems. Ambler's class B metallo-β-lactamases are one example of the non-OXA carbapenemases that have been reported in *A. baumannii*.

Fluoroquinolones

Substitutions in the quinolone resistance-determining regions (QRDRs) of DNA gyrase and DNA topoisomerase IV are the basis of *A. baumannii's* fluoroquinolone resistance mechanism. These substitutions prevent the fluoroquinolones from binding to their target proteins. In addition to increasing resistance in strains with RDRQ substitutions, over expression of efflux active pumps can also result in moderate resistance on its own.

Tetracyclines

Three primary mechanisms are thought to be responsible for resistance to tetracycline antibiotics: (i) ATP-dependent efflux, (ii) enzyme-mediated tetracycline inactivation, and (iii) ribosomal protection proteins (RPPs). Tetracycline resistance in *A. baumannii* refers to two energy-demanding efflux pump types. Tetracyclines can be efficiently removed by RND pumps, with AdeABC in particular, but they also significantly raise the minimum inhibitory concentrations (MICs) of tigecyline, minocycline, and tetracycline. Tetracycline major facilitator super family (MFS) efflux pumps TetA and TetB are included in the second group. TetA appears to be responsible for the tigecycline's efflux into the periplasm, after which RND pumps push the drug out through the outer membrane.

Polymixins

The lipid A of lipopolysaccharides (LPS) interacts with colistin (Polymyxin-E). Acquired polymyxin resistance is the result of its alteration. By adding a phosphoethanolamine residue to the hepta-acylated form of lipid A, negative charges are eliminated and the affinity of LPS for polymyxins is decreased. This modification technique is the most frequently reported. Complete loss of the original LPS is another way that *A. baumannii* develops this resistance.

Macrolides

Mutations in the rpoB gene, which codes for the rifamycin-sensitive beta-subunit of RNA polymerase and prevents RNA elongation immediately after the addition of the first nucleotides, have been connected to resistance to rifampin (also known as rifabicin) in A. baumannii infections. RpoB is linked to resistance to all rifamycins, including rifabutin, rifaximin, and rifapentine, in addition to rifampin.

Sulfonamides

Antifolate antibiotics work by preventing the synthesis of DNA and RNA by blocking purine metabolism. Trimethoprim is an inhibitor of dihydrofolate reductase (DHFR), which prevents dihydrofolic acid from forming tetrahydrofolic acid, a crucial stage in the biosynthesis of folate. DfrA1, DfrA5, DfrA7, DfrA10, DfrA12, DfrA14, DfrA16, DfrA17, DfrA19, DfrA20, DfrA27, and DfrB1 are trimethoprim-resistant dihydrofolate reductases that primarily confer resistance against diaminopyrimidines in *A. baumannii* infections.

III. BIOFILM FORMATION IN *ACINETOBACTER BAUMANNII*

Biofilms are bacterial communities that have formed in an extracellular polymeric matrix composed of polysaccharides, lipids, proteins, and nucleic acids. Biofilm development is a complex process in which microorganism cells switch from planktonic to sessile growth, influenced by a variety of environmental factors such as surface porosity, fluid flow, and nutrient availability. Quorum sensing regulates the common stages of biofilm development, which include initial contact or attachment to the biotic and/or abiotic surface, microcolony formation, biofilm maturation and architecture formation, and, finally, biofilm detachment or dispersion. *A. baumannii's* environmental survival is influenced by a number of factors, including its capacity to endure harsh environmental conditions, the dormancy of bacterial cells deep within the biofilm, its resistance to multiple antibiotics, its ability to prolong survival on inanimate objects, and its resistance to environmental stress. As a result, biofilms can cause a variety of sub-acute or chronic infections that are extremely difficult to treat. Compared to other *Acinetobacter* species, *A. baumannii* forms biofilms at the solid-liquid interface at a rate that is at least three times higher. Stronger biofilms can be formed by clinical strains than by environmental strains, and the development of biofilms on surfaces of medical significance influences the strains' resistance to desiccation, stress, nutrition availability, and antimicrobial therapy. Additionally, multidrug resistance and the expression of virulence factors like OmpA, the extracellular polysaccharide poly-β-1,6-N-acetyl glucosamine (PNAG), type I pili, Rec A, Bap, and the Omp CarO are positively correlated with the biofilm process of *A. baumannii* on abiotic surfaces. It requires chaperone-usher pili in order to form biofilm on an animate surface. The ability of *A. baumannii* to adhere to biotic and abiotic surfaces and form biofilms is facilitated by biofilm-related virulence genes and proteins.

Antibiotic resistance is inherent in *A. baumannii*. Multidrug-resistant (MDR) and extensively drug-resistant (XDR) bacteria have emerged as a result of the growing use of antibiotics. Consequently, the global spread of *A. baumannii* is turning into a serious issue. One of the main reasons for the high death rate is the appearance of MDR strains. despite the fact that there is ongoing discussion regarding the relationship between antibiotic resistance phenotypes and biofilm production. There is a positive correlation between biofilm formation and multidrug resistance, according to some evidence. Biofilm formers showed greater resistance to ampicillin-sulbactam, amikacin, ciprofloxacin, and ceftazidime than to imipenem and piperacillin.

IV. IMPACTS OF PATHOGEN AND CLINICAL INFECTIONS

Respiratory infections

MDR *A. baumannii*-induced ventilator-associated pneumonia (VAP) continues to be a major cause of high fatality rates in critically sick patients. Red blood cell transfusion and female gender were identified as independent risk factors for mortality in a more recent study from a university hospital. The frequencies of MDR, XDR, and PDR *A. baumannii* recovered from VAP cases were 13.3%, 68.3%, and 18.3%, respectively. *A. baumannii*-induced community-acquired pneumonia (CAP) is a growing issue, despite the fact that VAP caused by this organism seems to favour susceptible people. It primarily affects people with diabetes mellitus, smoking, chronic lung disease, and excessive alcohol use. It is distinguished by a fulminant course, high incidence of bacteremia, and a high fatality rate, particularly in tropical locations.

Blood vascular infections

The death rate from *A. baumannii*-caused bloodstream infections is close to 40%. For four years in a row, *A. baumannii* was the most common pathogen isolated from blood in burn patients admitted to an intensive care unit. The isolates had nearly 100% resistance to various antibiotics, with the exception of a low resistance profile to polymyxin B and minocycline.

Skin and soft tissues infection

Patients with severe burns, wounds, or trauma—such as soldiers hurt in combat or natural disasters—have had *A. baumannii* isolated from their skin and soft tissues on multiple occasions. Over the course of eight years, the percentage of *A. baumannii* isolates in a US military medical center rose from 4% to 55%, with wound isolates making up 24% of all *A. baumannii* specimens. Furthermore, compared to local patients (20%), combat casualties deployed overseas had a higher percentage of MDR *A. baumannii* isolates recovered (52%).

Urinary tract infection

According to one study, A. baumannii was the cause of 1.6% of UTIs acquired in intensive care units (ICUs) and can occasionally cause UTIs, particularly when indwelling urinary catheters are used. In a study examining the traits of A. baumannii isolated from intensive care units in ten Korean hospitals, urinary tract infections were linked to 55.6% of the isolates. Of these isolates, 19.8% exhibited imipenem resistance, 25% maropenem resistance, 13.5% polymyxin B resistance, and 17.7% colistin resistance.

Meningitis

With a mortality rate of nearly 70%, nosocomial meningitis caused by A. baumannii continues to pose a growing threat in intensive care neurosurgery units, particularly for patients undergoing post-operative antibiotic therapy and on indwelling ventriculostomy tubes or cerebrospinal fistulae. According to the largest case series of post neurosurgical A. baumannii meningitis published in 2019, 21% of isolates exhibited an XDR phenotype, meaning they were only sensitive to tigecycline and colistin. A. baumannii-related mortality in the neurosurgical intensive care unit was also associated with comorbidities (diabetes and hypertension), age over 40, the presence of an external ventricular drain, and an elevated white blood cell count in the cerebrospinal fluid.

V. CONCLUSION

A. baumannii is a significant opportunistic and emerging pathogen that can cause serious nosocomial infections. Its pathogenic potential includes the ability to adhere to surfaces, form biofilms, exhibit antimicrobial resistance, and acquire genetic material from unrelated genera, making it a difficult adversary to control and eradicate. *A. baumannii* can acquire antibiotic resistance through a variety of mechanisms, including changing the antibiotic target site, controlling antibiotic passage through its membranes, and enzymatically neutralizing antibiotics. In order to completely adapt to modern healthcare environments, *A. baumannii* has developed three fundamental properties: (i) The capacity to colonize skin, mucous membranes, and devices and to endure in a hospital setting; (ii) the expression of multiple virulence features; and (iii) broad resistance to antimicrobial agents due to antibiotic enzymatic modification, target gene mutation, altered permeability of outer membranes, and up regulated multidrug efflux pumps. The multitude of clinical infections caused by the bacteria and its biofilm formation along with drug resistance mechanisms make it a emerging universal risk for public health.

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OPTIMIZING NUTRITIONAL EFFICIENCY IN RUMINANTS THROUGH RUMEN BYPASS PROTEINS AND BYPASS FATS

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ABSTRACT

High-yielding animals need a larger percentage of nutrients in their diet that do not degrade in the rumen and instead provide the intestinally required amino acids. The efficiency of protein utilization is reduced when proteins are fermented in the rumen prior to enzymatic digestion. Feed ingredients that include proteins with a greater bypass value can be used to supply ruminants with bypass proteins. Supplementing with rumen-protected protein, fat, and vitamins increases immunity, lowers heat stress, and increases milk output. Therefore, using protected/by-pass dietary nutrients can be a potential technique for improving both the quality and quantity of animal production in order to supply dairy animals with precise and high-quality nutrition during times of high nutrient demand.

Keywords: Rumen, amino acids, peak yield, optimal production, microorganisms, metabolism

I. INTRODUCTION

In theory, there seem to be valid reasons to administer bypass nutrients to ruminants in order to improve their nutrient use efficiency, particularly at greater production levels. In actuality, though, the animals' reactions vary widely. Fast-growing or high-yielding animals in the early stages of lactation are likely to respond more favorably. These are common circumstances when there is a strong demand for nutrients and the animal may have a poorer body condition score due to a negative protein and energy balance.

Therefore, rumen-protected nutritional supplements can increase ruminant production in both quantity and quality, particularly in stressful situations. The nutritional needs of high-yielding dairy animals, particularly in the early stages of lactation, transition, and heat stress, are frequently greater than those met by rumen fermentation and microbial biomass synthesis. Additionally, in milch animals, a higher milk output during the early stages of lactation is frequently linked to a reduced feed intake. While maximum feed intake is several weeks behind peak milk yield, peak milk yield happens 6 to 8 weeks after delivery. Farm animals experience varied degrees of negative energy balance due to the disparity between the timing of their maximum energy output as milk yield, and their feed intake during the first 60 days of lactation. Animals in such circumstances use their body reserves to support production, which eventually leads to sterility, weight loss, and metabolic problems such milk fever and ketosis. In light of the aforementioned facts, transition nutrition has become increasingly significant to researchers around the world because of the different metabolic abnormalities that are linked to this period and influence the ensuing economic and productive losses. Dairy cows need better energy supplements during transition to counteract the negative impacts of decreased nutritional intake and body weight loss (Katiyar et al., 2019). Additionally, the rumen's significant breakdown of high-quality nutrients frequently renders them unavailable to the host, resulting in nutrient waste.

Proteins produce amino acids, which are used for development, maintenance, reproduction, and milk production. Based on how easily it breaks down during fermentation, crude protein in ruminant diets can be categorized into two groups: a. Protein degradable intake (DIP) b. Undegradable intake protein (UIP) becomes a limiting factor when there are high yielders and physiological stressors like pregnancy, lactation, transition, etc. In the aforementioned situations, rumen-protected or bypass nutrients are efficient at supplying nutrients in an efficient and usable form straight to the intestine.

Initially, as dietary proteins are the costliest nutrient in ruminant diets, they were protected. To achieve optimal production, however, nutrients such as lipids, vitamins, amino acids, and probiotics are now also fed to the animals in rumen-protected form.

II. AMINO ACIDS

Amino acids (AA) are generally essential for protein synthesis, animal maintenance, growth, reproduction, and production. As a result, rumen-protected limiting AAs provide a more accurate way to balance the diet's protein composition, which can save feed costs and enhance the body's total protein consumption. The most limiting necessary amino acids for high-yielding dairy animals are methionine and lysine, which are followed by arginine, histidine, phenylalanine, isoleucine, and threonine. Methionine and lysine are thought to be the first two co-limiting amino acids in tropical field circumstances, when animals primarily eat diets high in roughage and maize. As a result, feeds that are balanced for these AA, either separately or in combination, improve the ratio of milk to DM intake, milk energy and yield, milk protein percentage, and the percentage of dietary N that is collected as milk N.

III. PROTEIN

When cattle are given poor-quality forages, protein is typically the first limiting nutrient. In India, particularly in rural communities, isolated areas, and mountainous regions, farmers feed dairy cows locally sourced protein meals in addition to other components. A large portion of these protein-rich meals are converted to ammonia in the rumen, the ruminant's first stomach, which has a 50–60 liter capacity. The term "bypass nutrient fraction" refers to the portion of nutrients in the feed that are either low or not broken down by bacteria in the rumen but are digested and absorbed in the lower tract and made available to the animal. Protein meals typically undergo 65–70% degradation in the rumen, which results in nitrogen waste via excretion in urine and feces.

A small but variable amount of dietary protein escapes rumen degradation as "Un-degradable Dietary Protein" (UDP) or "bypass protein." The majority of the protein in most feed for ruminant animals is degradable in the rumen and is known as "Rumen Degradable Protein" (RDP). After enzymatic digestion, the majority of the UDP that enters the lower tract is absorbed as amino acids. A significant portion of the RDP fraction is used by rumen bacteria as a source of nitrogen for protein synthesis, with the remainder being absorbed as ammonia. Saliva only recycles a portion of the absorbed ammonia back to the rumen as urea; the remainder is eliminated through urine. Both UDP and microbial protein, which move down the lower tract, provide the host animal with the amino acids it needs. The microbiological supply of growing and high-yielding animals is less abundant than the tissue-level demand for amino acids; therefore, proteins in the form of UDP, escape proteins, or protected proteins must be supplied to meet the requirement.

Rumen microorganisms hydrolyse dietary protein that is soluble in rumen (RDP) into peptides and amino acids. Ammonia, organic acids, and carbon dioxide are the byproducts of further degradation of the amino acids (AA). The main nitrogenous base for microbial protein synthesis, which supplies over two-thirds to three-quarters of the protein required by host species, is ammonia. According to Mahesh and Thakur (2018), protein is the costliest and one of the main limiting nutrients in dairy animals' diets. This is especially true during transition and summer stress when their intake of dry matter (DM) is insufficient. Additionally, low DM intake reduces the amount of fermentable energy available in the rumen for the synthesis of microbial protein.

IV. RUMEN BYPASS PROTEINS

In high yielding foods, bypass fat or inert fat is essential for maintaining energy density balance. The goal of feeding "bypass" protein is that a high amount of the protein is available immediately at the lower section of gastro-intestinal tract, where it is digested and then absorbed as amino acids for utilisation at tissue level. The digestion of fiber is impacted when "bypass" starch is fed because it lessens the rumen's overproduction of lactic acid, which would otherwise cause acidosis, or low rumen pH. To prevent or lessen nutrient degradation in the rumen, a variety of techniques have been used, including heat treatment, chemical treatment, encapsulation, and specific modulation of rumen metabolic pathways. Bypassing the rumen, these techniques facilitate the movement of nutrients from the rumen to the the intestines.

V. FAT

The most variable component in milk when it comes to dietary changes is fat. When lactating cows are fed dietary bypass fat, their milk fat content rises. The main purpose of feeding "bypass" fat, also known as protected fat, is to prevent ruminal microbes from hydrolysing unsaturated fatty acids by bio-hydrogenation and to increase the feeds' energy density. As a result, the lipids are primarily broken down in the small intestine and absorbed as unsaturated fatty acids, which has no effect on the rumen's ability to ferment fibrous diets.

Without affecting DMI or nutrient digestibility, Tyagi et al. (2009) found that supplementing with bypass fat at a level of 2.5% of DMI enhanced milk output, lactation persistence, and the percentage of unsaturated FA in milk fat. In a tropical feeding scenario, lactating crossbred cows should consume 200–300g of bypass fat per day, while buffalo with a milk yield of 3000 L per lactation should receive 300–500g of bypass fat per day from 10 days before delivery to 30–50 days after delivery. Although supplementing with bypass fat is a sensible strategy, it should only be implemented after carefully weighing the costs and benefits.

VI. RUMEN PROTECTED FAT

In order to meet the energy needs of animals, excessive grain or oil/fat feeding may impact rumen fermentation and result in other metabolic problems. For dairy animals, protected fat can be added to the diet to prevent these issues. In high-yielding dairy animals, bypass fat, also known as inert fat, is essential for maintaining energy density balance. These are the dietary fats that are absorbed in the lower intestine but do not undergo ruminal lipolysis or biohydrogenation. Because of their hard outer seed coat, whole oil seeds, when fed without any processing other than drying, have inherent rumen bypass qualities. However, during mastication, the seed coat physically breaks down, resulting in poor rumen inertness. Certain rumen bypass fatty acids can also increase dairy animal reproduction and milk quality by lowering the amount of saturated fat.

Numerous methods have been developed to obtain rumen inert fatty acids, such as calcium salt of fatty acids, prilled fats, etc. The most common method for obtaining calcium salts of fatty acids is fusion and double decomposition. These calcium soaps are soluble in abomasum (pH 2-3) but insoluble in rumen pH (6.2 6.8). Prilled fat (PF) is made by liquefying and spraying a solution of saturated fatty acids under pressure into a cooled atmosphere. PF is not broken down in the rumen environment because of its higher melting point, which is 50-60°C.

VII. CONCLUSION

The use of bypass nutrients offers significant practical benefits, especially for high yielding, stressed, or lactating animals, but must be strategically managed to maximize productivity while minimizing costs and metabolic issues. By improving nutrient delivery to the intestines and supporting metabolic health during critical periods like lactation and transition, bypass nutrients can help dairy farmers optimize milk production and animal health.

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ENHANCING REPRODUCTIVE SUCCESS IN CATTLE: THE ROLE OF EARLY PREGNANCY DETECTION AND PREGNANCY-ASSOCIATED GLYCOPROTEINS (PAGS)

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ABSTRACT

Reproductive efficiency is vital for sustainable and profitable beef and dairy farming. Early detection of pregnancy and failure minimizes reproductive losses and optimizes herd productivity. Pregnancy-associated glycoproteins (PAGs), secreted by embryonic trophoblast cells, are reliable biomarkers detectable in maternal circulation as early as 24 days post-insemination. PAGs provide accurate early pregnancy diagnosis and insights into embryo viability and placental health. Despite challenges like postpartum interference and logistical constraints, advancements in assay technologies and ongoing research continue to enhance their role in improving reproductive outcomes.

Keywords: Reproductive efficiency, pregnancy diagnosis, pregnancy-associated glycoproteins (PAGs), cattle, bovine reproduction.

I. INTRODUCTION

Achieving successful pregnancies is a cornerstone for efficient and economically viable beef and dairy farming operations. Reproductive success ensures sustainability and profitability by optimizing herd productivity. However, reproductive losses, particularly during early pregnancy, remain a significant challenge. To address these issues, minimizing pregnancy failures and identifying them early are essential for implementing effective management strategies. Early detection of pregnancy failure offers farmers opportunities to mitigate losses, reduce costs, and improve overall herd performance.

Advancements in reproductive technologies and diagnostic tools have

revolutionized cattle farming. These innovations include hormonal analyses, ultrasonography, and the use of biomarkers such as pregnancy-associated glycoproteins (PAGs). These tools not only improve reproductive efficiency but also aid in understanding the physiological processes that influence conception and embryo survival.

II. IMPORTANCE OF EARLY PREGNANCY DETECTION

Efficient management of dairy and beef herds requires timely identification of nonpregnant cows after artificial insemination (AI). Early pregnancy detection reduces the interval between AI services, increases AI service rates, and contributes to higher overall pregnancy rates (Fricke, 2002). This early intervention enables farmers to make informed decisions about rebreeding strategies and resource allocation.

Traditional pregnancy detection methods, such as rectal palpation and ultrasonography, have limitations in sensitivity, specificity, and timing. As a result, there is a growing interest in biochemical tests that use reproductive hormones or conceptus-specific substances in maternal circulation. These tests are designed to detect viable pregnancies more accurately and at earlier stages than conventional methods.

III. ROLE OF PREGNANCY-ASSOCIATED GLYCOPROTEINS (PAGS)

Among the various biomarkers for pregnancy detection, PAGs have garnered significant attention. PAGs are produced by the trophoblast cells of the developing embryo and are secreted into maternal circulation. Their concentration rises significantly during early gestation, making them reliable indicators of pregnancy.

Discovery and early research

The identification of PAGs in the 1980s marked a milestone in reproductive biology (Butler et al., 1982). Early studies focused on isolating pregnancy-specific protein-B (PSPB), which was later reclassified as bovine PAG-1 (Xie et al., 1991). These discoveries led to the development of assays, including radioimmunoassays (RIA) and enzyme-linked immunosorbent assays (ELISA), that accurately detect PAG levels in maternal blood (Sasser et al., 1986; Green et al., 2005).

Mechanism of PAG Production

PAGs are produced by binucleated trophoblast cells that migrate to the maternal epithelium during early gestation. These cells release PAG-containing granules into maternal circulation, with concentrations peaking between days 22 and 36 of gestation. This makes PAG a reliable biomarker for early pregnancy diagnosis (Humblot, 2001; Wooding, 1992). PAG levels vary throughout gestation, reflecting placental growth and embryo viability.

IV. BENEFITS OF PAG TESTING IN HERD MANAGEMENT

Using PAG-based diagnostics offers several advantages in cattle reproductive management:

Early Detection

PAG levels are detectable in maternal blood as early as day 24 post-insemination, allowing timely decisions about rebreeding strategies.

Predicting Embryo Viability

Elevated PAG concentrations during early gestation are associated with higher embryo survival rates, making PAGs a useful tool for evaluating reproductive success (Kill et al., 2013).

Reduced Labor and Stress

Blood sampling for PAG tests can be less invasive than other methods, reducing stress on animals and labor requirements for farmers.

V. ADVANCEMENTS IN PAG TESTING TECHNOLOGIES

Modern PAG assays have evolved to enhance sensitivity, specificity, and ease of use. ELISA-based tests have been developed to detect PAGs with shorter half-lives, reducing the risk of false positives in postpartum cows (Green et al., 2005). Additionally, ongoing research aims to refine these assays for faster turnaround times and greater on-farm usability.

Comparative studies between PAG ELISA, RIA, and transrectal ultrasonography have shown similar accuracy for diagnosing pregnancy by day 28 of gestation (Szenci et al., 1998; Karen et al., 2015). These findings underscore the reliability of PAG testing in diverse management systems.

VI. CHALLENGES AND LIMITATIONS OF PAG-BASED TESTS

Despite their promise, PAG-based diagnostics face several limitations:

Blood Sample Requirement

Collecting blood samples can be logistically challenging on larger farms.

Postpartum Interference

Elevated PAG levels during the periparturient period can lead to false positives in cows inseminated too soon after calving.

Processing Delays

Laboratory-based assays often require 2–3 days for analysis and reporting, which can hinder immediate decision-making (Green et al., 2005).

Cost Considerations

While effective, PAG tests can be more expensive than traditional methods, limiting their widespread adoption in resource-constrained settings.

VII. FUTURE DIRECTIONS IN PAG RESEARCH

Research into PAGs continues to expand, with several areas showing promise for improving cattle reproductive management:

Development of On-Farm Tests

Efforts are underway to create portable, cow-side PAG detection devices that provide instant results, eliminating the need for laboratory processing.

PAGs as Immunomodulators

Studies suggest that PAGs may help disguise the embryo from maternal immune responses, enhancing placental competence (Perry et al., 2005).

Genetic Studies

Advances in genomics may reveal breed-specific variations in PAG expression, enabling tailored reproductive strategies for different cattle populations.

VIII. CONCLUSION

Early pregnancy detection is a critical component of reproductive management in cattle. Among the available methods, PAG-based diagnostics offer a reliable, accurate, and early means of identifying pregnancy and predicting embryo viability. While challenges such as cost and logistical constraints remain, ongoing advancements in PAG research and technology hold great promise for improving herd productivity and profitability.

By integrating PAG testing into reproductive management programs, farmers can achieve greater success in breeding and herd optimization, ensuring long-term sustainability in beef and dairy operations.

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TRANSFORMING THE INDIAN AGRICULTURAL ECONOMY THROUGH LIVESTOCK

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ABSTRACT

The livestock sector plays a crucial role in the transformation of India's agricultural economy, contributing significantly to rural livelihoods, employment, and food security. This review explores the role of livestock in economic growth, productivity enhancement, disease control, market reforms, and technological advancements. It also examines sustainable practices and policy interventions necessary for the sector's growth.

Keywords: Livestock, Growth, Economy

I. INTRODUCTION

India has one of the world's largest livestock populations, contributing around 4-5% to the national GDP and over 25% to the agricultural GDP. Livestock provides employment to millions, especially in rural areas, and ensures nutritional security through dairy, meat, and poultry products. This review highlights key factors influencing the transformation of the Indian agricultural economy through livestock.

II. CONTRIBUTION OF LIVESTOCK TO THE INDIAN ECONOMY

Livestock plays a multifaceted role in agricultural transformation:

Employment Generation

The sector employs over 20 million people in animal husbandry and related activities (FAO, 2020).

Income Diversification

Over 70% of rural households depend on livestock for supplementary income (NABARD, 2022).

Food Security

Livestock contributes to protein intake through dairy, eggs, and meat.

Export Potential

India is the largest producer of milk and a major exporter of meat and leather products (Ministry of Commerce, 2021).

III. Strategies for Transformation

1. ***Enhancing Productivity***

Genetic Improvement: Artificial insemination, embryo transfer, and genomic selection have enhanced livestock productivity (Singh et al., 2019).

2. ***Feed & Nutrition Management***

Adoption of high-quality fodder and silage has improved milk and meat yield (Sharma & Patel, 2020).

3. ***Disease Control and Veterinary Services***

Expansion of vaccination programs (e.g., Foot-and-Mouth Disease control program) has reduced mortality (ICAR, 2021).

Strengthening veterinary healthcare and mobile clinics for timely intervention (World Bank, 2022).

4. ***Modernization of the Dairy Sector***

Adoption of automation in milk testing and processing for improved quality (Kumar et al., 2021).

Strengthening dairy cooperatives to enhance farmer profitability.

5. ***Diversification into Poultry, Fisheries, and Small Ruminants***

Poultry Growth

India's poultry industry has seen significant growth due to modern breeding and feed management (FAO, 2020).

Aquaculture Expansion

India ranks second in global fish production, highlighting the importance of sustainable fisheries.

Small Ruminants

Goat and sheep rearing contribute significantly to meat exports and rural income (NABARD, 2022).

6. ***Market Reforms and Value Addition***

Strengthening livestock-based value chains such as dairy processing and meat exports.

Promotion of agripreneurship through food processing clusters and startups.

7. ***Technological Advancements and Digital Transformation***

Use of AI & IoT

Smart herd management, automated milking, and disease detection using AI (Pandey & Ramesh, 2022).

E-commerce in Livestock Products

Online platforms connecting farmers directly to consumers and markets.

8. ***Sustainable and Climate-Resilient Livestock Practices***

Organic Dairy Farming

Adoption of sustainable animal husbandry methods (Sharma et al., 2022).

Waste Management

Use of livestock waste for biogas and organic fertilizers.

Methane Emission Reduction

Strategies to reduce livestock-related greenhouse gas emissions (IPCC, 2021).

9. ***Policy Interventions and Government Initiatives***

National Livestock Mission (NLM)

Support for productivity enhancement and infrastructure development.

Rashtriya Gokul Mission

Improvement of indigenous cattle breeds (Govt. of India, 2021).

Dairy Processing and Infrastructure Fund (DIDF)

Strengthening dairy infrastructure (NABARD, 2022).

IV. CHALLENGES AND FUTURE PROSPECTS

Infrastructure Gaps

Need for better cold storage, transport, and processing facilities.

Access to Credit

Strengthening financial inclusion for small farmers.

Climate Chang

Addressing the impact of climate variability on livestock health and productivity.

Skill Development

Training farmers in modern animal husbandry techniques.

The livestock sector has the potential to be a key driver in transforming the Indian agricultural economy. With strategic investments in technology, disease control, market infrastructure, and policy reforms, India can achieve higher productivity, better farmer incomes, and sustainable agricultural growth.

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