LIVESTOCK MANAGEMENT: REPRODUCTIVE AND OTHER HEALTH ISSUES

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Pakistan is a state that largely contributes to agricultural activities (production). Among major agricultural activities in Pakistan, raising livestock is very prominent. It largely contributes to the agricultural economy as 55.6 % of the agricultural economy comes from the livestock sector (Khan et al., 2021) which contributes 19.3% of the GDP. Nearly 62 million tons of buffalo and cattle milk as well as 18,751 hides have been provided by livestock annually. Almost 8 million rural farmers with their spouses are engaged in livestock. However, this agricultural sector has recently faced numerous challenges like growing demands for agricultural products as well as an increasing population. To increase productivity, there is a need to implement sustainable alternatives on agricultural lands (Ahmad et al., 2021; Azeem et al., 2022). It was declared that 70% of the population lives in rural areas in Pakistan and is devoid of modern energy facilities. The consumption of livestock waste as an appropriate source of energy is a valuable approach for providing energy to prevailing rural areas that aid in the economic progress of the country (Khan et al., 2021).

Livestock services and products play a crucial role for humans as they supply 33% of protein and 17% of the calories consumed globally (Cheng et al., 2022). Dairy products provide a superior nutrient package like milk which is a robust source of various essential nutrients like calcium, proteins, potassium, etc. (Tricarico et al., 2020). In addition, livestock farming contributes in soil health and ecosystem management via upcycling of resources that are unsuitable for food production, minimizing pesticides and fertilizers (Leroy et al., 2022). Moreover, livestock are frequently kept to acquire transport and power, they also serve as a cultural and financial asset. Livestock production in rural areas on a small scale is highly based on family farming and is crucial to the livelihoods of poor people and their food security. Livestock offers food, income generation and gives quick cash in need of any hazard. Moreover, it has spiritual and cultural value. Small ruminants and poultry are managed by and gives benefits to women directly. In medical science, for improving human health, livestock provides many benefits. Animal models have been used for the advancement of prevention as well as therapeutics in many fields, vaccine production and in various neoplastic, metabolic and genetic disorders (Alders et al., 2021).

Livestock is the sub-area of agriculture; that is, the growth of livestock is directly proportional to agricultural growth. If there is improved agriculture, that corresponds to robust livestock. Ignorance of agriculture can also lead to a reduction in livestock production (Kakar, 2020). Livestock is an integral part of raising GDP having significantly positive effects on economic growth and poverty alleviation. Milk is the most important agricultural product enumerated as Pakistan's white gold. Globally, Pakistan is ranked among the top five milk-producing countries (Shahzad, 2022). Milk and other animal-produced foods are effective dietary sources of micro and macro-nutrients. Animal-source food demand is highly rising with an estimated 50 % growth in 2030 (Dror & Allen, 2011; van Wagenberg et al., 2017).

POTENTIAL DILEMMAS OF LIVESTOCK

The need for livestock products is rapidly growing, it also faces simultaneously climate change events affecting animal production, like elevated temperatures, changes in precipitation patterns, etc. Such changes influence performance in livestock across many regions. For food security management and sustainability, livestock production systems are already challenged to enhance the production of livestock and minimize environmental effects (Cheng et al., 2022).

In traditional livestock systems, the quality and amount of feed is often inadequate resulting in malnutrition of animals. Additional challenges regarding the production side include insufficient natural resources, lack of infrastructure, disease pressure and limited market access (Tricarico et al., 2020).

Various environmental issues impact the yield, reproduction and health of livestock species. Elevated temperatures potentiate heat stress risk for livestock species. As shown in several studies, heat stress has an impact on various biological processes resulting in high economic consequences. In dairy cattle, it potentiates several issues including a reduction in reproduction and milk production as well as leading to risk of mortality. Moreover, enhanced carbon dioxide levels along with increased temperature due to climate change result in decreased forage quality. This lessened quality is due to the composition of plants influenced by the climatic factors that make it less digestible for livestock. Similarly, an increase in climatic temperature allows vector-borne pathogens to live much longer than they would. This can lead to boosted transmission of disease in livestock (Cartwright et al., 2023).

LIVESTOCK MANAGEMENT SYSTEMS

To understand the livestock management system, we need to have an insight into livestock production systems. A common classification is Agroforestry livestock management and conventional livestock management. Agroforestry is similar to the organic practice of agriculture. Agroforestry is the intentional integration of shrubs and trees into crop and animal farming systems, on the same land, to create environmental, social and economic benefits. It has a multi-functional system of land use described as an agriculture with livestock and trees. It can serve as a sustainable alternative to agricultural practices traditionally. It provides enhanced agrobiodiversity, increased land security and income, more diverse livelihood, sources of water and decreased rainfall dependency. It has a major role in enhancing agricultural yield, improving soil fertility, decreasing soil erosion and in raising income (Ahmad et al., 2021; Ramil Brick et al., 2022).

Conventional system, on the other hand, focuses on technologies to enhance operations and productivity for instance: high-yielding breeds, veterinary health products, modern feeding techniques, fertilizers (synthetic), and pesticides. It was proposed in various studies that agroforestry is a more sustainable system as compared to conventional agricultural systems (Ahmad et al., 2021).

LIVESTOCK HEALTH ISSUES

Worldwide, health issues in animal farming are of utmost concern. The increasing demands of dairy outlets require improved efficiencies and agricultural intensification (McMahon et al., 2015). The environmental factors add to the increased risk factors in the interaction, evolvement, and transmission of bacterial pathogens. Detection, exposure, management, and prevention are the routes to manage the health issues among dairy animals. The disease aspects are complex and have multiple agents to aggravate (Perry et al., 2013). The management solutions, interdisciplinary approaches, and complexity of local bio-systems are used in response (Lorenzo E Hernández-Castellano et al., 2019).

Bacterial Livestock Infections

The pathogenic species (Brucella, Mycobacterium, and Leptospira) cause pandemic bacterial infections in farm animals (dairy producing). This requires proper knowledge and management to minimize the transfer and carriage among such animals, reducing zoonotic risks via contact with infected animal tissues and contaminated environments and food items. However, these days farming practices are connected with zoonotic diseases. Moreover, clinical mastitis in farm (dairy) animals is caused by bacteria Gram-positives (e.g., Staphylococcus, Streptococcus) and Gram-negatives (e.g., Escherichia and Klebsiella). (Lorenzo E Hernández-Castellano et al., 2019; Wall et al., 2016). Bacterial infections require adequate resources and knowledge to create awareness,

detection, and implementation of their control. Because it has a range, its transmission and zoonotic potential need methods of prevention, biosecurity, and control for the semi-intensified and local pastoral settings. In the tropics, the management of dairy animals demands added consideration for heat stress; which is a significant risk factor for suspected bacterial infection and its transmission (Lorenzo E. Hernández-Castellano et al., 2019).

Viral livestock Infections

Pakistan's climate offers favorable ground in keeping infectious diseases. Crimean-Congo Hemorrhagic fever (CCHF) or simply Congo Fever is a prevalent disease that produces severe fever outbreaks. It is caused by the Nairo virus, a tick-borne virus (Atim et al., 2022). It was discovered initially in Rawalpindi, in 1976. Thereafter, transmitted to further provinces in the country. It is found in areas where sacrificial animals are found (Masood et al., 2023).

LSD or Lumpy Skin Disease refers to a transboundary re-emerging disease in goats, sheep, buffaloes (outdoor bathwater) and cattle. LSD virus belongs to the Capripoxvirus genus (Azeem et al., 2022). Before January 2022, no case was reported in Pakistan but a sudden outbreak in Sindh occurred. To reduce the extent of disease, vaccination was increased. LPS is characterized by skin nodules followed often by secondary bacterial infection. This disease creates problems for the economy and livestock sector as it may cause skin damage, infertility, mortality, mastitis and reduced milk and meat production. LSD is not contagious to humans and causes no harm to public health (Gibbs, 2021; Imran et al., 2022).

Another potentially zoonotic viral infection affecting poultry is, the avian influenza virus (AIV, the outbreak of which, has been augmented globally, including in Pakistan. Poultry constitutes the largest agricultural subsector in Pakistan as it contributes overall 35% of meat production having a growth rate of 9.1%. It is influenced by a variety of bacterial and viral diseases, predominantly AIVs that instigated high mortality in poultry in the past decade (Channa et al., 2022). It has been observed that Pakistan suffered a heavy loss economically of around 5.4 billion in 2004-2005. Moreover, the outbreaks of AIV have occurred increasingly in past decades. It was reported earlier in studies that AIV can be transmitted to healthy birds from infected ones. The highly pathogenic virus H5N1 can also be transmitted to humans (Channa et al., 2020).

OTHER EMERGING DISEASES AMONG DAIRY ANIMALS IN TROPICS

Health concerns are of utmost importance for dairy animals. Reproduction and productivity are widely affected by diseases specifically in the tropics, for known reasons. However, intensive dairy has evolved at a large scale in other countries, dairy production is still practiced in low-scale farms having both low inputs and outputs. This decreases the chances of production-related diseases. Low input systems affect both quality and quantity. Feed, for instance, contains by-products that have low nutritional value causing deficiencies among farm animals. Moreover, they may have scarce resources for food and water even contaminated with biological and chemically hazardous mycotoxins, pathogens, antimicrobials, and heavy metals. The contamination may contribute to the development of diseases and the promotion of resistance to antimicrobials.

In the tropics, dairy farms often develop low levels of biosecurity and less frequent training possibilities, the animals are likely to be infected with diseases as they limit isolations that make them prone to infectious diseases. However, tropical climate-borne diseases such as East Coast Fever and Nagana (African animal trypanosomiasis) are dependent on climate and environment greatly. Not only environment or climate changes possess infectious diseases in the tropics, low income and scarcity of resources play a pivotal role in the widespread too. The veterinary services, lack of enforcement of regulations and authority, and unregulated pharmaceuticals common in numerous low-income states are the root causes. Limited possibilities for treatment and diagnosis eventually devastate the possibilities of implementing vaccination programs. With little or no knowledge, these farmers cannot prioritize prevention or control over numerous diseases. There are religious

or economic restrictions where the fear of animal losses creates havoc on selling infected animals in disease outbreaks, exacerbating the problem (Lorenzo E. Hernández-Castellano et al., 2019).

IMPROVEMENTS IN LIVESTOCK SYSTEM

As animal production and health are critical factors in the agricultural setting, the livestock's health directly impacts their productivity and subsequently the revenue to farmers. In recent years, advancements in technology have contributed to livestock production and health practices. The expansion of the livestock sector offers significant prospects for agricultural development, human nutrition, food security and poverty reduction. Public health and food safety depend on healthy, safe and efficient livestock production. Several techniques are being developed and assessed to increase the agricultural production of different animal species like drug delivery as nano/microsystem; improving animal nutrition by prebiotics, biosorbents, probiotics, or other bioactive substances, precision livestock farming, using genetic improvement methods, disease management by using the vaccines, nutraceuticals or using alternatives to antibiotics, etc. (Hernandez-Patlan et al., 2023). Some of the methods are listed below;

1. Viral Issues Prevention

Various fatal diseases deprive livestock farmers of income and place them at risk of food insecurity. In Pakistan, farmers do not vaccinate their animals regularly against these lethal diseases. Consequently, every third animal suffered, devoiding dairy production. In Pakistan, some livestock diseases still exist that have already been controlled in developed countries. These diseases result in huge economic losses. To avoid these diseases, preventive measures should be taken (Ashfaq et al., 2020).

In Pakistan, the Government advises implementing SOPs (standard operating procedures) prior to the Eid-ul-Azha holidays each year which includes, the use of gloves during sacrificial processes to avoid contact with animal blood. Livestock should be disinfected by anti-tick spray at borders among territories while animal crossing. Public awareness campaigns as a precautionary measure should be done to prevent endemics (Masood et al., 2023). Precautionary measures should be taken while slaughtering and skinning as ticks can bite humans (Ilyas, 2023).

To uplift the economy, Pakistan highly relies on the livestock sector. Lumpy disease is an emerging condition in Pakistan. To prevent this disease, the transport of animals from one to another territory should be stopped. Animals should be vaccinated to prevent this disease (Imran et al., 2022). To treat secondary bacterial infections, good care and antibiotics are recommended (Gibbs, 2021)

2. Optimizing Digitalization with PLF (Precision Livestock Farming)

The penetration of digitalization has been observed nowadays in almost all domains of life; social, political, educational, agricultural, etc. Technology and advanced digitalization tools can help modern farmers enhance their economic contribution, repetitive drudgery of tiring farming tasks and minimize isolated solutions. In livestock setup, digital data is a key factor. The cultural obligations emphasize reducing animal experimentation and even physical contact with animals to reduce outbreaks and promote awareness and welfare. Digitalization technologies are required to be researched and integrated into the trends where novel biometric sensors, blockchain, and big data can be practiced for mutually beneficial livestock management (producers, consumers, and dairy animals) (Neethirajan & Kemp, 2021; Subach & Shmeleva, 2022).

With the increasing population, to meet the needs we must adapt to trends that enhance efficiencies, productivity, quality, and implement improved standards while addressing the common dilemmas related to livestock agriculture. This can be possible with state-of-the-art digital animal agriculture with the PLF techniques mentioned above. Biometric sensors (invasive and non-invasive sensors) monitor each animal's behavior and health in no time and further integrate data for

population-level analysis. The real-time data collected is then processed and integrated with a big data analytics system; a statistical algorithm for sorting complex sets of information (data) to provide it to farmers in relevant trending pattern-enhancing decision-making tools. Blockchain (sensor) offers secure transference and traceability of livestock products from farm to table and also aids in monitoring and diagnosing diseases, outbreaks, prevention, calculating potential economic losses, and food-related health pandemics. PLF provides transparent and potential livestock agriculture to the above-stated concerns and entrusts consumers. The new PLF technologies are competitive and excelling but are still in their validation period. However, the next-generation PLF techniques need a proper foundation for prediction and prevention along with providing analytical platforms for precisely analyzed massive data (Neethirajan & Kemp, 2021).

Individual animal continuous data along with suitable analytical procedures may extend animal well-being and enhance production efficiencies. These efficiencies may result in improved livestock reproductive performance and weight, by enhanced precision in diagnosing abnormalities within the herd. Hence, they aid in lessening animal losses and suffering while reducing the administration of prophylactic medication. Sensor technology helps to reduce the repetitive and tedious tasks of laborers by providing flexibility in managing livestock activities. Sensor application reduces labor expenses and monitoring activities (Nyamuryekung'e, 2024).

3. Other Improvements in Livestock Sector

Cows have been manually milked by hand which is time-consuming and requires labor. Robotic machines for milk extraction enable the farmers to reduce physical labor, improve milk production, extract the milk anytime rather than on fixed schedules and keep the milking process hygienic. The sensors in the machine can also detect which cow is ready for milking. The machine can also detect impurities, quality and colour of milk.

Digital feed Monitoring systems allow farmers to inspect and manage the quality of feed and manage the animal feeding pattern. It can also aid in proposing customized diets for each animal based on their body weight, quality of milk and its yield and so enhance productivity and fertility per animal. An Automated traffic management system allows the movement of animals through computerized gates that close and open electronically as there is a risk of injuries to animals during movement (Mishra et al., 2022).

Reproductive Issues Associated with Livestock and Their Management

Poor animal health and diseases are the major risk factors for livestock production in Pakistan. The viability of livestock is determined by their procreative ability, influenced by environmental and genetic factors (Zhang et al., 2020). Successful reproduction is entirely important in food-animal practice to maintain productivity in livestock operations to meet the rising global need for human food (Akbarinejad & Cushman, 2024). Greater reproductive efficiency is crucial for an effective dairy operation and needs an interval for calving which enhances milk production in the herd. Good insemination techniques, good estrus detection, a healthy uterine environment and the quality of semen are the critical criteria of efficient reproductive efficiency (Abunna et al., 2018).

Reproductive performance in livestock is directly impacted by infectious diseases and can be categorized as before, during, and after gestation. Amongst them, Brucellosis is of utmost importance as it may cause miscarriage in the late gestation period or can cause retained placenta, infertility and endometritis in subsequent pregnancies. Regardless of sex, the mature animals are more susceptible to infection. It also contributes to public health concerns and large economic losses throughout the world. The environmental conditions and the management systems could significantly affect the incidence of reproductive disorders (Abunna et al., 2018). Reproductive problems cause huge economic losses to farmers as it can lead to prolonged calving intervals and inter-conception periods, uterine involution, high medication costs and decreased milk production (Arero, 2022).

The occurrence of STDs (sexually transmitted diseases) can be high if an infected male animal is mating with several female animals. These disorders may also spread by improper cleaning of equipment utilized during the process of artificial insemination. Vibriosis is a sexually transmitted disease of livestock, that may cause abortion, other physiological problems and infertility. General infectious diseases, unlike sexually transmitted diseases, are caused by pathogens, bacteria, parasites, viruses, etc. These infectious diseases may infect all animals at the same time in a herd and may result in abortion, infertility and disruptive reproductive cycles. In wild and domestic animals, brucellosis, leptospirosis and tuberculosis can be found that may be transmitted by contact among diseased animals. To prevent diseases, herd-health plans should be focused on avoiding diseases, especially during the early postpartum and prepartum periods, integrating management practices and incorporating a strategy to deal with the diseased animal. Additionally, the thermoregulatory mechanisms and abiotic stress should be managed as they have a pivotal role in the augmentation of reproduction and livestock production (Roy et al., 2020).

Hence, to improve reproduction in livestock, suitable pre and postpartum period treatments should be focused on controlled breeding programs, minimizing post-partum weight loss in livestock and treating repeat breeders and anestrus with appropriate therapy (Mohan, 2015).

The management practices to prevent sexual diseases include limited contact with external animals, sanitation of breeding equipment, use of artificial insemination techniques and implementation of the herd's scheduled vaccination. Vaccination can be more effective if given timely and must be given before breeding season. Other measures to control infection include isolating infected animals for some period, culling from herds and excluding from the breeding programs. The animals infected with reproductive disorders should be given treatment as early as the initial symptoms appear and should be placed under a veterinarian supervision and eliminated subsequently from the herd (Roy et al., 2020).

Table 1: Role of various micronutrients in livestock's reproductive system, (Izquierdo et al., 2019).

Micronutrient	Function	Deficiency Consequences
Vitamin A	Maintenance of reproductive tract integrity and reproduction in both males and females	Cessation of puberty, reduced rates of fertilization, embryonic mortality, reduced sexual desire
Selenium	A cofactor in glutathione per oxidase system, responsible for oxidation of cell membranes including reproductive tract's cell membrane.	Predisposition to reduced fertility, ovarian cysts, placental retention in females and reduced sperm concentration and motility in males
Vitamin E	Maintains and promotes reproductive life	Predisposition of low sperm concentration and sperm malformation in males and placental retention in females.
Zinc	Promotes functioning of various hormones and metabolic enzymes.	Predisposes to proliferation, placental retention and low fertility in females and reduced spermatogenesis in males
Copper	Promotes prostaglandin synthesis and hormones physiological parameters	Predisposes to disorders in estrous cycle, fetal death, placental retention.

Major Reproductive Problems in Livestock

The economic and biological livestock productivity is greatly influenced by reproductive performance (Tolosa et al., 2021). Impaired reproductive functioning results in the failure of an animal to produce its offspring. Reproductive livestock disorders impacting dairy farmer's

economy includes dystocia, metritis, retained fetal membrane, prolapse (vaginal and uterine), abortion, anoestrus, repeat breeder, etc. (Verma et al., 2020). Diseases may affect dairy animals by decreasing the reproductive efficiency, reducing milk yield as well as reducing the predicted length of productive life. Reproductive tract diseases are interrelated (Hossein-Zadeh, 2013). These reproductive disorders can be categorized as before (repeat breeding and anestrous), during (dystocia and abortion) and after a gestation (RFM, prolapse and hypocalcemia) (Tolosa et al., 2021).

Table 2: Description of some livestock disorder as adapted (Ghafar et al., 2020)

Constraint	Clinical Signs	Season of Occurrence
Anthrax	Sudden blood oozing from natural orifices and death	Year round
Repeat Breeding	Recurring heat signs, enhanced vaginal discharge	Year round
Anestrus	Frequent vaginal discharge	Year round
Mastitis	Clots, pus and blood in milk, salty taste, fever, swollen udders/ulcers on teats	Year round

Table 3 : Prevalence of reproductive problems in a dairy farm from Sep. 2016 till Sep. 2017 as adapted (Gebremeskel et al., 2019)

Reproductive Problems	No. of cow's infected (%)
Repeat Breeder	18.6
Abortion	5.81
RFM	6.98
Metritis	4.07
Dystocia	4.65
Vaginal Prolapse	1.16
Anoestrus	4.65

Abortion

Abortion is defined as the abnormal termination of the gestation period. It represents a loss in reproductive efficiency. In livestock, spontaneous abortions represent an underlying problem contributing to inefficiency and reduced herd viability. These causes often may be very difficult to diagnose resulting in frustration for the veterinarians and the dairymen. Numerous causes of abortion in livestock are reported, primarily infectious factors, like Brucella, Mycoplasma bovis, Salmonella Spp., and non-infectious agents including heat, genetics, stress, etc. It was declared that aborted cows were likely to abort in subsequent pregnancies as compared to livestock not ever aborted (Hossein-Zadeh, 2013). It represents a serious livestock threat frequently induced via zoonotic microorganisms. To prevent abortions due to the spread of infectious agents, control programs and effective vaccination strategies must be supported (Zhang et al., 2020).

Retained Fetal Membrane

It is the inability of a livestock to expel fetal membrane within 12 hours of parturition. This retention of fetal membrane results in enhanced postpartum diseases, declined reproductive performance, enhanced culling rates and reduced milk production. The membrane is expelled within 8 hours of parturition and by 12 hours, considered retained. In the US, this disease was reported as the third most affecting health disorder in dairy cows. It was also displayed in several studies that retained placenta produces a significantly negative impact on the yield of milk, weeks after calving (Mahnani et al., 2021; Tucho & Ahmed, 2017). In addition to bacterial and viral infections, nutritional deficiency of vitamins A and E, and selenium are also associated with a high probability

of retained placenta (Abdisa, 2018).

Dystocia

Dystocia is linked with fetopelvic imbalance, the inability of the cervix to dilate fully, or congenital defects in animals. It may result in an impaired nervous system of newly newborn at birth or a deceased newborn due to birth injury. Its risk factors include low or high birth weight of newborn, reduced muscle glycogen, mineral imbalance leading to hypocalcemia and lack of antioxidant nutrient levels. Environment and stress can also contribute to dystocia as stress hormones ACTH, cortisol and adrenaline have a pivotal role in the instigation and control of parturition (Jacobson et al., 2020). The consequences associated with dystocia include reduced milk production, decreased reproductive performance, enhanced risk of culling and mortality and increased chances of postpartum diseases (Roche et al., 2023). Dystocia can be relieved by obstetric methods, including fetotomy and cesarean surgery (Weldeyohanes & Fesseha, 2020).

Anoestrus

Anoestrus is the sexual inability to conceive for two months or more. It is associated with inactive ovaries and anovulation. It may be classified as ovulatory, inactive and anovulatory based on ovarian activity. Anoestrus develops due to several interacting factors including physiological, managerial, pathological and nutritional (Abdisa, 2018). Heat stress may also link to hyperprolactinemia, suppressing gonadotropin release and hence altering steroidogenesis and folliculogenesis (Vijayalakshmy et al., 2020).

Treatment for anoestrus could be hormonal and nonhormonal. Non-hormonal herbal treatments include different varieties of plants, as they are enriched with varieties of phytochemicals including minerals and vitamins having estrogenic properties. Plants listed for use in anoestrus include Nigella sativa (Kabir et al., 2001), Asparagus recemosus (satawar) (Pandey et al., 2018), Carica papaya (papaya) (Hitesh et al., 2023), Saracaasoca (ashoka tree) (Rajkumar et al., 2008), Murraya koenigii (curry leaves) (Satheshkumar & Punniamurthy, 2009), Semecarpus anacardium (oriental cashew) (Bechardas, 1992), Leptadenia reticulate (Hitesh et al., 2023).

Hormonal treatments include progesterone and estrogen administration to induce ovulation as exogenous estrogen due to its positive feedback mechanism for LH surge on the pituitary. Exogenous treatment of progesterone imitates the luteal phase of the estrus cycle by a negative feedback mechanism on the pituitary and hypothalamus for the release of LH (Abdisa, 2018). To improve the GnRH effectiveness, the analogue or the hormonal dose can be adjusted (Gallab et al., 2022).

Uterine Prolapse

Uterine prolapse is the exuding out of the uterus through the vulva soon after parturition. This can be due to enhanced intra-abdominal pressure linked with intraabdominal fat, increased pregnant uterus size, pelvic girdle softening, uterine inertia, the extreme force of delivery, lack of exercise, or hypocalcemia (Abdisa, 2018). The treatment protocol includes cleaning the uterus, lifting and replacing of uterus and suturing the vulva (Martin et al., 2023).

Trypanosomiasis

Trypanosomiasis is a life-threatening and common disease. It can lead to immense economic damage by both meat and milk production in livestock. The harmful effects may also extend to humans. It is caused by several trypanosome parasites, the most dangerous Trypanosoma evansi species causes a severe disorder having various pathological manifestations as well as immunosuppressive effects. In Africa, it is among the leading causes of limited livestock production. It causes significant harm to livestock's reproductive aspects resulting from gonads and endocrine damage. T. evansi infection in livestock causes a reduction in reproductive hormones as well as it causes severe

morphological changes in sperms due to enhanced oxidative stress and cortisol. It causes failure of complete reproductive functions in extreme cases (Amin et al., 2020). It can be controlled by using trypanocidal drugs therapeutically and prophylactically, targeting the tsetse fly, belonging to four classes: phenanthridine, diamidine, melaminophenyl arsenical and aminoquinalidine (Okello et al., 2021; Venturelli et al., 2022).

Future Recommendations for Improving Livestock in Pakistan

Pakistan's livestock sector possesses a huge potential for the progression of agronomy. Potential opportunities are available for researchers, economists, policymakers and government departments to positively impact the development of Pakistan's livestock sector, thereby contributing to food security, economic growth and poverty alleviation. The following actions to improve livestock are recommended:

Government authorities to conduct training and introduce relevant curricula to aid students learn innovative technologies. These sessions will also be conducted for agricultural consultants and farmers.

- The availability of veterinary doctors should be assured.
- Individualized livestock-based monitoring, traceability and evaluation must be developed.
- Service providers and PLF consultants should be more conscious about the prevailing conditions in Pakistan in order to respond to the needs of the farmers. The relationship of the farmer/consultant should be extended and physically supported to provide practical solutions for training, timely issue resolution and avoidance of impractical technology.
- Studies should be focused on agro-economical Punjab zones, particularly rain-fed areas where the rearing of livestock is a prominent source of living where poverty prevails.
- To develop systems for connecting small farmers to form practical conglomerates so that they can afford investments in innovative technologies and create links to national agencies to establish livestock surveillance.
- Awareness campaigns must be conducted for farm owners to improve livestock management like accurate heat detection, proper feeding, pondering the sire and dam size while using artificial insemination.
- Routine examination of livestock throughout prepartum and postpartum was essential as during this period, there is a higher risk of reproductive problems.
- The dairy animals should be placed in proper hygienic conditions and rescreened regularly to detect any disease.
- Formulations for controlling reproductive problems, awareness about disease transmission and its risk factors should also be focused.

Summary

Pakistan owns the potential to manage its livestock resources, especially its dairy herd, to alleviate poverty and hunger and to stimulate economic growth. Though, the majority of farmers have limited desires for their animals which leads to reduced efficiency, low yield and frequent culling. Moreover, reproductive health problems in livestock lead to high financial loss. All these factors create shortfalls and compromise productivity. There is a need to acquire techniques and trainings from developed industries to optimize and maximize productivity. The presence of high-tech firms, the impact of precision livestock specialists and next-generation education of dairy farmers for using such systems will aid sustain livestock resources as well as make a potentially

global impact on economic prosperity and ameliorating food security.

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