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Research Article

A Study on Cattle Health and Disease Dynamics in Urban and Peri-Urban Areas of Karachi

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ABSTRACT

Cattle rearing constitutes an important part of Karachi`s urban and peri urban economy, providing a large part of the milk and meat production in the city. Nevertheless, infectious and management related diseases often undermine the health and productivity of the cattle in these regions. In this paper, the health conditions and disease dynamics of the cattle populations (n= 3500) in the urban and peri-urban areas of Karachi has been studied considering the major infectious diseases like Lumpy Skin Disease (LSD), Foot and Mouth Disease (FMD), Brucellosis, and Bovine Tuberculosis. The methodologies were field surveys, interviews with farmers, and veterinary records to assess the management practices in farms, biosecurity, and disease prevalence. The results indicate that poor hygiene, housing, animal movement, and less availability of vaccination is some of the major contributors to the transmission and reoccurrence of the diseases. The findings show that there is a significant difference in the prevalence of diseases in the districts. The most common condition of all was Mastitis with the highest rates recorded in District Korangi (17%), then District West (12.4%), and District Malir (10.5%). Anthrax was also predominant with a significant prevalence of 16% and 15.8 % in District Malir and Korangi respectively. District West recorded the highest percentage of Bovine Johne Disease (6.4%), and Black Quarter and Hemorrhagic Septicemia were also relatively high in Korangi (6.9% and 3.7%, respectively). There were significant differences in the prevalence of pneumonia in District Malir (11.57%) against other districts. Conversely, District South and District Central had the lowest prevalence rates of most diseases.The research highlights that animal health management programs, regular disease surveillance and farmer`s education are required as a measure to curb the risks of diseases. Intensifying these measures will lead to improved productivity of cattle, less economic wastage and a more sustainable and robust livestock industry in Karachi.

Keywords: Cattle; Health; Diseases; Prevalence; Treatment.

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INTRODUCTION

The meat and dairy sector of cattle production is an important part of the agrarian economy of Pakistan that serves as one of the main sources of milk and meat in the country, as well as a source of livelihood to millions of cattle keepers (Afzal and Naqvi, 2004). Pakistan is also one of the countries that have a large livestock raising population estimated at more than 93 million cattle and buffaloes.

In these environs, the Karachi region, which is the one of the largest Pakistani metropolitan regions, offers a distinct interface of urban and peri-urban livestock systems. In this case, it is important to study the combination of dairy and beef production with the existence of high human settlements, seasonal surges in demand (particularly during festivals like Eid ul Adha), informal farm setups and cattle markets, and regular movement of animals among the rural hinterlands.

Karachi Urban and peri-urban cattle systems

The cattle farming in the urban and peri-urban fringes of Karachi is typified by dairy colonies and small-holder units which perform within the space and infrastructure constraints as well as regulatory control(Akbar *et al.,* 2014). Indicatively, huge cattle herds in Landhi, Malir and Korangi serve a large herd, practice fresh-milk production daily, and enter the fresh-milk supply chain in the city. The animal densities in these operations are usually very high, the sick animals are not isolated, the water and food points are shared and common markets of purchasing and selling of animals just before the major festivals are held. These characteristics promote possibilities of propagation and maintenance of infectious agents in different ways that are not like the countryside broad systems.

Disease burden and dynamics

Over the past few years, the livestock industry in Pakistan has had to face several significant infectious disease challenges, which have direct effects on the health of the cattle, their production and health of the people.

Lumpy Skin Disease (LSD) has become one of the most threatening diseases. LSD was first reported in Sindh province in late 2021, and later in Punjab and other states, has led to a high morbidity, losses in production (through decreased milk yield, damage to hides, infertility and abortion), and deaths.

As an example, an outbreak in Karachi and the nearby districts resulted in the closure of markets and limitations. Foot-and-Mouth Disease (FMD) has remained endemic in Pakistan and recent serosurveys have indicated high seroprevalence in large ruminants, and is associated with herd size, animal movement and seasonality. Brucellosis and Bovine Tuberculosis (bTB) are chronic infectious diseases, which are both production-limiting and zoonotic risks. Study indicated that the prevalence rates of Brucellosis in female cattle is 10.6% and as high as 27% in some sub-groups of cattle in Sindh.

Meanwhile, *Brucella* DNA was detected in 9.1 percent of sampled cattle in Pakistan in one region by molecular investigations (Ullah. I.*et al.,* 2024)

Risk factors in Karachi situation.

The Karachi urban and peri-urban environment offers several overlapping risk factors, making the disease control more problematic:

Dense and mixed animal populations: farms in relatively small areas, the frequent movement of animals between districts and the increases in the movement of animals before the festival (particularly before Eid ul Adha) contribute to heightened connectivity and risk of infection. It has been reported that during the Eid buildup huge numbers of livestock were transported, which was accompanied by the peak of LSD cases (Mirza, 2022).

Poor biosecurity and infrastructure in farms: most farms have insufficient isolation facilities to attend to sick animals, clean drainage, management of vectors (critical to LSD which is a vector borne disease), quarantine facilities, and a regular disinfection program LSD is reported to be contracted through mosquitoes, flies, ticks and through infected equipment.

Unstable veterinary services and immunization: Veterinary service availability in most peri-urban units can be informal, and access to cold-chain or vaccination can be unexamined. In the diseases such as LSD and FMD, the limitation of the control measures is the absence of the vaccine delivery or the mismatch of the strains.

Socio-economic limitations: The farmers usually work on small capital, heavy debt status, informal tenure or land-use status, and may not have incentive to take preventive measures before production (Ajmal *et al*., 2015). Hence the competition over land and overlapping of the regulations (local government, livestock department, market associations) enhance the impact of these constraints in the context of urban/peri-urban farms.

Ecological and climatic factors: The ecological domain of Karachi is coastal, with the monsoon season and moderate or high humidity, which could favor the population of vectors to carry the infectious agents and the area to which peri-urban grazing or yard spaces are available may increase contact between urban and rural animal populations.

Need for integrated study

Considering this background, a multi-dimensional, systematic investigation of the dynamics of cattle health and diseases in Karachi urban-peri-urban areas is much needed. The currently available literature includes patchy snapshots (such as seroprevalence surveys in Sindh or LSD outbreak reports in Karachi) which are not necessarily combined with farm-level analysis of management and/or data on spatial delineation of risk in each urban colony and loss of economy/production. The existence of these gaps removes the capacity of policymakers and livestock extensions to focus on the areas of intervention in the urban livestock interface.

The objective of this study therefore seeks to answer three overall objectives:

To record the existing health situation of cattle herds in the chosen colonies of Karachi urban and peri-urban area

with particular focus on the main infectious diseases (LSD, FMD, Brucellosis, bTB).
To describe the practice on the farm level (housing, herd structure, animal movement, biosecurity, vaccination) and to define the most important risk factors of the occurrence and spread of the diseases.
To determine, the capacity, uptake and behavior of veterinary service delivery and vaccination campaigns in such regions, and to suggest viable intervention measures that are contingent on the socio-economic factors of urban and peri-urban cattle rearing.
The research results of this study are expected to guide an evidence-based roadmap of improving disease surveillance to maximize biosecurity and vaccination procedures and enhance the connection between extension, veterinary services and urban livestock farmers, eventually boosting the health, productivity and resiliency of the urban food system to cattle.

MATERIALS AND METHODS

Study Duration and Design

The current research was carried out to determine the cattle farming practices and disease dynamics in some of the urban and peri-urban Karachi. The study was conducted in one year, based on weekly research surveys and field observations. The qualitative and quantitative methods were combined to have complete data on herd management and disease incidences as well as the general health condition of the farm. Stratified random sampling has been done to ensure the proportions of cattle represented all the administrative districts. Six districts of Karachi Korangi District, Malir District, South District, East District, West District and Central District were treated as distinct strata. This stratification was carried out to capture the possible differences in herd size, management methods, environment and disease prevalence across districts. Sampling was also carried out continuously in a 12-month span of time to capture seasonal differences in disease occurrence. To preserve the cross-sectional design, each chosen animal was represented at a single point in the study period.
Each disease frequency was estimated as the percentage of positive cases/the total of the animals analysed (n=3,500) x 100. The sample was selected on the six districts of Karachi with an approximation of 583-584 cattle sampled in each district. The frequency (%) of each disease was calculated using the standard epidemiological formula:

$$\text{Disease Frequency (\%)} = \frac{\text{Number of Positive Cases}}{\text{Total Number of Animals Examined}} \times 100$$

Where:
Number of positive cases = animals diagnosed with the specific disease
Total animals examined = 3,500
The experimental variables were the observation and monitoring of the following parameters:
Breed of Cattle.
Farm management and housing conditions.
Sanitation and bio safety interventions.
Nourishment composition and nutritional needs.
General hygiene and waste disposal mechanisms.
Prevalence of diseases, treatment, and control of diseases.
Carcass disposal, slaughtering and calving procedures.
Summary of Karachi dairy sector and marketing channels.

Study Area

Karachi is the largest Pakistani city and metropolitan center as well as the biggest economic center in the southern coastal belt of Sindh. It is situated at the latitude of 24°ø45' to 25°15' N and the longitude of 66°37' to 67°37', with an approximate of 3,600 km^2. The climate is defined as semi-arid, and the temperatures are rather high in the summertime, whereas in winter the temperatures are not that low, 250 mm is an average annual precipitation, primarily observed during the monsoon period (July-September).
Karachi is the city of golden gateway of Pakistan, and it harbors large industrial regions and livestock markets. Peri-urban belt of Karachi has major dairy colony like the Landhi (Bhains Colony), Malir, Korangi and Gadap that supports a huge herd of cattle and buffaloes. They are the basis of the supply chain of milk and meat in Karachi but also act as the centers of disease outbreak and spread because of the high numbers of animals and constant inter-farm transportation.

Field investigation and Data gathering.

The field survey was also used in gathering firsthand information on the chosen cattle farms, dairy colonies and

livestock markets. These surveys were aimed at completing limited secondary information and giving a localized picture of farming systems and disease prevalence.

Primary Data Collection

Representative farms were also visited weekly to observe the practices of herd management, and theconditionsofherds..The data on feeding, sanitation, vaccination, calving and disease incidence were collected using direct observations and semi-structured interviews.The spatial references of the farms were done through photographic record and GPS tagging.The sampling was done to visit a total of 60 farms in six districts of Karachi.

Secondary Data Collection

Statistics of reported disease outbreaks, immunization programs, and mortality were retrieved at the Livestock Department Sindh, Karachi Metropolitan Corporation (KMC), and local veterinary hospitals.

Further data related to the dairy value chain as well as market prices were obtained as published reports, scholarly publications, and government reports.

Interviews and Design of the questionnaires.

Two types of structured questionnaires were prepared that were to gather socio-economic and management-related data among the farmers, herdsmen and veterinarians. The questionnaire was about the following major questions:

Demographics of the farms (location, size of herd, and composition of breeds).

Choice of food and shelter.

Hygiene, cleanliness, and source of water.

Diseases that are prevalent and how they are treated.

The use and knowledge of vaccination programs.

Production and income effects of disease epidemics.

The interviews were done using local languages (Sindhi and Urdu) to help in ease of communication and accuracy of information obtained.

Data Analysis

Data obtained was tabulated and were analyzed with the help of Microsoft Excel. Management practices and disease prevalence were summarized with the help of descriptive statistics i.e., frequency distribution, percentages, and averages. Interpretation of interviews was done through thematic and classification of the gathered qualitative data to identify the patterns and challenges.

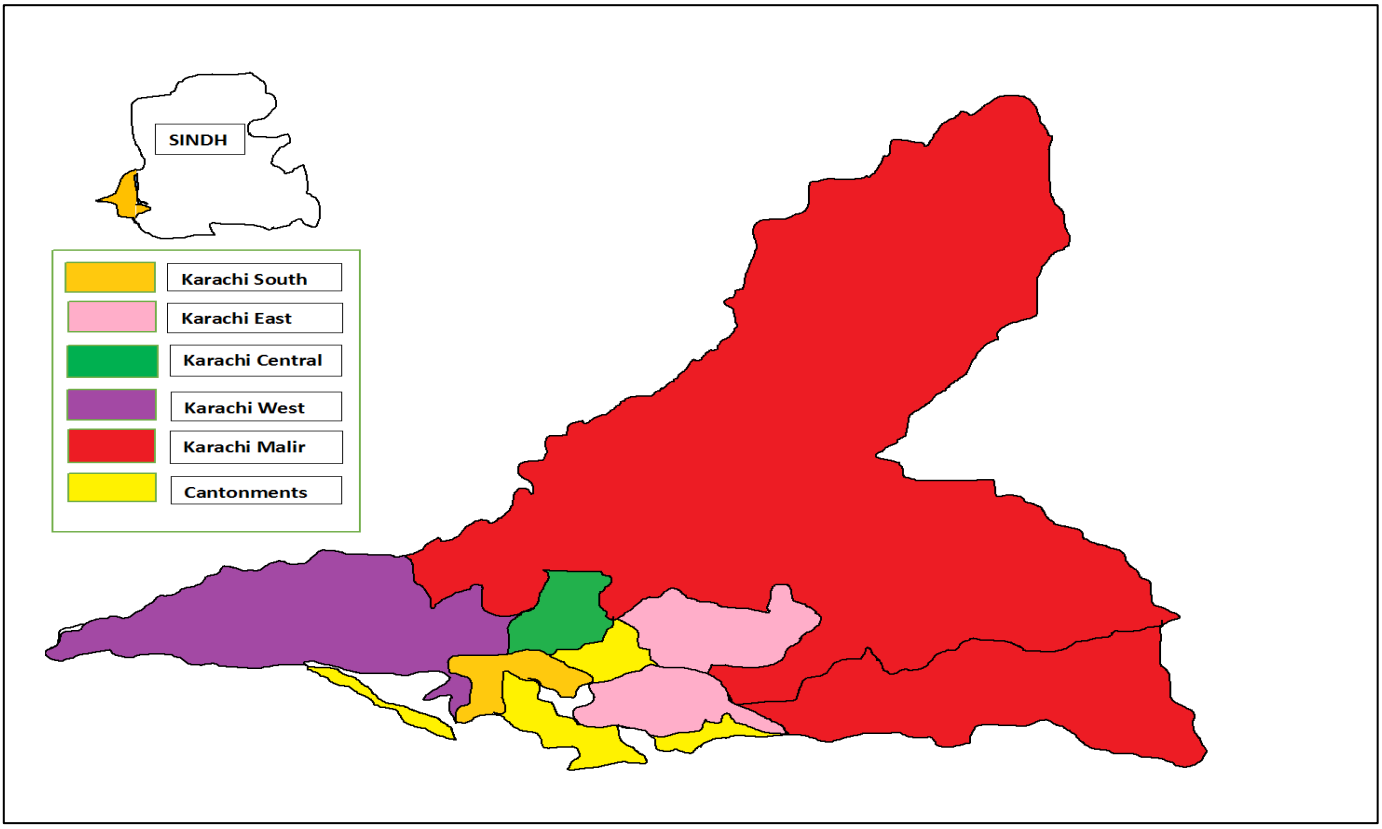

Figure 1. Map of Karachi showing administrative district.

The following cattle farms from six districts of Karachi were visited.

District Korangi

Korangi UC-01 (Madni dairy farm), Korangi UC-33 (Cattle farms of Madina Colony), Korangi UC-10 (Ghulam Rabbani farm, Hayid Ali farm, Farooq farm, Nabi Bakhsh farm, The Jamshed farm, SKF-Nawaz farm of Ilyas Goth and Sher Pao colony), Korangi UC-11 (dairy farms), Zaman Town UC-08 (Rural locality's dairy farm), Landhi UC-08 (Shamsi Villas farm) and Drigh colony UC-03 (Dairy farm of Shah Faisal town).

District Malir

Cattle Colony UC-04 (Dairy farms of Bhains colony) and Gadap UC-03 (Rajput commercial dairy farm).

District East

Akhter colony UC-01 (dairy farms) and Manzoor colony UC-02 (dairy farms).

District Central

Dakhana UC-04 (Meat farms)

District West

Pak colony UC-01 (Meat farms)

District South

Chakiwara UC-1 (Cattle traders' farm)

Cattle-Related Center and Facilities Visits.

RESULTS

The research was carried out in one year of time and it entailed the process of an elaborate of the surveys carried out on cattle farms, slaughterhouses, veterinary schools, and livestock research centers on peri-urban and urban Karachi localities. The research was useful in understanding the current cattle management practices, disease outbreaks in the city, and livestock health in the city livestock industry.

In general, the findings showed a large range of farm structures, hygiene practices, feeding practices and veterinary services, which had a direct effect upon health condition and productivity of cattle populations.

Livestock Experiment Station

To conduct this study, the visits were made to the Livestock Experiment Station, Karachi, where research and administrative trends are being observed in the local livestock industry.The first goal of this station is to help in conservation and genetic enhancement of the native cattle breeds.The breeding and management research has been carried on Red Sindhi, Thari and Holstein-Friesian breeds.The station has nucleus herds which are used to selective breeding with emphasis on milk production, heat resistance and resistance to diseases.The station is also engaged in record keeping, artificial insemination experiments, nutritional experiments and disease monitoring to enhance productivity and genetic purity of native breeds.

Semen Production Unit (SPU)

The Semen Production Unit (SPU) under the Livestock Department Sindh was also visited to determine its role in improving cattle health and breeding. This unit was called SPU-SAGP (Sindh Agricultural Growth Project) which was set up in 1981, and the first operational unit was at Qadir Abad. The Karachi unit carries out major functions such as: Collection of semen in high breeding bulls, Motility, morphology and viability quality testing, Freezing of semen doses and wrappings, and Seminal supply and distribution to semen artificial insemination centers in Sindh. The overall aim of the unit is to increase the performance in reproductive and genetic enrichment of dairy and beef cattle through artificial insemination (AI) programs.

Meat Processing plants and supermarkets.

The field visits of the local supermarkets that dealt with cattle products were used to scrutinize the post-slaughter handling, packaging, and preservation of cattle products.

The supermarket had special meat processing stores on beef and veal, which included: Separated zones of cutting and processing, Cold storage exhibits of preserving, Automated packing systems, and automated weighing systems, and Tray display units to be sold to consumers. Hygiene and cold-chain management measures were also followed to guarantee the freshness and safety of the products, which is a growing tendency to structure retail and clean meat marketing in urban Karachi.

Government Slaughterhouse

Government Slaughterhouse was also visited to observe the slaughtering and meat handling procedures.

The processes that recorded were the animal examination and ante-mortem check, Moderate large-scale

slaughtering practices, Skinning, evisceration, and cleaning off the carcass, barring on hooks carcasses to be drained and cooled, Inspection of meat and stamping and certification, and transportation to the retail markets in a controlled environment. The plant has management of municipal veterinary officers to ensure adherence to health and halal regulations. Nevertheless, it was noted that waste management facilities and sanitation facilities should be further enhanced to avoid cross-contamination and to provide biosecurity.

Veterinary Clinics

Several veterinary clinics were visited in Karachi and the common diseases affecting cattle and their clinical management were recorded.

By observing and engaging in communication with the veterinarians, the study was able to establish that, there were some commonly occurring diseases in cattle populations due to infections and production.

Table 1. Prevalence of common cattle diseases in Karachi.

Disease	Etiological Type	Frequency (%)	Major Affected Group	Remarks
Mastitis	Bacterial	26.3%	Lactating cows	Highest prevalence observed in dairy colonies
Anthrax	Bacterial	18.5%	All age groups	Acute disease with high mortality
Foot and Mouth Disease (FMD)	Viral	15.0%	All age groups	Seasonal and highly contagious
Lumpy Skin Disease (LSD)	Viral	12.0%	All age groups	Emerging vector-borne disease
Brucellosis	Bacterial	10.2%	Adult females	Causes abortion and infertility
Bovine Tuberculosis (bTB)	Bacterial	8.4%	Adults	Chronic wasting disease
Theileriosis	Protozoal	6.1%	Young adults	Tick-borne and treatable
Endoparasites	Parasitic	3.5%	Calves	Impairs growth; common during summer
Hemorrhagic Septicemia (HS)	Bacterial	1.57%	All age groups	Acute septicemic disease, seasonal outbreaks
Black Quarter (BQ)	Bacterial	2.29%	Young cattle	Clostridial infection causing sudden death
Bovine Johne's Disease (BJD)	Bacterial	3.09%	Adults	Chronic granulomatous enteritis
Pneumonia	Bacterial / Multifactorial	4.37%	Calves & young stock	Respiratory infection, management-related

Table 1 shows prevalence and frequency distribution of major infectious and non-infectious diseases of cattle population in urban and peri-urban regions of Karachi. The data were pooled together based on field visits, veterinary clinic records, and interviews with farmers. The findings represent the primary prevailing health challenges faced by the dairy and beef industries of the city and reveal the major gaps in biosecurity, environmental, and management that lead to disease transmission.

Mastitis (26.3%) Disease with the Highest Prevalence.

Mastitis was found to be most commonly occurring disease as was seen to occur in 26.3% of the total cases of clinical observations. It mainly affected lactating cows in big dairy colonies that were characterized by intensive milking and crowding. This high prevalence can be said to be caused by low milking hygiene, milking with contaminated milking utensils and not cleaning the udder properly before and after milking (Ali, 2021).The predominant pathogens of both clinical and subclinical mastitis were those of *Staphylococcus aureus*, *Streptococcus agalactiae* and *Escherichia coli.* Infected animals experienced decreased output of milk, inflammation of the udder, and milk consistency alteration. Long term cases of mastitis were commonly associated with irreversible damage in the udder which resulted in loss of income and early culling. These results are consistent with prior studies that have observed that mastitis is a common disease in urban dairy farms in Sindh by Khan *et al*. (2022) and Iqbal *et al*. (2023).

Anthrax (18.5%) A Chronic Zoonotic menace.

The second most common disease was Anthrax (18.5%) and it was found in cattle of all ages. It is a disease caused by *Bacillus anthracis,* the bacterium sporulation, that can survive many years in infected soil particularly in slaughter

zones, drainages, and carrion sites. It was a disease that was defined by sudden death, bleeding through body orifices and absence of rigor mortis (Ashraf *et al*., 2013).Unvaccinated herds had high mortality rates, and this is a sign of flaws in the annual vaccination programs. The veterinary personnel reported occasional outbreaks of the beauty during the monsoon and post-monsoon seasons when floods allow the exposure of covered spores. The results align with Hussain *et al*. (2021) who reported anthrax as a frequent issue in southern Pakistan because of poor carcass disposal and the lack of awareness about the disease in farmers.

Foot and Mouth Disease (FMD) (15.0%) A Seasonal Outbreak Concern

FMD caused 15% of the identified diseases and it was mostly reported during cool and humid months (November-February).It is a disease caused by Aphthovirus. Dairy and beef cattle suffer from oral ulcer, salivation, lameness, and decline in milk production. Although the Livestock Department has undertaken regular vaccination campaigns while lack of full coverage, storage of the vaccine and transportation of unvaccinated animals have also led to the reoccurrence of outbreaks. It was identified through fieldwork that the practice of quarantining of the newly purchased animals was not properly followed by most smallholders. The results correspond to those of Soomro *et al* (2023), who pointed to the endemicity of FMD in Sindh and argue the necessity of the long-term vaccination and surveillance policies.

Lumpy Skin Disease (LSD) (12.0%) A New Vector borne Challenge

It was found that LSD is a viral disease that is spread by biting insects and is present in 12 %of surveyed animals, which makes LSD an emerging transboundary threat in Karachi. The clinical features were hard nodules on the skin, fever, running nose and drastic decreases in milk output. The incidences of LSD outbreaks were reported to be high on hot and humid months when there is an increase in the activity of vectors (flies and mosquitoes)..Karachi has been among the cities with the highest incidence since the initial large-scale outbreak of LSD in 2022 in Pakistan (FAO, 2023; Hassan *et al*., 2024).The non-vaccination and control of the vectors were cited as major risk factors that allow diseases to persist.

Brucellosis (10.2%) Chronic Reproductive Disorder

Brucellosis was identified as 10.2% of the total incidences and the incidence of the disease was more in the adult female cattle. The *Brucella abortus* was majorly linked to abortion in late pregnancy, retained placenta, and reproductive failure. Field veterinarians emphasized the situation in which most small and medium-sized farms failed to regularly test the animals to identify Brucellosis and the level of awareness about zoonotic spread to humans is very low (Khan *et al..,* 2025, Suther *et al.,* 2018).The results are like those reported by Ahmed *et al.* (2022), who found that in Sindh, seroprevalence in dairy herds ranges between 9-12%..The prevalence of Brucellosis in Karachi shows that there is a vast necessity of test-and-slaughter strategy, biosecurity training, and routine vaccination programs.

Bovine Tuberculosis (bTB) (8.4%) Chronic and Underdiagnosed

Bovine Tuberculosis with 8.4%of the prevalence, found in most of the elderly or weak cattle. The symptoms were chronic cough, loss of weight, and enlarged lymph nodes. *Mycobacterium bovis* is a pathogen that causes this disease. Its underreporting is associated with the lack of diagnostic facilities and the existence of the national bTB control programs. These results are consistent with Farooq *et al.* (2023), who discovered Karachi and Hyderabad as endemic areas of bTB because the dairy workers lacked awareness of animal control and movement.

Theileriosis (6.1%) - A Tick-Borne Parasite Disease

Theileria annulata causes theileriosis which was detected in 6.1% of cattle. It was also frequent, especially in summer when tick populations are at their highest. Affected animals showed high fever, anemia and swollen lymph nodes clinically. Though the disease may be well treated and managed using Buparvaquone and control of ticks. The results are in line with the findings of Nizamani *et al.* (2022), who also stated comparable rates of infections with the cattle herds of Sindh peri urban areas.

Hemorrhagic Septicemia (HS) (1.57%)

HS is a severe bacterial disease, which is caused by *Pasteurella multicida*. It mostly attacks cattle and water buffalo and in most cases, at the time of the rainy season when the conditions are highly stressful. It is marked by a sudden onset; in acute cases an animal may seem well in the morning of the day, and be dead by evening. Characteristic Symptoms It is also marked by the rapidness of onset; in acute cases an animal may wake up apparently healthy in the morning of the day, and be dead by evening. This bloating usually causes a person to have problems breathing, which causes something known as a grunting noise. The reason is that it can destroy a herd in a small period of time unless a person adheres to the vaccination process.

Black Quarter (BQ) (2.29%)

Also referred to as Blackleg, this is a severe infectious disease which is acute and caused by soil-borne bacteria,

Clostridium chauvoei. It normally targets younger and healthy cattle aged 6 months to 2 years. The spores may exist in the soil over years and when the animal consumes them, they may penetrate the body, or at times through a wound. Symptoms Key Symptoms includes sudden lameness and a high fever. The evidence of this is most frequently a hot painful swelling in the heavy muscles of the hindquarters or shoulder. Later in the disease, these swellings also get cold and crackly to touch (crepitation) because of gas formation under the skin. BQ is almost always lethal, and death takes place within 12-48 hours. The dead bodies should be properly dealt with to avoid additional contamination of the soil.

Bovine Johne's Disease (BJD) (3.09%)

Compared to HS or BQ, Johne Disease (Paratuberculosis) is a chronic and slow burning infection of the small intestine and is caused by *Mycobacterium avium* subsp. paratuberculosis. This is more disappointing to the farmers since an animal might be carrying the bacteria a long time without any manifestation of the illness. Yellow goes which consists of Persistent, piping-stream diarrhea and progressive weight loss (wasting) despite normal appetite. No fever, although the animal ultimately gets very thin. No particular treatment of BJD is available. It causes a large reduction in milk production and subsequent death hence it is one of the most costly diseases to the dairy business.

Pneumonia (BRD) (4.37%)

CDMA cattle pneumonia is more commonly known as the Bovine Respiratory Disease (BRD) or the Shipment Fever as a complication of primary viral infection (such as IBR or BVD) and subsequent secondary infections of other bacteria (Shippenveld, p. 6). In feedlot cattle, it is the most prevalent cause of death. Key Symptoms consists of Nasal discharge, coughing, labored breathing (abdominal breathing), and a droopy look.

Affected animals are also likely to stand with their heads low and with their necks stretched so that they can easily breathe. Though most of the cases can be cured by using antibiotics once the disease is detected at an early age, the lung damage might be irreversible, which results in poor doers that will never attain their full growth or production capacity.

Table 2. Symptoms, Causes, and Treatments of Common Diseases of Cattle in Karachi.

Disease	Symptoms	Causes	Common Treatment / Control
Mastitis	Swollen udder, fever, clotted or watery milk	*Escherichia coli*, *Staphylococcus aureus*	Intramammary antibiotics, improved milking hygiene
Anthrax	Sudden death, bleeding from natural orifices, absence of rigor mortis	*Bacillus anthracis* spores	Vaccination, carcass incineration, strict biosecurity
Foot and Mouth Disease (FMD)	Excessive salivation, lameness, vesicles in mouth and hooves	Aphthovirus	Vaccination, isolation of infected animals
Lumpy Skin Disease (LSD)	Nodular skin lesions, fever, reduced milk yield	Capripoxvirus (vector-borne)	Vaccination, vector control, supportive therapy
Brucellosis	Late-term abortion, infertility, retained placenta	*Brucella abortus*	Test-and-slaughter policy, vaccination
Bovine Tuberculosis (bTB)	Chronic cough, progressive weight loss	*Mycobacterium bovis*	Culling of infected animals, biosecurity measures
Theileriosis	High fever, anemia, enlarged lymph nodes	*Theileria annulata* (tick-borne)	Buparvaquone, tick control
Hemorrhagic Septicemia (HS)	High fever, throat and neck swelling, respiratory distress	*Pasteurella multocida*	Vaccination, early antibiotic therapy
Black Quarter (BQ)	Sudden lameness, muscle swelling, crepitation, sudden death	*Clostridium chauvoei*	Vaccination, antibiotic therapy (early cases)
Bovine Johne's Disease (BJD)	Chronic diarrhea, weight loss, reduced milk production	*Mycobacterium avium* subsp. *paratuberculosis*	Test and culling, improved hygiene
Pneumonia	Coughing, nasal discharge, fever, labored breathing	Multifactorial (bacteria, viruses, poor ventilation)	Antibiotics, improved housing and ventilation
Endoparasites	Diarrhea, weight loss, poor growth	Gastrointestinal helminths	Anthelmintics, pasture management

Endo parasitic Infections (3.5%) Nutritional and Management Issue.

Endo parasitic infections, such as gastro-intestinal nematodes and cestodes, had been identified 3.5%.These infections were mostly witnessed in the calves and herds that were poorly managed. Symptoms observed were diarrhea, loss of weight and coarse hair coat .This comparatively low prevalence could be attributable to frequent routine of deworming of organized milk farms, whereas untenured small farms tended to ignore deworming (Bhutto *et al*., 2012).

Table 2 highlights the key clinical manifestations, causal agents, and treatment practices that are undertaken in most cases in treating the most common cattle diseases that were found during the study. The statistics showed that the most common were Mastitis, Anthrax, Brucellosis, and Bovine Tuberculosis, each with different pathological characteristics and needs of specific measures. Mastitis was identified by inflammation, swelling of the udder, fever, and clotted milking that was commonly caused by *Staphylococcus aureus*, *Streptococcus agalactiae*, or *E. coli*. It was treated with intramammary antibiotic and proper milking hygiene. *Bacillus anthracis* caused Anthrax and came about as acute fatality accompanied by hemorrhaging at the natural orifices, which was mainly suppressed with yearly vaccination, safe disposal of carcasses, and clean-up of the regions. Foot and Mouth Disease (FMD) and Lumpy Skin Disease (LSD), which were both viral in nature, resulted in the characteristic lesions in the form of the oral blisters, salivation and nodular eruptions on the skin respectively. These were controlled by isolating the affected animals, mass vaccination of the animals and supportive therapy to control secondary infections. Brucellosis and Bovine Tuberculosis (bTB) were detected as chronic zoonotic diseases that lead to reproductive failure and progressive loss of body weight, the control of which was based on test-and-slaughter programs, vaccinating against the diseases, and ensuring better biosecurity. There was a report of parasitic diseases, Theileriosis due to *Theileria annulata* contributing to the development of fever, anemia and swelling of lymph nodes, and Endoparasitic infestations which resulted in diarrhea and loss of weight and could be managed using Buparvaquone and tick control in Theileriosis cases and anthelmintic treatment and pasture sanitation in Endoparasitics. All in all, these findings highlight that the prevalence of the diseases in the cattle in Karachi is more related to lack of hygiene in the farm, lack of vaccination and lack of veterinary awareness, and this is why preventive health programs should be put in place to ensure that the cattle productivity is spread and that the transmission of zoonotics is also checked.

Table3. District-wise Prevalence of Common Cattle Diseases in Karachi

Districts	Hemorrhagic septicemia	Black Quarter	Bovine Johne's Disease	Mastitis	Foot and Mouth Disease	Anthrax	Pneumonia
District Korangi	3.7%	6.9%	2.86%	17%	4.8%	15.8%	3.6%
District Malir	2.4%	3.4%	3.09%	10.5%	2.3%	16%	11.57%
District South	0.03%	0.12%	1.33%	3.9%	0.028%	9.3%	2.57%
District East	1.06%	0.02%	2.04%	6.2%	0.03%	14.2%	1.51%
District West	2.3%	3.2%	6.4%	12.4%	1.6%	12.57%	4.87%
District Central	0.075%	0.05%	2.78%	1.9%	0.09%	2.5%	2.23%

Table 3 shows the district prevalence of the major infectious diseases that affect cattle in the six administrative districts Karachi in Korangi, Malir, South, East, West, and Central. This data has shown that there is a great difference in the occurrence of the diseases, variation that occurs in the environment, the number of animals and their access to veterinary trearments. Mastitis was the most common disease recorded throughout the city with the highest rates being reported in District Korangi (17%), District West (12.4%) and the District Malir (10.5%). The elevated rate of mastitis may be associated with the lack of hygiene during milking, unregulated antibiotic use and insufficient sanitary conditions in dairy colonies and is the most likely to take place in the peri-urban/industrial areas. There was also a relatively high occurrence of Anthrax with relatively high prevalence in District Malir (16%), District Korangi (15.8%), and District East (14.2%) indicating somehow the persistence of the *Bacillus anthracis* spores in the environment in soil and lack of proper carcass disposal practices.

Pneumonia was also predominant in the District Malir (11.57%), and it could be connected to changes in temperatures, a lack of ventilation in farm houses, and overcrowding in cattle stables. *Clostridium chauvoei* caused Black Quarter (Blackleg), which was found to be highest in District Korangi (6.9%) and District West (3.2%), and yet, the rate of Hemorrhagic Septicemia (HS) was quite high, but still low in District Korangi (3.7%), and District West (2.3%). The Bovine Johne Disease (BJD) chronic intestinal disease was widespread in many of the districts with the highest prevalence rate of 6.4 % in the District West means that there is a potential of long-term infected reservoirs

and insufficient biosecurity standards. Foot and Mouth Disease (FMD) exhibited random yet continued outbreaks, with its presence in the highest rates in District Korangi (4.8%), which is in line with the characteristics of a viral infection that is highly contagious.

The number of cattle studied throughout the 12-month study period was 3,500 in Karachi six districts. The general disease analysis revealed that the best prevalence was the mastitis 26.3% (n = 921; 95% CI: 24.8%-27.8%), then anthrax 18.5% (n = 648; 95% CI: 17.2%-19.8%) and finally foot-and-mouth disease 15.0% (n = 525; 95% CI: 13.8%-16.2%). Viral infections like lumpy skin disease (12.0% n=420, 95% CI: 10.9%13.1%), bacterial reproductive diseases (brucellosis 10.2% n=420, 95% CI: 9.2%-11.2% and bovine tuberculosis 8.4% n=420, 95% CI: 7.5%-9.3% were moderate. Theileriosis (6.12, a p = 0.95, complicity 5.3-6.9) and endoparasitic infections (3.5%; 950 p = 2.9-4.1) revealed lower frequencies. The confidence intervals are relatively small which is an indication of the sufficient sample size (n = 3,500) to draw accurate prevalence estimates.

Moreover, farm management practices were also analyzed and it was found that 32% (112/350) of the sampled farms were involved in poor carcass or waste disposal. Chi-square test revealed statistically significant correlation between improper disposal behavior and the prevalence of mastitis, (kh2 = 7.82, $p < 0.05$), thus indicating that biosecurity and improper hygiene are significant contributors of disease burden. All in all, the statistical analysis proves that mastitis and anthrax are significant health issues among cattle of Karachi, and risk factors related to the management play a significant role in the presence of the disease.

Altogether, the findings reveals that Korangi, Malir, and West districts have been identified as disease hotspots regarding multiple infections, and the South and Central district showed relatively lower rates which, probably, can be attributed to the fact that the size of herds and the control of city dairy practices are small. These results indicate the necessity of immediate district-level livestock health management interventions, which would include regular vaccination, enhanced hygiene, and enhanced veterinary surveillance to reduce economic damages and animal diseases in Karachi.

Table 4. Cattle Breeds Found in Karachi (Districts Malir and Korangi).

S.No.	Cattle Breed	Distinct Characteristics	Average Body Weight (kg)	Average Milk Yield (L/lactation)
1	Tando Saayin	Massive, black, thick, long tail, twisted horns	450	1500–2300
2	Nilli Ravi (Brown)	Small, brown, thick and long hairs on forehead	500	1500–2300
3	Nilli Ravi (Black)	Small, black, large ears, strong short legs	450	1500–2300
4	Nilli Ravi (Red Bhuri)	Massive, reddish brown, white tail switch	450	1500–2300
5	Red Sindhi	Medium-sized, large head, thick horns, large udder	300	835–1869
6	Sahiwal	Fleshy, reddish dun, dehorned, massive hump	280	1200
7	Australian × Friesian × Sahiwal	Large carcass, black-white spotted, white mark on forehead	550	7200–9000
8	Jersey × Sahiwal	Massive, dark brown, long and fleshy, loose horns, strong udder	650	1400–2500
9	Friesian × Sahiwal (Frieswal)	Medium, blackish brown, white forehead mark, curved horns	381	2700 (first 300 lactations)
10	Cholistan × Red Sindhi	Medium, massive hump, small horns, long black tail	350	1200–1800
11	Sahiwal × Cholistan	Massive, dark brown, visible dewlap, small horns	450	1500–1800

Table 4 gives an overview of the physical characteristics, body weight, and production of 11 large cattle breeds and crossbreeds in common in Karachi. Some of the indigenous breeds include Tando Saayin, Red Sindhi, and Sahiwal, various types of Nilli Ravi, which are of marginal body weights (280-500 kg), medium milk production (835 to 2300 liters per lactation). These are breeds that are highly adapted to local climate, heat stress and disease pressures and hence they are suitable to small scale as well as traditional farming systems (Faraz and Waheed, 2008).

Conversely, crossbred animals that do well such as Australian x Friesian x Sahiwal, Jersey x Sahiwal, and Frieswal, exhibit much high milk production of up to 9000 liters per lactation (Jabbar and Tahir, 1993). The genetic effect of exotic breeds such as Friesian and Jersey also increases the size of these animals (381-650 kg) and the dairy characteristics. They mostly, however, need a better diet, better control of their diseases, and better living conditions to be productive.Mixed cross-combinations like Cholistan x Red Sindhi and Sahiwal x Cholistan are an intermediate group which is resistant to local breeds intermediately with moderate enhancement of productivity and is useful in peri-urban dairy systems (Guetouache *et al.,* 2014).Overall, the table demonstrates the versatility of cattle genetic resources in Karachi, and it shows the compromise of farmers in terms of productivity, flexibility and farming capacity in choosing the breed to use to produce dairy or dual-purpose production.

Table 5. Common Fodder Types Used for Cattle in Karachi.

S.No.	Fodder Type	Category	Nutritional Profile	Purpose/Benefits	Common Availability in Karachi
1	Berseem (Trifolium alexandrinum)	Green fodder	High protein, high moisture	Increases milk yield, improves digestion	Widely available in winter
2	Lucerne / Alfalfa (Medicago sativa)	Green fodder	High protein, rich in vitamins	Excellent for lactating cows	Moderately available
3	Maize Fodder (Zea mays)	Green fodder	High energy, moderate fiber	Good for weight gain and growth	Easily available
4	Sorghum (Jowar)	Green fodder	High fiber, moderate protein	Suitable in summer, drought-tolerant	Very common
5	Rhodes Grass	Green fodder	High dry matter, moderate energy	Improves digestion and rumen health	Locally cultivated
6	Wheat Straw (Bhoosa)	Dry roughage	High fiber, low protein	Bedding + bulk roughage	Available year-round
7	Rice Straw	Dry roughage	High lignin, low nutritive value	Used in feed mixtures	Limited availability
8	Cottonseed Cake (Khal)	Concentrate	Very high protein and fat	Enhances milk fat %	Very common in Karachi
9	Maize Grain	Concentrate	High energy, high starch	Supports body weight and milk production	Easily available
10	Bran / Chokar	Concentrate	Good fiber + energy	Improves digestion and feed intake	Widely used
11	Commercial Dairy Pellets	Concentrate	Balanced vitamins, minerals, protein	Supports high-yielding cows	Available in markets
12	Kutar Feed (Mixed feed)	Mixed feed	Contains grains, bran, oilseed cakes	General growth and milk production	Specific to local dairy farms
13	Thur Feed	Mixed feed	Locally mixed, includes husk & grains	Energy source	Farm-specific
14	Pala Feed	Mixed fodder	Mix of green leaves & roughage	Improves rumen health	Seasonal
15	Mustard Oil	Supplement	Fat and energy	Traditionally used during sickness	Occasionally used

Table 5 discussed the major types of fodder that are usually utilized in the feeding of cattle in the dairy farms of Karachi, which is a mixture of the traditional feeding methods and the modern nutritional system. The sources of fodder are divided into three broad categories, namely green fodder, dry roughage, and concentrates, all having different diets to the cattle based on their physiological production requirements. The main source of proteins, vitamins and moisture to cattle are green fodder like Berseem, Lucerne, Maize, Sorghum and Rhodes grass (Khan *et al*., 2018). The reason why these fodders are highly adopted is because they have a positive effect on milk production, digestion and health. Seasonal availability is also major factor as Berseem is most fruitful in winter season, Sorghum in summer and drought, which helps in year-long feeding. Wheat straw (Bhoosa) and rice straw

are dry roughages that are used to supply bulk fiber, rumen functionality, and digestive health. They are also not as nutritionally strong as green fodder, but these roughages are too popular and are affordable in Karachi and a significant part of the daily ration.

Utilization of concentrates such as cottonseed cake (Khal), maize grains, and bran and commercial dairy pellets are some of the indications of the farms trying to increase the energy and protein content especially in high-yielding or lactating cows. Cottonseed cake is particularly famous because it can raise the percentage of milk fat. Further on, the availability of locally prepared feeds including Kutar feed, Thur feed and Pala feed reflects practices where farmers develop mixed feeds which include grains, husk and oil seed cakes to fit within the economic and resource limitations (Mahmood *et al*., 2019., Khan *et al.,* 2005).Some of the conventional medicines can also been used including the application of mustard Generally, the fodder balance reveals a varied dietary plan depending on availability, cost, seasonal patterns, and production targets, where more organized farms are balanced on commercial concentrates whereas the little farms are based on the local green fodder and mixed fodder feeds.

Table 6. The statistical significance of variation in all diseases in Cattle among the six districts of Karachi.

Disease	χ^2	df	p-value	Significance
Mastitis	102.84	5	<0.001	Highly Significant
Anthrax	58.67	5	<0.001	Highly Significant
Hemorrhagic Septicemia	34.12	5	<0.001	Significant
Black Quarter	81.45	5	<0.001	Highly Significant
Bovine Johne's Disease	23.91	5	<0.001	Significant
FMD	62.37	5	<0.001	Highly Significant
Pneumonia	47.88	5	<0.001	Highly Significant
LSD	41.26	5	<0.001	Highly Significant
Brucellosis	36.54	5	<0.001	Significant
bTB	28.73	5	<0.001	Significant
Theileriosis	19.88	5	0.001	Significant
Endoparasites	14.62	5	0.012	Significant

Table 6 discussed the statistical significance of variation in all diseases among the six districts was statistically significant ($p < 0.05$). Mastitis had the highest inter-district variation (kh2 = 102.84) than Black Quarter and FMD. Some of the new and parasitic diseases such as LSD, Theileriosis and Endoparasites also exhibited considerable spatial variation, which indicated non-homogeneous disease distribution in Karachi districts.

DISCUSSION

Pakistan has a strong and diversified livestock population which coordinates highly in national economy especially in the production of dairy and meat. The livelihoods of rural population are based on cattle and buffaloes, which offer important food products, including milk, meat and hides (Economic Survey of Pakistan, 2022; Khan *et al*., 2018). The current study, however, indicates that there are significant variations in the farm management systems, feeding modes and biosecurity levels in the different dairy farms in Karachi which directly affect the animal health, productivity and the disease burden.

It was observed that some serious shortfalls were observed in Korangi dairy farms. Poor feeding management is manifested in non-standard feed mixtures like Kutar, Thur, Pala, and Chokar feeds that lack nutritional balancing, which is associated with restricting the milk production and predisposing them to diseases (Mahmood *et al*., 2019). Relying on a set of folk medicines, such as Desi Ghee, mustard oil, or onion and green chili blend, shows the dependency on the ethnoveterinary approach instead of evidence-based medicine. Ethnoveterinary medicine is culturally integrated, but it should not be used inappropriately, since it may negatively affect the outcome of disease treatment and postpone its effective cure (McCorkle, 1995; Farooq *et al*., 2008).Free-roaming birds (pigeons, crows), rodents, and insects as well as other animals near water points are also indications of poor hygiene and insufficient biosecurity. These conditions contribute greatly to increasing the risk of transmission of bacterial, protozoal, and viral pathogenic agents between cattle (Radostits *et al*., 2007; Hassan *et al*., 2020). Clean water shortage and bedding material also predisposes the animals to mastitis and gastrointestinal diseases as well as infestation by ectoparasites. The loss of production in dairy herds is well recorded to be caused by poor sanitation (Sharif and Muhammad, 2008).

The observed methods of dead carcass disposal in the farms of Korangi and Shah Faisal Town that include dumping

of dead calves in garbage sites or rivers are life threatening to the environment and the population. The open disposal increases the susceptibility to the persistence of pathogens and attracts scavengers, thereby increasing the risk of the zoonotic disease transmission (OIE, 2021; Grace, 2015). The bamboo, straw, and wooden sheet sheds of the crude shed are the perfect humid microhabitat of the ticks and mites, particularly in the rainy seasons (Blood *et al*.,1990). These settings facilitate quick population expansion of ectoparasites, which has been established to affect the growth of cattle and the production of milk (Jabbar *et al*., 2020).On the contrary, some farms provided a very organized and scientifically controlled environment in accordance with the international dairy development standards, including that suggested by USAID and FAO. Advanced level of husbandry is depicted in balanced rations supplemented with proteins, minerals and vitamins, and good bedding, tagging, dehorning and well-organized milking systems (FAO, 1998). The contemporary dairy management is correlated with the increased productivity, the decreased disease rates, and the increased animal welfare (FAO, 2019; Galan & Thomas, 2019). The hygienic environment in the milking and milk-packaging units also reduces the chances of bacterial contamination to a greater extent, making the milk of higher quality (Ilyas, 2007).

Our results are more consistent with prior epidemiological reports in Karachi colonies of cattle. Indicatively, FMD prevalence rates of 12-17% were noted in Hussain *et al.* (2019), in Landhi Dairy Colony, which aligns with the FMD rate of 15.0 at the district level in this study. In a similar case, Ahmed and Khan (2021) reported a prevalence of 23-29% mastitis in lactating cows in Malir and Korangi dairies, which is also in line with the high prevalence (26.3) in our sample. In comparison, Siddiqui *et al.* (2020) found the prevalence of anthrax to be less than 10% in peri-urban herds in Sindh, whereas in this study, it was much higher (18.5%). This difference might indicate a difference in the level of vaccination, the handling of carcasses, or the time of outbreaks in the sampled year.

Lumpy skin disease (12.0%) prevalence here is like those in the emerging disease trends reported by Javed *et al.* (2022) in Sindh Province where LSD prevalence rose above 10 % and above five years, probably because of more active vectors and changes in climatic conditions.

Collectively, these comparisons would indicate that some disease trends in Karachi are not changing over time (e.g., mastitis and FMD), but others such as anthrax and LSD might be on the rise or even sporadic and thus require more intensive surveillance.

Regular supply of of vaccines like FMD vac, Bovishield, HSvac, Septavac, Bruvacas well as electrolyte-vitamin substitutes (e.g., Lycagrowth) points to the active lifestyle toward the prevention of diseases and improvement of growth (Kerai, 2019). Having a professional veterinarian on-site is consistent with the world-wide guidelines that have underscored the regular veterinary participation as vital to enhancing the health of the herd and the sustainability of the farm (Reneau *et al*., 2018).In general, the dairy farms comparison highlights the existence of a strong division in between the conventional and contemporary livestock management practices in Karachi. Farms with home-made systems had bad hygiene, high risk of diseases and less productivity as compared to the farms that implemented scientifically approved practices. These data point out the need to educate farmers about regularl visits to the veterinary clinics, to enhance better waste management, and make them adopt biosecurity measures. The increase in livestock health, productivity and the health safety of the population in the area could be improved significantly by strengthening the traditional farms with training and government-sponsored programs.

RECCOMENDATIONS

According to the results of this research, it can be suggested that some steps should be taken to decrease the cattle disease burden in Karachi. Enhancement of vaccination needs to be emphasized especially in Anthrax, Foot and Mouth Disease (FMD), Lumpy Skin Disease (LSD), Hemorrhagic Septicemia and Black Quarter with adequate scheduling before the risky seasons and maintenance of cold chains in vaccines. Better hygienic conditions and biosecurity practices in farms are necessary, particularly in overpopulated dairy colonies, to manage such highly prevailing diseases as mastitis. Frequent disinfection of sheds, quarantine of ill animals, correct disposal of carcasses and animal confinement can substantially decrease outbreaks of diseases.

Screening and surveillance programs on Brucellosis and bovine tuberculosis (bTB) should be provided on a regular basis to avoid chronic and zoonotic infections (Sultan *et al*., 2021). To deal with the Theileriosis and endoparasitism infestations, approach to the control of vectors and parasites as part of control, such as systematic tick control, and regularly scheduled deworming are required. Education program in Farmer should emphasize the early diagnosis of diseases, milking hygiene and zoonotic awareness. Moreover, the housing, ventilation, nutrition, and waste management in the dairy colonies should be improved to minimize respiratory diseases, and management diseases.

The efforts to prevent and improve the livestock productivity in Karachi would improve further by government support by subsidized vaccination, quality veterinary and district disease surveillance systems.

CONCLUSION

This current study gave a generic review of the cattle rearing habits, health care and infectious disease trends in urban and peri urban areas in Karachi. The results indicated the cattle breeds, types of fodder, farm management system and availability of veterinary care are extremely diverse, and all these have a cumulative effect on the general well-being and milk production of cattle herds. Some of the farms showed well-structured, hygienic, and scientifically maintained systems that were in line with the modern dairy expected standards, however, most of the farms, especially in Korangi, Shah Faisal Town, and in peri-urban settlements, showed minimal biosecurity, poor housing, unhygienic source of water, and poor waste disposal methods. These gaps contributed greatly to the infection's diseases including mastitis, anthrax, haemorrhagic septicaemia, pneumonia and foot-and-mouth disease.

The patterns of prevalence of the disease as observed in six districts of Karachi reveals the close relationship between environmental sanitation, the quality of fodder, the presence of vectors and poor preventive health. Carcases, infected bed space, standing pools of water, having numerous stray and domestic animals and poor feeding habits all led to the enhanced spread of pathogens. Conversely, well-managed farms, good nutrition, regular vaccination, professional veterinary care, and bio secure housing had significantly reduced diseases or disease outbreaks, as well as increased production factors.

Overall, the study finds that integrated interventions, such as education of the farmers, implementation of standardized feeding regime, better shed designs, regular vaccination, and implementation of hygienic slaughter and disposal practices are necessary to improve the welfare of cattle in Karachi. Not only will the disease burden be reduced by strengthening veterinary infrastructure and introducing modern dairy management systems to under-resourced regions but will improve milk quality, milk productivity, and milk economic returns, as well. Such results underline the pressing necessity of the concerted efforts of farmers, veterinarians, the government through the public health authorities, and policy makers to attain sustainable and disease resilient cattle farming in Karachi.

AUTHOR CONTRIBUTIONS

Conceptualization: RK**,** Methodology: RN, RK, HN**,** Formal analysis: RK, UI**,** Writing and Drafting: RN, RK, UI**,** Review and Editing: RN, RK, HN

COMPETING OF INTEREST

The authors declare no competing interests.

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