Assessing lead in milk and environmental samples elicited from a used lead acid battery separation factory in Dinajpur district of Bangladesh.

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Roll No: 0220/02
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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Applied Veterinary Epidemiology

One Health Institute
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This is to certify that we have examined the above master's thesis and have found that is complete and satisfactory in all respects and that all revisions required by the thesis examination committee have been made.

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List of symbols and abbreviations

BLRI	Bangladesh Livestock Research Institute
BCS	Bangladesh Civil Service
BFD	Bangladesh Forest Department
DLS	Department of Livestock Services
ELS	Economic Loss by Sold (ELS)
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
FGD	Focus Group Discussion
Fig	Figure
GDP	Gross Domestic Product
GPS	Global Positioning System
HCL	Hydrochloric Acid
IQ	Intelligence Quotient
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
i.e.,	That is
Kg	Kilogram
Mg	Milligram
Max	Maximum
Min	Minimum
ml	Milliliter
N	Total number of samples
PPB	Parts Per Billion
Pb	lead
STD	Standard Deviation
TEL	Total Economic Loss
ULAB	Used lead Acid Battery
WHO	World Health Organization
WOAH	World Organization for Animal Health (Founded as OIE)

^{o}C	Degree Celsius
wt	Weight
%	Percentage
µg	Micro Gram
>	More than
<	Less than

Abstract

Bangladesh is a developing country where rapid industrialization taking place now a days. Almost half of the industry's lead supply is sourced from ULABs in Bangladesh that is recycled by informal small enterprises. Lead (Pb) is a pervasive environmental pollutant with potential public health hazards a contaminant from industrial origin. The first reported lead outbreak in livestock was happened in 2020 at Magura district. At present, this type of lead out break is being observed in print media. In the year 2021, there was a lead outbreak in Fulbari upazila of Dinajpur district. This study was done on the base on that outbreak. The aim of this research was to determine lead in cow milk and environmental samples nearby the recycling factory in that outbreak area. We have collected 22 milk samples and 9 environmental samples (3 water, 3 soil and 3 green rice leaf) and 4 old rice straw (hay) after 10months later of outbreak to measure the lead concentration. The mean concentration of lead in milk was found 1.24±0.65 with a minimum of 0.32 ppb and a maximum of 2.57 ppb after 10 months later of the outbreak. The lead content in the green rice leaves was 9.65 ppb, 4.01 ppb, and 5.72 ppb at the distance of 10m, 100m and 500m, respectively. Whereas the lead content in the soil was 32.85 ppb 10m, 28.56 ppb 100m, and 31.13 ppb 500m, and the lead content in the water was 5.35 ppb 10m, 4.87 ppb 100m, and 6.21 ppb 500m 10 months later. It's a matter of concern that all the milk samples tested positive for the lead however did not accede the maximum level. Although lead is present in various components of the environment, it is not above the tolerable level. Building awareness at farmers' level is essential about lead poisoning and further study is needed to identify the presence of lead in food chain both in human and animal to avoid public health hazard by one health approach.

Keywords: lead poisoning, environmental hazards, milk lead concentrations.

Chapter I: Introduction

Bangladesh is an agriculture-based country with a Gross Domestic Product (GDP) for livestock was 16.52% in the fiscal year 2021-22 (DLS, 2021). Dairying in Bangladesh is growing fast but faces problems of high input and low output prices leading to lower profitability**.** Regarding lower profitability, industrialization has also influenced dairy production by losing agricultural land (Uddin et al., 2010). The main problems in dairy sectors concern breeding, feeding, management, diseases, and marketing (Adesina and Zinnah, 1993). Environmental contamination of heavy metals has also a negative influence on this sector. Among the heavy metals, lead(Pb) is considered to be a major environmental contaminant (Aktar et al., 2020). Lead poisoning is one of the most common causes of poisoning in domestic animals and is encountered most frequently in cattle (Traverso et al., 2004). Used lead acid battery (ULAB) is one of the most important sources of lead poisoning regarding ULAB, the residue of the leather industry, plastic industry by-products, and grasses of highway and railway roadsides are also sources of lead poisoning.

Almost half of the industry's lead supply is sourced from ULABs in Bangladesh that is recycled by informal small enterprises. The lead factories are built without the permission of appropriate authorities. Livestock producers especially backyard farmers are facing outbreaks of acute lead poisoning adjacent to the battery recycling field. Therefore lead-exposed to nature at a high level which antecedent to lead poisoning in livestock. lead poisoning is one of the most common toxicosis affecting domestic animals (The main impact of lead on livestock is the loss of population, more than 300 cattle died unexpectedly near a metal recovery plant located rural area of Thane district in India (Dogra et al., 1996).

Nervous signs predominate in cattle and are associated with large doses of lead whereas gastrointestinal signs are seen with moderate doses of lead. The mode of exposure is spreading the lead to the grass field and paddy land when battery plates melt at high temperatures in those factories. In cattle usually, two forms of lead poisoning occurred. One is acute and the other is sub-acute. The acute form occurs most often in calves whereas the subacute form is more common in adult cattle (Baker, 1987). The main clinical signs in acute forms are staggering movement, show muscle tremors, especially at the head and neck, head pressing to objects, blinking eyelids, cattle wandering aimlessly, circling movement, pupil dilatation, tetany, and convulsion. In the case of sub acute form dullness, complete anorexia, blindness, gait abnormalities, muscle tremor, and hyperesthesia may occur.

Due to its heaviness of toxicity in animals, the meat and other accessory organs are also intoxicated. Toxic residues of food animals can pose a public health risk in edible products (Puschner and Varga, 2012). One of the main problems with metals is their ability to bio-accumulate. Heavy metals residues in milk are of particular concern because milk is largely consumed by infants and children (Pilarczyk et al., 2013). lead poisoning can affect many organs and associated with various morphological, biochemical, and physiological changes, including kidney dysfunction, abnormal glucose metabolism, nervous system disturbances, liver dysfunction and haematological disorders (Hossain et al.,2014).

In Bangladesh, the first outbreak of lead poisoning happened in cattle in the Magura district in December 2020. In the year 2021, there was a report on livestock death by an unknown disease published in The Daily Jugantar newspaper on 4th December 2021. Twenty cattle was death in that incidence within a week in Fulbari upazila of Dinajpur district by an unknown disease. The reporter also reiterated that the cause of the death was a battery factory and effluent drainage from battery factory. The contemplation of the importance of the news, the Director (Administration) of the Department of Livestock Services (DLS) formed an investigation team to identify the causes of livestock invasion and death. The investigation team observed clinical signs which were similar the lead poisoning in cattle such as off-feed, drooling salivation, Gnashing teeth, lock jaw, bending neck, convulsion, shaking of head and dilated pupil etc. The possible exposure of lead poisoning might be taking contaminated rice straw, feeding effluent exposed grasses or grazing nearby the factory. The team collected demographic data, animal health related information, blood sample, meat sample, and environmental samples such as water, soil, green grasses for the confirmation of lead poisoning.

At the time of the outbreak, the overall attack rate was 54.27% (N=101). Among all age categories, the highest frequency of death occurred in pregnant cows (80%, 4/5), followed by calves (66%, 6/9). In the rice straw samples, the average lead concentration was (42257.6 ppb) 1.4 times higher than the permissible level 30000ppb with the limit of maximum 90887.91 ppb and minimum 8500.78 ppb. Moreover, results showed the concentration of lead in beef was 2957.51ppb (26 times higher than the permissible limit), in soil 108360.75 ppb (108.4 times higher), and in water 286.71 ppb (19 times higher) than the acceptable level. Indiscriminate handling and disposal of industrial effluents into the environment represents one of the major sources of environmental pollution which invariably affects plants, animals, and humans. The irregular disposal of industrial waste has created pollution problems since this waste is dispersed in the environment and accumulated in sediments, aquatic organisms, and water (Ogwuegbu and Muhanga, 2005). Heavy metals such as arsenic, mercury, iron, nickel, lead, zinc, copper, and cadmium are prominent components of industrial effluents (Hawkes, 1997). Heavy metals have become increasingly significant within the framework of environmental pollution investigation. They are of serious concern because of their persistence in the environment and their carcinogenicity to human beings (Hawkes, 1997).

lead is a heavy substance, toxic in nature, and remains in the environment for a long time. Therefore, it is very important to check how long the effect of lead remains in the environment and whether lead is coming into cow's milk from environmental exposure.

So, the objectives of my study are-

1. To detect the lead in milk and environmental samples.
2. To estimate the financial loss of backyard farmers, face in an outbreak.

Chapter II: Review of Literature

The overall goal of this chapter was to review past relevant research findings related to the master's project "**Assessing lead concentrations in milk and surrounding environment in a lead acid battery recycling elicited outbreak site in Dinajpur District of Bangladesh**" to identify the gaps and justify the present research. Published literature was obtained by searching online sources like PubMed, Google Scholar, and Web of Science. This chapter is arranged in a series of sections including a review of literature's on Bangladesh agriculture and livestock scenario, dairy sector in Bangladesh, industrial effluent in the dairy sector, heavy metal and its effect on the dairy sector, lead effect on dairy and milk, the human health hazard of lead, comparative study of lead in human health and milk production, lead outbreak scenario in Bangladesh, long term effect of lead in the dairy sector.

1.1. Bangladesh Agriculture and livestock scenario

Bangladesh is predominantly an agricultural country with over 80% of its population engaged in agriculture and livestock-related activities. According to the Food and Agriculture Organization (FAO), agriculture is the largest sector of the Bangladesh economy, employing about 47% of the total labor force and contributing about 14.2% to the country's GDP (BBS, 2015). Rice is the staple crop and the main source of food for the country, with an annual production of about 34 million tons (Bishwajit et al., 2013). Other important crops include wheat, maize, jute, tea, sugarcane, vegetables, and fruits.

The livestock sector in Bangladesh is also significant, employing about 25% of the agricultural labor force and contributing about 3.3% to the country's GDP (Rahman, 2017). The sector includes cattle, buffalo, goats, sheep, poultry, and fish. Livestock production has increased significantly in recent years due to the adoption of modern breeding and feeding techniques. However, the agriculture and livestock sectors in Bangladesh still face several challenges. These include natural disasters such as floods and cyclones, land degradation, low mechanization, and lack of access to credit and markets. The livestock sector also faces challenges such as diseases, low productivity, inadequate access to markets, and lack of access to veterinary services and inputs (Das et al., 2008).

The government of Bangladesh has taken several initiatives to address these challenges and promote sustainable agriculture and livestock practices. These initiatives include the establishment of veterinary clinics, vaccination programs, and the introduction of high-yielding livestock breeds. The government has also invested in irrigation infrastructure and introduced modern farming techniques to increase crop production and ensure food security (Quddus, 2012).

1.2. Dairy Sector in Bangladesh

The dairy sector in Bangladesh has been expanding rapidly in recent years due to the growing demand for milk and milk products in both rural and urban areas. According to Shamsuddoha and Edwards (Shamsuddoha and Edwards, 2000), the dairy sector has become one of the fastest-growing sectors in the country's agriculture, contributing significantly to the national economy. One of the main reasons for the growth of the dairy sector is the government's policy support, such as subsidies, tax incentives, and credit facilities, which have encouraged farmers to invest in the sector. As a result, the number of cows and buffaloes in the country has increased significantly, from 23.89 million in 2008 to 32.92 million in 2019 (BBS, 2015). The increase in milk production has also led to the establishment of new processing plants and the expansion of existing ones. According to a study by Uddin and others (Uddin et al., 2011), there are currently around 70 milk processing plants in Bangladesh, with a total processing capacity of 2.5 million liters per day.

Despite the growth in the sector, there are still some challenges that need to be addressed, such as low milk yield, poor quality of feed and fodder, inadequate veterinary services, and lack of market infrastructure. To overcome these challenges, the government and other stakeholders need to take concerted efforts to improve the productivity and quality of milk, enhance the skills of farmers and service providers, and strengthen the market linkages (Das et al., 2008).

In conclusion, the dairy sector in Bangladesh has enormous potential for further growth and development, which can contribute significantly to the country's economic growth and poverty reduction. However, this will require a sustained and coordinated effort from all stakeholders, including the government, farmers, processors, and other actors in the dairy value chain.

1.3. Industrial Effluent in the Dairy Sector

Industrial effluent in the dairy sector is a significant issue that has been studied extensively. The effluent from dairy processing plants can contain high levels of organic matter, nutrients such as nitrogen and phosphorus, and potentially harmful substances like antibiotics, hormones, and heavy metals. One study published in the Journal of Dairy Science found that dairy processing plants generate large volumes of effluent that can have negative environmental impacts if not properly managed (Loloei et al., 2014). The study notes that dairy effluent contains high levels of organic matter, nutrients, and potentially harmful substances, making it challenging to manage. However, the authors also suggest that proper treatment and management can significantly reduce the environmental impact of dairy effluent. To manage industrial effluent in the dairy sector, several steps can be taken:

Treatment: Dairy effluent can be treated through physical, chemical, or biological processes to remove or reduce the levels of pollutants in the wastewater before discharge, ***Recycling and reuse:*** Treated effluent can be reused for non-potable purposes such as irrigation or cleaning, reducing the overall volume of wastewater generated, ***Good housekeeping practices:*** Simple practices like regular maintenance of equipment, proper cleaning procedures, and spill prevention can help minimize the amount of effluent generated in the first place, ***Regulatory compliance:*** Dairy processing plants must comply with local and national regulations governing the discharge of industrial effluent, which may include limits on the levels of pollutants and monitoring requirements.

Another study published in the Journal of Environmental Management found that dairy processing plants in New Zealand had a significant impact on the quality of nearby waterways due to the discharge of untreated effluent (Houlbrooke et al., 2010). The study highlights the need for better management practices and increased regulatory oversight to protect the environment and public health from the negative impacts of dairy effluent.

Overall, these studies and others demonstrate the importance of effective management of industrial effluent in the dairy sector to minimize negative environmental impacts and protect.

1.4. Heavy Metal and its Effect on the Dairy Sector

Heavy metal contamination can have negative effects on animal health, including dairy animals. The accumulation of heavy metals in the body of dairy animals can affect their milk production, reproductive performance, and overall health. One study conducted in India assessed the levels of heavy metals in milk samples from different regions and found that milk samples from regions with higher industrial activity had higher levels of heavy metals such as lead, cadmium, and chromium. The study also found that cows fed with feed contaminated with heavy metals had higher levels of heavy metals in their milk compared to those fed with uncontaminated feed. Another study conducted in Iran evaluated the effects of cadmium on the reproductive performance of dairy cows. The study found that cows exposed to cadmium had lower conception rates and increased rates of early embryonic death compared to those not exposed to cadmium (Mostafidi et al., 2018). Furthermore, a study conducted in China assessed the effects of lead on the health and milk production of dairy cows. The study found that cows exposed to lead had lower milk production, lower milk quality, and an increased risk of reproductive disorders compared to those not exposed to lead.

In conclusion, these studies suggest that heavy metal contamination can have negative effects on dairy animal health and milk production. Therefore, it is important for dairy producers to monitor and control the levels of heavy metals in the feed, water, and environment of their animals to ensure the safety and quality of their products.

1.5. Lead Effect on Dairy and Milk

lead is a toxic heavy metal that can have harmful effects on human health, especially on children and pregnant women. Dairy and milk products can be a potential source of lead contamination, as lead can accumulate in the body of animals through contaminated soil, water, and feed. lead can accumulate in the bones, liver, and kidneys of animals, and can ultimately be passed on to humans through the consumption of dairy products such as milk and cheese. Studies have shown that lead can be present in milk and dairy products at levels that can pose a health risk to humans. For example, a study conducted in India found that milk from cows and buffaloes contained lead at concentrations ranging from 5.5 to 15.8 parts per billion (ppb), which exceeds the maximum permissible limit of 2.5 ppb set by the Food Safety and Standards Authority of India (Mostafidi et al., 2018).

Studies have shown that dairy animals can be exposed to lead through various sources. For example, a study conducted in India found that cows grazing near a battery manufacturing plant had higher levels of lead in their milk compared to cows grazing in areas with lower lead exposure (Giridhar and Samireddypalle, 2015). Similarly, a study conducted in Pakistan found that cows grazing near industrial areas had higher levels of lead in their milk compared to cows grazing in rural areas (Chirinos-Peinado and Castro-Bedriñana, 2020). In addition to contaminated feed and water, lead toxicity in dairy animals can also occur using lead-containing equipment such as milking machines and water pipes. A study conducted in the United States found that lead was present in some milking equipment, which can contribute to lead contamination in milk (Jacobs and Siegford, 2012).

In the United States, the Food and Drug Administration (FDA) has set a maximum permissible level of lead in milk at 0.05 parts per million (ppm) (FDA, 2021). However, studies have found that lead levels in milk and dairy products in the US are generally low and do not pose a significant health risk to consumers (Ettinger et al., 2014).

It is important to note that the levels of lead in milk and dairy products can vary depending on various factors such as the location, the animal's diet, and the farming practices. Therefore, it is essential to ensure that the milk and dairy products you consume come from sources that follow good farming practices and are regularly tested for lead contamination.

1.6. The human health hazard of lead

lead is a toxic heavy metal that can pose significant health hazards to humans, particularly to children and pregnant women. Here are some examples of how lead can affect human health: lead exposure can cause developmental delays and learning difficulties in children. Children who are exposed to lead may experience lower Intelligence Quotient (IQ) scores, decreased attention spans, and behavioral problems. lead can also cause damage to the nervous system, leading to symptoms such as headaches, fatigue, and irritability (Cecil et al., 2008). lead is a subfertility factor in male of particular current interest (Benoff et al., 2003). Prolonged exposure to lead can cause kidney damage, leading to kidney disease and even kidney failure. lead exposure can cause anemia, which occurs when the body doesn't have enough healthy red blood cells. Anemia can cause fatigue, weakness, and shortness of breath. lead exposure during pregnancy can cause a range of problems, including miscarriage, premature birth, and low birth weight (Serda et al., 2019). In adults, lead exposure can cause high blood pressure, joint and muscle pain, and memory loss. In severe cases, lead poisoning can lead to seizures, coma, and even death.

Overall, lead is a serious human health hazard that can cause a range of problems, particularly for children and pregnant women. It is important to take steps to minimize exposure to lead, such as avoiding lead-based paints and ensuring that drinking water is not contaminated with lead.

1.7. Comparative Study of lead in human health and milk production

lead is a toxic heavy metal that can have detrimental effects on both human health and milk production. The following comparative study provides a brief overview of the impact of lead on these two areas.

Human Health*:* Exposure to lead can lead to a variety of adverse health effects, ranging from mild symptoms such as headaches and irritability to more severe effects like anemia, kidney damage, and developmental delays in children. lead exposure can occur through various sources, including contaminated soil, air, water, and food. Ingestion of lead-contaminated food or water is a significant source of exposure for humans (Năstăsescu et al., 2020).

Milk Production: lead exposure can also have an impact on milk production in dairy cattle. Dairy cattle that consume feed or water contaminated with lead may produce milk that contains elevated levels of the metal. This can result in decreased milk production, as well as potential health effects in both the cows and consumers of the milk. lead can accumulate in the bones of dairy cattle, and may be mobilized during periods of stress or high milk production, resulting in increased lead concentrations in milk (Sarsembayeva et al., 2020).

In both human health and milk production, prevention is key to minimizing the risks associated with lead exposure. The following are some strategies that can help to reduce exposure:

Human Health: Avoid or minimize exposure to sources of lead, such as lead-based paint, contaminated soil, and water; Ensure that drinking water is tested for lead and take steps to remove any sources of contamination; Wash hands frequently, especially before eating, to reduce the risk of ingesting lead.

Milk Production: Monitor lead levels in feed and water sources to prevent contamination; Avoid using lead-containing equipment, such as pipes or troughs; Limit exposure to other sources of lead, such as lead-based paint or battery acid.

In conclusion, while lead can have detrimental effects on both human health and milk production, there are steps that can be taken to minimize the risks associated with exposure. By implementing effective prevention strategies, we can help to ensure the safety of both consumers and dairy cattle.

1.8. lead Outbreak Scenario in Bangladesh

In 2019, Bangladesh experienced an outbreak of lead poisoning in a neighborhood of Dhaka, the capital city, affecting more than 200 children. The outbreak was linked to the informal battery recycling industry in the area, where used batteries were melted down in open-air furnaces to extract lead. This process released toxic fumes and contaminated the surrounding soil and water sources with lead, which the children were exposed to through air and water (Hore et al., 2019). According to a study published in the Journal of Hazardous Materials in 2020, the lead concentrations in soil, water, and dust samples collected from the affected area were significantly higher than the safe limits set by the World Health Organization (WHO). The study also found that the blood lead levels of the affected children were much higher than the national and international guidelines, indicating a high risk of neurological and developmental damage (Mitra et al., n.d.).

The outbreak prompted the Bangladeshi government to take action to address the issue, including shutting down the illegal recycling plants, providing medical treatment to affected children, and launching a nationwide campaign to raise awareness about the dangers of lead exposure. This outbreak highlights the dangers of informal and unregulated industries and the importance of enforcing environmental and health regulations to protect public health. It also underscores the need for increased awareness and education about the risks of lead exposure and the importance of safe disposal and recycling of batteries and other hazardous materials.

1.9. Long-term effect of lead in the dairy sector

There is limited research on the long-term effects of lead in the dairy sector. However, lead contamination can have serious health implications for both animals and humans. In a study published in the Journal of Dairy Science in 2019, researchers found that cows exposed to lead had reduced milk production, decreased milk fat content, and altered milk protein profiles. The study also found that lead accumulated in the cows' liver and kidneys, indicating potential long-term health effects on the animals (Sharma et al., 1982). lead contamination in dairy products can also pose a significant health risk to humans. According to the World Health Organization (WHO), exposure to lead can cause a range of health problems, including damage to the central nervous system, kidneys, and reproductive system. Children and pregnant women are particularly vulnerable to lead exposure, which can lead to developmental delays and behavioral problems in children and miscarriages and stillbirths in pregnant women. A study published in the Journal of Agricultural and Food Chemistry in 2016 found that lead was present in 15% of dairy products tested in China, with higher levels found in products from small-scale producers. The study highlights the need for regular monitoring and enforcement of lead standards in the dairy sector to protect consumer health (Harborne et al., 2017).

Overall, lead contamination in the dairy sector can have significant health implications for both animals and humans. Regular monitoring and enforcement of lead standards are necessary to ensure the safety of dairy products for consumers.

Chapter III: Materials and Methods

3.1. Description of the study area:

The study area is located at Fulbari Upazila (sub-district) in the Dinajpur District of Bangladesh. Dinajpur district is in the northwestern part of the Rangpur division. The average height of this district from the sea level is 112 feet to 120 feet. Geographically the district is located between 25010' and 26004' north latitude and 88005' and 85028" longitude. Dinajpur district extending vertically north-south is bounded by Thakurgaon and Panchagarh districts to the north, Gaibandha and Jaipurhat districts to the south, Nilphamari and Rangpur districts to the east, and West Bengal state of India to the west. The total area of this district is 3437.98 square kilometers consisting of 13 Upazilas.

Dinajpur district is famous for litchi. The best litchi in Bangladesh is produced in this district. This district is rich in animal resources also, there are 1671214 cows, 3132 buffaloes, 1010158 goats, 140849 sheep, and a lot of poultry. Moreover, this district has 1129 dairy farms, 599 goat farms, 330 sheep farms, 341-layer chicken farms, 830 broiler farms, 11 parent stock farms, 03 grandparent stock farms, 437 duck farms, and 31 hatcheries. Besides, 29 quail and 126 turkey farms have been developed. About 20% of the population is directly and 50% indirectly dependent on the livestock sector. Dinajpur is basically an agricultural district. That is why most of the industries that have been established in this district are agriculturally based. Setabganj Sugar Mills Ltd. and Dinajpur Textile Mills Ltd. are among the major industries and factories in the Dinajpur district. Barapukuria Coal Mining Company Limited is in Parvatipur Upazila of Dinajpur District which is the largest coal mine in the country and has been playing an important role in the country's economy (http://www.dinajpur.gov.bd).

Figure 1: Study area Global Positioning System (GPS) location

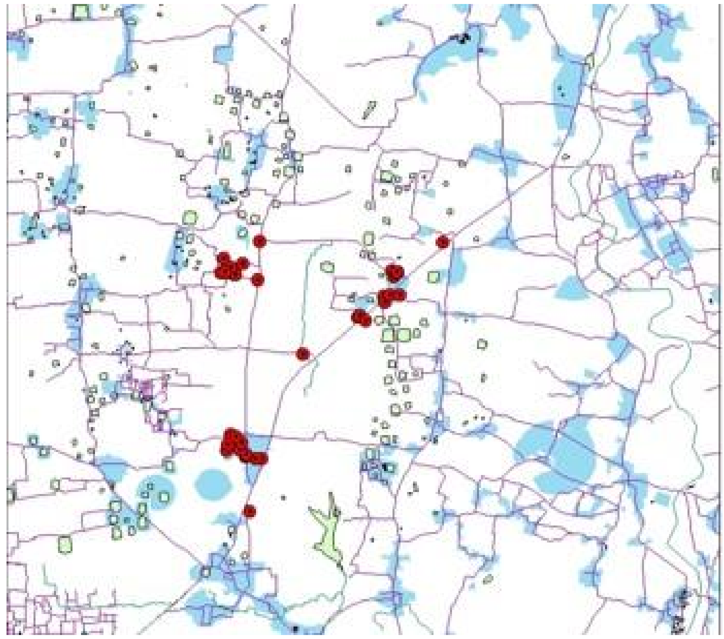


Figure 2 : Study area map of Fulbari Upazila

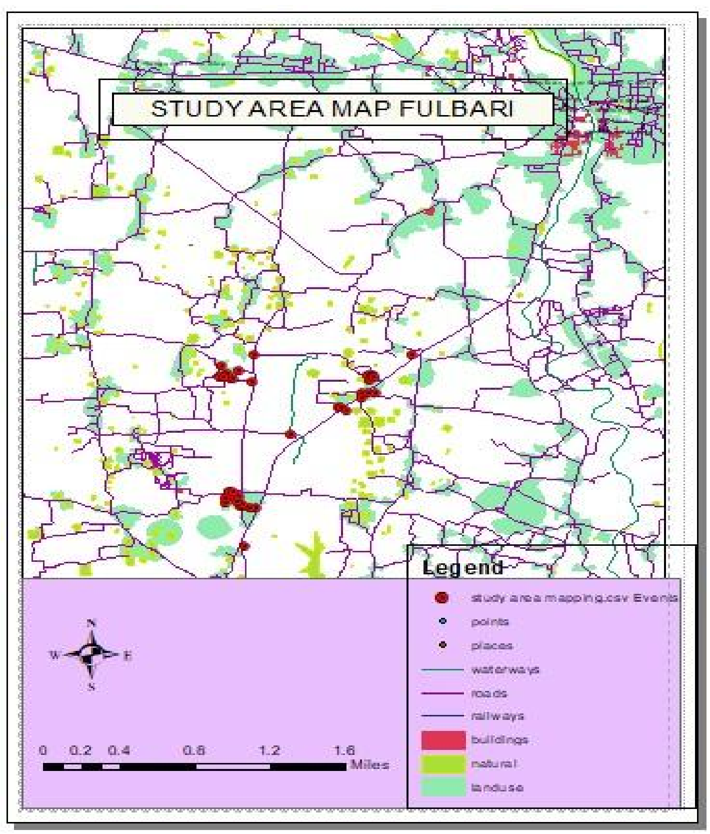


Figure 3: Location of Used lead Acid Battery (ULAB) factory which is surrounded by paddy land (Greenish area) along with an adjacent small canal in Google map.

3.2. The context of study site selection:

There was an incidence of cattle death in Fulbari Upazila of Dinajpur District in 2021. Fulbari consists of 07 unions. The number of cattle in this Upazila is about 143163 out of which there are about 1500 cattle in the Maheshpur and Basudebpur villages of Aladipur and Betdighi union. Our study area included surrounding other unions also although the outbreak was confined to two unions (Aladipur and Betdigi) only. Whereas around 40 cattle died in that outbreak. It was a lead outbreak confirmed by the Epidemiology Unit of DLS after a joint investigation. After confirmation of the lead outbreak, it should be necessary to investigate the long-term effects of lead on the environment and whether the lead is entering into livestock products through consuming water, grasses, rice straw, etc.

3.3. Study design:

A cross-sectional study measures the prevalence of health outcomes or determinants of health, or both, in a population at a point in time or over a short period. It is an observational study, where a sample of an individual from a population is enrolled and their exposures and health outcomes are measured simultaneously. The cross-sectional study tends to assess the presence (prevalence) of the outcome at that point in time without regard to duration. Cross-sectional study is a perfectly fine tool for descriptive epidemiology purposes.

I conduct a cross-sectional study between 13 August 2022 to 21 August 2022. Data was collected by a predesignated questionnaire. The questionnaire was designed by reviewing the literature then the questionnaire was revised by epidemiologists and field veterinarians and other experts. Before final data collection, the questionnaire was validated by interviewing 5 farmers in the non-outbreak area. Data were collected from the owner and attendance of the farmer's absence of the owner, but permission was taken from the owner by mobile phone.

The questionnaire contained 4 parts where parts 1 and 2 were related to farmers and farm demography along with animal information. Part 3 was related to clinical information and Part 4 was related to management or risk-related information. Finally, the questionnaire possessed 36 questions. Data was compiled in Excel after the collection on daily basis. Both animal and environmental samples were collected from the study site.

Verbal consent was taken from the owner of the animals. No incentive was given to the farmer for this study. Participation in the study was voluntary. The study objectives were described to the owner before data and sample collection. Data was stored anonymously.

3.4. Sampling technique:

There were 46 farmers interviewed from the list of farmers (annex attached) affected by the outbreak in the previous year and the snowball technique of farmers' answers of outbreak-affected farmers. Among them, 37 farmers still have cows on their farms. Of the cow-rearing farmers, 31 of them had milk-producing cows, 5 farmers had cows in the dry periods, 2 of the farmers were not interested, and 2 of the farmers were absent.

3.5. Data collection and management:

Information was collected through face-to-face interviews. The daily collected information was imported into excel at the end of the day. After the compilation of raw data, it was cleaned by removing extra space, treating the blank cells, removing duplication, changing text to lower/Upper/Proper cases, and discarding some unwanted spelling mistakes. Finally, the cleaned data was used for both descriptive and analytical purposes.

Final coded data were then transferred to STATA-14 for analysis and visualization. Variables were summarized by using descriptive statistics and presented in tables and figures. Pearson's Chi-square or Fisher's exact tests were used to assess the associations between positive cases and their characteristics. Questionnaire data were compared with the laboratory findings to assess any association for lead poisoning.

3.6. Sample collection and processing:

A total of 22 raw milk samples were collected directly from the farmers to avoid the chance of contamination around the outbreak area, 3 water samples, 3 soil samples, and 3 green rice leaf samples were collected as environmental samples from 10m, 100m, and 500m distances respectively towards the air flow from the factory site. Four old logs collected during the outbreak were also sampled.

All the required materials were planned before going to the sample collection. The following items were used for the collection of milk samples.

- Clean, dry, leak-proof, sterile containers (mainly plastic) and polythene zip bags.
- A cool box with sufficient gel packs for carrying the milk during transportation.
- Personal protecting cloths
- Sticker tags, markers, notepads, masks, sanitizers, and biohazard bags.
- A hand sanitizer to sanitize hands at the time of sample collection.
- EDTA tube for blood collection.

There was a 50 ml conical bottom disposable centrifuge tube with clear white graduation for the collection of milk and water samples and plastic zip lock bags for environmental samples. A cool box with a sufficient ice bag was used at the time of sample collection. For the maintenance of the cool chain, we collected 5 milk samples per day. All the collected samples were refrigerated immediately after the collection. After collection and primary refrigeration, the fastest communication system was used for the transportation of samples from the field to the laboratory. In the laboratory, the samples were stored at -20°C until further analysis.

3.7. Sample digestion and analysis:

The sample was digested and analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). It is an elemental analysis technology capable of detecting most of the periodic table of elements at milligram to nanogram levels per liter. It is used in a variety of industries including, but not limited to, environmental monitoring, geochemical analysis, metallurgy, pharmaceutical analysis, and clinical research.

3.7.1. According to Digesting program (power program):

1 gm of a sample (Solid, semi-solid) weighted with an electronic balance.

↓

Then it was kept in the Teflon vessel and add 8ml HNO_3 and 1 ml H_2O_2

↓

After adding chemicals, sealed the vessels and placed them into the microwave digester, and heat by following digesting program (1600 w (100%), RAMP time 20 min, Temperature 200°C, hold for 20 min, and cooling time 20 min).

↓

After digestion, sample solutions were cooled to room temperature before being quantitatively transferred into 100 mL standard volumetric flasks that had been acid cleaned.

↓

Then added 5ml of 10% HCl and further, it was diluted to 100 ml w/H_2O.

↓

In this way, the samples were digested and diluted.

↓

Then the digested solutions were filtered with HPPTFE 0.2 micro-meter filter before running in the ICP-MS.

↓

Finally, 10 ml of filtered solution was kept in the ICP-MS tube for analysis.

3.8. Economic Estimation:

The procedure of economic estimation was solely based on discussion with farmers by recalling memory of the outbreak incidence. The economic estimation was done by the calculation of economic value of total death, sold, and decrease price value of sold animal. Economic Loss by Sold (ELS) = (Total original price of sold animals- total decrease price of sold animals)

Total Economic Loss (TEC)= Total price value of death animals + ELS

Chapter IV: Results

4.1. Demographic Description:

Farms and farmers demography have been presented in Table 1. Of all the farmers interviewed (N=46), 67.39% of farmers were from Aladipur union and rest were from Betdighi union. Among the farmers 19.57%(n=9) were female. Considering the educational qualification 34.8% farmers having secondary and higher secondary education, 21.7 % primary and 43.5 % farmers have no formal education. Though no one had any previous knowledge on lead factory but after the outbreak100% of peoples blamed the lead factory for the outbreak and now they all are aware about lead industry and united to prevent to establish these sorts of industries.

Table 1: Frequency table of demographic descriptions

Sl No	Variable	Category	Frequency (n)	Percentage (%)
1.	Union	Aladipur	31	67.39
		Betdighi	15	32.61
2.	Village	Basudebpur	18	39.13
		Nandalalpur	15	32.61
		West Narayanpur	13	28.26
3.	Gender	Male	37	80.43
		Female	9	19.57
4.	Education	Absence of institutional study	20	43.5
		Primary	10	21.7
		Secondary and higher secondary	16	34.8
5.	Source of lead	Battery factory	46	100%
6.	Know about the lead	Yes	1	2.17
		No	45	97.83
7.	Provided treatment	Yes	27	58.70
		No	19	41.30
8.	Concern about the factory	Don't know	46	100%
9.	Step to prevent the	Avoid cutting grass	0	0
		Avoid grazing	0	0

Sl No	Variable	Category	Frequency (n)	Percentage (%)
	incidence again	Both (Avoid cutting grass and avoid grazing in and around the industry)	46	100%
10.	Perception of new battery factory establishment	Inform the news to the livestock office	9	19.57%
		Inform the news to the administration	37	80.43%
11.	Action against establishment	all the villagers will get together against the industry.	42	91.31
		Not reaction	4	8.69

4.2. Management Practice and exposure related to Outbreak:

Management practice and exposure variables related to lead outbreak have been presented in table 2 Of the farmers grazing cattle(N=46), 41.3% farmers still grazing their cattle, and 91.3% farmers provided grasses around from the battery factory area. In case of drinking water, only 4.35% farmers are using the field water for their cattle but 60.87 % farmers still providing rice straw as feed for their cattle. 91.35 % of the farmers have been practicing grain for their cattle's. Among them 45% farmers provide below 1 kg grain per day per cattle and only 8.7 farmers provide more than 6 kg grain per cattle per day.

Table 2: Frequency table of variables

Sl no	Variable	Category	Total (n)	Percentage (%)
1	Distance of Cattle grazing from factory site	Around the battery factory area (200m approximately)	19	41.3
		> 200m from the battery factory area	25	54.35

Sl no	Variable	Category	Total (n)	Percentage (%)
		Intensive	2	4.35
2	Drinking water from filed	Yes	2	4.35
		No	44	95.65
3	Collecting grasses for feeding purpose	Yes	42	91.30
		No	4	8.70
4	Feeding rice straw collected from battery factory area	Yes	28	60.87
		No	18	39.13
5	Feeding grain	Yes	42	91.30
		No	4	8.70
6	How much grain per day/cattle (kg)	Below 1	21	45.65
		1.1 to 3	20	43.48
		3.1 to 6	1	2.17
		More than 6	4	8.7

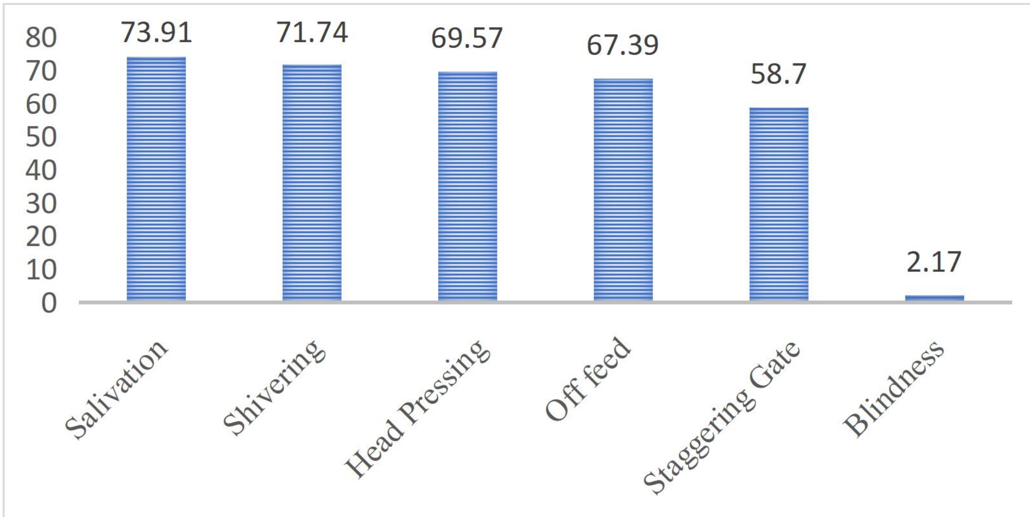
4.3. Clinical signs frequently observed in acute lead poisoning:

The main clinical signs of acute lead poisoning described in different research articles were muscle tremors, especially at the head and neck, staggering gait, wondering aimlessly, head pressing to objects, blinking eyelids, pupil dilatation, circling movement, convulsion, and tetany. Besides the regular findings such as Head pressing 69.57%, Staggering gait 58.70% and blindness 2.17% we have observed some unusual finding, such as salivation 73.91%, shivering 71.73%, and off feed 67.39%. Detail description provided in table 4 and figure 4.

Table 3: Frequency table of clinical signs of infected cattle

Sl No	Variable	Category	Total, n	Percentage (%)
1	Presence of salivation	Presence	34	73.91
		Absence	12	26.09
2	Showing off feed	Presence	31	67.39
		Absence	15	32.61
3	Visible staggering gait	Presence	27	58.70
		Absence	19	41.30
4	Head pressing towards object	Presence	32	69.57
		Absence	14	30.43
5	Showing neck bending	Presence	0	0
		Absence	46	100
6	Presence of shivering	Presence	33	71.74
		Absence	13	28.26
7	Showing blindness	Presence	1	2.17
		Absence	45	97.83

Figure 4: Presence of clinical signs in cattle in lead outbreak (Highest to lowest)



4.4. Descriptive statistics of confirmed cases in milk samples:

Among the 22 confirmed cases 95.45% (21) individual reared in semi-intensive and 4.55% (1) intensive system. Of the 22 cows 63.63% (14) provided rice straw and 95.45% (n=21) provided grain. Among the grain consumption cows, 40.91% (9), 54.55% (12) and 4.55% (1) fed <1 kg, 1.1 to 3 kg, 3.1 to 6 kg, grain per day per animal respectively. Detail description provided in table 4.

Table 4: Descriptive statistics of Confirmed case

Sl no	Variable	Category	Confirmed Total (n)	Percentage (%)
1	Dairy Farm	Intensive	1	4.55
		Semi-intensive	21	95.45
2	Cure	No	16	72.73
		Yes	6	27.27
3	Deaths	No	12	54.55
		1 death	8	36.36
		3 deaths	2	9.09
4	Treatment	No	10	45.45
		Yes	12	54.55
5	Rice straw	No	8	36.37
		Yes	14	63.63
6	Feed grain	No	1	4.55
		Yes	21	95.45
7	Amount of grain	< 1 kg	9	40.91
		1.1 to 3 kg	12	54.55
		3.1 to 6kg	1	4.55

4.5. Comparative results of lead in the same rice straw during and after outbreak:

The highest and lowest value of lead concentration in rice straw during outbreak was 90887.91 ppb and 23106.7 ppb respectively. But after 10 months later the highest and lowest value was 6.75 ppb and 4.68 ppb. Detail description provided in table 5.

Table 5: Comparative results of lead concentration in the old rice straw at the time of outbreak and 10 months later

	Old rice straw	Presence of lead in rice straw			Compare the new results with the old one.
		During outbreak (ppb)	10 months later in same samples (ppb)	Acceptable value (ppb)	
1	Sample 1	23106.70	6.75	30000 ppb	3423 Times lower
2	Sample 2	90887.91	5.24	30000 ppb	17345 Times lower
3	Sample 3	73113.79	6.88	30000 ppb	10627 Times lower
4	Sample 4	57848.71	4.68	30000 ppb	12361 Times lower

4.6. lead concentration in the plant, water, and soil:

The results of lead concentration in soil samples were 32.85 ppb, 28.56 ppb, and 31.13 ppb; in water were 5.53 ppb, 4.87 ppb and 6.21 ppb; in green rice leaf were 9.65 ppb, 4.01 ppb, and 5.72 ppb at 10m, 100m and 500m respectively from the factory site towards the air flow. Detail description provided in table 6.

Table 6: The concentration of lead in environmental samples

Sl no	Sample name	Distance from the factory site			Reference value
		10 m (ppb)	100 m (ppb)	500 m (ppb)	
1	Soil	32.85	28.56	31.13	1 to 7 mg/ 100 gm dry soil or (10,00000 to 70,00000 ppb) (FAO/WHO/OIE, 2008)
2	Water	5.53	4.87	6.21	0.01mg/liter or 10 ppb (WHO, 2003)
3	Green Rice Leaf	9.65	4.01	5.72	0.3 ppm or 300 ppb. The limit of World Health Organization (WHO) and Kenya (NEMA and KEBS) on lead concentrations are 0.3 ppm

4.7. Descriptive statistics of confirmed cases of milk samples:

I collected 22 milk samples from 72 cows of 46 farms. The mean concentration of lead was found (1.24 ± 0.65) ppb with minimum 0.32 ppb and maximum 2.57. Detail description provided in table 7.

Table 7: Descriptive statistics of lead in the milk of confirmed cases

Sample (n)	Mean (ppb)	STD	Min (ppb)	Max (ppb)	Reference value
Milk 22	1.24	0.65	0.32	2.57	0.02 mg/kg or 20 ppb (Maximum level mg/kg) {(CODEX ALIMENTARIUS) International Food Standards} (CXS 193-1995) Revised 2019. Maximum level and related terms: (The Codex maximum level (ML) for a contaminant in a food or feed commodity is the maximum concentration of that substance recommended by the Codex Alimentarius Commission to be legally permitted in that commodity). https://www.fao.org

4.8. Estimation of financial loss:

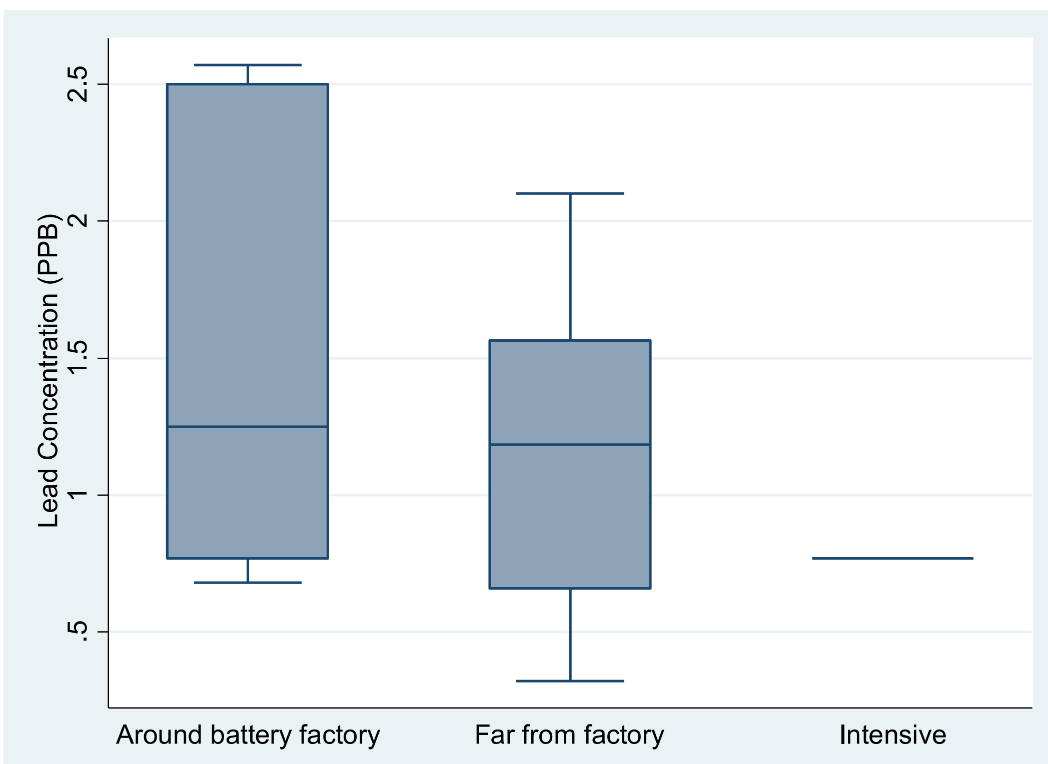
Of the 46 farmers who participated in the interview, the total number of cattle during outbreak was 155. Of those, 79 showed clinical signs, 7 recovered and 32 become expired.

Though they had sufficient cattle at that time but now they have only total 152 cattle where calf 51, heifer 25, cow 72, and bull 4. In that lead outbreak the average morbidity, mortality and case fatality was 52.59%, 21.3%, and 30.13% respectively. During the outbreak the farmers sold 49 cattle. The original price of sold animals was 2670000 Tk but they got only 754000 Tk and the price value of death animals was 2224000 Tk. So, the Total Economic Lost (TEL) by the outbreak was the summary of economic lost by sold and total price value of death animals. i.e. (1916000 Tk + 2224000 Tk) = 4140000 Tk. The average individual farmers loss was 90000 Tk in that lead outbreak. (Annex-1 attached).

4.9. Results in Box and whisker plot:

In milk sample, though the mean value of lead concentration in Box and whisker plot is almost close to 1.3 in case of around battery factory and far from factory but the lead concentration is higher in cases of animals rearing around battery factory than rearing far from the factory. The mean value is much lower in intensive rearing pattern.

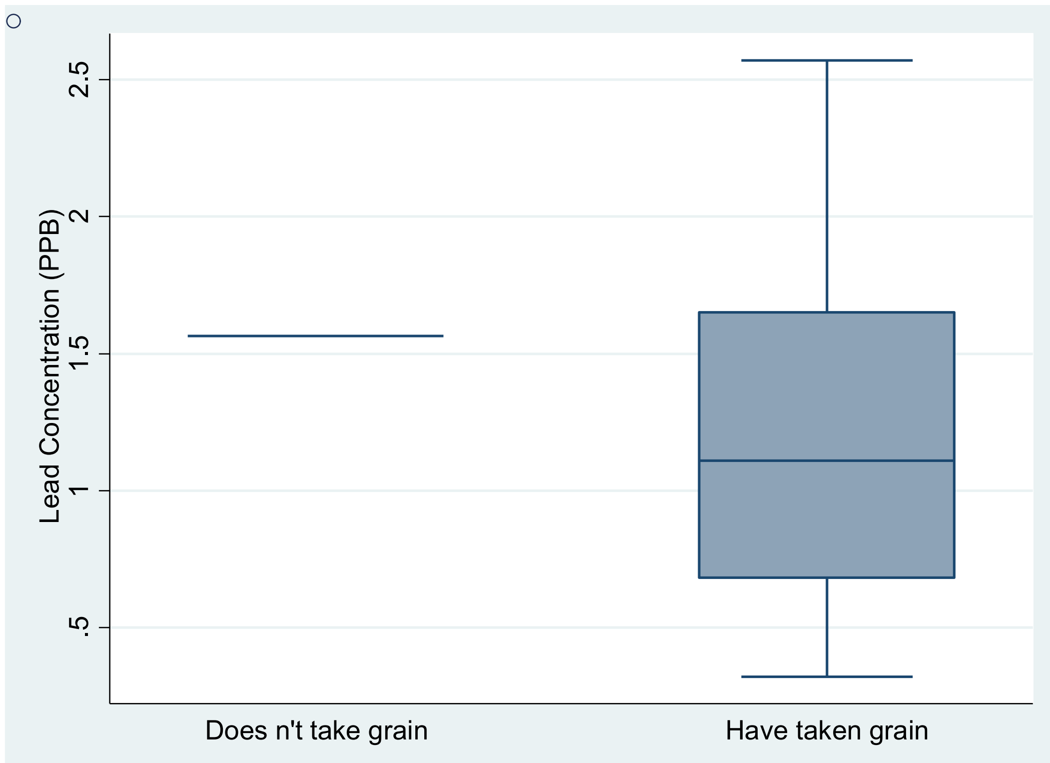
Figure 5: Results showed in Box and whisker plot of confirmed milk sample cases.



Comparative results of taking grain within the confirmed cases:

The results of lead concentrations are higher up to maximum level (2.5 ppb) in case of taking grain group rather than doesn't taking grain. But the mean value of doesn't taking grain group is higher (1.6 ppb) than the group taking grain (1.2 ppb).

Figure 6: Comparative results of taking grain within the confirmed cases.



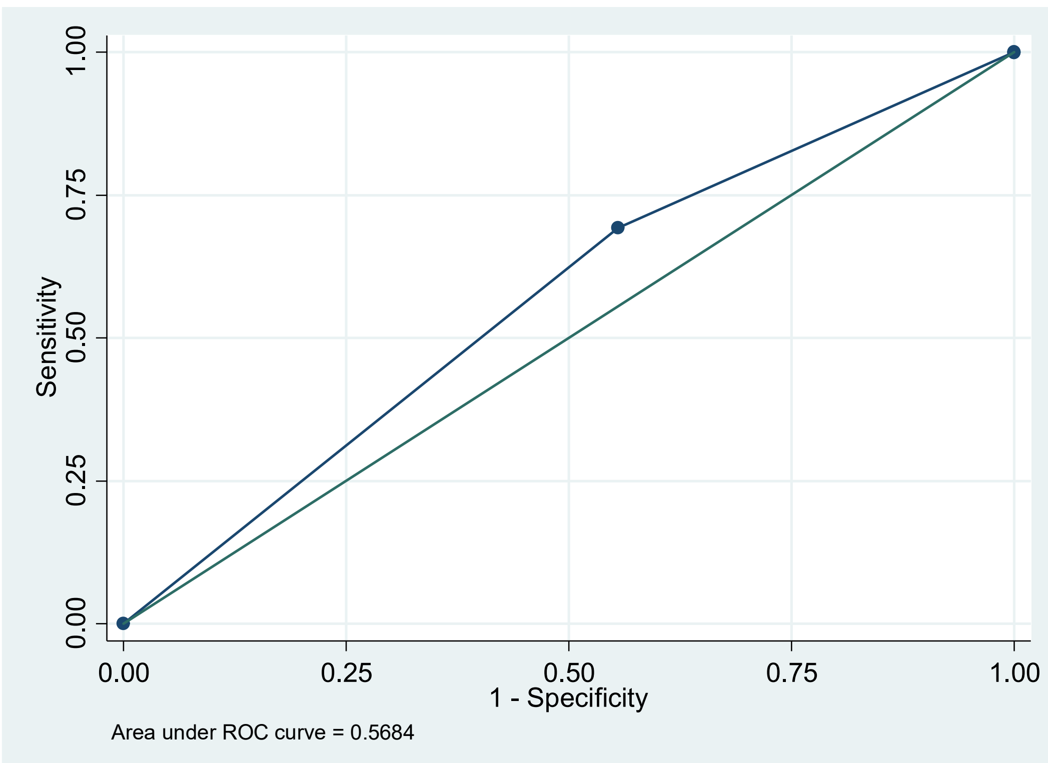
4.10. Results of logistic regression:

The animals or cattle which graze in the field possessed 1.8 times higher lead concentration (*P*=0.5 with *95% CI*) in milk than the cattle reared on concentration without grazing.

4.11 Interpretation of LROC curve:

In the ROC curve, the area under the curve (AUC) was 0.063 which means the model's predictive power is 63%.

Figure 7: ROC curve for association of predictive power



Chapter V: Discussion

The study investigated the impact of lead on cattle and the surrounding environment nearby a lead-battery recycling plant. Literature reported the development of clinical signs and the occurrence of deaths from battery ingestion in Canada (Gudmundson, 1993; Hoff, 1998). The study found the presence of lead in soil, water, and green rice leaf samples which are describe below however, all the concentrations were lower than the limit values provided by World Health Organization (WHO).

5.1. Green rice leaves:

Leaf samples of rice plants growing around the factory are an important marker of lead contamination. It was assumed that the lead concentrations in the plant leaves were the sum of the surface lead deposits from the air and those possibly absorbed by the roots.

The conducted research shows lead concentrations in the extracts from the green rice leaves of the surrounding area ranged from 4.01 ppb to 9.65 ppb with an average of (6.46 ±2.89) ppb (table no 7). The study found the lead content in the green rice leaves was 9.65 ppb, 4.01 ppb, and 5.72 ppb at the distance of 10m, 100m and 500m respectively. The limits of the World Health Organization (WHO) and Kenya (NEMA and KEBS) on lead concentrations are 0.3 ppm or 300 ppb (Table no 7). Tested samples results are much lower but long-time exposure may pose health risks to the animal exposed. The accumulation of dust particles on the surface of leaves was a result of active lead-filled air particles generated from the factory. A study on plants 20 m from a lead battery factory suggested that lead particles in the air from the company operations are deposited on their surfaces (Onianwa et al., 2000). Uddin and Mitu., 2020. In addition, the study compares the concentration of lead in rice straw during the outbreak and 10 months after the outbreak and found the concentrations decreased significantly over time.

5.2. Soil:

In this study, the lead content in the soil was 32.85 ppb(10m), 28.56 ppb(100m), and 31.13 ppb(500m), all the results are much lower than the maximum level (10,00000 -70,00000 ppb) of lead established in soil by (FAO/WHO/OIE,2008), but the soil sample during outbreak period contained high lead level 108360.75 ppb. The route of entry into the soil would be through irrigation water and fine dust particles and vapors from the battery factory. The study Ericson et al., 2019. found no statistically significant association between proximity to the lead smelter and soil lead concentrations ($p < 0.05$) in a radius of at least 130 m. This is despite (Ericson et al., 2019) finding higher lead levels in the plant extracts closer to the factory because of elevated soil lead levels in nearby soils. lead concentration in soils decreases with an increase in distance from the factory similar study near a lead–acid battery recycling operation in Kenya's Nairobi slums found elevated levels of lead in soil and dust samples (Ondayo et al., 2016).

5.3. Water:

The conducted research shows lead concentrations in the extracts from the water of the surrounding area ranged from 4.87 ppb to 6.21 ppb with an average of (5.2 ±2.82) ppb (table no 7).

The lead content in the water was 5.35 ppb(10m), 4.87 ppb(100m), and 6.21 ppb(500m), all the results are lower than the maximum level (10 ppb) of lead established in water by (WHO, 2003) but the lead results in water during outbreak was 286.71 ppb within 10 m from the factory site. The average lead concentration in water is still 5.47ppb within 500m distance. A further study is necessary to observe the livestock population whether this level of lead exposure has created any health hazards or not.

5.4. Milk:

The average lead concentration in milk produced at 1.24 ppb was lower than the upper limit (0.02 mg/kg or 20 ppb) established by Codex Alimentarius (2007) and the European Union and the EC Regulation, 2006. In Multan, Pakistan, the lead content in raw and commercial milk was found to be high (0.048– 0.418 mg/L or 48 ppb - 418 ppb), which was attributed to industrial and agricultural mismanagement and inadequate sanitary measures during animal feeding and milking (Akhtar et al., 2015). In China, the average lead content in raw milk was 1.75 µg/L or 1.75 ppb (Zhou et al., 2018). Our results are like those reported in other developing countries where animals consume feed and water contaminated with lead and Cadmium from industrial emissions that do not exceed the maximum limits. Though the presence of lead in milk is lower in quantity but the matter of concern is collected all samples tested positive.

The milk produced in this area is safe till the lead percentage does not go beyond the maximum level of 20 ppb (CODEX ALIMENTARIUS, International Food Standards, CXS 193-1995) but the milk sample should be tested periodically to check the lead level.

To understand the lead toxicity in cattle should be considered the nature of lead metabolism. The oral absorption of lead salts and metallic lead is slow and incomplete (Osweiler, 1996). Only 2%– 10% of the ingested lead is absorbed, and insoluble lead complexes are excreted in the feces. Once absorbed by the gut, lead is rapidly distributed to soft tissues by the blood. lead is deposited in the kidneys, liver, and bone. Accumulation may occur in the central nervous system of the neonate because of the immaturity of the blood–brain barrier. lead is excreted by active transport into bile and is eliminated in the urine. Secretion into milk and redistribution into bone may also be significant. Bone is the tissue that serves as the long-term storage site for lead (Osweiler., 1996).

The risk of exposure to heavy metals through food intake is a major concern in most countries of the world due to the substantial risk to human health (Shahbazi et al., 2016; Sobhanardakani., 2018). Among the heavy metals, lead (Pb) and cadmium (Cd) have caused the most concern regarding their harmful effects on human health because they are toxic, stable, not easily biodegradable, and easily transferable into the food chain (Friberg et al., 1979; Rahimi 2013; Sobhanardakani et al., 2017). The International Agency for Research on Cancer (IARC) has classified Pb as a probable human carcinogen (Group 2A) (IARC 2006; Yaman 2006). Pb exposure has been attributed to gastrointestinal colitis, brain function disorders, anemia, leukemia, hyperactivity, and thrombotic diseases (Fakhri et al. , 2018; Mishra 2009; Nutescu et al., 2016; Tarrago et al. 2010; Wang et al., 2009). High concentrations of Pb and Cd are often observed in animal feed due to livestock grazing in contaminated areas. These metals can accumulate in the milk and meat of animals after feeding contaminated food and water (Abedi et al., 2011; Demirabas 1999; Demirezen and Uruc 2006; Hosseini et al., 2013; Ismail et al., 2017; Sobhanardakani et al., 2018). Milk contamination can also occur with toxic metals such as Pb and Cd through environmental pollution such as air, water, soil, and ingestion of cow's milk, which can adversely affect human health (Mass et al., 2011; Sobhanardakani and tizhosh 2016; Swarup et al., 2005; Zain et al., 2016). Because children consume more milk than adults, they are more vulnerable to the risk of toxic metal exposure (Gonzalez et al., 2017; Tripathi et al., 1999). As a result of bioaccumulation, chronic intake of low concentrations of Pb and Cd may adversely affect children's health, including their kidney function, mental development, concentration, blood chemistry, and cardiovascular system (Schoeters et al. 2006; Szkup-Jablonska et al., 2012). Therefore, it is very important to monitor the residual amount of these toxic metals in milk and assess the risk to consumers, especially children.

To the best of my knowledge, this is the first study of its nature in the country. Moreover, the scarcity of previous literature limits the comparison of the study findings. Further investigations including blood lead levels among the exposed cattle population are strongly recommended. Moreover, environmental and human health impacts should be established for the region.

5.5. Limitation:

The main objectives of the study were to detect the lead in milk, environmental samples, and the amount of loss backyard farmers, face in a lead outbreak. However, due to the absence of a well-defined sampling frame and shorter study period, a purposive sampling strategy with a manageable sample size was adopted by the snowball sampling technique.

To avoid recall biases in a cross-sectional study several focus group discussions were arranged. In the focus group discussion, it was assured of equal participation. But I cannot say that there is no information bias in my study.

The milk and environmental samples were comparatively lower in number due to the high cost of testing.

Chapter VI: Conclusion and Recommendations

Conclusion:

Unauthorized recycling battery factories and their emitted waste materials are as direct threat to livestock as well as a serious disaster to the environment. Though the mean value of lead concentration in milk is lower and the environmental findings in soil and grasses also lower in quantity after 10 months later, but the presence of lead in water is still remarkable and long-term effects may create animal health hazards. We need an intensive study and close monitoring on used lead acid battery factories thorough out the country for future betterment in human, livestock, and environmental health through one health approach.

Recommendations:

1. Any reported outbreak area should be monitored closely before consuming and selling of agricultural products such as green leafy vegetables, green grasses, etc, and livestock products such as meat, milk, and milk products to minimize the entry of the lead into the food chain.
2. We need an immediate study on employee related to factories, animals, and their products adjacent to factories and the surrounding environments of the industries to investigate the presence of lead in human, animals, animal products and environments surrounding of used lead acid battery recycling industries.

References:

Akhtar S, Ismail T, Riaza M, Shahbaza M, Ismaila A, and Amin K. 2015. Minerals and heavy metals in raw and ultra-heat-treated commercial milks in Pakistan. International Journal of Food and Allied Sciences. 1:18–24.

Adesina A, Zinnah MM. 1993. This document is discoverable and free to researchers across the globe due to the work of AgEcon Search . Help ensure our sustainability , Journal of Gender, Agriculture and Food Security, 1(3), pp. 1–22.

Aktar S, Sarker YA, Sachi S, Ferdous J, Al Noman Z, Mohiuddin KM, Sikder MH. 2020. Environmental contamination of lead in dairy farms in Narayangonj, Bangladesh. Journal of Advanced Veterinary and Animal Research. Dec;7(4):621.

Assi MA, Hezmee MN, Haron AW, Sabri MY, Rajion MA. 2016. The detrimental effects of lead on human and animal health. Vet. World 9:660–671.

Astete J, Cáceres W, Gastañaga M, Lucero M, Sabastizagal I, Oblitas T, Pari J, Rodriguez F, 2009. lead intoxication and other health problems in the children population who live near mine tailing. Rev Peru Med. Exp. Salud Publica. 26(1):15–19.

Baker JC. 1987. lead poisoning in cattle. The Veterinary clinics of North America. Food animal practice. 3(1), pp. 137–147.

Bangladesh Bureau of Statistics (BBS). 2015. Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

Bishwajit G, Sarker S, Kpoghomou M-A, Gao H, Jun L, Yin D, Ghosh S. 2013. Self-sufficiency in rice and food security: a South Asian perspective. Agriculture and Food Security. 2. 10.1186/2048-7010-2-10.

Castro J, Chirinos D, Ríos E. 2016. lead content and placental weight and its association with gestational age, weight, length, and hemoglobin in newborns of metallurgical region—Peru. Rev. Toxicol. 33(2):88–92.

Cecil KM, Brubaker CJ, Adler CM, Dietrich KN, Altaye M, Egelhoff JC, Wessel S, Elangovan I, Hornung R, Jarvis K, Lanphear BP. 2008. Decreased Brain Volume in Adults with Childhood lead Exposure. PLOS Medicine, 5(5), e112.

Chirinos-Peinado DM, Castro-Bedriñana JI. 2020. lead and cadmium blood levels and transfer to milk in cattle reared in a mining area. Heliyon. 6(3), e03579.

Das SC, Chowdhury SD, Khatun MA, Nishibori M, Isobe N, and Yoshimura Y. 2008. Poultry production profile and expected future projection in Bangladesh. World's Poultry Science Journal, 64(1), 99–118.

DLS (2021) Livestock Economy at a Glance, 22, p. 80.

Dogra RKS, Murthy RC, Srivastava AK, Gaur JS, Shukla LJ and Varmani BML. 1996. Cattle mortality in the Thane district, India: A study of cause/effect relationships. Archives of Environmental Contamination and Toxicology. **30**, 292–297.

Ericson, Otieno B, Nganga VO, St Fort C, Taylor J, MP. 2019. Assessment of the Presence of Soil lead Contamination Near a Former lead Smelter in Mombasa, Kenya. J. Health Pollut. 9, 190307.

Ettinger AS, Roy A, Amarasiriwardena CJ, Smith D, Lupoli N, Mercado-García A, Lamadrid-Figueroa H, Tellez-Rojo MM, Hu H, Hernández-Avila M. 2014. Maternal Blood, Plasma, and Breast Milk lead: Lactational Transfer and Contribution to Infant Exposure. Environmental Health Perspectives, 122(1), 87–92.

FDA. 2021. Food and drug administration. United States of America.

FAO/WHO/OIE. 2008. Joint FAO/WHO/OIE Expert Meeting on Critically Important Antimicrobials Joint FAO/WHO/OIE Expert Meeting on Critically Important Antimicrobials. FAO/WHO/OIE, Rome, Italy.

Gudmundson J. 1993. lead poisoning in cattle. Agri-Practice 14(5):43–47.

Giridhar K, Samireddypalle A. 2015. Impact of Climate Change on Forage Availability for Livestock. In Climate Change Impact on Livestock: Adaptation and Mitigation. Springer India. pp. 97–112.

Ghasemidehkordi B, Malekirad A.A, Nazem H, Fazilati M, Salavati H, Shariatifar N, Rezaei M, Fakhri Y, Mousavi Khaneghah A. 2018. Concentration of lead and mercury in collected vegetables and herbs from Markazi province, Iran: a non-carcinogenic risk assessment. Food and Chemical Toxicology, 113, 204–210.

Hoff B, Boermans HJ, Baird JD. 1998. Retrospective study of toxic metal analyses requested at a veterinary diagnostic toxicology laboratory in Ontario (1990–1995). Can Vet J 39:39– 43.

Harborne Ed JB, Hall C London UKC, Crozier A, Jaganath IB, Clifford MN, Howard LR. 2017. Advances in Polyphenol Research: A Journal of Agricultural and Food Chemistry Virtual Issue. Journal of Agricultural and Food Chemistry, 65(37), 8093–8095.

Hore P, Alex-Oni K, Sedlar S, Nagin D. 2019. A Spoonful of lead: A 10-Year Look at Spices as a Potential Source of lead Exposure. Journal of Public Health Management and Practice, 25, S63–S70.

Houlbrooke DJ, Horne DJ, Hedley MJ, Hanly JA, Snow VO. 2010. A review of literature on the land treatment of farm-dairy effluent in New Zealand and its impact on water quality. 47(4), 499–511.

Islam MB, Khalekuzzaman M, Kabir SB, Rana MM. 2021. A Study on Recycling Used lead-Acid Batteries (ULABs) in Bangladesh. Proceedings of the WasteSafe 2021 – 7th International Conference on Integrated Solid Waste and Faecal Sludge Management in South-Asian Countries, 27-28 February 2021. Khulna, Bangladesh.

Johnsen I, Aaneby V, J. 2019. Soil intake in ruminants grazing on heavy-metal contaminated shooting ranges. *Science of The Total Environment*, *687*, 41–49.

Jacobs JA, Siegford JM. 2012. Invited review: The impact of automatic milking systems on dairy cow management, behavior, health, and welfare. Journal of Dairy Science, 95(5), 2227–2247.

Loloei M, Alidadi H, Nekonam G, Kor Y. 2014. Study of the coagulation process in wastewater treatment of dairy industries. International Journal of Environmental Health Engineering, 3(1), 12.

MA Hossain, M Mostofa, MN Alam, MR Sutana, MM Rahman. 2014. Assessment of lead Contamination in Different Samples Around the Industrial Vicinity in Selected Areas of Bangladesh, Bangladesh Journal of Veterinary Medicine, 12(1), pp. 83–89.

Ministerio del Ambiente (MINAM). 2017. Decreto Supremo N_ 011-2017-MINAM. Aprueban Estándares de Calidad Ambiental (ECA) para Suelo (Approval of Environmental Quality Standards (EQS) for Soil).

Mitra AK, Ahua E, Saha PK. 2012. Prevalence of and risk factors for lead poisoning in young children in Bangladesh. Journal of Health Population and Nutrtion. Dec;30(4):404-409.

Mostafidi M, Zahedi MT, Ziarati P, Shirkhan F. 2018. An Overview of the Heavy Metal Contamination in Milk and Dairy Products Chemical dyes-Chemistry View project A Book Pharmaceutical Wastewater Treatment Technologies: Concepts and Implementation Strategies (IWA Publishing) View project Parisa Ziarati Formerly Academic member in Pharmaceutical Faculty An Overview of the Heavy Metal Contamination in Milk and Dairy Products.

Năstăsescu V, Mititelu M, Goumenou M, Docea AO, Renieri E, Udeanu DI, Oprea E, Arsene AL, Dinu-Pîrvu CE, Ghica M. 2020. Heavy metal and pesticide levels in dairy products: Evaluation of human health risk. Food and Chemical Toxicology, 146, 111844.

Ogundiran, MB, Ogundele DT, Afolayao PG, Osibanjo O. 2012. Heavy metals levels in forage grasses, leachate and lactating cows reared around lead slag dumpsites in Nigeria. Int. J. Environ. Res. 6:695–702.

Onianwa P, Fakayode SO. 2000. lead Contamination of Topsoil and Vegetation in the Vicinity of a Battery Factory in Nigeria. Environmental Geochemistry and Health. 22. 211-218. 10.1023/A:1026539531757.

Ondayo, MA, Simiyu Raburu GM; Were PO, FH. Child Exposure to lead in the Vicinities of Informal Used lead-Acid Battery Recycling Operations in Nairobi Slums, Kenya. J. Health Pollut. 6, 15–25.

Pilarczyk R, Wójcik J, Czerniak P, Sablik P, Pilarczyk B, Tomza-Marciniak A. 2013. Concentrations of toxic heavy metals and trace elements in raw milk of Simmental and Holstein-Friesian cows from organic farm. Environmental Monitoring and Assessment. Oct;185(10):8383-92.

Puschner B, Varga A. 2012. Retrospective study of cattle poisonings in California: recognition, diagnosis, and treatment, Veterinary Medicine: Research and Reports, p. 111.

Quddus MA. 2012. Adoption of dairy farming technologies by small farm holders: Practices and constraints. Bangladesh Journal of Animal Science, 41(2), Article 2.

Reuer MK, Bower NW, Koball JH, Hinostroza E, De la ME, Torre Marcas, Hurtado Surichaqui AH, Echevarria S. 2012. lead, arsenic, and cadmium contamination and its impact on children’s health in La Oroya, Peru. International Scholarly Research Network, Public Health; 12.

Rahman MT. 2017. Role of Agriculture in Bangladesh Economy: Uncovering the Problems and Challenges (SSRN Scholarly Paper No. 3697022).

Silbergeld EK, Sauk J, Somerman M, Todd A, McNeill F, Fowler B, Fontaine A, van Buren J. 1993. lead in bone: storage site, exposure source, and target organ. Neurotoxicology. Summer-Fall;14(2-3):225-36.

Sing MK, Jha D, Jadoun J. 2012. Assessment of Physico-chemical status of groundwater samples of Dholpur District, Rajasthan, India. International Journal of Chemistry; Volume 4:96– 104.

Sarsembayeva NB, Abdigaliyeva TB, Utepova ZA, Biltebay AN, Zhumagulova SZ. 2020. Heavy metal levels in milk and fermented milk products produced in the Almaty region, Kazakhstan. Veterinary World, 13(4), 609.

Serda M, Becker FG, Cleary M, Team RM, Holtermann H, The D, Agenda N, Science P, Sk SK, Hinnebusch R, A RH, Rabinovich I, Olmert Y, Uld DQ. GLQ, Ri WK. HU, Lq V, Frxqwu WKH, Zklfk E, Edvhg LV, (2019). Proposal For Evaluating lead Education Materials for Pregnant Women in Allegheny County. Uniwersytet Śląski, 7(1), 343–354.

Shamsuddoha AK, Edwards GW. 2000. Dairy Industry in Bangladesh: Problems and Prospects.

Sharma RP, Street JC, Shupe JL, Bourcier DR. 1982. Accumulation and Depletion of Cadmium and lead in Tissues and Milk of Lactating Cows Fed Small Amounts of These Metals. Journal of Dairy Science, 65(6), 972–979.

Shahbazi Y, Ahmadi F, Fakhari F. 2016. Voltammetric determination of Pb, Cd, Zn, Cu and Se in milk and dairy products collected from Iran: An emphasis on permissible limits and risk assessment of exposure to heavy metals. Food Chemistry, 192, 1060–1067.

Sobhanardakani S, Tayebi L, Hosseini SV. 2018. Health risk assessment of arsenic and heavy metals (Cd, Cu, Co, Pb, and Sn) through consumption of caviar of Acipenser persicus from Southern Caspian Sea. Environmental Science and Pollution Research, 25(3), 2664–2671.

Sobhanardakani S. 2017. Potential health risk assessment of heavy metals via consumption of caviar of Persian sturgeon. Marine Pollution Bulletin, 123(1–2), 34–38.

Sobhanardakani S. 2018. Human Health Risk Assessment of Cd, Cu, Pb and Zn through Consumption of Raw and Pasteurized Cow's Milk. In Iranian Journal of Public Health (Vol. 47, Issue 8).

Sobhanardakani S, Tizhosh M. 2016. Determination of Zn, Pb, Cd and Cu contents in raw milk from Khorram-Abad dairies, Food Hygiene, 6(2 (22)), pp. 43-50.

Szkup-Jabłońska M, Karakiewicz B, Grochans E, Jurczak A, Nowak-Starz G, Rotter I, Prokopowicz A. 2012. Effects of blood lead and cadmium levels on the functioning of children with behaviour disorders in the family environment. In Annals of Agricultural and Environmental Medicine (Vol. 19, Issue 2).

Traverso S, Loretti A. Donini M, Driemeier David. 2004. lead poisoning in cattle in southern Brazil. Arquivo Brasileiro De Medicina Veterinaria E Zootecnia - ARQ BRAS MED VET ZOOTEC. 56. 10.1590/S0102-09352004000300023.

Tripathi RM, Raghunath R, Sastry VN, Krishnamoorthy TM. 1999. Daily intake of heavy metals by infants through milk and milk products. In The Science of the Total Environment (Vol. 227).

Uddin MM, Mitu KN. 2020. Applicability of Used Tea Leaves for Heavy Metal Retention from Industrial Effluents. Applied Ecology and Environmental Sciences. 8, 187-91.

Uddin MM, Sultana MN, Ndambi OA, Alqaisi O, Hemme T, Peters KJ. 2011. Milk production trends and dairy development in Bangladesh. Outlook on Agriculture, 40(3), 263–271.

Uddin MM, Sultana MN, Ndambi OA, Torsten H, Peters KJ. 2010. A farm economic analysis in different dairy production systems in Bangladesh. Livestock Research for Rural Development. 22(7).

Varga A, Puschner B. 2012. Retrospective study of cattle poisonings in California: recognition, diagnosis, and treatment. Vet Med (Auckl). Nov 14; 3:111-127.

World Health Organization (WHO). 2003. lead in water. Background document for preparation of WHO Guidelines for drinking-water quality. Geneva, World Health Organization.

Zhou, Qu X, Zheng N, Su C, Wang J, Soyeurt H. 2018. Large scale study of the within and between spatial variability of lead, arsenic, and cadmium contamination of cow milk in China. Science of Total Environ. 650:3054–3061.

Biography

Syed Hossain passed the Secondary School Certificate Examination, SSC, in 2000 obtaining First Division with more than 800 mark and then Higher Secondary Certificate Examination, HSC, in 2002 obtaining First Division. Mr. Syed obtained his Doctor of Veterinary Medicine Degree in 2009 from Chattogram Veterinary and Animal Sciences University, CVASU, Bangladesh. After completion of his graduation, he was devoted to wildlife management in Bangladesh Forest Department (BFD). Then he was recruited in Bangladesh Civil Service (BCS) at Department of Livestock Services under the Ministry of Livestock and Fisheries. Currently he is posted in Bangladesh National Zoo. Now, he is a candidate for the degree of Master of Science in Applied Veterinary Epidemiology under the One Health Institute of Chattogram Veterinary and Animal Sciences University. He has immense interest working on lead poisoning in livestock, its environmental degradation, and ultimate effects of lead in human food chain.

Annex 1

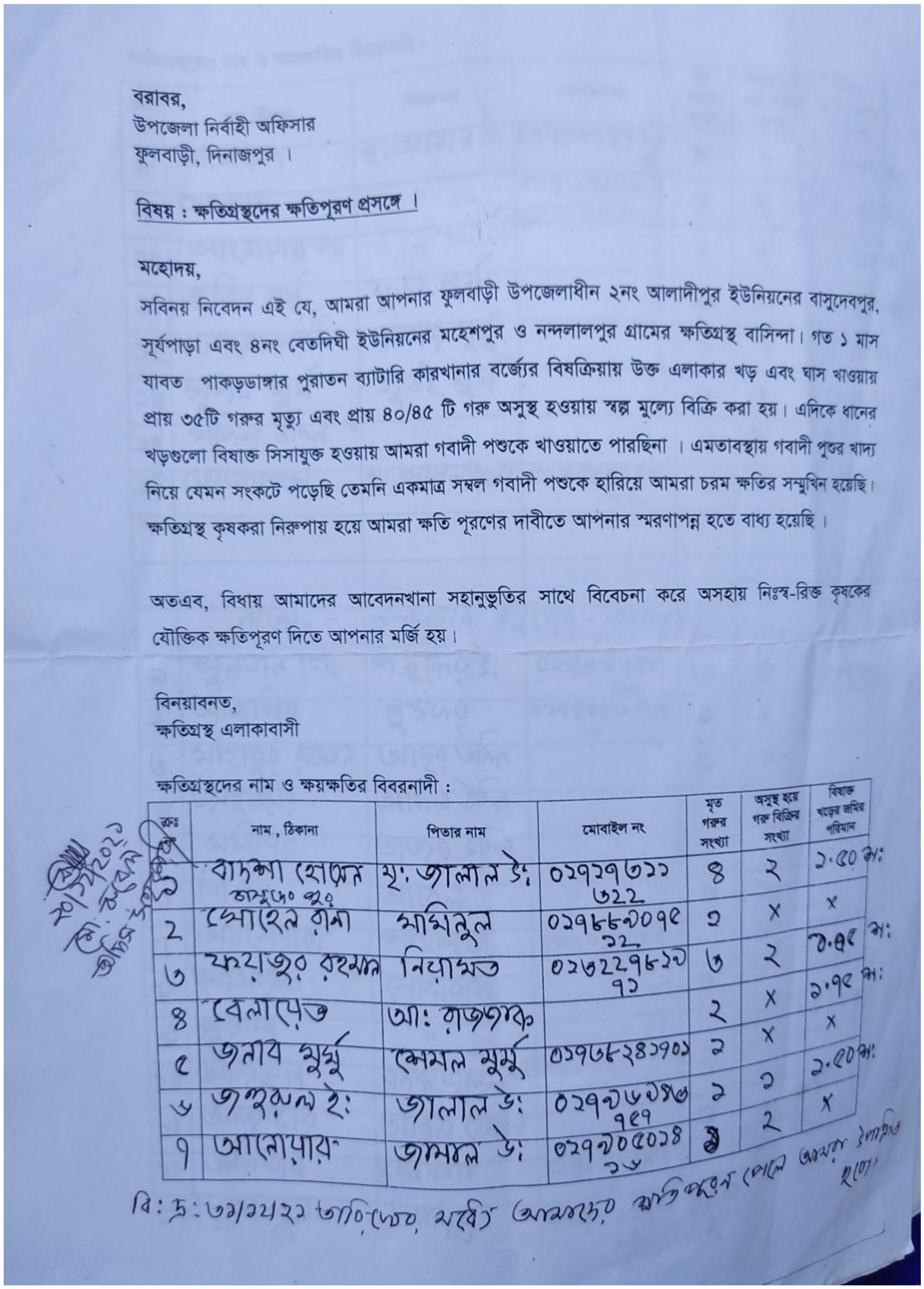
Economic loss calculation

Sl no	Total Animal number (Death)	The total price of Death (TPD) animal	Total number of sold animal	Original Price of sold animal	Decrease the price of sold animal	Economic loss by sold (ELS)	Total Economic Lost (TPD+ ELS)
1.	3	160000	2	120000	26000	94000	254000
2.	0	0	1	55000	13000	42000	42000
3.	0	0	1	55000	12000	43000	43000
4.	1	40000	2	77000	29000	48000	88000
5.	4	140000	2	120000	28000	92000	232000
6.	0	0	0	0	0	0	0
7.	1	10000	3	135000	55000	80000	90000
8.	3	135000	1	70000	12000	58000	193000
9.	1	35000	2	125000	40000	85000	120000
10.	3	210000	4	305000	65000	240000	450000
11.	1	40000	1	45000	28000	17000	57000
12.	1	100000	2	140000	60000	80000	180000
13.	1	45000	0	0	0	0	45000
14.	2	100000	2	120000	29000	91000	191000
15.	2	80000	1	45000	25000	20000	100000
16.	1	60000	0	0	0	0	60000
17.	2	160000	1	45000	8000	37000	197000
18.	0	0	2	150000	42000	108000	108000
19.	1	25000	1	46000	6000	40000	65000
20.	1	85000	1	65000	12000	53000	138000
21.	1	30000	1	55000	12000	43000	73000
22.	0	0	0	0	0	0	0
23.	1	45000	1	40000	8000	32000	77000
24.	1	55000	1	75000	12000	63000	118000
25.	0	0	0	0	0	0	0
26.	0	0	0	0	0	0	0
27.	0	0	0	0	0	0	0
28.	0	0	0	0	0	0	0
29.	0	0	0	0	0	0	0
30.	0	0	1	40000	28000	12000	12000
31.	0	0	0	0	0	0	0
32.	0	0	0	0	0	0	0
33.	1	90000	2	190000	75000	115000	205000
34.	1	35000	1	40000	9000	31000	66000
35.	2	85000	3	85000	30000	55000	140000
36.	3	194000	0	0	0	0	194000
37.	0	0	2	91000	17000	74000	74000

38.	1	35000	1	33000	7000	26000	61000
39.	0	0	0	0	0	0	0
40.	0	0	0	0	0	0	0
41.	0	0	2	75000	11000	64000	64000
42.	0	0	0	0	0	0	0
43.	0	0	1	38000	8000	30000	30000
44.	1	45000	1	42000	9000	33000	78000
45.	3	145000	2	113000	29000	84000	229000
46.	1	40000	1	35000	9000	26000	66000
Total	44	2224000	49	2670000	754000	1916000	4140000

Annex 2

The list of farmers affected lead outbreak in 2021.



বরাবর,
উপজেলা নির্বাহী অফিসার
ফুলবাড়ী, দিনাজপুর ।

বিষয় : ক্ষতিগ্রস্থদের ক্ষতিপূরণ প্রসঙ্গে ।

মহোদয়,
সবিনয় নিবেদন এই যে, আমরা আপনার ফুলবাড়ী উপজেলাধীন ২নং আলাদীপুর ইউনিয়নের বাসুদেবপুর, সূর্যপাড়া এবং ৪নং বেতদিঘী ইউনিয়নের মহেশপুর ও নন্দলালপুর গ্রামের ক্ষতিগ্রস্থ বাসিন্দা। গত ১ মাস যাবত পাকড়ডাঙ্গার পুরাতন ব্যাটারি কারখানার বর্জ্যের বিষক্রিয়ায় উক্ত এলাকার খড় এবং ঘাস খাওয়ায় প্রায় ৩৫টি গরুর মৃত্যু এবং প্রায় ৪০/৪৫ টি গরু অসুস্থ হওয়ায় স্বল্প মুল্যে বিক্রি করা হয়। এদিকে ধানের খড়গুলো বিষাক্ত সিসাযুক্ত হওয়ায় আমরা গবাদী পশুকে খাওয়াতে পারছিনা । এমতাবস্থায় গবাদী পশুর খাদ্য নিয়ে যেমন সংকটে পড়েছি তেমনি একমাত্র সম্বল গবাদী পশুকে হারিয়ে আমরা চরম ক্ষতির সম্মুখিন হয়েছি। ক্ষতিগ্রস্থ কৃষকরা নিরুপায় হয়ে আমরা ক্ষতি পূরণের দাবীতে আপনার স্মরণাপন্ন হতে বাধ্য হয়েছি ।

অতএব, বিধায় আমাদের আবেদনখানা সহানুভুতির সাথে বিবেচনা করে অসহায় নিঃস্ব-রিক্ত কৃষকের যৌক্তিক ক্ষতিপূরণ দিতে আপনার মর্জি হয়।

বিনয়াবনত,
ক্ষতিগ্রস্থ এলাকাবাসী

ক্ষতিগ্রস্থদের নাম ও ক্ষয়ক্ষতির বিবরনাদী :

ক্রঃ নং	নাম , ঠিকানা	পিতার নাম	মোবাইল নং	মৃত গরুর সংখ্যা	অসুস্থ হয়ে গরু বিক্রির সংখ্যা	বিষাক্ত খড়ের জমির পরিমান
১	বাদশা হোসেন বাসুদেবপুর	মৃ: জালাল উ:	০১৭১৭৩১১৩২২	৪	২	২.৫০ শ:
২	সোহেল রানা	আমিনুল	০১৭৮৮৬৩০৭৫ ১১	১	x	x
৩	ফয়জুর রহমান	নিয়ামত	০১৩২২৭৮১৩ ৭১	৩	২	৩.৭৫ শ:
৪	বেলায়েত	আ: রাজ্জাক		২	x	১.৭৫ শ:
৫	জনাব মুর্মু	কোমল মুর্মু	০১৭৩৮২৪১৭০১	২	x	x
৬	জহুরুল ই:	জালাল উ:	০১৭৩৬৩৪৩ ৭৫৭	২	১	২.৫০ শ:
৭	আনোয়ার	জামাল উ:	০১৭৩০৫০১৪ ১৬	৪	২	x

বি: দ্র: ৩১/১১/২১ তারিখ থেকে, [illegible] ক্ষতিপূরণ পেলে আমরা উপকৃত হবো।

ক্ষতিগ্রস্থদের নাম ও ক্ষয়ক্ষতির বিবরনাদী :

ক্রঃ নং	নাম , ঠিকানা	পিতার নাম	মোবাইল নং	মৃত গরুর সংখ্যা	অসুস্থ হয়ে গরু বিক্রির সংখ্যা	বিষাক্ত খড়ের জমির পরিমান
৮	আমজাদ	মৃ: আলাল উ:	০১৭১০০৪৭১৬৪	X	X	২.০০ শ:
৯	আজাদ	"	০১৭৩৪৮৩৩১৫২	X	X	২.৭০ শ:
১০	আনোয়ার হো:	"		X	X	২.৫০ শ:
১১	জুতিষ মুর্মু	ফুটই মুর্মু		X	X	০.৭৫ শ:
১২	আগনেষ মার্ডি	মনতাজ মুর্মু		X	X	০.৫০ শ:
১৩	সুশল মুর্মু	সুভই মুর্মু		X	X	২.০০ শ:
১৪	মফিল উদ্দিন			X	X	০.২৫ শ:
১৫	তোফাজ্জল	মৃ: আসমতুল্লা	০১৭৫০৪০৪৬৯২	X	X	২.৯৩ শ:
	নীচে: -	নন্দলাল পুরের তালিকা				
১	সুলতান হো:	পি. ছাকির উ:	০১৭৬৯৭৭১৭১৩			
২	আজামির	লুৎফর	০১৭৫০৮৬৫৭৭৩	৩	৪	৬.০০ শ:
৩	মাহাবুর রহমান	আদুর উদ্দিন		১	২	
৪	জাহাঙ্গীর	আফিল উদ্দিন		১	X	
৫	মজিবর	জজর উদ্দিন			১	
৬	মিলন	আবেল		১		
৭	আনোয়ারা	কাহাজান	০১৩০৪৬৬৫৯৯৪	১	১	
৮	মোসাদ্দেক	মোবারক			১	০.৫০ শ:
৯	মুকুমর	"		১		০.৮০ শ:
১০	আরিফুল	বদরুজ্জামান			১	০.৮০ শ:
১১	আজাহার	আবুল হোসেন		১		
১২	আফজাব	মৃ: রাজ্জাক		১		০.৬০ শ:
১৩	জামসুল	আমির	০১৭১৯৮২৮৭১৫		১	২.০০ শ:
			০১৭২৬৪৯৯১২২ ছাগল ২			২.৫০ শ:

ক্ষতিগ্রস্থদের নাম ও ক্ষয়ক্ষতির বিবরনাদী :

ক্রঃ নং	নাম , ঠিকানা	পিতার নাম	মোবাইল নং	মৃত গরুর সংখ্যা	অসুস্থ হয়ে গরু বিক্রির সংখ্যা	বিষাক্ত খড়ের জমির পরিমান
১৩	ছামসুল	আমিন উদ্দিন	০১৭২৬৩৪২৯১ ২২	ছাগল ২	X	১.৫০শ:
১৪	আমিনুল	মোহাম্মদ উদ্দিন	০১৮৬৬৩৬৬৯ ২৬৮	১	X	X
১৫	মোফাজ্জল	আক্কাস আলি	০১৭৬৭৩৯৯০৬৪০	২	X	X
১৬	গোলাম মস্তফা	মফিজ উদ্দিন	০১৭৩৯২৩৩২৮৫ ৭	১	X	X
১৭ (X)	রফিকুল	বেলাল হোসেন	০১৭৭৪৪৭৩১ ২০	১	X	X
	মো: জমির উদ্দিন আমুদিয়ানগর	মোস্তাফা	০১৭৪৪৮৬২২ ৯০	X	১	X

Annex 3

Questionnaire

Republic Government of Bangladesh
Department of Livestock Services
Epidemiology Unit
Questionnaire for the cross-sectional study of an outbreak investigation in
Fulbari Upazila of Dinajpur District

ID No: Date of interview:

Farmers Demography:

1. Name of the farmer:
2. Address:
3. Sex: 4.Mobile No:
5. GPS location:
6. Occupation:
7. Income Source: ☐ Business ☐ Job ☐ Labour ☐ Any other (Please specify…)
8. Educational Study:

☐ No institutional study ☐ Primary ☐ Secondary
☐ Higher Secondary ☐ Tertiary ☐ Any other (Please describe….)

Farm Demography and Animal information

9. Type of farm: ☐ Intensive ☐ Semi-intensive ☐ Open ☐ Other (Please specify…)
10. Spatial location: Length: Width:
11. Age:
12. Sex:
13. Number of animals ☐ Calf: ☐ Heifer: ☐ Cow: ☐ Bull: ☐ Any other:
☐ Total:
14. The number of ills: ☐ No of the sold animal: ☐ Number of dead animals:
☐ Total:
15. Price value of dead animal:
Decrease the price of sold animals:

Information related to Knowledge related question AP (Knowledge, attitude, and practice)

16. Do you know about lead? □ Yes □ No □ Don't know
17. If yes, what is it? (From the list, please identify which you think about the link)
□ Lead is the name of a chemical.
□ Lead is an industrial by-product that causes problems.
□ Lead is an essential component that is good for the environment.
□ I don't know □ any others (Please specify…)
18. What is the source of lead? □ Industry Battery factory □ Use of fertilizer in field □ Pesticide use in field (need to input data according to the question the in data set of excel) □ I don't know □ Any others (Please specify…)
19. What do you think about the battery factory / (lead instead of battery factory)? □ Is it good □ Very good □ Bad □ Very bad □ I don't know
Do you think the lead is responsible/ harmful for causing disease/outbreaks?

20. What do you do to prevent the incidence from again in your livestock? □ Avoid the cutting grass
□ Avoid grazing in and around the industry □ Both □ Do nothing
21. What do you do if a new battery factory wants to establish in another part of your village?
□ Inform the news to the livestock office □ Inform the police □ Infor the UNO
□ Inform the Member/ Chairman □ Do nothing

Clinical information:

23.What kind of problems did you see when your cow got sick?
□ Salivation □ Off feed □ Staggering gate □ Head pressing □ Neck bending
□ Shivering/convulsion □ Lock jaw □ Dilated pupil
□ Blindness Gnash the teeth □ Any others (Please specify…)
24. Do you have any sick animals at present? □ Yes □ No
25. If yes, when does it show the clinical sign? Date…
26. Did you provide any treatment? □ Yes □ No
27. What are the medicines given for treatment? Specify, please…

Management/Risk related information

28. Where do you take your cattle to graze?
□ Around the battery factory area □ Far from the m battery □ Do not Graze factory
□ Any other place (Specify please…)
29. Do your cattle drink water from the field? □Yes □No
30. If yes, where do they drink water?
□ Around the battery factory area □ Far from the m battery factory area
□ Do not drink water from the field □ Any other place (Specify please…)
31. Do you provide grasses to your cattle? □ Yes □ No
32. Where did you get the grass cut for your cattle?
□ Around the battery factory area □ Far from battery factory area
□ Do not cut grass □ Any other place (Specify please…)
33. Do you feed your cattle rice straw? □ Yes □No
34. If yes, where did your collect rice straw?
□ Around the battery factory area □ Far from battery factory area
□ Do not feed rice straw □ Any other place (Specify please…)
35. Do you feed grain to cattle? □ Yes □ No
36. If yes, how then how much grain feed do you feed a cattle per day?
□ No Grain feed □ Below 1 Kg □ 1.1 kg to 3 kg □ 3.1 to 6 kg □More than 6 kg

Field work images at a glance

Taking interview in field from grass collector

Taking interview at farm level

Taking interview at house hold level

Taking interview at house hold level   Sometimes they lost their last hope in outbreak

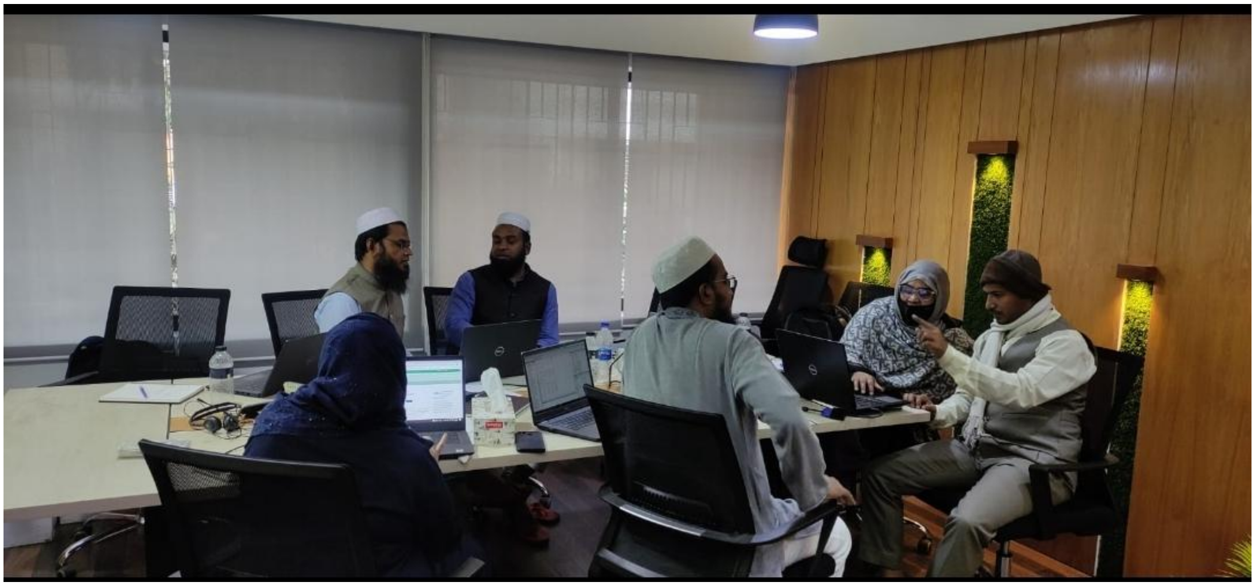
The Old log (Hey) of rice straw collected during the outbreak period

Environmental sample collection water and soil

Laboratory activities in BLRI

Laboratory activities in BLRI

Laboratory activities in BLRI



Data analysis workshop with Associate Professor Kanis Fatama Ferdusi (SUST)

Awareness sign board given by Department of Livestock Services

The End