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Environmental Impact of Poultry Waste Management Practices in Jhenaidah, Bangladesh

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ABSTRACT

The poultry industry is one of the major agricultural sector which contributes to the economic development of Bangladesh. Improper poultry waste management practices causes environmental pollution and also public health hazards. Our study assessed the biosecurity measure and poultry waste management practices of 35 poultry farms in Jhenaidah Sadar Upazila, Bangladesh. Data were collected by the questionnaire from the poultry farmers. Our focusing on farmers demographics, farm characteristics, sanitation, and waste disposal practices. The results revealed that most farms were run by middle-aged, educated males. Around 77% of the owners lacked formal training on waste management. Poultry waste was predominantly disposed of on roadsides (62.85%) or in pits (37.14%). Waste was repurposed as manure (45.71%) or fish feed (22.85%) by some, but biosecurity measures remained inadequate. Complaints of noise and odour pollution were commonly reported by neighbours. Continued mismanagement led to practices of improper disposal, despite sporadic attempts at cleaning and disinfection through methods such as calcium oxide or potassium permanganate. Poultry waste can be utilized for composting or for biogas production to support environmental protection and public health.

INTRODUCTION

Bangladesh is a country based on agriculture. Over half of the population in the country is directly or indirectly engaged in agriculture. Those engagement on either through crop, fisheries or livestock farming. The poultry sector plays a vital role in the livestock farming system. It generates fresh animal protein as well as huge employment opportunities (Masud *et al.,* 2020; Sen *et al.,* 2021; Islam *et al.,* 2022). The livestock sub sector accounts for 12% of the total agricultural GDP and supports approximately 20% of rural employment (Sobur *et al.,* 2024; Pal *et al.,* 2024; Islam *et al.,* 2025). Poultry sector helps to reduce poverty not only rural areas but also urban areas of Bangladesh. Meat and egg production meet 68% and 64% of the national demand respectively. Poultry meat contributes 37% of the total meat production (Rashid *et al.,* 2023). The demand for meat, eggs, and related products has been rising rapidly. It is due to income growth in recent years, population expansion and changing dietary habits of people (Hamid *et al.,* 2017). Large poultry production produces huge waste. Poultry waste management is a big concern in Bangladesh nowadays.

Poultry waste contains all essential plant nutrients such as nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, boron, cooper, iron, manganese, molybdenum and zinc. Those are widely recognized as an excellent fertilizer (Musa *et al.,* 2021; Hileman, 1967; Stephenson *et al.,* 1990; Simpson, 1991; Edwards & Daniel, 1992). Broiler litter consists of manure, bedding material, wasted feed, feathers, and sometimes soil (Jacob *et al.,* 1997). Globally around 90% of poultry waste is applied as fertilizer on farmland near poultry operations (Seidavi *et al.,* 2019). Litter from caged layers includes the same components except bedding materials. Both wastes effectively used in land for crop production. Poultry litter repurposed as fish feed. Waste from poultry farms are used as fuel in power generation through biogas production (Bhatnagar *et al.,* 2022). Improper disposal of poultry waste is increasing the nutrient contaminations of surface waters and also polluting groundwater through infiltration (Rashmi *et al.,* 2020). Poultry manure, litter, compost and wastewater are often applied to land on a large scale. They are typically not concentrated enough to be considered direct sources of nitrogen and phosphorus pollution (Abdullah-Al-Amin *et al.,* 2009). However, exceptions include areas where manure is stored. Mass disposal of dead poultry in landfills following disease outbreaks. Excessive nutrient levels from poultry litter in water bodies can lead to accelerated growth of algae or aquatic plants which increased water turbidity and degradation of water quality (Weil *et al.,* 1990; Edwards & Daniel, 1992). Salmonellosis, colibacillosis, mycoplasmosis, fowl cholera, infectious bursal disease, and newcastle disease are caused by inadequate management of litter and biosecurity (Abid, 2022; Islam & Dutta, 2021).

Bangladesh produced yearly around 1,560,000 metric tonnes of waste from poultry farms (Miah *et al.,* 2016; Arefin *et al.,* 2024). Effective poultry waste management

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is critical for protecting the environment. Rapid growth of the poultry industry generate large volume of waste is a major challenge if not managed sustainably. Addressing these issues requires urgent attention and the adoption of environmentally and economically viable solutions. This can be minimize the adverse impacts of poultry waste on the country's ecosystems and public health (Shamsuddoha, 2011; Rahman *et al.,* 2022).

Bangladesh lacks established protocols for poultry farm waste management and biosecurity. There is an lack of understanding of public health implications. While some studies have explored the effects of improper poultry waste management but none have focused on the region. This study aims to address this gap by assessing the waste management practices, biosecurity measures and associated public health concerns in poultry farms of Jhenaidah. It seeks to evaluate available waste management facilities, examine biosecurity practices, and understand the environmental sustainability of these practices.

LITERATURE REVIEW

Poultry Farming in Bangladesh

Poultry farming is a growing sector in Bangladesh. It significantly contributing to food security, employment, and economic development (Hennessey *et al.*, 2021). Poultry sector supports rural and urban livelihoods and addresses protein deficiencies through increased meat and egg production. However, the rapid expansion of poultry farming has amplified concerns over waste management and its impact on the environment and public health (Masud *et al.,* 2020; Hamid *et al.,* 2017).

Composition and Potential Uses of Poultry Waste

Poultry waste, including manure, litter, feathers, and wastewater, is a nutrient-rich resource containing nitrogen, phosphorus, and potassium (Ahmed *et al.,* 2023; Sommers and Sutton, 1980). It can serve as an organic fertilizer, fish feed or a biofuel for biogas production. Studies have highlighted its use in sustainable crop production, making it an asset for agricultural development (Jacob *et al.,* 1997; DLS, 2000).

Environmental Impacts of Improper Waste Management

In Bangladesh, untreated poultry waste disposal in open fields or water bodies is common. Soil degradation, and water contamination are common impact of uncontrolled disposal. Excessive nutrient loads in water bodies cause eutrophication which affecting aquatic ecosystems (Arefin *et al.,* 2024; Weil *et al.,* 1990). Poor waste management results in the emission of greenhouse gases including ammonia and methane (Edwards & Daniel, 1992).

Public Health Concerns

Improper poultry waste management increases the risk of foodborne illnesses and zoonotic diseases to the exposed people especially farmers. Pathogens such as Salmonella spp. and Escherichia coli can contaminate water sources. Newcastle disease and Avian Influenza pose significant threats to both poultry and human health. Limited biosecurity measures in Bangladeshi poultry farms exacerbate these risks (Al-Gheethi *et al.,* 2021; Hamid *et al.,* 2017).

Challenges in Waste Management

Small-scale farmers lack awareness, resources and access to technology for sustainable waste disposal. The absence of regulatory frameworks in Bangladesh further complicates waste management efforts. Unlike developed countries, where stringent guidelines exist, Bangladesh lacks comprehensive policies for addressing agricultural waste management (Simpson, 1991; Magette *et al.,* 1989).

Potential Solutions and Recommendations

Solutions include converting poultry waste into compost and organic fertilizers, and biogas. Soil and nutrient testing can optimize the use of poultry waste as a fertilizer, reducing environmental risks. Enhancing biosecurity through proper sanitation and training farmers in waste management. Public awareness campaigns and government-led initiatives are essential for promoting sustainable practices (Hileman, 1967; Edwards & Daniel, 1992).

MATERIALS AND METHODS

Study area

This study was carried out in Jhenaidah Sadar Upazila, Jhenaidah, Bangladesh from January to June 2024.

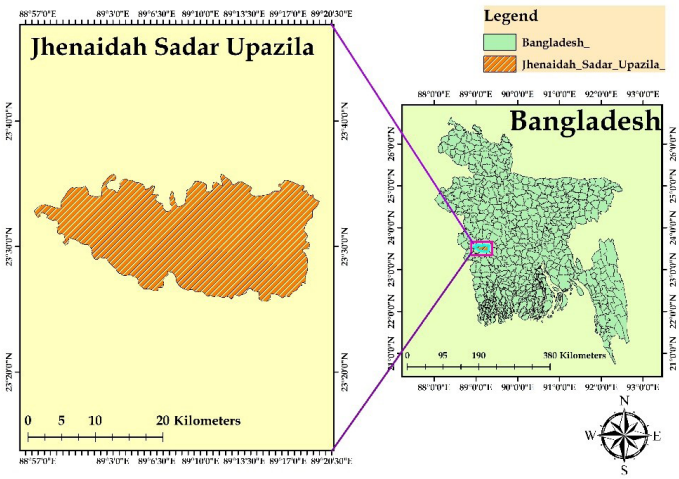

Figure 1: Map of the study area

Data Collection

A total of 35 farms, consisting of both layer and broiler operations, were visited. The combined poultry population was approximately 145250, with 36350 layers (25.02%) and 108900 broilers (74.97%). A structured questionnaire-based survey was conducted across 35 small-scale poultry farms through personal interviews with farm owners. Data were categorized into demographics, farm characteristics, and water management practices.

Statistical Analysis

The collected data were entered into MS Excel 2020. Various descriptive statistical measures, such as percentage distribution, range, mean, and standard deviation, were calculated on this software.

RESULTS AND DISCUSSION

This study examined the waste management practices and biosecurity measures of 35 poultry farms in Jhenaidah Sadar Upazila, Bangladesh, highlighting the environmental and public health implications. The findings reveal significant gaps in waste management practices and biosecurity protocols, posing risks to both the environment and surrounding communities.

Demographic Characteristics of Farm Owners

The majority of the farmers were male (85.72%, 95% CI: 70.8 - 94.4). Only a small proportion were female (14.28%, 95% CI: 5.6 - 29.2). Which indicating a gender imbalance in poultry farming and waste management participation. In terms of age distribution, most participants were middle-aged (31-50 years, 62.86%, 95% CI: 45.5 - 78.5), followed by older individuals aged above 50 years (20.00%, 95% CI: 9.5 - 36.1), and younger individuals below 30 years (17.14%, 95% CI: 6.6 - 33.6) (table 1).

Regarding educational qualifications, 37.14% (95% CI: 22.2 - 54.5) of the respondents had secondary education, followed by 25.72% (95% CI: 13.6 - 42.0) with higher education, 20.00% (95% CI: 9.5 - 36.1) with primary education, and 17.14% (95% CI: 6.6 - 33.6) who were graduates (Table 1). These findings suggest that many respondents had basic and intermediate level of formal education. On the other hand only small percentage had advanced qualifications.

Training on waste management was found to be inadequate with only 22.85% (95% CI: 11.3 - 39.7) of the respondents having received any form of training. While majority (77.15%, 95% CI: 60.3 - 88.7) had not undergone any formal training (Table 1).

In comparison, the national literacy rate in Bangladesh stands at 77.90% (BBS, 2024). Educated farmers are generally more likely to adopt proper waste management practices and demonstrate greater environmental awareness, as they can access information through various media, including books, bulletins, and leaflets. However, only 22.85% of the farmers in the study area had received training on waste management, while 77.15% had not. This highlights a need for expanded training programs. Studies, such as Akteruzzaman *et al.* (2009), have shown that trained farmers tend to achieve higher earnings and better outcomes compared to those without training.

Arefin *et al.* (2024) reported a similar trend. The study highlighted that a large proportion of poultry farmers lacked formal training in waste management and biosecurity, with only 9% receiving such training. Additionally, most farmers lacked proper waste disposal systems, with 69% disposing of litter waste on agricultural land, which poses potential environmental hazards. The study also emphasized that a significant number of farmers (97%) were aware of the environmental and health risks associated with poultry waste, yet proper management practices were not widely implemented.

Table 1: Farm owner's demographic characteristics of Jhenaidah Sadar Upazilla

Items	Category	Percentage (%)	95% CI
Gender	Male	85.72	70.8 - 94.4
	Female	14.28	5.6 - 29.2
Age (years)	Young (<30)	17.14	6.6 - 33.6
	Middle (31- 50)	62.86	45.5 - 78.5
	Old (>50)	20.00	9.5 - 36.1
Educational qualification	Primary	20.00	9.5 - 36.1
	Secondary	37.14	22.2 - 54.5
	Higher	25.72	13.6 - 42.0
	Graduate	17.14	6.6 - 33.6
Waste management training	Yes	22.85	11.3 - 39.7
	No	77.15	60.3 - 88.7

Poultry Farm Characteristics

The broiler farms were the most prevalent, accounting for 65.71% (95% CI: 48.52 - 81.90), while layer farms made up 34.28% (95% CI: 18.10 - 51.47). No breeder farms were recorded in the study. In terms of farm size, medium-sized farms (2-5 acres) were the most common, representing 54.28% (95% CI: 39.7 - 68.8), followed by small farms (<2 acres) at 37.14% (95% CI: 22.2 - 54.5). Large farms (>5 acres) were the least frequent, comprising only 8.57% (95% CI: 1.5 - 17.7). Regarding flock size,

farms with large flocks of more than 3,000 birds were the most dominant (45.71%, 95% CI: 31.6 - 60.8), followed by medium-sized farms with 2,000-3,000 birds (34.28%, 95% CI: 22.2 - 54.5), and small farms with fewer than 2,000 birds (20.00%, 95% CI: 7.0 - 33.6). The majority of farms practiced the floor rearing system (71.42%, 95% CI: 54.5 - 85.4), whereas cage rearing accounted for 22.85% (95% CI: 9.5 - 36.1), and the shelf system was the least utilized (5.71%, 95% CI: 0.6 - 18.5) (Table 2).

Shah *et al.* (2006) noted that many small to medium-sized poultry farms have been losing interest in continuing their businesses, with many exiting the sector due to reliance on brokers and middlemen for operations. Between 2011 and 2018, the number of poultry farms in Bangladesh decreased from approximately 150,000 to 70,000, representing a significant decline (Adam, 2021). Simultaneously, the average size of poultry farms has increased, with farms now housing 50,000–100,000 chickens, compared to 5,000–10,000 chickens per farm previously. This shift is attributed primarily to higher interest rates on loans for small and medium-sized farmers compared to the more favourable loan conditions offered to larger farms.

Compared to Arefin *et al.* (2024), both studies show a strong preference for broiler farming (65.71% vs. 71%) and widespread use of floor rearing (71.42% vs. 74%). Medium-sized farms dominate in both, but this study has a higher proportion of large farms (45.71% with >3,000 birds vs. more small farms in Arefin *et al.* (2024). Waste management training remains inadequate (22.85% vs. 9%), and traditional disposal methods, like burial and land application, are common. Both studies highlight the urgent need for better waste management practices and farmer education.

Table 2: Selected characteristics of poultry farms

Items	Category	Number (N)	Percentage (%)	95% Confidence Interval (CI)
Type of farms	Broiler	23	65.71	48.52 - 81.90
	Layer	12	34.28	18.10 - 51.47
	Breeder	00	00.00	N/A
Farm size (Acres)	Small (<2)	13	37.14	22.2 - 54.5
	Medium (2-5)	19	54.28	39.7 - 68.8
	Large (>5)	03	08.57	1.5 - 17.7
Flock size	Small (<2000)	07	20.00	7.0 - 33.6
	Medium (2000-3000)	12	34.28	22.2 - 54.5
	Large (>3000)	16	45.71	31.6 - 60.8
Rearing system	Case	08	22.85	9.5 - 36.1
	Shelf	02	05.71	0.6 - 18.5
	Floor	25	71.42	54.5 - 85.4

Waste Management of Poultry Farms

Daily waste or waste in production showed considerable variation, with 17.14% of farms producing less than 100 kg, 34.28% producing between 100 kg and 200 kg, and 48.57% producing more than 200 kg (Table 3). This variation in waste production may be influenced by differences in feed intake, water consumption, environmental factors, and the age of the birds. North and Bell (1990) suggested that variations in wastes production can be attributed to differences in feed and water consumption, feed composition and form, as well as humidity and temperature. According to 37.14% of farm owners, the time required for cleaning wastes ranged from 30 to 60 minutes or more, while only 11.43% reported needing less than 30 minutes. This variation could be attributed to differences in farm size, flock size, the distance between the shed and disposal site, and labor efficiency. The cost of cleaning waste per day varied between 100 Tk and 500 Tk. The narrow range of costs might be due to the similarity in labor costs and efficiency in the area. Additionally, 91.43% of farm owners reported that the distance between disposal pits and sheds was less than 1 Km, while non-indicated that this distance was over 5 km.

Table 3: Characteristics of waste management in poultry farms

Items	Category	No. of farms	Percentage (%)	95% Confidence Interval (CI)
Wastes production/day (kg)	<100	06	17.14	6.6 - 33.6
	100 to 200	12	34.28	22.2 - 54.5
	>200	17	48.57	34.2 - 63.9
Time required/ time to clean wastes (min)	<30	04	11.43	3.1 - 23.8
	30 to 60	13	37.14	22.2 - 54.5
	>60	18	51.42	35.1 - 67.7

Cost to clean wastes/day (Tk.)	<100	09	25.71	11.3 - 39.7
	100 to 500	15	42.85	27.2 - 58.5
	>500	11	31.42	17.3 - 46.5
Distance between disposal pit and shed (km)	<1	32	91.43	80.3 - 98.7
	1 to 5	03	08.57	1.3 - 19.7
	>5	00	00	

According to Table 4, most poultry farms (11.42%) collected waste every three days, while 40.00% collected it weekly or after each batch. A majority of farm owners recognized waste management as an important issue. In Bangladesh, waste cleaning is often viewed as a low-prestige and unpleasant task. Among the farmers, 62.85% reported dealing with odor problems during waste cleaning, while 37.14% experienced irritation from ammonia gas (NH_3). Farms that removed manure more frequently reported fewer odor issues (Bell & Weaver, 2002).

Regarding disinfectant use, 8.57% of farmers used detergent, another 8.57% used phenol, 42.85% used potassium permanganate (PPM), 2.86% used a combination of PPM and Savlon, 25.71% used bleaching powder, and 11.42% used other unspecified disinfectants. There was no clear preference or recommendation for disinfectants among the farmers. Proper disposal of layer waste is critical for both effective management and environmental protection. Improper disposal, such as roadside dumping (62.85%) or pit storage (37.14%), can lead to environmental pollution, nutrient loss, and the spread of diseases (Hossain *et al.,* 2009). None of the farms used biogas plants for waste disposal.

Manure storage in pits presents further risks, with 34.28% of pits located on high ground and 65.71% on low land. Pits situated on low land are more susceptible to rainwater runoff, increasing the risk of environmental contamination (Alam *et al.,* 2005). Improper management of these pits can lead to nitrate leaching into groundwater, phosphorus runoff into surface water, and pathogen release (Hossain *et al.,* 2009).

Regarding waste trade, 77.14% of farm owners sold their poultry waste, most commonly as manure, suggesting that some farmers view it as a simple and beneficial practice. Alam *et al.* (2005) noted that poultry waste can be used for composting, as organic fertilizer, fish feed, or even as fuel. Sarker *et al.* (2009) similarly reported that waste could be sold, used for fish feed, or contribute to crop production. The Department of Livestock Services (DLS, 2008) also recognizes poultry waste as a potential source of cattle feed and biofuel. Among those purchasing the waste, 22.85% were involved in fish farming, 45.71% were crop farmers, and 31.42% engaged in both crop and fish farming.

Table 4: Characteristics of waste management in poultry farms (continued)

Items	Category	Number	Percentage (%)	95% Confidence Interval (CI)
Frequency of wastes collection	1-2 days interval	12	34.28	22.2 - 54.5
	3 days interval	04	11.42	3.1 - 23.8
	1 week interval	05	14.28	6.6 - 33.6
	After the batch (broiler)	14	40.00	27.2 - 58.5
Odor problem during cleaning	Yes	22	62.85	48.5 - 76.2
	No	13	37.14	23.8 - 51.5
Use of disinfectant	Detergent	03	08.57	0.6 - 18.5
	Potassium permanganate + water	15	42.85	27.2 - 58.5
	Permanganate + Savlon	01	02.86	0.1 - 13.0
	Bleaching powder	09	25.71	13.6 - 42.0
	Phenol	03	08.57	0.6 - 18.5
	Others	04	11.42	3.3 - 22.5
Site of disposal	Selective pit	13	37.14	22.2 - 54.5
	Roadside	22	62.85	45.5 - 78.5
	Biogas plant	00	00	
Site of pit	High land	12	34.28	22.2 - 54.5
	Low land	23	65.71	50.4 - 80.9
Use of wastes	Sale	27	77.14	60.3 - 88.7
	Not sale	08	22.85	11.3 - 39.7

Wastes buyer	Crop Farmers	16	45.71	30.6 - 62.9
	Fish farmers	08	22.85	9.5 - 36.1
	Both	11	31.42	17.3 - 46.5
Disposal of dead birds	Selected pit	14	40.00	22.2 - 58.5
	Roadside	21	60.00	41.5 - 78.8
	Dustbin	00	00	
Site of disposal of dead bird	Inside the farm	03	08.57	1.6 - 22.3
	Outside the farm	32	91.43	77.7 - 98.4
Neighbors complain about pollution	Yes	26	74.28	60.3 - 88.7
	No	09	25.71	11.3 - 39.7
Pollution by wastes, dead birds, and bad odor	Yes	24	68.57	53.7 - 81.2
	No	11	31.43	18.8 - 46.3
Measure to minimize pollution	Regularly clean	13	37.14	22.2 - 54.5
	CaO spread	06	17.14	6.6 - 33.6
	Do nothing	16	45.71	30.6 - 62.9

According to Table 4, 40% of farmers disposed of dead birds in designated pits, while 60% disposed of them on the roadside, and surprisingly, none used government-provided dustbins for disposal. Additionally, 08.71% of farmers stated that the disposal pit was located inside their farm. Around 91.43% reported it being outside. Moreover, 25.71% of farmers mentioned they had no complaints from neighbors regarding waste management. Whereas the remaining 74.28% faced complaints. Table 4 also shows that 31.43% of farmers believed that poultry wastes do not cause environmental pollution, while 68.57% considered them a pollutant.

Hossain *et al.* (2009) and Griffiths (2004) highlighted that improper handling of waste can contribute to environmental pollution. Poultry wastes represent the largest waste issue, with problems arising from disposal, odors, and pollution of soil, water, and air (Sims and Wolf, 1994; Henuk, 2001; Bell, 2002). Proper disposal of dead birds is an essential component of structural biosecurity (Aziz *et al.,* 2009). In efforts to minimize environmental pollution, 37.14% of farmers regularly cleaned their farms, 17.14% spread CaO (lime), and 45.71% took no action. Proper poultry waste management is critical in protecting the environment from pollution (Hossain *et al.,* 2009).

CONCLUSIONS

The findings of this study highlight significant gaps in poultry waste management and biosecurity practices in Jhenaidah, Bangladesh. Improper waste disposal methods lead to contamination of water sources, soil degradation, and the spread of poultry diseases. The lack of awareness and training among farm owners, inadequate biosecurity measures exacerbates the risks associated with poultry farming. However, there are opportunities to improve waste management through the adoption of sustainable practices. The study underscores the need for government intervention, farmer education and the development of standardized waste management protocols. By improving waste disposal practices and promoting biosecurity measures, the poultry sector can mitigate its environmental impact, reduce public health risks and contribute to the sustainable development of Bangladesh's agricultural economy.

Author's contribution

Conceptualization, data curation, investigation, and writing original draft: Bristi Devnath; Data analysis and writing the manuscript: Anwar Hossain Rana and A.S.M. Mohiuddin; Data collection and methodology: Deepanjana Sarker, Md. Muraduzzaman and Shayed Mohaimen; visualization and review: Partha Pratim Ghosh; Preparation of final manuscripts, formal analysis, review and editing: Kazi Abdus Sobur; Supervision of the study: Biplob Kumar Sarker

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