

# Chapter-1

## Introduction

Poultry farming in Bangladesh is the mode of keeping various types of birds for meat, egg, feather or sale. Poultry birds are broadly used in Bangladesh for meat and egg. Weather condition of Bangladesh is immensely friendly for poultry farming. According to DLS, 2019-2020 survey total poultry population in Bangladesh is 3563.18lakh.

Although poultry industry having extensive effect in both livelihood and economical effect in any country but it has some negative effect in our environment related to large scale accumulation of poultry wastes including manure and litter which may pose public health and environmental problems. About 3079 metric tons poultry manures are produced daily from a total of 42 million chickens in Bangladesh (Waste concern, 2005). Farmers in Bangladesh do not concern or knowledgeable about waste management of Poultry although it has posed serious environmental pollution problems. Globally, an excess of 90% poultry waste is spread as fertilizer on land close to the poultry farms (Moore *et al.*, 1995). This practice could negatively affect the environment protection and safety through surface and groundwater pollution at high level (Gerber *et al.*, 2006). Water-borne diseases can also spread from the poultry manure. Moreover, improper management of poultry wastes also causes air pollution through offensive odors and promotes the breeding of fly and rodent (Adeoye *et al.*, 1994).

According to (Thornton *et al.*,2006) natural resource base, public health, social equity and economic growth can be hampered by negative livestock system effects. Necessary precautions must be taken along the poultry production, marketing and processing chains, poultry meat and eggs, otherwise it can be spread infectious agents that are harmful to humans.

The positive significant effect of education and farming experience on the farmers' perceptions increase their knowledge in handling environmental challenges relating to commercial poultry farming practice to provide safety environment in the society.

By using appropriate biosecurity measures including management and physical measures can help to reduce the risk of entrance, induction and spread of diseases, infections or infestations within a population. According to previous studies (Fraser *et al.*, 2010; Julien and Thomson, 2011) biosecurity helps in improving the health status of poultry by preventing the introduction of new disease pathogens by assessing all possible risks to animal health.

Clear understanding of the perception of poultry farmers on the environmental issues associated with commercial poultry farming is a useful first step because good perception helps the farmers to maintain appropriate environment on the farming area. According to Adesina and Baidu-Forson (1995) perception on waste management is a vital indicator on adaptation process. In Bangladesh, very limited numbers of studies have so far done to understand the status of farmer's perception or knowledge about poultry waste management. Therefore, the present study was undertaken to evaluate the present status of farmer's knowledge, perception and attitude towards the waste management strategies among the poultry farmers in Mirsharai Upazila, Chattogram, Bangladesh.

## Chapter-2

### Materials and Method

#### 2.1 Study Area

The study was conducted at Mirsharai Upazila with an area of Chattogram District in the division of Chattogram, Bangladesh. It consists of 2 Thana and 2 Pauroshava. Mirsharai is located at 22.7722°N 91.5750°E. 55771 households are staying here and total area is 482.88 km<sup>2</sup>. The population of poultry farms are near about 100 and 35 farms are randomly selected from this population as sample for this study.

#### 2.2 Data Collection Procedure

A Structure Questionnaire is formulated and Including plethora of data for keeping our study objectives in view. The questionnaire was pre-evaluated with selected Livestock officers at Mirsharai Upazila so as to ensure that the questionnaire did not contain any obscurity and it could be easily perceived and complete by respondent. Data were collected through personal interview during February to May 2021.

Information was obtained on Socio demographic characteristics of farmers, Litter and Waste management knowledge, Housing and litter Management, Biosecurity practicing, Personal Hygiene, Knowledge about Zoonotic diseases, health and environmental effects of poultry wastes, perception of farmers on environmental issues related with farming, etc. Additional information was gathered through personal communication during farm visits.

**Data analysis:** Data were analyzed by using simple statistical methods for calculating frequencies and percentages and the results are submitted in tables.

## Chapter- 3

### Results and Discussion

**Table 1** indicates the current scenario of socio-demographic characteristics of farmer in the study area. The age of the majority (46%) of the farmers of this study is ranges from 30-39 years followed by the age group 20-29 years (34%). The highest part of the age group fell into the age group of 39 to 45 years which was 36 percent. Around 97% farmers were male whereas only 3% was female. It is indicating that women farmer participation in poultry rearing is low in this area. In addition, that poultry farming needs physical strength which is low in women.

**Table 1: Socio demographic Characteristics of farmers**

Types	Categories	Frequency (N)	Percentage
Age (years)	20-29	12	34
	30-39	16	46
	40-49	4	11
	50-59	3	9
Gender(M/F)	Male	34	97
	Female	1	3
Marital Status	Married	24	69
	Unmarried	11	31
Education Level	Under SSC	2	6
	SSC	11	31
	HSC	10	29
	Honours	5	14
	Masters	4	11
	Uneducated	3	9
Monthly Income	1k-10k	16	46
	11k-20k	11	31
	21k-1lakh	2	6
	Running	6	17
Other Livestock	Cattle	6	17
	Goat	1	3
	None	28	80

Majority of the responds (69%) were married. Most of the responds completed only SSC (31%), HSC (29%) whereas the 14 and 11% farmers obtained graduate and Master's degree, respectively. Around 9% famer is illiterate and 6% only completed

primary education level. This result indicates the education level of the farmers under this study is average. Skinner (2004) reported that education plays crucial role to proper waste management and hygiene leading to prevention of diseases and their potential hazards. Monthly income of the framers (46%) is under 10,000 taka. Only 20% farmers were having only cattle and goat in addition with poultry that indicates farmers did not engage large animal farming.

**Table 2: Characteristics of study farms**

Types	Categories	Frequency (N)	Percentage
<b>Farm types</b>	Sonali	3	8.57
	Desi	3	8.57
	Broiler	25	71.43
	Pigeon	1	2.86
	Duck	2	5.71
	Fancy	1	2.86
<b>Flock size</b>	0-1000	18	51.43
	1001-2000	11	31.43
	2001-3000	4	11.43
	3000>	2	5.71
<b>Experience</b>	Yes	21	60
	No	14	40

**Table 2** showed that around 71% poultry farmers were preferred broiler rearing due to its upgraded genetic combination from others. These results agree with (Laseinde *et al.*, 2005) who said that broiler production is more profitable than layer production in this part of the country. This study also showed that around 3% of poultry farmers reared fancy birds. The flock size of the most of the farmers (51.43%) was very small (0-1000 birds) whereas a small percentage of farmers (5.71%) had large flock (<3000 birds). Around 60% farmers were experienced in poultry farming while 40% farmers had no experience.

**Table 3: Housing & litter management of study farms**

Parameter	Categories/Time interval/Name	Frequency (N)	Percentage
<b>House type</b>	Tin shed	14	40
	Semi Paka	19	54
	Building	2	6
<b>Floor type</b>	Concrete	26	74
	Mud	9	26
<b>Litter Material used</b>	Saw dust	27	77
	Sand	5	14
	Rice husk	2	6
	None	1	3
<b>Litter Removal Method</b>	All in All out	33	94
	None	2	6
<b>Clean all before replace</b>	Yes	34	97
	No	1	3
<b>Remove only top most litter</b>	Yes	4	11
	No	31	89
<b>Time of litter change</b>	4 days interval	1	3
	15 days interval	10	28
	30 days interval	21	60
	60 days interval	1	3
	Not change	2	6
<b>Litter-treatment Method</b>	PLT solution	6	17
	Yuka	3	9
	Savlon	10	29
	Timsen	7	20
	GPC 8	4	11
	Potash	1	3
	None	4	11
<b>Material used to prevent Air</b>	Yes	12	34
	No	23	66

**Table 3** indicates that around 54% people preferred semi paka house and 74% people reared poultry in concrete as floor. (Moore *et al.*, 2004) found that similar results as farmer reared birds in Concrete floors due to concrete are damp proof thereby making it easier to manage litter. Saw dust was commonly use, around 77% because of its availability. (Charles *et al.*, 2005) also reported that saw dust was the most popular

poultry litter materials used in the world. Most of the respond (94%) clear litter material at a time. In addition, that 89% people expel out whole litter material at a time and whereas 97% people did clear all sorts of materials before replacement. Around 60% people replaced litter in 30 days gaps before entry of new flock. Farmers preferred to use antiseptic as Savlon 27% and Timsen 20% for Cleaning the litter materials. Most of the responds (66%) used material to prevent air during cold weather.

**Table 4: Biosecurity status of the farms**

Types	Categories	Frequency (N)	Percentage
<b>Biosecurity</b>	Good	6	17
	Fair	23	66
	Poor	6	17
<b>Disinfectant</b>	Savlon	10	28
	Timsen	12	34
	GPC 8	9	26
	Blis. Powder	1	3
	None	3	9
<b>Foot Bath</b>	Yes	7	20
	No	28	80

**Table 4** showed that 66% people maintained biosecurity as fair mark. Maximum farmer used Timsen solution as a disinfectant where as 80% people do not use foot bath. Application of standard biosecurity measures is vital in protecting poultry birds from any disease (Dorea *et al.*, 2010) because good biosecurity in any farm keep freeing off any vulnerable diseases and increasing production performance.

**Table 5: Status of personal hygiene of working staffs**

Name	Use	Frequency (N)	Percentage
<b>Facemask</b>	Yes	16	46
	No	19	54
<b>Cloth Change</b>	Yes	0	0
	No	35	100
<b>Handwash</b>	Yes	16	46
	No	19	54
<b>Separate footwear use</b>	Yes	7	20
	No	28	80
<b>Gloves</b>	Yes	4	11
	No	31	89

Personal hygiene like use of face mask, change of clothing, washing hands, use of separate footwear, gloves was shown in **table 5**. Around 46% people used facemask during standing in farm, Zero percent not farmer were shown that did not change cloth before entrance and exit, besides 46% farmer used handwash for cleaning hand where as 20% people were used separate footwear before and after entry in farm. Using of gloves as a health safety measures used in only 11% farmers.

**Table 6: Farmers knowledge about zoonotic diseases**

<b>Disease Name</b>	<b>Known/Unknown</b>	<b>Frequency (N)</b>	<b>Percentage</b>
<b>Salmonellosis</b>	Yes	16	46
	No	19	54
<b>Colibacillosis</b>	Yes	4	11
	No	31	89
<b>Psittacosis</b>	Yes	0	0
	No	35	100
<b>Influenza</b>	Yes	27	77
	No	8	23
<b>Cryptosporidiosis</b>	Yes	0	0
	No	35	100

**Table 6** showed maximum farmer were known two zoonotic disease such as Salmonellosis 46% and Influenza 77%. Epidemiological analyses of human infections with the H5N1 avian influenza strain demonstrate that close interaction with domesticated live poultry is a risk factor for human infection with the virus (van Boven et al., 2007; Babakir-Mina et al., 2007). Farmers were well known about Avian influenza in this study area.



**Table 7: Waste generated in the study farms**

Name	Waste produce	Frequency (N)	Percentage
<b>Dung</b>	Yes	6	17
	No	29	83
<b>Waste feed</b>	Yes	17	49
	No	18	51
<b>Broken eggs</b>	Yes	0	0
	No	35	100
<b>Feather</b>	Yes	0	0
	No	35	100
<b>Dead birds</b>	Yes	7	20
	No	28	80
<b>Hatchery Waste</b>	Yes	0	0
	No	35	100
<b>Biosolids</b>	Yes	0	0
	No	35	100
<b>Litter</b>	Yes	16	46
	No	19	54

**Table 7** showed that waste generated in farm by several means like dung (17%) from Cattle, Goat, waste feed (49%), dead bird (20%) and litter (46%). (Waste concern,2005) showed about 3079 metric tons poultry manures are produced daily from a total of 42 million chickens in Bangladesh.

**Table 8: Waste management systems of study farms**

Name	Using procedure	Frequency (N)	Percentage
<b>Disposal of dead birds</b>	Burning	3	9
	Burial	23	65
	Throwing	7	20
	Selling	2	6
<b>Disposal of litter materials</b>	Agriculture land	24	69
	Fish culture	5	14
	Sell	5	14
	River	1	3

**Table 8** showed that management of waste by several means. A majority of farmers (65%) buried the dead birds followed by throwing (20%) and burning (3%). In case of litter materials, maximum (69%) farmer threw out litter material in Agriculture land whereas 16 % farmers sell or used litter in fish culture. A small percentage (3%) of

farmers disposes the litter materials in the river. Moreki & Kealkitse (2013) reported that there were several ways of disposing poultry waste which include burial, rendering, incineration, composting, feed for livestock, fertilizer or source of energy which is in agreement with current finding in this area.

**Table 9: Knowledge about farm management**

Managements	Name	Frequency (N)	Percentage
<b>Therapeutic managements</b>	Self	4	11
	Vet	11	31
	Dealer	3	9
	Self & Vet	15	43
	Self& Dealer	2	6
<b>Knowledge about farm management</b>	<b>Yes</b>	13	37
	<b>No</b>	22	63

The highest number of farms (43%) treated sick birds by both veterinarian and self- whereas only 31% farms were treated by only veterinarian (Table 9). A small percentage of farm's (9%) were treated by both dealer and self -experience. These results agreed with Radwan *et al.* (2011) and Kantengwa (1988).

**Table 10: Farmers awareness about health and environmental effects of poultry wastes**

Name	Aware/Not Aware	Frequency (N)	Percentage
<b>Depletion of Ozone Layer</b>	<b>Aware</b>	<b>19</b>	<b>54</b>
	Not Aware	16	46
<b>Water Pollution</b>	<b>Aware</b>	<b>33</b>	<b>94</b>
	Not Aware	2	6
<b>Air Pollution</b>	<b>Aware</b>	<b>34</b>	<b>97</b>
	Not Aware	1	3
<b>Prevalence of poultry diseases</b>	<b>Aware</b>	<b>34</b>	<b>97</b>
	Not Aware	1	3
<b>Pest infestation</b>	<b>Aware</b>	<b>34</b>	<b>97</b>
	Not Aware	1	3
<b>Risk of human Diseases</b>	<b>Aware</b>	<b>34</b>	<b>97</b>
	Not Aware	1	3
<b>Noise</b>	<b>Aware</b>	<b>35</b>	<b>100</b>
	Not aware	0	0

**Table 10** showed the status of farmer’s awareness about on health and environmental effects of poultry wastes. All (100%) the farmers were aware about the noise problems produced from poultry farms. Most of the farmers were concern about the poultry farms related water pollution (94%), air pollution (97%), pest infestation (97%) and risk of human disease (97%). Only 46% farmers were aware about the depletion of ozone layer due to poultry farm waste. Anosike (2007) reported that poultry production activities enhance environmental pollution of air, water and foul odour emission which causes huge discomfort to both the human and animal lives. Evans & Woolf (2013) was also said that ammonia emissions from poultry waste can have multiple health hazards including nasal irritation and cough for both human and animal.

**Table 11: Farmers receive training**

<b>Name</b>	<b>Training</b>	<b>Frequency (N)</b>	<b>Percentage</b>
<b>Farm Management</b>	Yes	5	14
	No	30	86
<b>Waste Management</b>	Yes	3	9
	No	32	91
<b>Biosecurity</b>	Yes	3	9
	No	32	91

Farmers receive training in several fields which present in **Table 11**. This table showed that only 14% farmer received training on farm management. Around 91% farmers had no training on waste management and biosecurity. This observations in not consistent with finding of previous studies (Sarker *et al.*, 2009; Hossain and Ali, 2009) where 21% and 36% farmers received biosecurity and farm management training.

**Table 12: Waste Management facilities**

<b>Name of facilities</b>	<b>Present/Absent</b>	<b>Percentage</b>
Manure Storage System	<b>Absent</b>	0
Box Type Manure Spreader	<b>Absent</b>	0
Incinerator	<b>Absent</b>	0
Pits flush System	<b>Absent</b>	0
Automated dry system	<b>Absent</b>	0
Double deck pre-cleaner	<b>Absent</b>	0
Pressure sprayer for fumigation	<b>Absent</b>	0

Different types of waste management facilities were showed in **table 12**. None of the farms under this study had manure storage system, box type manure spreader, incinerator; pits flush system, automated dry system and fumigation facilities. Amin et al. (2009) reported that 90% of storage systems were uncovered in poultry industries which are closely related with this study area finding.

**Table 13: Farmers awareness about environmental protection agency**

Statement	Aware/Not Aware	Frequency (N)	Percentage
Hear about environmental protection agency	Not Aware	0	0
Awareness environmental protection laws	Not Aware	0	0
Agencies Visit to farm in the past	Not Aware	0	0

**Table 13** shows the scenario of awareness on environmental protection agency among the farmers of the study area. The table indicated that none of the farmer under this study had any kind of awareness on environmental protection agency, environmental protection laws and their tasks.

**Table14: Farmer’s attitude towards adaption of new technology of waste management**

Technology help to recycling waste	Agree All Persons
Technology increases the working efficiency	Agree All Persons

### **Farmer’s attitude**

**Table 14** showed that farmers attitude towards adaption of new technology of waste management. All the farmers (100%) were agreed that technology can help to recycling waste and technology subsequently increases the working efficiency.

**Table 15: Knowledge level of farmers about waste management**

Statement	Frequency		Percentage		Knowledge level
	Known	Unknown	Known	Unknown	
Manure & Dead poultry are the only Poultry wastes	31	4	89	11	Well Known
Poultry houses should be kept dry all the time	31	4	89	11	Well Known
Frequent packing of litter is only to prevent birds to contact disease	19	16	54	46	Mediocre
Poultry litter is not useful for land application	14	21	40	60	Fair
Storage of litter before land application must be done on the farm	30	5	86	14	Well Known
Dry litters should be stored in the open for a long time	21	14	60	40	Mediocre
Composting poultry litters does not reduce their odor	17	18	49	51	Fair
Collection of dead birds every other day will prevent spreading of disease	29	6	83	17	Well Known
Empty containers must be disposed according to the discretion of the farmer	32	3	91	9	Well Known
Poultry waste cannot be useful for other purposes	26	9	74	26	Good
Dead birds can be buried anywhere on the farm	14	21	40	60	Fair
Too much noise from birds kept inside the pen can cause hearing problems to the farmers	34	1	97%	3%	Well Known

### **Farmer's knowledge**

**Table 15** summarizes the knowledge level of waste management. Knowledge level in case of Manure & Dead poultry wastes, Storage system of litter materials, Poultry house management, Dead birds that spreading diseases, noise problem related to neighbors is well known. Knowledge level about litter management is mediocre. Using of poultry litter and dead bird buried system knowledge is at fair level.

**Table 16: Perception of commercial poultry farmers on environmental issues associated with poultry farming**

Statement	Strongly Agree	Agree	Disagree	Undecided	Decision
Odour from poultry house produces flies and causes discomfort to the neighbours.		94%	3%	3%	High
Odour from poultry wastes can cause sickness to farmers and their neighbours	3%	97%			High
Excessive dumping of poultry wastes in water can cause harm to aquatic life		91%	3%	6%	High
Offensive odour coming from Poultry house can cause conflict between farmers and their neighbours.	3%	94%	3%		High
Offensive odour coming from animal house can make neighbours house unfit for social gathering	3%	91%		6%	High
Dead birds buried in the ground can decay and contaminate the ground water.		94%	3%	3%	High
Poultry wastes produce poisonous gases which can cause respiratory problems to the farmers when continuously inhaled.		97%		3%	High
Poultry wastes gathered up together in one place can decay and contaminate the water table and pollute drinking water nearby.		94%		6%	High
Improper poultry waste disposal invites pests and rodents such as rats, cockroaches e.tc which can be vectors or carriers of diseases.		97%		3%	High
Poultry wastes produce gases which contribute to global Poultry wastes produce gases which contribute to global warming and climate change		97%		3%	High

### **Farmer's perception**

Perception of commercial poultry farmers on environmental issues associated with poultry farming is shown in **Table 16**. Perception level on odour problem from poultry house, sickness to farmers and their Neighbours, fly problem, aquatic life, contaminate ground water, pollution of drinking water, Global warming and climate change is High level.

**Table: 17: Overview of Constraints to adoption of integrated waste management practices**

<b>Parameter</b>	<b>Very Severe</b>	<b>Severe</b>	<b>Not Severe</b>	<b>Not Constraint</b>
Insufficient fund	3%	9%	82%	6%
Shortage of labor	3%	9%	82%	6%
Lack of extension information and contacts	3%	9%	85%	3%
Lack of demand for manure from livestock farmers	3%	12%	71%	14%
Inadequate waste storage facilities	0%	26%	63%	11%
Inadequate knowledge of waste management practices	0%	9%	77%	14%
Difficulty to burn during raining season	0%	20%	69%	11%
Lack of vehicle and transport costs	3%	3%	68%	26%
Poor pricing of poultry manure	0%	14%	72%	14%
Inadequate access to land	3%	11%	57%	29%
Bad attitude of farm attendants	0%	11%	35%	54%
Inadequate waste disposal facilities	0%	11%	66%	23%

**Constraints of adoption of integrated waste management practices**

Table 17 summarizes the different constraints that are facing by farmers towards the adoption of integrated waste management practices. Around 3% farmers mentioned that insufficient fund, shortage of labor, lack of extension of information and contacts, lack of demand of manure from livestock farmers and lack of vehicle and transport costs are the severe constraints in adopting integrated waste management practices. Around 26 and 20% farmers thought that inadequate waste storage facilities and difficulty of burring waste during rainy seasons also act as severe constraints respectively in adoption of integrated waste management practices. In this finding 70-90% farmer do not have severe problem about insufficient fund, labor shortage, lack of extension information and lack of manure demand, inadequate knowledge of waste management, whereas 30-69 % farmer do not face severe problem on waste storage area, vehicles problems, land problem, waste disposal facilities.



## **Chapter- 4**

### **Conclusion**

In conclusion, knowledge level of waste management was well known by the farmers in the present study area. Perception of commercial farmers on environmental issues associated with poultry farming was high. None of farmer had waste management facilities. None of them were aware about the task of Environmental Protection agency. All the farmers were agreed that using technology could help in recycling waste with increasing working efficiency. Biosecurity level was fair among the farmers in this area. Highest percentage of farmers was known about two zoonotic disease name's salmonellosis and avian influenza. All farmers agreed with recycling waste by using technology and aware with health and environmental effect on poultry wastes.

## **Limitation of the Study**

- All farmers were not co-operative and friendly.
- Observable poultry disease and clinical sign was not available.
- The study was conducted in selected farm due to limited time during internship rotation.

## **Recommendation**

The study recommends that increase waste management facilities among the farmers and giving training about farm management and biosecurity. Campaign or training should be provided to the farmers to raise awareness about environmental protection act and awareness about public health issues.

## Chapter -5

### References

**Adesina, A. A., & Baidu-Forson, J. (1995).** Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. *Agricultural economics*, 13(1), 1-9.

**Adeoye, G. O., Sridhar, M. K. C., & Mohammed, O. E. (1994).** Poultry waste management for crop production: Nigerian experience. *Waste management & research*, 12(2), 165-172.

**Anosike, V. (2007).** Health Implications of Poultry Waste Utilization for Urban Agriculture: An Ecohealth Approach. *Epidemiology*, 18(5), S53.

**Abdullah-Al-Amin, M., Rahman, M. S., Howlider, M. A. R., & Ahmed, M. M. (2009).** Disposal of layer droppings reared in case and impact on environmental pollution. *Journal of the Bangladesh Agricultural University*, 7(452-2016-35804).

**Concern, W. (2005).** CDM project potential in the poultry waste management sector in Bangladesh. *Banani Model Town, Dhaka, Bangladesh*.

**Charles, E. B. (2005).** Litter management for confined turkeys. *Poultry science and technical guide*, (41), 3-7.

**Dorea, F. C., Berghaus, R., Hofacre, C., & Cole, D. J. (2010).** Survey of biosecurity protocols and practices adopted by growers on commercial poultry farms in Georgia, US A. *Avian diseases*, 54(3), 1007-1015.

**DLS. Livestock Economy at a glance. (2019-20)**

**Evans B and SH Woolf. (2013).** The potential health impact of a poultry litter- to-energy facility in the Shenandoah Valley, Virginia. Center for Environmental studies Virginia Commonwealth University.

**Fraser, R. W., Williams, N. T., Powell, L. F., & Cook, A. J. C. (2010).** Reducing Campylobacter and Salmonella infection: Two studies of the economic cost and attitude to adoption of on-farm biosecurity measures. *Zoonoses and Public Health*, 57(7-8), e109-e115.

**Gerber, P., Opio, C., & Steinfeld, H. (2007).** Poultry production and the environment—a review. *Animal production and health division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 153.*

**Hossain, M. M., & Ali, M. S. (2009).** Waste management in poultry farms and environmental protection in Bangladesh. In *Proceedings of the 6th International Poultry Show and Seminar. The World Poultry Science Association, Bangladesh Branch, Dhaka, Bangladesh* (pp. 199-202).

**Leibler, J., Otte, J., & Silbergeld, E. K. (2008).** Zoonotic disease risks and socioeconomic structure of industrial poultry production: review of the US experience with contract growing. *Research Reports RR*, (08-06).

**Moore, P. A., Daniel, T. C., Sharpley, A. N., & Wood, C. W. (1995).** Poultry manure management: Environmentally sound options. *Journal of soil and water conservation*, 50(3), 321-327.

**Moreki, J. C., & Keaikitse, T. (2013).** Poultry waste management practices in selected poultry operations around Gaborone, Botswana. *International Journal of Current Microbiology and Applied Sciences*, 2(7), 240-248.

**Radwan, G. N., Wahid, W. Y. A., El-Derwy, D., & El-Rabat, M. (2011).** Knowledge, attitudes, and practices of avian influenza among backyard poultry breeders in Fayoum Governorate, Egypt. *The Journal of the Egyptian Public Health Association*, 86(5 and 6), 104-110.

**Swu, I. C., & Singh, S. P. (2012).** Constraints perceived by broiler farmers in adoption of scientific poultry production practices. *Veterinary Practitioner*, 13(1), 116-120.

**Skinner, J. H. (2004).** Solid waste management policies for the 21st century. In *Waste Management Series* (Vol. 4, pp. 1091-1098). Elsevier.

**A. Keftop, and P. Lacy (Eds).** Solid Waste Assessment, Monitoring and Remediation. Twardorwska pp. 1091-1098

**Sarker, B. C., Alam, M. A., Rahman, M. M., Islam, A. F. M. T., & Chowdhury, M. G. F. (2009).** Waste management of commercial poultry farms in Bangladesh. *Journal of innovation and development strategy*, 2(3), 34-37.

**Thornton, P. K. (2010).** Livestock production: recent trends, future prospects. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1554), 2853-2867.

## Appendix

### Questionnaire:

#### ✓ Socio Demographic characters

<b>Name Of Farmer</b>	
Location	
Gender	
Age	
Marital Status	
Education level	
Monthly Income	
Other Livestock	

#### ✓ Farm Characteristics

<b>Types of Farm</b>	
Flock Size	
Farming experience	

#### ✓ Housing and litter Management

1. House type	
2. Type of floor	
3. Litter material used	
4. Litter removal method	
a. Clear all and sweep floor before replacing	
b. Remove only topmost litter	
5. Frequency of litter change (every day, once a week, every month, every 6 months)	
6. Litter treatment method (lime, drying etc. or other method)	
7. Material Used to prevent air passage	

✓ **Biosecurity Practicing**

<b>Biosecurity</b>	<b>Good/fair/Poor</b>
Disinfectant use	
Foot bath	

✓ **Personal hygiene of working staffs**

<b>Parameter</b>	<b>Observation (yes/NO)</b>
Face mask	
Change of clothing	
Hand washing before entrance	
Hand washing after work	
Separate footwear	
Change footwear before leaving the farm	
Use gloves	

✓ **Knowledge About Zoonotic diseases/ Waste related Diseases**

<b>Disease Name</b>	<b>Known/ Unknown</b>
Salmonellosis	
Colibacillosis	
Psittacosis	
Influenza	
Cryptosporidiosis	

✓ **Waste Management**

Disposal of dead birds	Burial/Burning/Selling/Throwing
Disposal of litter materials	Sell/Fish Culture/Agricultural land

➤ **Waste Generated by respondents**

<b>Waste generated</b>	<b>Amount</b>
Dungs	
Waste feed	
Broken eggs	
Feather	
Dead birds	
Hatchery waste	
Biosolids	
Litter	

✓ **Waste management facilities**

<b>Parameter</b>	<b>Present/Absent</b>
Manure storage system	
Box type manure spreaders	
Incinerator	
Pits flusher system	
Automated litter dryer system	
Double deck pre cleaner	
Pressure sprayer for fumigation	

✓ **Knowledge level of waste management**

<b>Knowledge statement</b>	<b>Yes/No</b>
Manure and dead poultry are the only poultry wastes	
Poultry houses should be kept dry all the time	
Frequent packing of litters is only to prevent birds to contact diseases	
Poultry litter is not useful for land application	
Storage of litter before land application must be done on the farm	
Dry litters should be stored in the open for a long time	
Composting poultry litters does not reduce their odor	
Collection of dead birds every other day will prevent spreading of disease	
Empty containers must be disposed according to the discretion of the farmer	
Poultry wastes cannot be useful for other purposes	
Dead birds can be buried anywhere on the farm	



✓ **Health and environmental effects of poultry wastes**

Parameter	Awareness/Not Awareness
Depletion of ozone layer	
Water pollution (surface water and ground water)	
Air pollution	
Prevalence of poultry disease	
Pest infestation	
Risk of human infection (respiratory, digestive, etc.)	
Noise	

✓ **Other management:**

Therapeutics management	Self/veterinarian/dealer/quack
Knowledge about farm management	

✓ **Perception of commercial poultry farmers on environmental issues associated with poultry farming:**

Odour from poultry house produces flies and causes discomfort to the neighbours.	SA, AG, UD, DA
Odour from poultry wastes can cause sickness to farmers and their neighbours	SA, AG, UD, DA
Excessive dumping of poultry wastes in water can cause harm to aquatic life	SA, AG, UD, DA
Offensive odour coming from Poultry house can cause conflict between farmers and their neighbours.	SA, AG, UD, DA
Offensive odour coming from animal house can make neighbours house unfit for social gathering	SA, AG, UD, DA
Dead birds buried in the ground can decay and contaminate the ground water.	SA, AG, UD, DA
Poultry wastes produce poisonous gases which can cause respiratory problems to the farmers when continuously inhaled.	SA, AG, UD, DA
Poultry wastes gathered up together in one place can decay and contaminate the water table and pollute drinking water nearby.	SA, AG, UD, DA
Improper poultry waste disposal invites pests and rodents such as rats, cockroaches e.tc which can be vectors or carriers of diseases.	SA, AG, UD, DA
Poultry wastes produce gases which contribute to global warming and climate change	SA, AG, UD, DA
Too much noise from birds kept inside the pen can cause hearing problems to the farmers	SA, AG, UD, DA

Unpleasant odour from the poultry house can prevent vehicles from transporting people to the area.	SA, AG, UD, DA
Pesticides used in washing or disinfecting poultry house can cause pollution when they enter surface or ground water.	SA, AG,UD, DA
Dust generated during food distribution can cause nose irritation	SA, AG,UD, DA
Over application of poultry wastes to the soil can contaminate the soil and make it useless for crop production.	SA, AG,UD, DA

✓ **Farmers on awareness of Environmental Protection agency**

Hear about environmental protection agency	Yes	No
Awareness environmental protection laws	Yes	No
Agency's visits to farm in the past	Yes	No

✓ **Farmers' awareness of activities performed by EPA in managing environmental pollution**

Activities	Aware/Not Aware
Enforcement of environmental laws	
Arresting and prosecuting environmental law offenders	
Conducting environmental awareness campaign	
Issuing of warning notice to farmers due to public complaints on Pollution	
Education of poultry farmers on waste disposal	
Inspection of poultry houses	
Monitoring and survey of water, air, land and soil in case of Pollution.	

✓ **Farmers attitude towards adaption of new technology of waste management**

1. Technology help to recycling waste
2. Technology increases the working efficiency

✓ **Constraints to adoption of integrated waste management practices**

---

	<b>Constraints</b>	<b>Very severe</b>	<b>Severe</b>	<b>Not severe</b>	<b>Not a constraint</b>
1	Insufficient fund				
2	Shortage of labor				
3	Lack of extension information and contacts				
4	Lack of demand for manure from live stock farmers				
5	Inadequate waste storage facilities				
6	Inadequate knowledge of waste management practices				
7	Difficulty to burn during raining season				
8	Lack of vehicle and transport costs				
9	Poor pricing of poultry manure				
10	Inadequate access to land				
11	Bad attitude of farm attendants				
12	Inadequate waste disposal facilities				

✓ **Farmers received any training on farm management, waste management, biosecurity**

<b>Types of training</b>	<b>Response of farmers (yes/no)</b>
Farm management	Yes/No
Waste management	Yes/No
Biosecurity	Yes/No