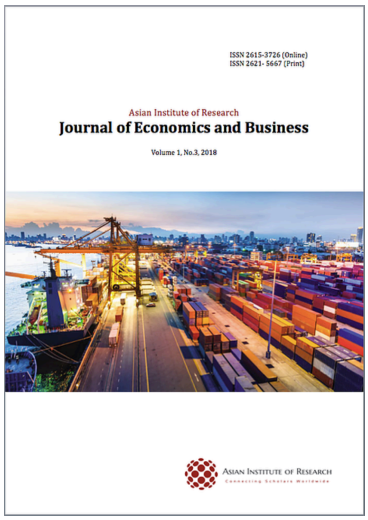

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Economic Impact of Newcastle Disease on Village Chickens – A Case of Bangladesh

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Abstract
Newcastle Disease (ND) is a highly contagious viral disease and makes up to 100 percent mortality in susceptible populations during devastating outbreaks. The households face huge economic losses throughout the year. Still, it is ranked 1st among other poultry diseases in village chickens. However, the study was undertaken to determine the profitability of village chicken and to estimate the direct and indirect economic loss due to ND as well as its impact on household dietary diversity. The study was encompassed four Upazilas from four Districts, i.e., Gopalpur from Tangail, Nilphamary Sadar from Nilphamary, Gowainghat from Sylhet and Barishal Sadar from Barishal District. Both primary and secondary data were used in this study. From each Upazila 75 sample farmers were interviewed randomly who reared the village chicken, and the total sample size was 300. Primary data were collected through a structured questionnaire during the months of October to January 2017. Total return was estimated at BDT 4530 and BDT 6099, respectively for affected and non-affected farm household. The study also found that due to ND outbreak, the average economic loss was calculated to BDT 2,561 per household per annum and average eight poultry birds were forgone per household per annum. On average, the country incurred economic loss BDT 2.43802765*1010 (US$ 288.49 million) per annum. Only 27% of household had access to Upazila Veterinary Hospital. The study found an adverse impact on household dietary diversity and in animal source food consumption. Swab and tissue sample result sowed its prevalence in study areas. In the light of research findings, the following steps should be considered: Flock size should not be higher than 20 birds, keep chicken and duck in the separate shade, training for scientific rearing system and diseases control method and mass vaccination program.

Keywords: Village Chicken, Newcastle Disease, Economic Loss, Animal Protein

1. Introduction

Bangladesh is an agriculture-based economic country with a small territory and large population. Most of the people directly depend on agriculture and live in rural and semi-urban areas. Livestock is a vital component of their farming system and an important source of animal protein. In the financial year 2011-12, Bangladesh had

produced 2428.66 lakh chickens (BBS, 2012). Avian Influenza and Newcastle Disease (ND) are the two prime fatal threats for destroying poultry sector not only in Bangladesh but also all over the globe. Undoubtedly, avian influenza is a great threat for commercial poultry sector, but in the case of village chickens, ND is a silent killer. Every year it kills millions of village chickens and takes away the last belongings of the rural poor women. From January to June/2014, there are 1408251 number chickens affected and 76337number chicken dead due to ND in Bangladesh (DLS, 2015). In developing, country like Bangladesh chickens are commonly reared by rural farm families in the traditional method that means scavenging system. Village chickens are also one of the few types of livestock that cause little impact on the environment and that require few inputs in order to yield a significant output in terms of meat and eggs (Alders and Spradbrow, 2001a). They are the livestock most likely to be owned and cared for by women and children (Gueye, 2000; Spradbrow, 1993-94). By common agreement of all but a very few of those who have studied village poultry, ND is the single greatest constraint on the production of village poultry (Alders and Spradbrow, 2001b; Alexander, 1988a, 2001; Kitalyi, 1998; Spradbrow, 1993-94). Newcastle Disease is one of the main constraints for village chicken production in Bangladesh.

In areas where ND is endemic, the disease is generally well-recognized by farmers, and it discourages them from investing time and money in improving the standard of their poultry husbandry (Spradbrow, 1996). In fact, it has been argued that ND may represent a bigger drain on the world economy than any other animal viral disease. Village chickens may be provided with rudimentary housing and occasional supplementary feed. Flocks are usually small, containing 5-20 birds per household (Gueye, 1997). ND in local scavenging chickens is very common. Rural women raise chickens under traditional management system. The majority of farmers keep their chickens in a scavenging system, where the main source of feed is household refuse and picking from the surrounding. Before the advent of avian influenza, ND was considered as the cause of the highest economic loss in village chickens in most developing countries including Bangladesh (Chowdhury *et al*., 1982; Alexander, 2001). Data on the epidemiology of ND and the impact of vaccination against ND in backyard production systems is limited (Otim *et al*., 2007). Chickens are the most significant livestock species in terms of the level of ownership, access to animal protein and the potential for earning cash income (SANDCP 2005). Village chickens play a vital role in the improvement of nutritional status and income of many poor rural households and a global asset for many millions who live below the poverty line (Copland and Alders 2005). Village poultry provides scarce animal protein in the form of meat and eggs and provides the owners with a form of saving which can help in times of need to meet essential family expenses such as medicines, clothing and school fees. Families can also increase their income by taking advantage of seasonal peaks in poultry demand, such as at religious festivals or celebrations. (Johnston and Cumming, 1991). The benefits of family poultry production include other functions for which it is difficult to assign any monetary value. These include pest control, provision of manure, and household contribution to traditional ceremonies and festivals. In addition, village chickens provide some benefits in terms of cleanliness and hygiene (Johnston and Cumming 1991). ND can cause up to 100 percent mortality in susceptible populations during devastating outbreaks. Several studies were conducted to assess the effects of vaccination against ND in village chickens. But there is no detailed research work regarding the economic loss for ND in Village Chickens.

3. Objectives of the Study:

- **i.** To assess the profitability of village chicken in traditional method;
- **ii.** To estimate the direct and indirect economic loss of the farmer and the nation as a whole due to Newcastle Disease in village chickens; and
- **iii.** To delineate the impact of Newcastle Disease on household dietary diversity status.

2. Methodology

The study was covered 4 Upazilas from 4 districts taking 75 sample farmers randomly comprised with 50 ND affected and 25 non-affected farmers were interviewed. The total sample size was 300, and simple random sampling technique was followed. Before preparing the final survey schedule, the draft schedule was pre-tested to verify the relevance of the questions and the nature of the response from farmers. After pre-testing and

necessary corrections, modifications, and adjustments, the final survey schedule was developed. Data were collected on mortality, morbidity, vaccine cost, medicine, veterinary service cost, feed, labour, and housing, etc.

Data were collected during the months of October 2016 to January 2017 by face-to-face interview. In the tabular research, technique was applied for the analysis of data using simple statistical tools like averages and percentages etc. Cost and returns analysis were done on both variable and fixed cost basis. The following profit function was used to assess the profitability of village chickens farming. The profit function, $\mu = PbQb + PLQL - \sum(PxiXi) - TFC$

Where,

$$\mu = \text{Profit or loss per farms per 10 village chickens}$$

P_b = Per unit price of live village chicken (BDT/Kg)
P_L= Per unit price of used litter and excreta (BDT/sack)
Q_b= Quantity of live village chickens (BDT/Kg)
Q_L= Quantity of waste litter (sack/10 village chickens)
P_{xi} = Per unit piece of i^{th} (variable) inputs
X_i = Number / quantity of i^{th} inputs
TFC = Total fixed costs.

Economic Loss Estimation: Economic loss was estimated comprising direct loss and indirect loss. The direct loss was estimated by summation of the value of chicken which was died due to ND attacked and treatment cost (medicine & vaccination and doctor's fee). On the other hand, the indirect loss was calculated adding up two components that mean additional time spent on taking care of affected chicken and production loss such as less egg laying. Formula written as follows:
Total Loss = Direct Loss + Indirect Loss
Direct Loss = Value chicken (dead) + Treatment Cost (medicine & vaccine + doctor's fee)
Indirect Loss = Additional time spent for taking care of affected chicken + production loss such as less egg laying
So, Total Loss = Value chicken (dead) + Treatment Cost (medicine & vaccine + doctor's fee) + Additional time spent for taking care of affected chicken + production loss such as less egg laying

$$T_c = V_c + M_c + A_c + P_c$$

Statistical Techniques: Variance and co-variance were measured to determine the relationship between household income loss from native chicken and other socioeconomic factors. Furthermore, to find out the factors influencing the household income from native chicken, the following OLS analysis was adopted. In this study, 'Multiple Regression Model' was estimated using a binary independent variable. The independent variables were household, education, family size, farm size, knowledge on ND, ND transfer, experience, training and disposal of dead chicken, etc. Multiple regression model could be written as:

$$Y = a + ß_1X_1 + ß_2X_2 + ß_3X_3 + ß_4X_4 + ß_5X + ß_6X_6 + ß_7X_7 + \beta_8X_8 + \beta_9X_9$$

Where,
Y = HH income from native chicken
X_1 = Household (1= affected, 0 = non-affected)
X_2 = Education
X_3 = Family size
X_4 = Farm size (Hectare)
X_5 = Knowledge on ND (1= Yes, 0 = otherwise)
X_6 = ND transfer (1= Yes, 0 = otherwise)
X_7 = Experience
X_8 = Training (1= Yes, 0 = otherwise)
X_9 = Disposal of dead chicken (1= if bury, 0 = otherwise)

a = Intercept
ß = Coefficient

To find out the factors influencing the household income, the following OLS analysis was adopted. In this study, 'Multiple Regression Model' was estimated using a binary independent variable. The independent variables were education, family size, farm size, knowledge on ND, ND transfer, experience, training, treatment opportunity, disposal of a dead chicken and ND outbreak, etc. Multiple regression model could be written as:

$$Y = a + ß_1X_1 + ß_2X_2 + ß_3X_3 + ß_4X_4 + ß_5X + ß_6X_6 + ß_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10}$$

Where,
Y = HH income loss from native chicken
X_1 = Education
X_2 = Family size
X_3 = Farm size (Hectare)
X_4 = Knowledge on ND (1= Yes, 0 = otherwise)
X_5 = ND transfer (1= Yes, 0 = otherwise)
X_6 = Experience (Year)
X_7 = Training (1= Yes, 0 = otherwise)
X_8 = Treatment opportunity (1= Yes, 0 = otherwise)
X_9 = Disposal of dead chicken (1= if bury, 0 = otherwise)
X_{10} = ND outbreak (1= if winter, 0 = otherwise)
a = Intercept
ß = Coefficient

To find out the factors influencing the household dietary diversity score, the following OLS analysis was adopted. In this study, 'Multiple Regression Model' was estimated using a binary independent variable. The independent variables were household, education, family size, farm size, total HH income, knowledge on ND, ND transfer, experience, training, treatment opportunity, disposal of a dead chicken and ND outbreak, etc. Multiple regression model could be written as:

$$Y = a + ß_1X_1 + ß_2X_2 + ß_3X_3 + ß_4X_4 + ß_5X + ß_6X_6 + ß_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12}$$

Where,
Y = HH dietary diversity score
X_1 = Household (1= affected, 0 = non-affected)
X_2 = Education
X_3 = Family size
X_4 = Farm size (Hectare)
X_5 = Total HH income
X_6 = Knowledge on ND (1= Yes, 0 = otherwise)
X_7 = ND transfer (1= Yes, 0 = otherwise)
X_8 = Experience
X_9 = Training (1= Yes, 0 = otherwise)
X_{10} = Treatment opportunity (1= Yes, 0 = otherwise)
X_{11} = Disposal of dead chicken (1= if bury, 0 = otherwise)
X_{12} = ND outbreak (1= if winter, 0 = otherwise)
a = Intercept
ß = Coefficient

3. Results

Rearing cost of village chicken

Costs are the spend expenditure for operating and managing the production system. The cost of production comprised of various variable cost items like feed cost, treatment cost, labour and shade preparation. Both cash expenditure and imputed value of family supplied inputs were included. The feed was the major cost item incurred by the affected and non-affected both. Feed cost was estimated for 10 birds per year BDT 531 and 542 for affected and non-affected farm household, respectively and those were 55% and 47% of the total cost. The total cost was estimated at BDT 957 and BDT 1145, respectively for affected and non-affected farm household (Table 1).

Table 1. Rearing cost of village chicken

Cost items		10 bird/ year			
		Affected		Non-affected	
		BDT	Percentage (%)	BDT	Percentage (%)
Treatment	Medicine & vaccine	133	14	169	15
	Doctor's fee	22	2	68	6
Feed		531	55	542	47
Labour wage (family supplied)		52	5	175	15
Shade		219	23	190	17
Total		957	100	1145	100

Source: Field survey, 2017.

Return from village chicken

The study identified some cash inflow streams those were chicken sold, egg sold, chicken and egg consumption in the family and gift or donation of chicken to relatives or to others. Among those cash inflow stream to the household income, chicken consumption was calculated highest for the followed by chicken sold both in affected and non-affected farm families. Total return was estimated at BDT 4530 and BDT 6099, respectively for affected and non-affected farm household (Table 2).

Table 2. Return from village chicken

Income items	10 bird/year			
	Affected		Non-affected	
	BDT	Percentage (%)	BDT	Percentage (%)
Chicken sold	1208	27	1496	25
Egg sold	1030	23	1463	24
Chicken consumption	1345	30	2036	33
Egg consumption	939	21	1079	17
Gift/donation	8	0.18	25	0.41
Total	4530	100	6099	100

Source: Field survey, 2017.

Coefficients of household income from village chicken

The independent variables were the household type, education, family size, farm size, knowledge on ND, ND transfer, experience, training and disposal of a dead chicken. It was predicted that household type, education, family size, farm size, knowledge on ND, ND transfer, experience, training and disposal of dead chicken might have positive influence to household income from native chicken. It was apparent from the value of coefficient that most of the prediction was justified and statistically significant at different levels of confidence intervals (Table 3). So, it could be concluded that non- affected farm families had better income form village chicken.

Table 3. Income from native chicken

Explanatory variable	Coefficients	Std. Error	Probability	Sig. Level
Household type	-0.219***	0.093	-0.036	0.019
Education	0.042***	0.011	0.065	0.000
Family size	0.016	0.020	0.056	0.406
Farm size (Hectare)	0.281**	0.131	0.539	0.032
Knowledge on ND	0.034	0.099	0.229	0.730
ND transfer	0.081	0.095	0.270	0.395
Experience (Year)	0.007	0.005	0.018	0.162
Training	0.227**	0.112	0.448	0.044
Disposal of dead chicken	0.175	0.094	0.362	0.065
Constant	7.410***	0.171	7.748	0.000
R^2	0.160	-	-	-
F value	6.150***	-	-	0.000

Source: author's calculation. (*,**,*** represent significant level of 10, 5 and 1 percent, respectively)

Household incurred an economic loss due to ND outbreak

In a study in India, a total of 13 flocks of 11 layer farms, total economic losses were calculated 3,719,223 rupees where mortality contributed 2,998,105 rupees (Khorajiya *et al*., 2017). In this study, due to ND outbreak, the average economic loss was calculated to BDT 2,561 per household per annum and average eight poultry birds were forgone per household per annum. In the year (2017), 37.29 percent household was affected by ND. On an average, we estimated, the country incurred economic loss BDT 2.43802765 $*10^{10}$ (US$ 288.49 million) per annum (Table 4).

Table 4. Household incurred an economic loss due to ND outbreak

Items	Tangail	Nilphamari	Barishal	Sylhet	Average
Direct Loss	1998	1651	2344	1940	1983
Indirect Loss	674	525	770	341	578
Total Loss	2672	2176	3114	2282	2561
Death chicken (no.)	7.44	9.48	8.64	7	8

Source: Field survey, 2017. (1 US$ = 84.5105 BDT)

Coefficients of Income Loss of the affected household

The most devastating disease of village poultry is ND and is responsible for a great economic loss (Awan, *et al*., 1994). For a model of economic loss, the independent variables were education, family size, farm size, knowledge on ND, ND transfer, experience, training, treatment opportunity, disposal of a dead chicken and ND outbreak, etc. It was predicted that education, family size, farm size, knowledge on ND, ND transfer, experience, training, treatment opportunity, disposal of a dead chicken and ND outbreak might have positive influence to household income from native chicken. It was apparent from the value of coefficient that most of the prediction was justified and statistically significant at different levels of confidence intervals (Table 5). So, it could be concluded that non- affected farm families had a better income than the affected families from the village chicken.

Table 5. Coefficient of income loss

Explanatory variables	Coefficients	Std. Error	Probability	Sig. Level
Education	0.012	0.012	0.037	0.318
Family size	0.030	0.021	0.072	0.164
Farm size (Hectare)	-0.089	0.131	0.169	0.497
Knowledge on ND	-0.245***	0.103	-0.042	0.018
ND transfer	-0.206**	0.099	-0.009	0.040
Experience (Year)	0.005	0.005	0.016	0.292

Training	-0.439***	0.120	-0.201	0.000
Treatment opportunity	-0.385***	0.105	-0.177	0.000
Disposal of dead chicken	-0.207**	0.103	-0.002	0.047
ND outbreak	-0.279**	0.131	-0.019	0.035
Constant	8.369***	0.205	8.774	0.000
R^2	0.307	-	-	-
F value	8.410***			0.000

Source: author's calculation. (*,**,*** represent significant level of 10, 5 and 1 percent, respectively)

Farmers' get treatment facility

Farmers had taken treatment from various sources in the study areas. Upazila Veterinary Hospital was the only means of authentic animal medical services. Only 27% of household had access to Upazila Veterinary Hospital for the treatment of ND affected poultry bird to curb the fatal disease (Table 6).

Table 6. From where farmers' get treatment

Organizations	Affected HH	Non-affected HH
Upazila Veterinary Hospital	28 (14%)	39 (39%)
Quack	151 (76%)	51 (51%)
Research Organization	0 (Nil)	0 (Nil)
Own	21 (11%)	10 (10%)

Source: Field survey, 2017.

Impact on household dietary diversity

The study found an adverse impact on household dietary diversity showing the score for affected 8.79 and non-affected 9.11 meaning that the affected farm families had consumed less amount than the non-affected farm families because the affected household had got less income or incurred loss due to chicken died for ND attacked and the purchasing capacity become squished too. They also faced a problem of safe family supplied chicken because chicken was infected by ND (Table 7).

Table 7. Impact on household dietary diversity

Sl. No.	Items	Affected	Non-affected
1	Food grains	198	100
2	Pulses	137	61
3	Edible oil	195	97
4	Leafless vegetables	163	69
5	Leafy vegetables	164	70
6	Meat	115	64
7	Egg	118	60
8	Milk	90	53
9	Fruits	111	64
10	Fish	119	63
11	Spices	126	74
12	Beverage	120	66
13	Others	102	70
	Average (**HDDS**)	**8.79**	**9.11**

Source: Field survey, 2017.

Animal source food consumption

In a household, had a wide range of animal source food items such as meat, egg, fish, and milk. But the consumption depends on the availability of the food, purchasing capacity and demand. As we know that we have demand but supply is limited. Most of the time village people tried to manage by producing them. When their

livestock specifically village chicken affected by ND and had died, simultaneously they counted loss both in cash and animal loss. It was a huge loss for a marginal farmer. It affects their consumption pattern. In case of animal source food consumption, the study found that affected household consumed 4.82 kg per week and on the other hand, non-affected household taken 5.76 kg per week (Table 8).

Table 8. Animal source food consumption

Items	Affected (n=200)			Non-affected (n=100)		
	Amount (kg.)	Sources		Amount (kg.)	Sources	
		Own	Purchase		Own	Purchase
Red meat	52.5	-	52.5	36	-	36
Goat Meat	13.5	-	13.5	8	-	8
Chicken	179.75	27	152.75	114	19	95
Duck	7	1.5	5.5	3	-	3
Pigeon	4	1	3	2.5	1.5	1
Quail	2	-	2	-	-	-
Liver	1	-	1	1.5	-	1.5
Egg	1650 (78.4)	638 (30.3)	1012 (48.1)	872 (41.5)	335(16)	537 (25.5)
Fish	285	31	254	147.5	15	132.5
Milk	341.5	139	202.5	221.5	97.5	124
Total	964.63	229.81	734.82	575.5	149	426.5
Average		1.15	3.67		1.49	4.27

Source: Field survey, 2017. Egg in number and value in the parentheses indicate Kg.

Coefficients for household dietary diversity score

The independent variables were household, education, family size, farm size, total HH income, knowledge on ND, ND transfer, experience, training, treatment opportunity, disposal of a dead chicken and ND outbreak, etc. It was predicted that education, family size, farm size, knowledge on ND, ND transfer, experience, training, treatment opportunity, disposal of a dead chicken and ND outbreak might have positive influence to household dietary diversity score. It was apparent from the value of coefficient that most of the prediction was justified and statistically significant at different levels of confidence intervals (Table 9). So, it could be concluded that non-affected farm families had a better score than the affected families.

Table 9. Coefficients of household dietary diversity score

Explanatory variable	Coefficients	Std. Error	Probability	Sig. Level
Affect HH	-0.131***	0.033	-0.064	0.000
Education	0.003	0.004	0.012	0.380
Family size	-0.010	0.007	0.003	0.129
Farm size (Hectare)	-0.045	0.049	0.052	0.359
Total HH income	2.49E	1.34E	5.12E	0.063
Knowledge on ND	0.062	0.034	0.130	0.077
ND transfer	0.072**	0.034	0.140	0.036
Experience (Year)	0.001	0.001	0.005	0.365
Training	-0.029	0.039	0.048	0.453
Treatment opportunity	-0.031	0.035	0.037	0.373
Disposal of dead chicken	0.016	0.035	0.086	0.655
ND outbreak	0.008	0.038	0.084	0.827

Constant	2.145***	0.063	2.270	0.000
R^2	0.109	-	-	-
F value	2.930***	-	-	0.000

Source: author's calculation. (*,**,*** represent a significant level of 10, 5 and 1 percent, respectively)

Swab sample and tissue sample result

ND has devastating consequences on poultry for high morbidity and mortality rates. The morbidity and mortality rates may reach up to 100% for unvaccinated flocks (Ashraf and Shah, 2014). A study in Chad, due to ND mortality was found at 55% (Antipas, *et al*. 2012). Swab sample result showed about 7% live village chicken carried ND and the tissue sample (sample was taken from the dead bird) result showed 100% carried ND indicating that ND is a fatal disease and causes huge economic loss to the household (Table 10). For this, government along with other organizations should come forward to curb the disease and protect the very enterprise of farm household.

Table 10. Swab sample and tissue sample result

	Districts	Sample size	Positive	Percentage (%)
Swab sample	Tangail	30	3	10
	Sylhet	42	0	0
	Barishal	36	6	16.67
	Nilphamary	33	0	0
	Grand total	141	9	6.38
	Districts	Sample size	Positive	Percentage (%)
Tissue sample	Barishal	21	21	100
	Nilphamary	9	9	100
	Grand total	30	30	100

Source: Field survey, 2017.

4. Conclusion

In conclusion, Native chicken might be an important source of safe animal protein supply cradle to the human dietary menu. As it is one of the primary income sources of village housewives and they deprived of a good amount of cash income every year. So, the government along with other organizations should come forward to protect this very cute enterprise of livestock and ensure sustainable development of village chicken throughout the country. In the light of research findings, the following steps should be considered:

- Flock size should not be higher than 20 birds
- Keep chicken and duck in separate shade
- Hands-on training for scientific rearing system and diseases control method
- The mass vaccination program is needed for sustainable growth and development of all livestock species

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