An Official Journal of Bangladesh Livestock Research Institute (BLRI)

Bangladesh Journal of Livestock Research

Journal Homepage: https://www.banglajol.info/index.php/BJLR

ISSN 1022-3851

Prevalence of Foot and Mouth Disease (FMD) in different affected regions of Bangladesh and its economic losses

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Abstract

The study was conducted in 13 upazilas from 850 Foot and Mouth Disease (FMD) affected households of four regions of Bangladesh during the period of July 2017 to June 2018. In all there were 4857 crossbred cattle and 2138 native cattle in the affected households. The crossbred and native cattle were grouped into three categories such as adult female, adult male and calf. The morbidity and mortality rates in crossbred cattle were 55.43%, and 5.15%, respectively and that rates in native cattle were 77.83% and 12.39%, respectively. Morbidity and mortality were found significantly higher in native cattle than in crossbred. Mortality of native calf was higher (21.27%) than in crossbred calf (9.50%). Seasonal influence of FMD was observed significantly higher in January- February (44.12%) and March-April (21.76%). There were a total of 248 pregnant cows infected in which abortion was reported in 26 (10.48%) cows. Besides this some clinical signs reported were lameness, mastitis and repeat breeding with incidences of 21, 12 and 43 cases, respectively. It was reported that 65.78% crossbred and 16.93% native cattle were vaccinated. Of the vaccinated crossbred cattle 78.37% were vaccinated by Department of Livestock Services (DLS) produced vaccine and 21.63% by imported vaccines. Vaccination cost per crossbred cattle by DLS vaccine was Tk. 49.49 and by imported vaccine Tk. 249. Disposal of dead cattle practices were left in open field, dropped into water, and buried were 17.63%, 52.87%, and 11.29%, respectively. Extrapolating the financial losses on 25.7 million cattle the annual financial losses due to FMD would be Tk. 188569.6 million (US$ 2220.82 million).

(**Keywords:** Morbidity, mortality, native cattle, Foot and Mouth Disease, Vaccination)

Bang. J. Livs. Res. Vol. 26 (1&2), 2019: P. 21-33 https://doi.org/10.3329/bjlr.v26i1-2.49934

Introduction

Livestock enterprises and animal production provide household source of income, food security, source of energy, draft power for crop cultivation, high quality animal proteins and vitamins, manure, hides and skins and bride price. In Bangladesh livestock is a vital source of providing dietary protein and also still a major source of farm power service as well as direct or indirect employment (20% of the total population) and part-time

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employment for another 50% (Rahman *et al.*, 2014; Ali *et al*., 2013). Contribution of the livestock to the country's GDP is 2.9% and its annual rate of growth is 5.5%. Agriculture contributes BDT 10468.80 millions to the national GDP, which is 13.41% to the total GDP. Agricultural farming system is contributing about 23.40% of GDP. Out of these contributions of 23.40%, livestock contributes 1,579 million (1995 US$), which is 14.40% to the total GDP (Rahman *et al.*, 2014). According to Bangladesh Institute of Development Studies (2018), livestock contributes 2.60% to the GDP of Bangladesh and 9% to the agricultural GDP. The contribution of livestock to agricultural GDP increases to 14% if the value of draught power and manure are included in GDP computation (Alam, 2002). These changes have been prompted by a rapid growth in demand for livestock products due to increase in income, rising population, and urban growth.

Though livestock contributes significantly to the economy of Bangladesh, animal diseases are still a major constraint on economic growth, reduction of poverty, and food security (Khokon *et al.*, 2017; Ali *et al.*, 2013; Bary *et al*., 2018). Among the significant diseases, foot and mouth disease (FMD) is one of the most important contagious and economically devastating viral animal disease that causes severe economic losses due to high morbidity and export trade restrictions imposed on affected countries (FAO, 2002; 2007). Morbidity can approach 100% (Woodbury, 1995; Salt *et al*., 1996; OIE, 2007), while mortality is rare in adult animals, though it may be as high as 50% (Woodbury, 1995; OIE, 2007), when the virus replicates in the heart muscles of younger animals resulting in death (Ali and Sultana, 2012).

The studies available in Bangladesh revealed that FMD is one of the most prevalent diseases. Once the outbreak starts, it continues round the year affecting large number of cattle herd (Ali *et al*., 2019). The incidence of the disease was recorded highest in 1990. An average of 130 outbreak of FMD every year has been reported from Bangladesh (Domingo *et al.*, 2002; Baryet al., 2018; Ali *et al.*, 2013). Rahman *et al*. (2014) reported the prevalence of FMD were 13.04, 12.48, 9.42 and 55.85% for cattle, buffalo, goat and sheep, respectively during 2004-2006. Giasuddin *et al*. (2017) collected 68 suspected samples from different areas of Sirajgonj district, Bangladesh from 2014-2016 and found out of these samples 48 were FMDV positive with susceptibility 70.6%. They observed higher positive cases in female cattle (75.7%) than in male cattle (64.5%). They also observed higher positive cases (77.8%) in crossbred cattle than in indigenous cattle (56.5%).

Howlader *et al*. (2004) conducted a study in Baghabari milk shed area in 1999 observed higher incidence in cows (68.01%) than in bulls/ bullocks (60.09%) and calves (56.02%). They estimated economic losses due to calf mortality, reduced milk yield and draft power followed by sheep/goats (50.96%) and buffaloes (48.02%). They estimated an economic losses at US$ 163329 incurred from 3072 FMD affected cattle due to calf mortality, reduced milk and draught power losses. Baluka *et al*. (2014) reported the annual economic cost per head of cattle due to FMD was US$ 123, US$ 41 and US$ 17 for small medium and large herd sizes, respectively. The total economic loss due to FMD is 60 million US dollar per year in Bangladesh and in India it is 4.45 billion per year (Mardones *et al.*, 2010). FMD is one of

the most prevalent diseases and whatever may be the type of virus of this disease, it causes immense loss to the livestock farmers by its high morbidity and export trade restriction imposed on affected countries (Ali *et al.*, 2020). The disease is highly contagious and known as one of the most economically devastating disease of livestock (James and Rushton, 2002). Literature on economic implications of important diseases based on field level data is scant in Bangladesh. Therefore, in this study an attempt was made to know the effect of FMD on morbidity, mortality according to age, sex and breeds of cattle, seasonal variation of the disease, financial loss incurred therein in terms of reduction in milk, death loss of, loss due to body weight of fattening cattle, treatment cost, labour cost for taking care of infected cattle, and disposal of dead cattle which caused environmental and public health hazards.

Materials and Methods

A cross-sectional study was conducted on 850 randomly selected affected households from four geographic regions of Bangladesh namely Central region (CR), North West region (NWR), South west regions (SWR) and South east region (SER) covering 13 upazilas'.

Data were collected from July 2017 to June 2018. In all there were 4857 crossbred cattle and 2138 native cattle in the affected households. The crossbred and native cattle were grouped into three categories: like adult female, adult male and calves. The proportion of crossbred and native cattle was 2.27:1. Data on cattle population, morbidity, mortality, fatality and financial losses of each affected household were recorded and uploaded into Microsoft Office Excel 2013 spreadsheet (Microsoft Corporation, USA) export into IBM SPSS Statistics for Windows, version 16 (IBM Corp., Armonk, N.Y., USA) (SPSS 16) for analysis. Chi-square test was carried out for better precision of data for estimation of morbidity, mortality and fatality due FMD. The economic losses on the selected parameters were calculated by the procedures of Kumar (2020)

Results and Discussion

Morbidity, fatality and mortality rate of crossbred and native cattle by region

The overall morbidity, fatality and mortality in crossbred cattle were 55.43%, 9.29% and 5.15%, respectively (Table 1). The SWR cattle had the highest morbidity (83.9%), followed by NWR (73.3%), CR (63.6%) and SER (28.4%).

Fatality was found the highest in CR (15.55%) followed by SER (13.63%), SWR (7.69%) and NWR (6.51%). Mortality was found the highest in CR(9.88%) followed by SWR (6.45%), NWR (4.73%) and SER (3.87%). Morbidity, fatality and mortality in crossbred cattle differed significantly by different study areas.

Again, the overall morbidity, fatality and mortality in native cattle were observed 77.8%, 15.9% and 12.4%, respectively. Significantly ($p<0.01$) higher morbidity in native cattle was found in SWR (84.92%), followed by NWR (74.56%) and CR (73.29%). Comparatively higher fatality was found in CR (21.86%) than in SWR (16.45%) and NWR (13.72%). Mortality was observed the highest in CR (16.02%) followed by SWR (13.97%) and NWR (10.23%). No

Table 1. Morbidity, fatality and mortality of crossbred and native cattle by area

Area	No. of farms	Crossbred cattle				Native cattle			
		Total no. of cattle	Morbidity	Fatality	Mortality	Total no. of cattle	Morbidity	Fatality	Mortality
Central Region	210	678 (13.96)	431 (63.57)	67 (15.55)	67 (9.88)	337 (15.76)	247 (73.29)	54 (21.86)	54 (16.02)
North West Region	298	2367 (48.73)	1736 (72.61)	113 (6.51)	113 (4.73)	1085 (50.75)	809 (74.56)	111 (13.72)	111 (10.23)
South West Region	110	31 (0.64)	26 (83.87)	2 (7.69)	2 (6.45)	716 (33.49)	608 (84.92)	100 (16.45)	100 (13.97)
South East Region	30	1757 (36.17)	499 (28.40)	68 (13.63)	68 (3.87)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
Total	850	4857 (100)	2692 (55.43)	250 (9.29)	250 (5.15)	2138 (100)	1664 (77.83)	265 (15.93)	265 (12.39)
χ^2 values*			833.40	47.17	37.98		31.57	9.56	10.40
Significance			P<0.01	P<0.01	P<0.01		P<0.01	P>0.05	P>0.05

Figures in parentheses are percentages the respective area total

native cattle were found in SER. Chi-square values showed that morbidity in native cattle differed significantly ($p<0.01$) with areas but fatality and mortality did not ($p>0.05$). The findings in the present study are supported by a previous study (Ali *et al.*, 2019) that demonstrated overall 53.89% morbidity, where as 36.34% cases in calf, and 59.77% cases were in adult cattle. They also reported mortality rate overall 2.2% with highest mortality rate in calf (71.46%). Giasuddin *et al*. (2017) in a study in Sirajgonj District found 56.5% and 77.8% FMD positive cases in native and crossbred cattle, respectively. Sorwar *et al.* (2016) in a study in Chuadanga sadar upazila in Bangladesh observed 38% and 62% prevalence of FMD in local and crossbred cattle. Mannan *et al.* (2009) reported higher (39.18%) prevalence of FMD in indigenous breed than in crossbred cattle (15.38%). Chowdhury *et al.* (2020) reported higher prevalence of FMD (33.56%) in indigenous cattle than in crossbred (15.14%). Rahman *et al.* (2015) observed higher prevalence (63.86%) of FMD in indigenous breed than crossed breed cattle (36.14%). Kouato *et al.* (2018) also reported 54% morbidity of FMD in Kenya in 2013. The mortality rate in FMD was also recorded 2.8% in Ethiopia (Rufael *et al.*, 2008) and 1.4% in South-East Asia during 2000–2010 (Ben Madin, 2011). The calves are more sensitive in FMD due to it causes myocardial necrosis called 'tiger heart disease' (Kitching, 2002). Therefore, FMD in calf causes 9.33 and 5.56 times more mortality than adult (Negusssie *et al.*, 2011).

Morbidity, fatality and mortality rate of crossbred and native cattle by category

The overall morbidity, fatality and mortality were 55.43%, 9.29% and 5.15%, respectively in crossbred cattle (Table 2). Morbidity was observed the highest for adult male (74.87%), followed by calves (67.98%) and adult female (48.40%). Fatality in crossbred cattle was observed 13.98%, 12.80% and 6.17%, for calves, adult male and adult female, respectively. Mortality was observed the highest for adult male (9.59%) followed by

Table 2. Morbidity, fatality and mortality of crossbred and native cattle by category

Category of cattle	Crossbred cattle					Native cattle				
	Total No. of cattle	Morbidity	Fatality	Mortality	Herd age specific mortality	Total No. of cattle	Morbidity	Fatality	Mortality	Herd age specific mortality
Adult female	3250	1573 (48.40)	97 (6.17)	97 (2.98)	38.80	940	752 (80.00)	79 (10.51)	79 (8.40)	29.81
Adult Male	386	289 (74.87)	37 (12.80)	37 (9.59)	14.80	582	458 (78.69)	55 (12.01)	55 (9.45)	20.75
Calves	1221	830 (67.98)	116 (13.98)	116 (9.50)	46.40	616	454 (73.70)	131 (28.85)	131 (21.27)	49.43
All category	4857	2692 (55.43)	250 (9.29)	250 (5.15)	100	2138	1664 (77.83)	265 (15.93)	265 (12.39)	100
χ^2 values* Significance		201.86 P<0.01	44.08 P<0.01	94.10 P<0.01			8.90 <0.01	9.56 p<0.01	849.86 P<0.01	

Figures in parentheses are percentages; χ^2 was estimated from absolute numbers and not from percentages; Herd category age proportional mortality rate, i.e., death specific category in a year per total deaths in the same year, expressed per 100.

calves (9.50%) and adult male (2.98%). It was found that morbidity, fatality and mortality in crossbred cattle differed significantly ($p<0.01$) with categories of cattle. Herd category specific mortality rate in crossbred cattle was found the highest for calves (46.40%) followed by adult female (38.80%) and adult male (14.80%).

Again for native cattle the overall morbidity, fatality and mortality were 77.83%, 15.93% and 12.39%, respectively. Morbidity in native cattle was the highest (80.0%) for adult female, followed by adult male (78.69%) and calves (73.70%). The highest (28.85%) fatality was observed for calves followed by adult male (12.01%) and adult female (10.51%). Mortality was 21.27%, 9.45% and 8.40% for calves, adult male and adult female, respectively. The results of chi-square values showed that morbidity, fatality and mortality in native cattle differed significantly ($p<0.01$) with categories. Herd category specific mortality rate in native cattle was the highest for calves (49.43%) followed by adult male (29.81%) and adult female (20.75%). These findings are in accordance with findings of Chowdhury *et al.* (1993) who reported calf mortality as 50.9% and Mannan *et al.* (2009) recorded higher (35.77%) incidence in male cattle than in female (15.97%) and 39.18% prevalence of FMD among indigenous breeds and 15.38% in crossbred cattle. Rahman *et al.* (2015) reported male cattle (59.04%) were more susceptible than female cattle (40.96%). Datta *et al.* (2015) observed males

(32.50%) were more susceptible than females (17.00%) and indigenous breeds are more susceptible.

Native cattle are more neglected to vaccinate and medication in the rural community due to low profitability. Native cattle are managed by low income group people with conventional farming system. Therefore, morbidity and mortality of native cattle become higher compared to crossbred cattle.

December (9.71%), September- October (6.68%) and July-August (2.75%). The occurrence of FMD differed significantly ($p<0.01$) with seasons. The result of prevalence of FMD in different seasons were also referred to the report of Chowdhury *et al.*, (1993), Khan *et al.* (2002), Mannan *et al.*, (2009), Sarker *et al*., (2011), Datta *et al.*, (2015), Rahman *et al.*, (2015), Sorwar *et al.*, (2016), who reported higher prevalence in winter seasons. In this study the infection

Table 3. Prevalence of FMD in cattle by season (% of cattle)

Area	May-June	July-August	September-October	November-December	January-February	March-April	Total
Central	0	242	96	150	190	0	678
	(0.00)	(35.69)	(14.16)	(22.12)	(28.02)	(0.00)	(100)
North West	0	31	195	273	1732	314	2545
	(0.00)	(1.22)	(7.66)	(10.73)	(68.06)	(12.34)	(100)
South West	0	0	0	0	0	634	634
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(100.00)	(100)
South East	120	379	0	0	0	0	499
	(24.05)	(75.95)	(0.00)	(0.00)	(0.00)	(0.00)	(100)
All area	120	652	291	423	1922	948	4356
	(2.75)	(14.97)	(6.68)	(9.71)	(44.12)	(21.76)	(100)
χ^2 values*	953.81	2176.57	145.87	36487.82	39071.43	37592.79	
Significance	P<0.01	P<0.01	P<0.01	P<0.01	P<0.01	P<0.01	

Prevalence of FMD by seasons

A total of 4356 crossbred and native cattle were infected by FMD in the study areas in the reference year. The seasonal variation of outbreaks of FMD is shown in Table 3. Occurrence of FMD was found to be the highest in the months of January-February (44.12%), followed by March-April (21.76%), July-August (14.97%), November-

days was found 18.46±0.36 days which varied from 14.13±0.52 to 20.48±0.79 days for crossbred cattle and for native cattle it varied from 16.14±0.64 to 23.38±1.67 days with an average of 20.68±0.44 days. Chowdhury *et al.* (1993) referred it to be ranged from 14 to 24 days with an average of 21.2 days. Howlader *et al.* (2004) found average infected days varied from 15-20 days with an average of were 18.8 days. Winter

season is more favorable for FMD virus to spread and maintain in susceptible host (Bhattacharya *et al.*, 2005).

Estimation of financial loss due to FMD infection

The FMD is a severe and highly contagious disease that causes a great financial loss to the farmers as well as to the national economy of Bangladesh. Farmers affected by presence of FMD suffer severe economic losses due to application of quarantine measures, production losses resulting from reduction in milk yield, treatment cost for affected cattle, weight loss of fattening cattle and labour cost for taking care of affected cattle. Besides these, in some cases there are occurring of abortion, mastitis, lameness and repeat breeding. The total financial loss was calculated as Taka 53.07 million for 850 affected households (Table 4).

Financial loss due to reduction in milk production

A total of 1011 crossbred milking and 440 native milking cows were infected by FMD in the studied farms.The average affected period lasted for 18.46±0.27 days and 19.56±0.40 days for crossbred and native cows, respectively. Average loss in milk yield per cattle for the infected period was 98.59 liter and 18.50 liter for crossbred and native cattle, respectively which was found to be 56%. Total milk production loss for infected period was Tk. 43,04,941 for crossbred and Tk. 3,589,74 for native cattle with a total of Tk. 46,63,915.

Financial loss due to death of crossbred cattle

A total of 250 crossbred and 265 native cattle died with the mortality rate of 5.15% and 12.39% for crossbred and native cattle, respectively. The average unit price of

Table 4. Vaccination cost of crossbred cattle.

Area	No. of crossbred cattle	No. of cattle vaccinated	Vaccination of crossbred cattle by DLS vaccine		Vaccination of crossbred cattle by other vaccine		Total Vaccination cost for crossbred cattle
			No. cattle vaccinated	Vaccination cost/cattle	No. cattle vaccinated	Vaccination cost/cattle	
Central Region	678	315 (46.46)	263 (83.49	50.50	52 (16.51)	237.50	25631.50
North West Region	2391	1314 (54.88)	1314 (100)	44.49	0 (0.00)	0.00	58460.00
South West Region	31	0 (0.00)	0 (0.00)	0.00	0	0.00	0.00
South East Region	1757	1565 (89.07)	926 (59.17)	55.50	639 (40.83)	250.00	211143.00
All area	4857	3194 (65.78)	2503 (78.37)	49.49	691 (21.63)	249.06	295973.93

Figures in parentheses are the percentages of cattle vaccinated.

crossbred cattle died was estimated as Tk. 85,920 and for native cattle Tk. 46,788.76. Total loss incurred for death of crossbred and native cattle due to FMD infection was Tk. 3,38,79,021 (33.88 million). A total of 347 farms suffered from mortality of cattle. The average loss per affected farms was Tk. 97,634 (USD 1149).

Cost of treatment of affected cattle

For calculating treatment cost veterinary doctors' fee, antibiotics, use of multivitamins and antiseptics for infected wound treatments were considered. Besides these for recovery of body weight of infected cattle farmers supplied concentrate feed. During the survey period, a total of 2692 crossbred and 1664 native cattle were affected by FMD. Average treatment cost per affected cattle was Tk 1,956 and Tk 1,043, for crossbred and native cattle, respectively. Total treatment cost for crossbred and native cattle was Tk 52,65,552 and Tk 17,35,552 , respectively. Hence total cost of treatment for infected cattle was Tk 7001104 (7.00 million) (USD 67041).

Loss due to FMD infection in Crossbred and Native fattening cattle

Financial loss due to weight loss of fattening cattle was estimated by considering the expected price of cattle before and after infection and the difference of the two prices were considered as body weight loss of the cattle. There were a total of 239 crossbred and 308 native cattle were fattened. Average financial loss per fattening cattle due to FMD infection was Tk.12349 and Tk. 8215 for crossbred and native cattle, respectively. Total financial loss due to FMD infection in 547 fattening cattle was Tk. 54,81,631 (USD 66895).

Cost of labour for taking care of affected crossbred cattle and extra feed supplied to affected cattle

During FMD outbreak the farmers of the affected farms had to spend extra time for nursing the affected cattle, disinfecting sheds and surroundings. Considering 30 minutes/ cattle per day for affected cattle during the infection period the labour cost was

Table 5. Vaccination cost of native cattle

Region	No. of native cattle	No. of cattle vaccinated	Vaccination of native cattle by DLS vaccine		Total Vaccination cost for native cattle
			No. cattle vaccinated	Vaccination cost/cattle	
Central	337	44 (13.06)	44 (100)	51.14	2250.16
North West	1085	318 (29.31)	318 (100)	51.73	16450.14
South West	716	0 (0.00)	0 (0.00)	0.00	0.00
South East	0	0 (0.00)	0 (0.00)	0.00	0.00
All area	2138	362 (16.93)	362 (100)	51.66	18700.3

Figures in parentheses are the percentages of cattle vaccinated

calculated. The cost of labour was calculated at prevailing market price of Tk. 400.00 for 8 working hour a day. The labour cost for taking care per affected cattle was Tk. 453 and Tk. 495 for crossbred and native cattle, respectively. Total cost for taking care of infected cattle was estimated to Tk. 3177266 (USD 37419) for 4356 infected cattle.

Vaccination of crossbred cattle and cost of vaccines

There were a total of 4857 crossbred cattle of which 3194 (65.76%) were reported to be vaccinated (Table 4). Vaccination of crossbred cattle was highest in South East Region (89.07%) followed by North West Region (54.88%) and Central Region (46.46%). No crossbred cattle were reported to be vaccinated in South West Region of the vaccinated crossbred cattle 2503 (78.37%) were vaccinated by Department of Livestock Services (DLS) produced FMD vaccine and 691 (21.63%) were vaccinated by imported vaccine. DLS vaccine price is 10 Tk/dose. But overhead cost of vaccination is varied in region. Vaccination cost per crossbred cattle by DLS produced vaccine was Tk. 49.49 which varied from Tk. 44.49 in North West Region to Tk. 55.50 in South East Region. Imported vaccine cost usually Tk 100-150/ dose. For vaccination by imported vaccine the average cost per cattle was Tk. 249.06 and it varied from Tk. 237.50 in Central Region to Tk. 250.00 in South East Region. Total cost for vaccination of 3194 crossbred cattle was Tk. 295973.93. Proper vaccination and vaccine matching with circulating strains is the important preventive method against FMD in endemic regions (Lyons *et al.*, 2019). Subsequently, it is needed to ensure proper vaccination strategies over the country and government should take initiatives to maximum coverage of FMD vaccine.

Vaccination of native cattle

There were a total of 2138 native cattle of which 362 (16.93%) were reported to be vaccinated (Table 5). The native cattle vaccinated were vaccinated by DLS produced vaccine. The average vaccination cost per cattle was Tk. 51.66 which varied from Tk. 51.14 in Central Region to Tk. 51.73 in North West Region. Total vaccination cost for 362 native cattle was Tk. 18700. Tendency of vaccination and medication to native cattle is poor compared

Table 6. Breed-wise financial loss due to FMD

Description	Crossbred cattle (Tk)	Native cattle (Tk)	Total Cost (Tk)	% loss
Milk reduction cost	4304941	358974	4663915	8.74
Death loss	21480000	12399021	33879021	63.46
Veterinary cost	5266386	1735885	7002271	13.12
Weight loss of fattening cattle	2951411	2530220	5481631	10.27
Labour cost	1218668	823364	2042032	3.83
Vaccination cost	295974	18700	314674	0.59
Total cost (Tk)	35517380	17866164	53383544	100

to crossbred cattle due to profit margin is higher in crossbred cattle.

Total financial loss due to FMD infection in cross and native cattle

The financial loss incurred due to occurrence of FMD for different reasons is summarized in Table 6. There were 4857 crossbred and 2138 native cattle in the affected farms. Among the crossbred cattle 2692 (55.43%) and native cattle 1664 (77.83%) were affected due to FMD outbreak, which caused financial loss of Tk 53383544 (USD 628115). Table shows that highest 63.46% loss incurred due to death of infected cattle followed by veterinary cost (13.12%), loss due to body weight loss of affected fattening cattle (10.27%), reduction in milk yield (8.74%), manpower loss due to taking care of affected cattle (3.83%) and vaccination cost (0.59%).

Table 7. Effects of FMD infection in cattle

Area	No. of pregnant cattle infected	No. of abortion case	Mastitis	Lameness	Repeat breeding
Central Region	46	5 (10.87)	7	-	10
North West Region	102	9 (8.70)	5	10	16
South West Region	40	5 (12.50)	-	2	2
South East Region	60	7 (11.67)	9	-	15
Total	248	26 (10.48)	21	12	43

Figures in the parentheses are percentage of abortion cases in each area.

Indirect effect of FMD outbreak

In 850 affected surveyed households there were a total of 488 (396 crossbred and 92 native)

Table 8. Disposal of dead cattle.

Area	Total number of cattle died	Left in open field	Dropped into water	Buried
Central Region	120 (23.30)	41 (34.17)	20 (16.67)	59 (49.17)
North West Region	225 (43.69)	80 (35.56)	33 (14.67)	112 (49.78)
South West Region	102 (19.81)	28 (27.45)	41 (40.20)	33 (32.35)
South East Region	68 (13.20)	8 (11.76)	29 (42.65)	31 (45.59)
All area	515 (100)	157 (30.49)	123 (23.88)	235 (45.63)
χ^2 values* Significance		17.63 ($p<0.01$)	52.87 ($p<0.01$)	11.29 ($p<0.01$)

pregnant cows. Of the total pregnant cows, 248 (50.82%) were infected by FMD (181 crossbred and 67 native). In 248 infected pregnant cows abortion was reported in 26 cows (10.48%). Twenty one cases of mastitis, 12 cases of lameness and 43 repeat breeding cases were reported by the respondents. The findings are supported by the report of Lewis *et al*. (2019), they reported FMD causes abortion, retained placenta and conception failure as 2.7%, 1.3%, and 12.47% respectively in cows in Kenya.

Disposal of dead cattle

Disposal of dead cattle is presented in Table 8. Two hundred fifty crossbred and 265 native cattle (total 515) died from FMD infection in all the areas under study. The disposal of dead cattle is presented in Table 8. Of the dead cattle 30.49% were left in open field, 23.88% were dropped into water and 45.63% were buried. The results showed that disposal of dead cattle varied significantly ($p<0.01$) by areas. Dropping in water and dismount in open field of the dead cattle create hazards in environment and to public health (Chakraborty *et al.*, 2012). Awareness campaign should be undertaken to stop this type nuisances.

Conclusion

The findings of the study revealed that breed type, age categories and seasonal influence are the major risk factors for occurrence of FMD. Native cattle are more susceptible to this disease. Mortality of calves was higher in native than in crossbred. Outbreak of FMD was found higher in winter season followed by spring season. Total financial losses due to FMD in the study area were Tk. 5,33,83,544. Vaccination rate of native cattle was found very low and vaccination cost was very high. Disposal of dead animal was found very unhygienic. Therefore, findings of this study provide information on epidemiology of FMD and its detrimental impacts on cattle population growth and on the economy of Bangladesh. It also signifies the need of effective disease management and control strategies.

Acknowledgments

The research was conducted with the financial support of development project entitled ‘Research on FMD and PPR in Bangladesh’ (Award no. 7080) of Ministry of Fisheries and Livestock, Bangladesh.

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