Indian Journal of Animal Sciences **90** (7): 971–976, July 2020/Article

Economic Impact of FMD in cattle and buffaloes in India

GOVINDARAJ G*, GANESH KUMAR B, KRISHNAMOHAN A, RAVEENDRA HEGDE, NANDAKUMAR S, KOKILA PRABHAKARAN, VINAY MOHAN, NARESH KAKKER, LOKHANDE T, KRISHNA SHARMA, AMIT KANANI, LIMAYE A, NATCHIMUTHU K, TANVEER AHMED KHAN, JYOTI MISRI, DASH B B, PATTNAIK B and RAHMAN H

ICAR–National Institute of Veterinary Epidemiology and Disease Informatics, Bengaluru, Karnataka 560 064 India

Received: 13 August 2019; Accepted: 1 November 2019

ABSTRACT

In India, among various diseases that limit livestock production, Foot and Mouth Disease (FMD) stands first and affects thousands of animals every year. The estimation of loss due to FMD is of paramount importance for designing appropriate control plans. The economic impact studies on various livestock diseases including FMD are very minimal and hence this study assessed the economic loss due to FMD in cattle and buffaloes in few states and overall loss in the country. The total loss estimated comprise of milk yield reduction, unavailability of draught power, distress sale, treatment cost, mortality and opportunity cost of labour based on primary survey undertaken in 10 states and one Union territory. The results revealed that there was variation in loss levels between species and among the study states due to variation in disease incidence and severity levels, productive capacity of the animals, animal health infrastructure in the respective states, etc. The total estimated loss due to FMD in cattle and buffalo was INR 20,897 crore during 2013–14 with wide variation in magnitude across the states studied. The study provided empirical evidence of loss due to FMD in cattle and buffaloes in few states and overall loss in the country.

Keywords: Bovines, Financial loss, FMD, India

Livestock is an important sub-sector of Indian agriculture and contributes nearly 25.6% of value of output at current prices of total value of output in Agriculture, Fishing and Forestry sector. The overall contribution of livestock sector in total GDP is 4.11% at current prices during 2012–13 (DAHD&F, Government of India, 2012). In India, animal husbandry supports livelihood of more than two-thirds of the rural population. The growth of livestock sector was above 5% during 1980s but in recent decade it is below 4%. Despite deceleration, the livestock sector growth is 1.5 times larger than the crop sector indicating its importance in cushioning agricultural growth (Roop Raj and Gupta 2015). Unlike other sectors, the livestock sector ensures equity, as smallholders and landless farmers together own 75% of livestock and earn 50% income from it (Govindaraj *et al*. 2017). The growth of livestock sector is severely constrained by infectious and contagious diseases like foot and mouth disease (FMD).

FMD is a contagious viral disease that primarily affects cloven-hooved animals characterized by fever and vesicular eruptions in the mouth, nose, muzzle, feet and on the mammary glands which later become erosions (Meyer and Knudsen 2001). The disease causes severe mortality and morbidity in infected farms. Earlier the mortality was recorded low but in the recent outbreaks, it was unusually high due to increase in number of exotic germplasm (Singh *et al*. 2008). The disease reduces productivity of animals and affects various stakeholders involved in the entire livestock sector value chain. At micro level, the primary producer is affected due to mortality, reduction in milk yield, and draught power unavailability. Further, significant amount is spent by the farmers to control the secondary bacterial infection. Some farmers resort to distress sale and may even replace the morbid animals altogether, as there will be marked decline in productivity of infected animals for a very long period. At macro level, the disease affects productivity of livestock sector and pulls down the growth of associated and interlinked sectors due to ripple effect on all the upstream and downstream stakeholders and industries (FAO 2006). In India, in order to control the disease, vaccination under Foot and Mouth Disease Control Programme (FMD-CP)was initiated during 2003–04 in 54 districts which was later expanded to 221 districts during XI plan and 640 districts during XII plan with a target to cover 316 million animals. It was also planned to establish one or more defined FMD free zones through vaccination by 2020. Since 2017–18, the control programme is being implemented in the entire country.

In India, the reported loss due to FMD was estimated based on secondary data on various time periods (Singh *et al*. 2013) and few studies employed primary data collected from few livestock farms (Goel 1989, Prabhu *et al*. 2004,

*Corresponding author e-mail: Govindaraj.Naidu@icar.gov.in

Thirunavukkarasu and Kathiraven 2006, Thirunavukkarasu and Kathiraven 2006, Litty and Deepa 2008, Ganesh Kumar 2012, Govindaraj *et al*. 2017). The severe drawbacks of secondary data based loss estimates are data limitation (only reported outbreaks were considered for loss calculations) and unwarranted assumptions. Similarly, the primary data based survey studies reported till date were limited to few districts and few loss parameters. Hence, to address the gap, the present study was conducted comprehensively to assess various visible losses associated with FMD, viz. milk yield reduction, draught power unavailability, treatment cost, mortality, opportunity cost of labour and distress sale. The present study was to assess the monetary impact of FMD in cattle and buffaloes in India.

MATERIALS AND METHODS

Sample size: The sample size for undertaking primary survey was determined based on Cochran (1963) formula:

$$n=\frac{Z^2\times(P)\times(1-P)}{C^2}$$

where, n, sample size per district; z, 90% confidence level (1.645); p, proportion of bovine rearing households in a district in India (0.306) as per 19th livestock census 2012 and c, margin of error (0.06).

The estimated sample size was 156 cattle and buffalo rearing farms per district and accordingly, the primary survey was undertaken in each of the identified sample districts with a minimum sample of 150 in each district except Puducherry. The survey was undertaken during the year 2013–14 with the pilot tested schedule developed for the purpose.

Sampling procedure: Multistage random sampling procedure was adopted for the primary survey. In the first stage, 10 states and one UT covering various geographical regions were selected. In the second stage, minimum of three districts were selected randomly in each state. In the third stage, minimum six blocks/mandals/circles/taluks were selected and in each of them a minimum two villages were selected randomly. In the fourth stage, the required number of samples to be surveyed was distributed in proportion to number of cattle and bovine rearing farms in the village. In the fifth stage, the cattle and buffalo rearing farms in each of the identified village for the primary survey were selected randomly. The total number of districts, villages and farms surveyed to assess the various loss due to FMD in various states and all India were 31, 530 and 4,822, respectively (Table 1). A farm is designated as FMD affected based on the clinical signs observed by the farmer, triangulation with the village head and corroboration with the local field veterinarian. In all the selected states minimum three districts were surveyed except Maharashtra where only two districts could be surveyed. In Puducherry (UT), one region was surveyed out of four regions.

Estimation of loss: The visible loss due to FMD, viz. milk yield reduction, unavailability of draught power, treatment cost, opportunity cost of labour, distress sale and mortality in cattle and buffaloes were estimated. The mortality loss was calculated based on number of animals that died due to FMD in each category [male and female calves (<one year),in-milk, dry, heifer, immature males (1–3 years),bullocks (>three years) and bull] in the surveyed farms multiplied by value of the animal in apparently healthy state. The milk yield loss per animal was calculated based on difference in milk yield (before disease) and actual milk yield (during the disease) in in-milk category animals and duration of FMD infection in the farm. The draught power loss was calculated based on the number of days disease persisted in the farm and bullock hiring charges per day. Treatment cost incurred by the farmer includes veterinarian fee, cost of drugs and indigenous treatment cost. The opportunity cost of labour was estimated based the incremental labour hours engaged, number of days disease persisted in the farm and prevailing labour wage rate in the survey village. The distress sale loss in the event of FMD outbreak in the farm was calculated as the difference between the market value of the animal before FMD and distress sale value of the animals realized by the farmer. Appropriate weightages were considered based on the number of animals died, infected and recovered among the various FMD infected species and age groups reared by the sample farmers for estimating the loss per animal. Based on FMD incidence, disease cost in cattle (indigenous cattle and crossbred cattle) and buffaloes, total risk population in each of the surveyed states and the loss due to FMD loss in each of the surveyed states were projected. For non-surveyed group of states, the FMD incidence level in different category of animal and disease cost per animal in the reference states and susceptible risk population in the respective state were used to calculate the total loss these were summed up total loss in these states. For Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Delhi, and Chandigarh, the disease incidence and disease cost per

Table 1. Number of districts, villages and farms surveyed in different states of India

State	Number of district surveyed	Number of blocks/ mandals/ circles/ taluks	Number of villages/ panchayats	Farms surveyed
Undivided Andhra Pradesh	3	15	77	455
Assam	3	19	51	447
Gujarat	3	6	54	500
Haryana	3	10	46	450
Karnataka	3	6	68	450
Kerala	3	6	28	430
Madhya Pradesh	3	6	46	451
Maharashtra	2	8	44	334
Puducherry	1	7	10	105
Punjab	4	8	73	750
Tamil Nadu	3	6	33	450
Total	31	97	530	4822

animal estimated for Haryana was considered, whereas for Uttar Pradesh, Bihar, Jharkhand, Odisha, Chhattisgarh and West Bengal, the disease incidence level and disease cost in Madhya Pradesh was considered. For Rajasthan, Daman and Diu and Dadra and Nagar Haveli the reference state was Gujarat and for Goa and Lakshadweep, the reference states were Maharashtra and Kerala, respectively. For all the north eastern states, the reference state was Assam.

RESULTS AND DISCUSSION

The loss per animal due to FMD infection at 2013-14 prices in the surveyed farms in various states are presented in Table 2. Among the indigenous cattle, in the study states, the milk reduction loss per animal ranged from INR 427 to INR 2949. The highest milk reduction loss was observed in Karnataka followed by other states whereas least loss per animal was observed in Assam. The milk loss among the crossbred cattle in different surveyed states was in the range INR 1,145 to INR7,826. In buffaloes, the milk reduction loss ranged from INR 1,689 to INR 8,886. It is evident that the highest average milk reduction loss was observed in crossbred cattle followed by buffaloes and indigenous cattle. Similar findings of the highest losses in cattle (65.62%) followed by buffaloes (33.04%) were reported by Ganesh Kumar (2012) and Singh *et al*. (2013). Among the study states, considerable variation in monetary loss due to milk yield reduction was mainly due to differences in species, breed, age, lactation stage, milk yielding capacity of animals, number of days FMD persisted in the farm etc.

In general, mortality due to FMD was observed in young animals whereas during 2013–14 outbreaks mortality was observed in adult animals also in some of the states. The mortality loss ranged from INR 2,027 to INR 50,000 per animal in indigenous cattle and INR 1,912 to INR 35,920 in crossbred cattle. Similarly, the estimated mortality loss per animal in indigenous and upgraded buffalo in different surveyed states is presented in Table 2. The loss variation within species was due to difference in prices of various milch breeds reared by farmers in each of the surveyed states. Among the indigenous cattle, highest mortality loss per animal (INR 50,000) was observed in Gujarat and least in Madhya Pradesh state. The indigenous cattle breed (Gir/ Red Sindhi/Sahiwal) reared in Gujarat is highly valued over the breeds of similar age and sex reared in Madhya Pradesh like Manthani, Kenwariya etc. Further, the death of young animals resulted in less average mortality loss than old animals. Several studies revealed that mortality of young animals due to FMD were more, whereas during 2013–14 outbreaks adult animals died in large numbers in the southern states and hence, estimated mortality loss per animal varied across species (Govindaraj *et al*. 2017). More deaths of adult animals might be due to change of composition of species reared (more crossbreds than indigenous breeds), change in husbandry practices, free movement of animals for trade and transit across borders etc. Further, change in climatic factors might also favour the transmission and full expression of FMD virus causing heavy mortality in the susceptible host (Singh *et al*. 2008).

The distress sale occurs in the farm when the farmer decides to sell the infected animals at less price than its original value. The distress sale loss varied depending on the species, age, disease condition, availability of market for the infected animals etc. The estimated distress sale loss per animal at 2013-14 prices in indigenous cattle range from INR 200 to INR 11,727 with the loss being the least in Madhya Pradesh and the most in Karnataka during the study period. In crossbred animals, the distress sale loss ranged from INR 4,000 to 32,286. The distress sale estimated for indigenous and upgraded buffaloes in the surveyed states is presented in Table 2. Among the states surveyed during 2013–14, highest loss of INR 11,727, INR 32,286 and INR 21,250 in Indigenous cattle, Crossbred cattle and Indigenous buffalo was observed in Karnataka and the results corroborates with earlier study by Govindaraj *et al.* 2017. The distress sale affects the regular income generation from livestock and the asset structure of the farmers in the long-run.

In India, draught power from animals is an important energy source for agricultural operations like ploughing, intercultural operations, post-harvest activities etc. The estimated loss per animal ranged from INR 2,453 to INR 8,886,with highest loss in Assam, which might be due to more use of indigenous cattle in Assam for agricultural operations than in other surveyed states. The average effective working days lost ranged from 5 to 15 days in the surveyed states and similar results were reported by Jemberu *et al*. (2014). The treatment cost incurred by farmers to control FMD varied in different states depending on the severity of infection, disease persistency, timely treatment and veterinary infrastructure in the states. In Indigenous cattle, the treatment cost per animal range from INR 246 to INR 2,700 with highest in Kerala whereas in crossbred cattle, the cost ranged from INR 250 to INR 3,068 (Table 2). The treatment cost estimated varied from the study reported by Young *et al.* (2013) in Cambodia (INR 1059/ USD 15.13). The differences in estimated treatment cost might be due to difference species affected, recovery period, timely availability of professionals, treatment regimen adopted etc. The cost of labour for nursing the infected animal vary depending on the number of animals in the farm, prevailing labour wages in the village and number of days of infection. The estimated incremental labour cost was least in Assam (INR 341) and highest in Kerala ranging from INR 3,375 to INR 4,500 per animal.

In general, there is variation in loss per animal between the species and between different components due to various host and management factors. In the present study, the mortality loss was highest followed by draught power and milk loss whereas Ganesh Kumar (2012) found in Andhra Pradesh that the maximum loss was on draught power reduction, followed by milk yield reduction, treatment cost and mortality and Litty and Deepa (2008) found in Kerala that the highest loss was due to milk yield reduction. The variation in loss components estimated in the present study

Table 2. Estimated average unit cost per animal affected by FMD among the sampled farms in the surveyed states at 2013–14 prices

Category/State	Species	Andhra Pradesh*	Assam	Gujarat	Haryana	Karnataka	Kerala	Madhya Pradesh	Maharashtra	Puducherry	Punjab	Tamil Nadu
Milk loss	IC	2936	427	1445	NO	2949	2940	2346	784	NA	NO	768
	CB	NO	4804	1145	NO	5454	6850	7826	2659	1476	NO	1991
	IB	3617	NO	2641	4514	1660	NO	5684	1015	NA	NO	1152
	UB	6058	NO	NO	NO	1689	NO	7685	NO	NA	NO	NO
Draught power loss	IC	2625	8886	3656	NO	3752	NO	2453	6681	NA	NO	NO
	CB	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
	IB	NO	NO	NO	NO	NO	NO	NO	NO	NA	NO	NO
	UB	NO	NO	NO	NO	NO	NO	NO	NO	NA	NO	NO
Treatment cost	IC	246	735	1245	1750	1050	2700	505	1250	NA	NO	990
	CB	250	1480	1177	NO	2379	1965	3068	3324	541	NO	1274
	IB	366	NO	982	2283	2379	NO	975	1374	NA	NO	1138
	UB	419	NO	NO	NO	1572	1400	3150	NO	NA	NO	NO
Opportunity cost of labour	IC	1341	341	494	1080	1950	3375	611	1422	NA	NO	1100
	CB	1341	341	494	NO	1950	4214	611	1422	499	NO	1100
	IB	1341	NO	494	1106	1950	NO	611	1422	NA	NO	1100
	UB	1341	NO	NO	NO	1950	4500	611	NO	NA	NO	NO
Mortality loss	IC	13125	2150	50000	4000	26250	NO	2027	NO	NA	NO	NO
	CB	NO	1912	16000	NO	35920	11845	25459	22800	5750	NO	13450
	IB	9562	NO	4063	31226	17885	NO	8833	NO	NA	NO	13500
	UB	15968	NO	NO	NO	25724	NO	11690	NO	NA	NO	NO
Distress sale loss	IC	NO	3500	11667	NO	11727	NO	200	NO	NA	NO	NO
	CB	NO	NO	NO	NO	32286	13155	4000	NO	15667	NO	NO
	IB	NO	NO	13333	NO	21250	NO	NO	NO	NA	NO	NO
	UB	NO	NO	NO	NO	NO	28000	13000	NO	NA	NO	NO

*Undivided Andhra Pradesh; NO, FMD was not observed in the respective species during the survey; and NA, Animals of particular species were not available in the surveyed sample farms; IC, Indigenous Cattle; CB, Crossbred Cattle; IB, Indigenous Buffalo; UB, Upgraded Buffalo.

Table 3. Estimated loss due to FMD in cattle and buffaloes in surveyed and other states (non-surveyed group of states) in India during 2013–14

State	INR in crore (at 2013–14 prices)
Surveyed states	
Undivided Andhra Pradesh	1,738.97
Assam	1,994.75
Gujarat	1,016.57
Haryana	35.04
Karnataka	6,500.93
Kerala	272.11
Madhya Pradesh	1,364.90
Maharashtra	545.39
Puducherry	1.52
Punjab	No
Tamil Nadu	355.29
Sub-total (A)	13,825.47
*Non-surveyed group of states***	
Other states	7,071.05
Sub-total (B)	7,071.05
Total	20,896.52

No, FMD incidence was not observed among the surveyed farms in the respective state; **projected loss for these group of states were based on FMD incidence levels (%) in different species and unit disease cost in the reference states.

might be due to more mortality of adult animals in south states during 2013–14 FMD outbreaks. The study conducted by Senturk and Yalcin (2008) in Turkey was in line with present study that in all breeds, the highest losses occurred when animals died after FMD infection. Similarly, Jemberu *et al*. (2014) reported that the highest mean economic loss at the individual affected animal level was due to mortality USD 129/animal in crop-livestock mixed and USD 151/animal in pastoral system.

The disaggregated (state level) loss due to FMD in bovines in the surveyed states and other group of states is presented in Table 3. The total estimated loss due to FMD in bovines in India during 2013–14 was INR 20,897 crore with wide variation among the surveyed states. The variation in loss levels among the surveyed states were due to variation in disease incidence and severity levels, productive capacity of the animals, animal health infrastructure, population level, composition of crossbreds etc. in the respective states during the surveyed period. In future, the long-term studies need to be undertaken to capture variation in disease incidence along the disease cycle for comprehensive assessment and control of FMD in India.

The study clearly indicated that FMD caused huge visible loss to the farmers. It has ripple effect on the upstream and downstream activities of the whole livestock economy. Hence, its control is imperative mainly through preventive actions like vaccination and adopting appropriate biosecurity measures at the farm. Despite implementation of vaccination programme in some of the states, the estimated loss due to FMD in bovines was high. Hence, there is need for timely vaccination with effective vaccines to mitigate the mortality, morbidity and consequent loss to farmers and other stakeholders in the entire livestock economy in different states in India.

ACKNOWLEDGEMENTS

Authors would like to thank Directorate on Foot and Mouth Disease (DFMD), Mukteshwar, Uttarakhand for funding the project. We extend our thanks to the AICRP centres of FMD in the study for their assistance during data collection. We thank the farmers, project staff and other stakeholders for their active participation and help in executing the study.

REFERENCES

Cochran W G. 1963. *Sampling Techniques.* 2 edn. John Wiley and Sons, New York.

Department of Animal Husbandry, Dairying and Fisheries (DAHD&F), Government of India. 2012. Basic Animal Husbandry and Fisheries Statistics 2014 (http://dahd.nic.in/)

Department of Animal Husbandry, Dairying and Fisheries (DAHD&F), Government of India, Foot and Mouth Disease Control Program (http://dadf.gov.in/division/more-about-fmdcp1)

FAO. 2006. *Impact of animal disease outbreaks on livestock markets*. 21st session of the inter-governmental group on meat and dairy products Rome, Italy (http://www.fao.org/docs/eims/upload/234375/ah670e00.pdf.)

Ganesh Kumar B. 2012. Economic impact of Foot-and-Mouth Disease in India: A pilot study in Andhra Pradesh, FAO-ICAR in Proceedings of the International Conference on Scientific developments and technical challenges in the progressive control of FMD in South Asia held at New Delhi during 13–15 February, 2012. (http://www.fao.org/fileadmin/user_upload/eufmd/docs/India_meeting_feb_2012/32Kumar_Socio_economic_impacts.pdf)

Goel Y P. 1989. A note on some epizootiological observations on foot and mouth disease outbreak in an organized herd. *Indian Veterinary Medical Journal* **13**: 127–29.

Govindaraj G, Ganesh Kumar B, Nethrayini K R, Shalini R, Balamurugan V, Pattnaik B and Rahman H. 2017. Farm community impact of Foot and mouth disease in cattle and buffaloes in Karnataka, India. *Transboundary and Emerging Diseases* **64**(3): 849–60.

Jemberu W T, Mourits M C M, Woldehanna T and Hogeveen H. 2014. Economic impact of foot and mouth disease on smallholder cattle farmers in Ethiopia. *Preventive Veterinary Medicine* **116**(1–2): 26–36.

Litty M and Deepa G M. 2008. Economic impact of FMD in Chazhoorpanchayath. *Veterinary World* **1**(1): 5–6.

Livestock in Indian Economy. 2013. (http://www.insightsonindia.com/wp-content/uploads/2013/08/role-of-livestock-in-indian-economy.pdf)

Meyer R F and Knudsen R C. 2001. Foot-and-mouth disease: A review of the virus and the symptoms. *Journal of Environmental Health* **64**(4): 21.

Prabhu M, Safiullah A M and Selvam S. 2004. Evaluation of economic loss due to Foot and mouth disease in bovines of Salem district. *Agricultural Economics Research Review* **17**(1): 77–84.

Roop Raj D and Gupta S K. 2015. Relative share of livestock

population of Haryana. *International Journal of Advanced Research* **3**: 790–96.

Senturk B and Yalcin C. 2008. Production losses due to endemic Foot- and- Mouth Disease in cattle in Turkey. *Turkish Journal of Veterinary and Animal Sciences* **32**(6): 433–40.

Singh B, Pandey A B, Chandra D, Singh K P and Mehrortra M L. 2008. Epidemiology of malignant form of Foot and mouth disease in susceptible cattle and buffalo population of Punjab and Uttar Pradesh. *Indian Journal of Animal Sciences* **78**: 3–7.

Thirunavukkarasu M and Kathiraven G. 2006. Economic losses due to mortality and culling of foot and mouth disease affected livestock. *Tamil Nadu Journal of Veterinary and Animal Sciences* **2**(1): 13–17.

Thirunavukkarasu M and Kathiraven G. 2010. Economic losses due to reduced milk output and draught power in FMD affected bovines. *Indian Veterinary Journal* **67**: 273–76.

Young J R, Suon S, Andrews C J, Henry L A and Windsor P A. 2013. Assessment of financial impact of foot and mouth disease on smallholder cattle farmers in Southern Cambodia. *Transboundary and Emerging Diseases* **60**(2): 166–74.