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Estimation of economic losses due to foot and mouth disease in India

B SINGH[1], SHIV PRASAD[2], D K SINHA[3] and MED RAM VERMA[4]

Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh 243 122 India

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ABSTRACT

In the present study methodology for evaluation of economic losses was developed by considering all possible direct and indirect losses in cattle, buffalo, sheep, goat and pig. The methodology was used to compute economic losses using the data (i) reported by Department of Animal Husbandry, Dairying and Fisheries, Government of India, (ii) based on sample survey studies and (iii) published information in scientific journals. The methodology was demonstrated on the basis of the data reported by Government of India. The morbidity losses contributed about 97.64% and rest (2.36%) by mortality of animals. Among different components of losses the maximum loss of 49.83% was observed due to milk loss (direct and indirect), followed by opportunity cost (16.15%) and reduction in growth (12.20%). The total losses per infected animal due to FMD in cattle, buffalo, sheep, goat and pig were ₹ 12,532, 21,682, 2,023, 3,046 and 2,830, respectively. From this study it is concluded that the annual total economic loss due to FMD in India ranges from ₹ 12,000 crore to 14,000 crore.

Key words: Economic loss, Morbidity loss, Opportunity costs

Animal diseases pose significant threat to livestock sector throughout the world, both from the standpoint of economic impacts of diseases themselves and the measures taken to mitigate the risk of disease introduction or spread. The foot and mouth disease (FMD) is highly contagious and can spread rapidly in cloven-footed animals viz. cattle, buffaloes, goats, sheep and pigs, and is endemic in India. Economic losses caused by the disease are mainly due to loss in milk production, reduction in working ability of work animals, reduction in the body weight leading to reduced yield of meat. In addition to this, the milk and milk products, meat and hide and skin are not accepted by countries free from the disease causing reduction in export potential of livestock industry in India.

Different workers reported the losses due to FMD by considering various factors/ components, viz. mortality and culling (Thirunavukkarasu and Kathiravan 2006), milk loss (Goel 1989, Saxena 1994 b), non-milk losses – draught power, permanent disability, death and treatment for cattle and buffaloes (Saxena 1994 a), milk loss, death, abortion, treatment, additional man power, draught power, vaccination (Mathew and Menon 2008), milk loss, depreciation in market price, hide and skin, working capacity in cattle and buffaloes (Prabu *et al.* 2004), milk and draught power loss in cattle and buffaloes (Thirunavukkarasu and Kathiravam 2010), and reproductive failure in bovines (Thirunavukkarasu and Kathiravam 2007). None of them considered all the direct and indirect losses due to FMD. They also worked out the losses for outbreak areas and extrapolated for the country on the basis of morbidity and mortality rates which are obviously very high. There is need to have the information on morbidity and mortality for outbreak as well as non-outbreak areas for calculation of losses at the national level.

In the present study, efforts were made to develop methodology for evaluation of economic losses considering all possible direct and indirect losses in five species, viz. cattle, buffalo, goat, sheep and pig. The methodology was used to compute economic losses using the data (i) reported by Department of Animal Husbandry, Dairying and Fisheries, Government of India, (ii) based on sample survey studies, and (iii) published information in scientific journals.

MATERIALS AND METHODS

The data from three sources, (a) the secondary data on number of cases and deaths due to FMD in cattle, buffaloes, goats, sheep and pigs for last 5 years 2006–10 taken from Annual Reports of Department of Animal Husbandry, Dairying and Fisheries, Government of India, (b) the data on 15,857 animals regarding their morbidity and mortality in different species from four states, viz. Himachal Pradesh,

Present address : [2]Principal Scientist (shivprasad@ivri.res.in), [4]Senior Scientist (mrverma19@yahoo.co.in), [1]Division of Livestock Economics, Statistics and Information Technology (bsinghccpi@gmail.com); [3]Senior Scientist (CADRAD).

Uttar Pradesh, Madhya Pradesh and Maharashtra collected through sample surveys under post graduate and institute research projects in the division (Bonger 2011, Chaudhary 2012, Dohare 2011, Gupta 2011, Sharma 2012 and Singh et al. 2010) and (c) data based on 2.42% morbidity rate (Mathew and Menon 2008) and 5.5% case fatality rate (Singh 2011) were used for computing economic losses due to FMD in India.

Methodology for evaluation of losses: The total economic loss due to FMD was worked out as sum of (A) loss from mortality, (B) direct loss in milk yield, (C) losses due to reproductive failure in affected female animals (D) loss in animal draught power, (E) reduction in growth of new born animals**,** (F) cost of treatment of affected animals, and (G) opportunity costs. These components of losses due to FMD in different species are summarized in Table 1. The methodology for different species is given as under:

Bovines (cattle and buffalo)

The total economic losses (T_L) is expressed as

$$T_L = A + B + C + D + E + F + G \quad (1.1)$$

A. Loss from mortality: This is worked out as the number of animals died (D_A) due to the disease multiplied by the average price (V) of the animal. That is,

$$A = D_A V \quad (1.2)$$

B. Direct loss in milk yield: For the proportion of sick animals in milk in the herd, the losses are expressed in terms of reduced milk yield which, through the price of milk, can be directly converted into monetary terms. The immediate fall in milk production in lactating animals is never recovered later and therefore constitutes a significant form of loss. The loss due to the direct decline in milk production is estimated by the formula

$$B = I P_L L Z M \quad (1.3)$$

Where, I, Number of infected animals; P_L, proportion of sick animals in lactation; L, proportion of milk yield lost; Z, average annual milk yield (kg); and M, price of milk/kg.

C. *Losses due to reproductive failure:* Besides causing substantial monetary loss through reduction in milk yield this disease remains a continuous threat to the dairy farming by challenging the reproductive capability of milch bovines. It not only results in abortion especially in later stages of pregnancy but also extends the calving interval of the affected animals which go repeat breeders/infertile. The milk loss and monetary value of calves, which could have been born, are worked out.

$$C = C_{11} + C_{12} + C_{21} + C_{22} \quad (1.4)$$

C_1. Losses due to increased abortions

C_{11}. *Milk loss:* If the time for abortion is 7.5 months from conception and there follows a 6 months delay in the next conception, the calving interval is increased to 13.5 months in aborting cases and the milk loss due to increased abortions are estimated from

$$C_{11} = \left\{ \frac{12}{C_I} - \frac{12}{C_I + 13.5} \right\} I P_L A_I Z M \quad (1.5)$$

where C_I is calving interval and A_I is the rate of increased abortions due to FMD.

C_{12}. Value of calves that could have been born

$$C_{12} = \left\{ \frac{12}{C_I} - \frac{12}{C_I + 13.5} \right\} I P_L A_I V_C \quad (1.6)$$

where V_C is the price of new born calf.

C_2. Losses due to increased calving interval

C_{21}. *Milk loss:* The problem of infertility caused by the disease is the lengthening of the calving interval, therefore, fewer animals will be in milk at any given time. The effect of this infertility problem will consequently reduce the output of milk. An average delay of 3 months in the next conception is assumed for all animals affected by the disease. The loss of milk is the reduction in the proportion of animals lactating in any year multiplied by the average milk yield per year

Table 1. Components of losses due to FMD in different species

	Species		
Cattle and buffalo	Goat	Sheep	Pig
A. Mortality	A. Mortality	A. Mortality	A. Mortality
B. Direct milk loss	B. Direct milk loss	B. Wool loss	-
C. Reproductive failure	C. Reproductive failure	C. Reproductive failure	C. Reproductive failure
i) Increased abortions	i) Increased abortions	i) Increased abortions	i) Increased abortions
ii) Increased calving interval	ii) Increased calving interval	ii) Increased calving interval	ii) Increased calving interval
D. Draught power loss	D. Body weight loss	D. Body weight loss	D. Body weight loss
E. Reduction in growth of calves	-	-	-
F. Treatment cost	F. Treatment cost	F. Treatment cost	F. Treatment cost
G. Opportunity cost*	G. Opportunity cost*	G. Opportunity cost*	G. Opportunity cost*

* It includes the cost of higher feeding and rearing inputs in surviving infected animal, loss due to extra human labour on longer rearing time in young stock, cost of permanent disability, extra human labour for nursing of animal and disinfection of shed, transportation of sick animals for treatment.

and by the price (M). That is,

$$C_{21} = \left\{ \frac{12}{C_I} - \frac{12}{C_I + W} \right\} I P_L (1-A_I) Z M \quad (1.7)$$

where W is delay in next conception

C_{22}. Value of calves that could have been born

$$C_{22} = \left\{ \frac{12}{C_I} - \frac{12}{C_I + W} \right\} I P_L (1-A_I) V_C \quad (1.8)$$

D. *Loss in animal draught power:* In work animals, FMD causes significant loss to the farmers by making them unavailable for ploughing, traction and other draught animal-led crop farm works. The loss is worked out by using the formula

$$D = I P_D D_W H_W \quad (1.9)$$

P_D, Proportion of infected draught animals; D_W,number of days animal could not work; H_W, per day hiring charges per animal.

E. *Loss due to reduction in growth of calf:* The FMD infection in bovines also results in retardation of growth rate in calf. The loss is computed by the following formula

$$E = I P_C G_R V \quad (1.10)$$

P_C, proportion of infected calves; G_R, reduction in growth rate; V, market value of adult animal.

F. *Cost of treatment:* One of the most immediate economic losses in FMD affected animals is the treatment cost which includes cost of medicines and fee to veterinarians. Sick animals are usually provided at least one week antibiotic treatment, 3 days antipyretic, 3 days Vit. B complex along with liver extract, 14 days application of ointment on foot, udder etc. and 14 days application of boroglycerol on tongue and in buccal cavity (Shaheen *et al*. 2005). The species wise treatment cost (T_C) is summarized in Table 2. The cost of the treatment is given by

$$F = I T_C \quad (1.11)$$

G. *Opportunity costs:* The opportunity costs include the following:

1. The cost of higher feeding and rearing inputs in surviving infected animals.
2. Loss due to extra human labour on longer rearing time in young stock.
3. Cost of permanent disability.
4. Extra human labour for nursing of animals and disinfection of sheds.
5. Transportation of sick animals.

These costs are difficult to quantify where records and estimates on cost of feeding, rearing, extra human labour for sick animals and disinfection of the shed are lacking. In absence of any suitable data in the regard, these costs are assumed approximately as 10% of the cost of animals. That is,

$$G = I V/10 \quad (1.12)$$

Sheep

The total economic loss (T_L) due to FMD in sheep is worked out as sum of (A) loss from mortality, (B) direct loss in wool yield, (C) Losses due to Reproductive Failure, (D) Loss in body weight, (F) Cost of treatment of affected sheep and (G) Opportunity costs.

$$T_L = A + B + C + D + F + G \quad (2.1)$$

A. Loss from mortality

$$A = D_A V \quad (2.2)$$

B. *Direct loss in wool yield:* For the proportion of sheep in shearing age in a year, the loss is expressed in terms of the reduced wool yield. The price of wool can be directly converted into monetary terms. The fall in wool production in a diseased sheep is never gained later and therefore constitutes a significant form of loss. The loss due to the direct decline in wool yield is estimated from the formula:

$$B = I P_H Y_L Y_W P_Y \quad (2.3)$$

P_H, Proportion of sheep in shearing age; Y_L, proportion of wool yield lost; Y_W, average annual wool yield; P_Y, price of wool per kg.

C. Losses due to reproductive failure

$$C = C_1 + C_2 \quad (2.4)$$

C_1. Body weight loss due to increased abortions

Table 2. Treatment cost (T_C) of different species of FMD affected animals

Items	Cattle and buffalo	Sheep and goat	Pig
Antibiotic inj. (i/m)	15 ml/ day × 7 day ₹ 100	5 ml/ day × 7 day ₹ 35	7 ml/ day × 7 day ₹ 50/
Antipyretic inj. i/m inj	15 ml/day × 3 day ₹ 60	5 ml/day × 3 day ₹ 20	7 ml/day × 3 day ₹ 30
Vitamin B complex with liver extract	10ml/day × 3 day ₹ 40/	3 ml/day × 3 day ₹ 15	5 ml/day × 3 day ₹ 25
Cream/lotion	Local application × 14 day ₹ 70	Local application × 14 day ₹ 35	Local application × 14 day ₹ 35
Boro glycerol	Tongue and in buccal cavity ₹ 50	Tongue and in buccal cavity ₹ 30	Tongue and in buccal cavity ₹ 30
Para-vet visit charges	₹ 700 for 7 day	₹ 350 for 7 day	₹ 350/ for 7 day
Infertility treatment	₹ 250/	-	-
Total	1,270	485/	520/

The reduction in number of lambs born due to increase in abortions causes loss in live body weight. Such losses are estimated by the formula:

$$C_1 = \left\{ \frac{12}{K_I} - \frac{12}{K_I + 9.5} \right\} I\, P_L\, A_I N_K\, B_W\, P_W \qquad (2.5)$$

P_L, proportion of sheep in milk; K_I, lambing interval; B_W, average birth weight of a lamb; N_K, average number of lambs per lambing; A_I, increase in abortion rate; P_W, price of live weight per kg.

C_2. Body weight loss due to increased inter lambing period: The reduction in number of lambs born due to the increased inter lambing period (w=2 months) due to a disease causes loss in live body weight. Such loss is estimated by the formula:

$$C_2 = \left\{ \frac{12}{K_I} - \frac{12}{K_I + W} \right\} I P_L (1\text{-}A_I) N_K\, B_W P_W \qquad (2.6)$$

D. Loss in body weight: The value of direct loss due to reduction in body weight (sheep not in milk) is estimated by the formula:

$$D = I\,(1\text{-}P_L)\, W_L\, W_A\, P_W \qquad (2.7)$$

W_L, proportion of body weight loss; W_A, average body weight.

F. Cost of treatment

$$F = I\, T_C \qquad (2.8)$$

G. Opportunity Costs

$$G = I\, V/10 \qquad (2.9)$$

Goats

The total economic loss due to FMD in goats is worked out as sum of (A) Loss from mortality, (B) Direct loss in milk yield, (C) Losses due to Reproductive Failure, (D) Body weight loss, (F) Cost of treatment of affected goats and (G) Opportunity costs.

The total economic losses (T_L) is expressed as

$$T_L = A + B + C + D + F + G \qquad (3.1)$$

A. Loss from mortality

$$A = D_A\, V \qquad (3.2)$$

B. *Direct loss in milk yield:* The loss due to the direct decline in milk production is estimated by the formula

$$B = I\, P_L\, L\, Z\, M \qquad (3.3)$$

C. Losses due reproductive failure

$$C = C_{11} + C_{12} + C_{21} + C_{22} \qquad (3.4)$$

C_1. Losses due to increased abortions

C_{11}. *Milk loss due to increased abortions:* If the time for abortion is 3.5 months from conception, and there follows a 6 months delay in the next conception, the kidding interval is increased to 9.5 months in aborting cases and the milk loss due to increased abortions are estimated from

$$C_{11} = \left\{ \frac{12}{K_I} - \frac{12}{K_I + 9.5} \right\} I P_L\, A_I\, Z M \qquad (3.5)$$

where K_I is kidding interval.

C_{12}. Kid loss due to increased abortions

$$C_{12} = \left\{ \frac{12}{K_I} - \frac{12}{K_I + 9.5} \right\} I P_L\, A_I\, N_k P_C \qquad (3.6)$$

where P_C is the price of new born kid.

C_2. Losses due to increased kidding interval

C_{21}. *Milk loss:* The problem of infertility caused by a disease is the lengthening of the kidding interval, therefore, fewer goats will be in milk at any given time. The effect of this infertility problem will consequently reduce the output of milk. An average delay of 3 months in the next conception is assumed for all goats affected by the disease. The loss of milk is due to the reduction in the proportion of animals lactating in any year multiplied by the lactation yield per year and by the price (M), which is represented by

$$C_{21} = \left\{ \frac{12}{C_I} - \frac{12}{C_I + W} \right\} I P_L (1\text{-}A_I) Z M \qquad (3.7)$$

C_{22}. Value of kids that could have been born

$$C_{22} = \left\{ \frac{12}{K_I} - \frac{12}{K_I + W} \right\} I P_L (1\text{-}A_I) N_k P_C \qquad (3.8)$$

D. *Body weight loss:* The value of direct loss due to reduction in body weight is estimated by using the formula:

$$D = I\,(1\text{-}P_L)\, W_L\, W_A\, P_W \qquad (3.9)$$

P_L, proportion of goat in milk; W_L, proportion of body weight loss ; W_A, average body weight; P_W, price of live weight per kg.

F. Cost of treatment

$$F = I\, T_C \qquad (3.10)$$

G. *Opportunity costs:* The opportunity costs is calculated by formula

$$G = I\, V/10 \qquad (3.11)$$

Economic losses due to FMD in pigs

The total economic loss (T_L) due to FMD in pigs is worked out as sum of (A) loss from mortality, (C) Losses due to Reproductive Failure in affected pigs, (D) Loss in body weight, (F) Cost of treatment of affected pigs and (G) Opportunity costs.

$$T_L = A + C + D + F + G \qquad (4.1)$$

A. Loss from mortality

$$A = D_A V \qquad (4.2)$$

C. Losses due reproductive failure

$$C = C_1 + C_2 \qquad (4.3)$$

C_1. *Body weight loss due to increased inter farrowing period:* The reduction in number of piglets born due to the increased inter farrowing period due to a disease causes loss in body weight. Such losses are estimated by the equation:

$$C_1 = C_1 = \left\{ \frac{12}{K_I} - \frac{12}{K_I + W} \right\} I P_L (1-A_I) N_K B_W P_W \qquad (4.4)$$

K_I, inter farrowing interval; B_W, average birth weight of a piglet; N_K, average number of live piglets per litter.

C_2. Body weight loss due to increased abortions

The reduction in number of piglets born due to increase in number of abortions causes loss in body weight. Such losses are estimated by the formula:

$$C_1 = \left\{ \frac{12}{K_I} - \frac{12}{K_I + 5} \right\} I P_L A_I N_K B_W P_W \qquad (4.5)$$

D. Loss in body weight

1. *Value of direct loss due to reduction in body weight:*

Table 3.1. Probable estimates of parameters for FMD effects in bovines

Parameters	Notation	Cattle	Buffalo	Source of information
Number of infected animals	I	28716	8357	Annual Reports of DAHD and BAHS (2010)
Number of animals died	D	437	99	
Proportion of herd in lactation	P_L	0.37	0.52	
Average annual milk yield in kg	Z	1500	1800	BAHS (2010), Planning Commission (2007)
Average market value of animal (₹)	V	20000	35000	Probable value
Increased abortion rate (%)	A_I	10	10	Doel (2003)
Proportion of lactation lost	L	0.25	0.25	Doel (2003), Mathew and Menon (2008)
Calving interval in months	CI	20	20	Singh and Lal (1991) and AICRP reports
Price of milk (₹)	M	30	40	Probable value
Delay in next conception (months)	W	3	3	Probable value
Price of new born calf	V_C	4000	6000	Probable value
Proportion of draught animals	P_D	0.28	0.06	BAHS(2010)
Proportion of calf	P_C	0.35	0.42	BAHS(2010)
Reduction in growth (%)	G_R	20	20	Doel (2003))
Number of days animal could not work	D_W	30	30	Saxena (1994) Thirunavukkarasu and Kathiravan (2010)
Per day hiring charges of draught animals (₹)	H_W	200	200	Mathur (2011)
Treatment cost of an infected animal	T_C	1270	1270	Shaheen *et al.* (2005)

Table 3.2. Probable estimates of parameters for FMD effects in sheep/goat/pigs

Parameters	Notation	Sheep	Goat	Pig	Source of information
Number of infected animals	I	888	1724	93	BAHS (2010)
Number of animals died	D_A	33	65	10	
Proportion of sheep in shearing age	P_H	0.80	-	-	BAHS(2010)
Proportion of animals in lactation	P_L	0.60	0.52	0.70	BAHS(2010)
Average annual milk yield in kg	Z	-	120	-	BAHS(2010)
Average annual wool yield in kg	Y_W	1.2	-	-	BAHS(2010)
Average market value of animal (₹)	V	6000	7500	7500	Probable value
Increased abortion rate (%)	A_I	10	10	10	Doel (2003)
Proportion of lactation lost	L	0.25	0.25	0.25	Doel (2003), Mathew and Menon (2008))
Proportion of wool yield loss	Y_L	0.25	-	-	Singh (2011)
Lambing/kidding/ farrowing interval in months	K_I	12	12	7.5	AICRP Reports
Price of milk per kg (₹)	M	-	20	-	Probable value
Price of wool per kg (₹)	P_Y	50	-	-	Probable value
Delay in next conception (months)	W	2	2	1.5	Probable value
Price of live weight per kg	P_W	250	250	150	Probable value
Treatment cost of an infected animal	T_C	485	485	520	Shaheen *et al.* (2005)
Number of live kids born	N_K	1.5	1.5	6	AICRP Reports
Birth weight	B_W	2	2.5	1	AICRP Reports
Average body weight (kg)	W_A	25	25	50	AICRP Reports
Proportion of body weight lost	W_L	0.25	0.25	0.25	Singh, 2011
Price of new born	P_C	500	625	1000	Probable value

The body weight loss occurred due to FMD is estimated by using the formula:

$$D = I\,(1\text{-}P_L)\,W_L\,W_A\,V_W \quad (4.6)$$

W_L, proportion of body weight loss; W_A, average body weight.

F. Cost of treatment

$$F = I\,T_C \quad (4.7)$$

G. Opportunity costs

$$G = I\,V/10 \quad (4.8)$$

The treatment cost used for cattle/buffalo, sheep/ goat and pig was ₹ 1,270, 485 and 520/ infected animal, respectively and the details are given in Table 2. The formulae mentioned above use the values of different parameters, some of which were obtained from secondary sources (published Reports/ papers). For remaining parameters the probable values were used for computation of economic losses and are given in Table 3.1 and 3.2 respectively.

RESULTS AND DISCUSSION

The average number of infected animals and animals died during the last five years (Jan – Dec 2006–2010) reported by Department of Animal Husbandry, Dairying and Fisheries, Government of India are given in Tables 3.1, 3.2. Considering the population of cattle, buffaloes, goats, sheep and pigs in the year 2007 (Livestock Census Report), the average morbidity rates due to FMD in India were 0.014%, 0.008%, 0.001%, 0.001%, 0.0008% in these respective species. The mortality rates in these respective species were 2.2, 1.0, 0.46, 0.46 and 1.0/millions of population. The sample survey studies data covering Himachal Pradesh, Uttar Pradesh, Madhya Pradesh and Maharashtra revealed that the estimated morbidity and mortality rates due to FMD in these respective species were 0.90%, 2.06%, 11.14%, 8.08% and 29.52%, and 0.08%, 0.37%, 2.04%, 1.73% and 5.06%, respectively. In an investigation, Saxena (1994) reported that the highest incidence of FMD in India was in indigenous cattle and draught animals (both 29%), followed by dairy cattle (25%), young animals (23%), buffaloes (20%), crossbred animals (17%) and sheep, pigs and goats (16% each). The highest incidence was in the eastern region of the country (35%) and lowest in the southern region (11%). Similar high prevalence of FMD in cattle (16.51% in adult and 25.84% in young cattle), followed by buffaloes (11.01% in adult and 10.34% in young buffaloes) was observed by Thirunavukkarasu and Kathiravan (2010) in four districts of Cauvery delta of Tamil Nadu. However, Mathew and Menon (2008) reported 2.42% incidence rate and 0.12% mortality rate in bovines in Chazhoor Panchayath of Thrissur district in Kerala.

To illustrate the application of the methodology the component-and species-wise losses due to FMD based on the average number of cases and deaths reported by Government of India are given in Table 4. It is evident that the highest losses occurred in cattle (65.62%), followed by buffaloes (33.04%), goats (0.96%), sheep (0.33%) and pigs (0.05%). The morbidity losses contributed about 97.64% and rest (2.36%) by mortality of animals. Among different components of losses the maximum loss of 49.83% was observed due to milk loss (direct and indirect), followed by opportunity cost (16.15%), reduction in growth (12.20%), loss of work power (9.35%) and treatment cost (8.83%). However, the total losses due to reproductive failure contributed 14.95% to total loss. The total losses per infected

Table 4. Component- and species-wise economic losses (₹ lakh) due to FMD based on data reported by Govt of India

Components	Cattle	Buffalo	Sheep	Goat	Pig	Total	% loss
Mortality loss (A)	87.40	34.65	1.98	4.88	0.75	129.66	2.36
Morbidity losses							
Wool loss	-	-	0.11	-	-	0.11	0.002
Milk loss							
Direct	1195.30	782.22	-	5.38	-	1982.9	36.16
Increased abortions	115.61	75.65	-	0.95	-	192.21	3.51
Increased calving interval	336.76	220.38	-	0.45	-	557.59	10.17
Total milk	1647.67	1078.25	-	6.78	-	2732.70	49.83
Value of new born							
Increased abortions	10.28	6.30	0.18	2.77	0.52	20.05	0.37
Increased calving interval	29.93	18.37	0.51	1.30	0.04	50.15	0.91
Total value of new born	40.21	24.67	0.69	4.06	0.56	70.19	1.28
Reduction in growth	402.02	245.70	5.55	15.52	0.14	668.93	12.20
Draught power	482.43	30.09	-	-	-	512.51	9.35
Treatment cost	364.69	106.13	4.31	8.36	0.48	483.98	8.83
Opportunity cost	574.32	292.50	5.33	12.93	0.70	885.77	16.15
Total morbidity loss	3511.35	1777.33	15.98	47.65	1.88	5354.19	97.64
Total loss (₹)	3598.75	1811.98	17.96	52.52	2.63	5483.84	100.00
% loss	65.62	33.04	0.33	0.96	0.05	100.00	
Loss per infected animal (₹)	12532	21682	2023	3046	2830		

animal due to FMD in case of cattle, buffalo, sheep, goat and pig were ₹ 12,532, ₹ 21,682, ₹ 2,023, ₹ 3,046 and ₹ 2,830 respectively.

The economic losses due to FMD were evaluated for three data sets reported by Government of India, sample survey studies as mentioned above and data based on published information in scientific journals (2.42% morbidity rates and 5.5% case fatality rates) considering the values of different parameters given in Tables 3.1, 3.2. The total annual economic losses due to FMD in India based on these three data sets are ₹ 54.83 crore, ₹ 12,233.51 crore and ₹ 13,798.84 crore, respectively. Though, AICRP FMD Project estimated the economic losses of FMD at approximately ₹ 15,000 million/ year and ₹ 3,861 million were from Maharashtra alone (Mahajan and Rautmare 2005). The annual loss based on the data reported by Government of India is very small as compared to losses based on survey studies and published reports due to less number of infected animals reported in different species. This study revealed that the morbidity loss per infected animal in cattle, buffalo, sheep, goat and pig was ₹ 12,227, ₹ 21,267, ₹ 1,799, ₹ 2,763 and ₹ 2,024, respectively.

To prevent economic losses due to FMD and to develop herd immunity in cloven-footed animals about 689.90 lakh vaccinations were carried out by the Central Government during 2010–11(GOI 2011–12). Thus, considering the cost of single vaccine equal to ₹ 8 (Garg 2010). The cost of above vaccination was about ₹ 55.19 crore. It is concluded from this study that the annual total economic loss due to FMD in India ranges from ₹ 12,000 crore to ₹ 14,000 crore.

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