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Research Article

ECONOMIC IMPACT OF FOOT-AND-MOUTH DISEASE IN INDIA: A MICROLEVEL STUDY FROM ANDHRA PRADESH

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A B S T R A C T

Effective diseases control is crucial to the optimal contribution of livestock to the national economy. One of the most contagious and the most devastating diseases of farm animals is foot and mouth disease virus (FMDV) infections. The direct economic losses are mainly due to loss in milk production and reduction in the working ability of draught animals. The indirect losses are due to the non-acceptance of milk and milk products, meat and hide by FMDV-free countries. Control of FMDV is mainly through prophylactic immunization of susceptible animals populations. This pilot study was conducted mainly with the objectives of (i) estimating the costs and losses associated with FMDV infections; and (ii) characterizing and quantifying the costs and benefits associated with FMD-Control Programme (FMD-CP) in two groups of FMD-CP and FMD non-CP districts in Andhra Pradesh during 2009-2010. Results revealed that FMDV outbreaks persisted longer period in the areas where there is no vaccination programme. Despite the FMD-CP, farmers reported that outbreaks persisted. In addition, the morbidity was higher than mortality and they were both higher in areas without vaccination coverage. The total economic losses was estimated to be, Rs. 41,482 and Rs. 63,768 due to FMDV in CP and non-CP districts, respectively. The CP in the state of Andhra Pradesh reduced the cost to Rs. 22,286 per farm during the outbreak. The causes of economic losses were arranged in this study as the following: the value of milk lost, draught power lost, treatment cost and the mortality percent in livestock. Factors such as education, the experience in dairy farming, and the total income positively influenced the urge of farmers for vaccination of their animals against FMDV. Livestock of lower caste farmers, especially milch animals of Other Backward Class (OBC) and Scheduled Tribe (ST), were not involved completely by the vaccination programme, due to the notion that 'milk production might fall'. The total economic loss estimated to be Rs.1147.31 crores per year in the state of Andhra Pradesh due to FMDV outbreaks. The ultimate stamping out of the disease from India necessities expansion of FMD-CP to whole of the state, ring vaccination, incentive system for susceptible animals population, quick response of the veterinary authority during outbreaks, and regulation of animals movement across regions.

INTRODUCTION

India has vast resources of livestock, which play a vital role in improving the socio-economic conditions of rural masses; of about 302.34 million bovines, 74.26 million sheep, 148.8835.2 million goats and 9.06 million pigs (DADF, 2020). Livestock is an integral part of the agricultural production system in India. According to estimates of the Central Statistics Office (CSO), Govt. of India, the output from this sector was about Rs. 10, 43, 656 crores during 2017-18; 28.6% of the output from agriculture and allied sectors (DADF, 2019-20).

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important driver for achieving the targeted 4% growth in the agricultural sector by 2020 (OECD/ICRIER (2018)).

Effective disease control is fundamental to the optimal contribution of livestock in the national economy. FMD is one of the most contagious and the most devastating diseases of mammals (Royal Society, 2002). Primarily, domestic livestock are more productive thus more susceptible to the effects of FMDV. Furthermore, the increase in global trade in livestock products, so the risk of virus spread intensifies. In addition, the increase noted in the gap between the developed and developing countries, increased likelihood of direct and indirect encounters between highly infectious and highly susceptible animals (Knight-Jones and Rushton, 2013). This increasing global impact is not distributed evenly, whether

geographically, or by production systems, or by sector, or by socio-economic status (World Social Report, 2020).

Foot and mouth disease virus is a highly contagious virus affecting over 60 species of cloven-hoofed domestic and wild animals (OIE, 2007). Morbidity can approach 100%, while mortality is rare in adult animals, though it may be as high as 50%, when the virus replicates in the heart muscles of younger animals resulting in death, but the disease often leaves them debilitated and less productive (OIE, 2007; Gulbahar *et al.,* 2007). After recovery, the productivity of the animals does not return to normal. Abortions and infertility may continue leading to uneconomical farming. The disease circumstances are complicated by several factors and the notable ones among them are: (i) large population of susceptible animals; (ii) no efficient vaccination programme; and (iii) unrestricted movement of animals within the country. FMDV causes severe economic losses especially in high producing dairy animals and serious drops in draught power needed for crop husbandry and rural transportation. The indirect losses are due to the non-acceptance of milk, milk products, meat, and hide by FMD-free countries causing reduction in the export potential. As the result, there is a necessity to attach the highest priority to the control and prevention of FMD.

An epidemiological and economic study on FMD conducted in 1976 revealed that about 15% of the Indian livestock were affected causing more than Rs.4,000 million loss yearly (Ellis and James, 1976), while Bandyopadhyay (2004) estimated the annual loss due to FMD in India at US $800 million. Govindaraj, *et al*. (2017) found that in indigenous cattle, the highest loss due to FMD was distress sale (208 USD) followed by other losses, whereas, in crossbred cattle, the highest loss was mortality loss (515 USD), while in local and upgraded buffaloes, the mean total loss per affected animal was 440 USD and 513 USD, respectively.

Control of FMDV, depends mainly on prophylactic immunization of susceptible animal population The Union Government has initiated Foot and Mouth Disease Control Programme (FMD-CP) in the X five year plan implemented in 54 districts in 8 states (Andhra Pradesh, Gujarat, Haryana, Kerala, Maharashtra, Punjab, Tamil Nadu and Uttar Pradesh) and 5 UTs (Delhi, Andaman & Nicobar Islands, Lakshadweep, Dadra & Nagar Haveli and Daman & Diu) in its first phase with 100% central funding as cost of vaccine and other logistic supporting vaccination (FAO, 2012). All the cattle and buffaloes in these target districts were vaccinated twice a year. The programme has shown the desired results in terms of reduction in the incidence of disease compared to other areas (Bandyopadhyay, 2004). Hence, it has been extended to additional 167 districts since August, 2010 (FAO, 2012); covering all the districts in the States/UTs of Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Maharashtra, Goa, Gujarat, Punjab, Haryana, Andaman and Nicobar Islands, Dadra and Nagar Haveli, Daman and Diu, Delhi, Lakshadweep, Puducherry, and 16 districts in Uttar Pradesh.

Foot and mouth disease virus control is still more complex issue, because outbreaks were recorded even in immunized herds, (as the developed immunity was against one (sub) type of virus which does not guarantee immunity to another.

However, there are very few observed evidences on the economic recovery were available that will enhance planning economically feasible FMDV prevention/control programme(s).

This pilot study was conducted mainly with the objectives of (i) estimating the costs and losses associated with FMDV on specific actors of the dairy and meat value chains; and (ii) characterizing and quantifying the costs and benefits associated with FMD-CP.

DATA AND METHODOLOGY

This study was conducted in the state of Andhra Pradesh during, which has been selected based on the high prevalence of FMDV and the implementation of FMDV control programme. About 600 farm were chosen randomly from 4 districts of the Andhra Pradesh, 2 from FMD-CP implemented districts (Chittoor and Medak) and 2 from FMD non-CP districts (Nellore and Mahbubnagar) were surveyed with the help of a well-structured and pre-tested interview schedule during the period, 2009-10.

The study tried to assess the economic impact, mainly the direct impacts on the smallholder producers in the study area. Other related information on availability of animal health services; number of visits to these services during FMDV outbreaks, treatment type, and other incidental costs incurred during these visits. The mechanisms and coping strategies employed by the farmers were investigated. For assessing the economic losses caused by FMDV were recorded.

The direct impact indicators chosen in the study were as follows:

1. Loss due to reduced milk output
2. Loss due to reduced draught power
3. Loss due to treatment of sick animals
4. Loss due to mortality or culling

In India, the disease occurs primarily in cattle and buffaloes, therefore, 75-85% of FMDV outbreaks were noted. The incidence of the disease in sheep and goats is generally low. the infection in small ruminants takes a milder form compared to cattle and pigs. Hence, in our study it was decided to have an in-depth analysis of the impacts on the cattle and buffaloes only at farm level.

Loss due to Reduced Milk Output

The immediate effect of FMDV in lactating stocks is loss of milk production, which is never regained later in the lactation. The due to milk yield reduction (L_Y) is equal to:

$$L_Y = (M_{Pre} - M_{Post})^{*}D^{*}P$$

Where,

M_{Pre} = Milk yield at pre-FMD period (Litres/day)
M_{Post} = Milk yield at post-FMD period (Litres/day)
D = Duration of infection in in-milk animals
P = Price / litre of milk (Rs.)

Loss due to Reduced Draught Power

FMDV in draught animals has its implications very much in crop production. The effect of the disease on the working capacity of draught animals was the recorded evidence. The profit could be earned or the cost of hiring replacement of draught power during the period of incapacitation. That is, loss due to draught power reduction (L_D) is equal to:

$$L_D = [(H_{Pre} - H_{Post}) / 8]^{*}D^{*}W$$

Where,

H_{Pre} = Draught power at pre-FMDV period (Hours/day)
H_{Post} = Draught power at post-FMDV period (Hours/day)
D = Duration of infection in bullocks
W = Hiring charges / day (Rs.)

Loss due to Treatment of Infected Animals

The instant loss to the farmer because of FMDV infection in his animal(s) is the cost of treatment including; medicines, veterinarian's fee, and the cost of additional labor that might be required to provide extra care to the sick animals. That is, Treatment costs (L_T) is equal to:

$$L_T = (C_P * N) + C_I$$

$$C_P = F + M$$

Where,

C_P = Cost of professional treatment (Rs.)
F = Fees for veterinarians / visit (Rs.)
M = Cost of medicines / visit (Rs.)
N = No. of visits to animal health services
C_I = Cost of indigenous treatment during the infected period (Rs.)

Loss due to Mortality or Culling

Although FMDV is generally called as a 'morbidity high and mortality low' disease, mortality noted especially in young stock which were unable to withstand the hardships of the disease. Besides, as the productive performance of affected animals goes down to uneconomical dimensions, forcing the farmers to cull such stock usually at a low market price. The difference between the value of animals before the disease and the cull value was used as the loss due to mortality.

That is, loss due to mortality (L_M) is equal to:

$$L_M = \sum A_{ij} * V_{ij}$$

Where,

A_{ij} = Species-wise category of bovine
V_{ij} = Difference between the value of animals before the disease and the cull value (Rs)
i = Species of animal; Indigenous cattle, crossbred cattle, local buffaloes and upgraded buffaloes
j = Category of animals; In-milk, dry, bull, bullock, immature males, heifer, male calf and female calf

Factors Influencing Compliance to Vaccination

In the FMDV endemic area, vaccination of the susceptible animals is the most common strategy and option exercised by the farmer to prevent the occurrence of the disease. Nevertheless, it had been observed that the act of vaccination *per-se* was influenced by many socio-economic factors. It might be the age of the farmers, education level of the farmers, caste, family size of the farm households, experience of the farmers in dairying, farm size, income of the farmers, etc. Accordingly, it was decided to understand the nature of influence of these factors on the vaccination of animals against FMDV in the study area. Hence, the dependent variable, vaccination could take two scenarios, one might be 'yes' (value = 1) and the other could be 'no' (value = 0). In such a situation, probit regression function would be the appropriate model to capture the nature and magnitude of the relationship, all the independent variables exert on the dependent variable. Accordingly, the functional relationship between the vaccination of animals and various factors was specified as mentioned below:

$$Y = \alpha_0 + \beta_1 AGE + \beta_2 EDN + \beta_3 FAMILY + \beta_4 EXP + \beta_5 FARM + \beta_6 TINC + \beta_7 CASTE(D_1) + \beta_8 CASTE(D_2) + \beta_9 CASTE(D_3) + U_i$$

Where,

Y = Vaccination in 2008 (1 for 'Yes' and 0 for 'No')
AGE = Age of the farmer
EDN = Education level of the farmer (No. of years of formal education)
FAMILY = Family size of the farm household
EXP = Experience in dairying (No. of years)
FARM = Farm size (No. of bovine in the farm household)
TINC = Total income of the farmer
D_1 = Dummy (Other backward caste)
D_2 = Dummy (Scheduled caste)
D_3 = Dummy (Scheduled tribe)
U_i = Error term

RESULTS AND DISCUSSION

Impact of Foot-and-Mouth Disease Virus Outbreaks

While FMD affects the clinical wellbeing of most susceptible livestock and the food-producing performance of higher-producing animals, it is not a killer disease, and there is a wide variation in its morbidity (Perry and Rich, 2007). The broad framework of FMDV impacts in a society could be depicted through the diagrammatic representation.

FMD Episodes

It was found that FMDV outbreaks persisted more number of days in the areas where there is no vaccination programme against FMDV (Table 1). The disease also affected cattle more than buffaloes and crossbred more than indigenous breeds in the study area, which was in conformity with the species and breed susceptibility to this problem (Aidaros, *et al*., 2016).

Table 1 Details about FMDV episodes in the sample districts in 2008

No.	Particulars	FMD CP districts		FMD Non-CP districts	
		Chittoor	Medak	Nellore	Mahbub nagar
1.	Number of households/village reported FMDV outbreak	48 (31%)	26 (17%)	53 (35%)	43 (31%)
2.	Number of households reported outbreak	29 (19%)	26 (17%)	52 (35%)	35 (25%)
3.	Average number of daysFMDV persisted in village	25.9	28.1	33.4	24.5

All FMDV outbreaks in the sample districts from the year 2004 to 2008 were depicted in Figure 2. The number of FMDV outbreak incidences reported in the FMD-CP implemented districts were highest during 2005 than the remaining years of the study, while highest during 2008 than the rest of the years in the districts where the CP was not implemented. However, despite the FMD-CP, farmers report that FMDV outbreaks still persist. It necessitates the importance of covering the whole area / state in the vaccination programme as there is no check at present over animal movement controls in the country.

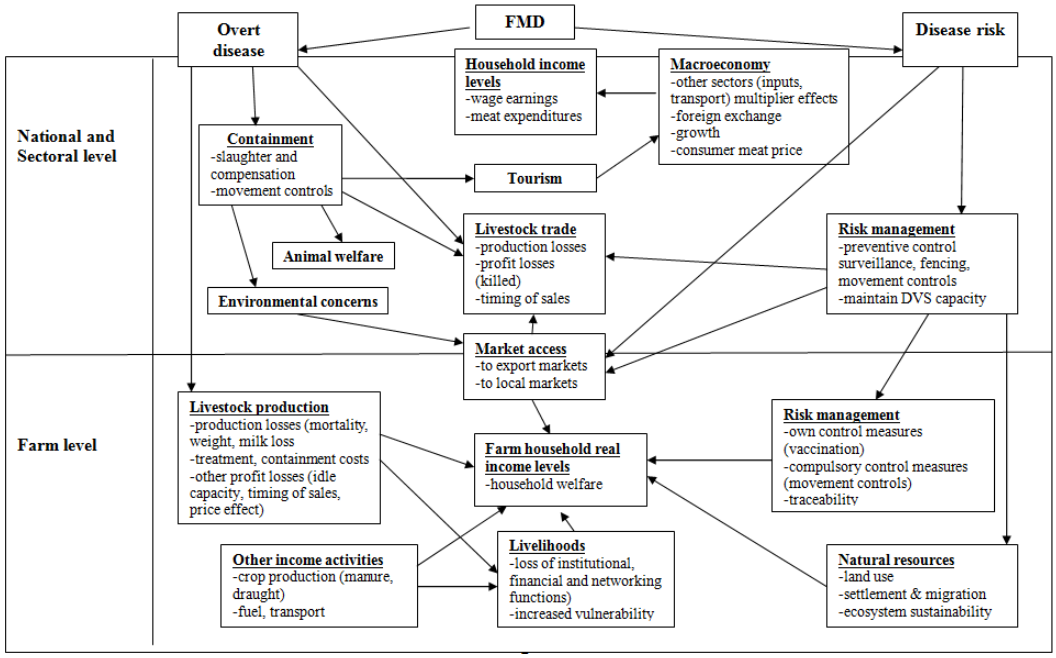

Figure 1 Impacts of foot-and-mouth disease (Perry and Randolph, 2003)

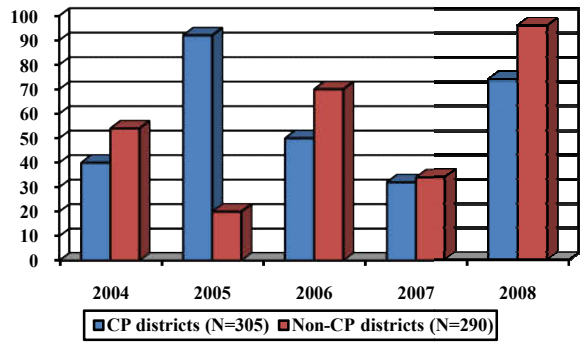

Figure 2 FMDV outbreaks in the sample districts during 2004-2008

Morbidity and Mortality due to FMDV

It was also found from Table 2 that in all districts surveyed the number of animals affected by FMDV was more than those died due to the disease, indicating that the morbidity was higher than mortality and the magnitude was more in the districts where there is no vaccination coverage.

Table 2 FMDV attacks and deaths in sample farms in 2008

No.	Particulars	FMD CP districts		FMD non-CP districts	
		Chittoor	Medak	Nellore	Mahbub nagar
1.	Total animals in affected farms	203	240	482	345
2.	No. of attacks	38 (18.72)	80 (33.33)	98 (20.33)	122 (35.36)
3.	No. of deaths	7 (18.42)	8 (10.00)	21 (21.43)	27 (22.13)

Note: Figures in parentheses under 'attacks' indicate percentages to total no. of animals in the affected households Figures in parentheses under 'deaths' indicate percentages to total no. of animals attacked

Net Direct Economic Impact of FMDV on Bovine

The net economic impact of FMDV incidences in milch animals of Chittoor district (FMD-CP district) and Nellore district (FMD non-CP district) portrayed in Table (3 & 4).

Table 3 Net economic impact of FMDV on bovine in Chittoor district

Particulars	Cattle*		Buffaloes*	
	Indigenous	Crossbred	Local	Upgraded
Value of milk loss	2436 (36.57)	8658 (52.69)	4751 (95.23)	6855 (87.15)
Value of draught power loss	3121 (46.85)	5502 (33.48)	---	---
Treatment costs	1105 (16.58)	1760 (10.71)	238 (4.77)	1011 (12.85)
Loss due to mortality per farm	0 (00.00)	512 (3.12)	0 (00.00)	0 (00.00)
Total	6,662 (100.00)	16,432 (100.00)	4,989 (100.00)	7,866 (100.00)

Note: * Rs./animal
Milk loss corresponds to adult female animals.
Draught power loss corresponds to adult male animals.
Treatment costs and loss due to mortality correspond to all animals at the farm.
Figures in parentheses indicate percent to total.

On perusing category of animals in Chittoor district, value of draught power lost with 46.85% of total loss (Rs. 3121) outweighed value of milk lost (Rs.2436) and treatment loss (Rs. 1105) in case of indigenous cattle. However, in case of crossbred cattle, the value of milk lost was much higher with 52.69% of total loss (Rs. 8658), followed by value of draught power lost (33.48%), treatment costs (10.71%) and the loss due to mortality (3.12%). Surprisingly in case of local and upgraded buffaloes, 95.23% and 87.15% of the total losses were due to the value of milk lost alone, respectively, followed by treatment costs (4.77% and 12.85%). Singh *et al*. (2013) also observed that value of milk loss was more, followed by opportunity cost and reduction in growth of animals.

In Nellore district, in case of indigenous cattle, the net economic impact of FMDV was observed to be more through the loss of value of draught power with 63.31% (Rs.11855) of total loss, followed by the value of attainable milk lost with 26.72% (Rs.5002), treatment costs with 9.61% (Rs.180) and mortality and culling with 0.36% (Rs. 67). The scenario was more or less similar among crossbreed cattle also, with loss of Rs. 10074 (44.40%) due to draught power reduction followed by Rs.8906 (39.25%) through the value of milk lost. Similar findings were reported by Thirunavukkarasu and Kathiravan

(2010) in Tamil Nadu. Treatment costs were higher in case of cattle than buffaloes. Loss due to mortality was more in case of crossbred and upgraded species than indigenous bovine. The loss due to milk yield reduction was found to be more among upgraded and local buffaloes with 83.94% and 84.92%, respectively, of the total losses due to FMDV; Rs. 10165 and Rs. 6791, respectively. The loss due to treatment cost (Rs. 1725) and mortality (Rs. 220) were also estimated to be higher in upgraded buffaloes than in local buffaloes; Rs. 1110 and Rs. 95, respectively.

Table 4 Net economic impact of FMDV on bovine in Nellore district

Particulars	Cattle*		Buffaloes*	
	Indigenous	Crossbred	Local	Upgraded
Value of milk loss	5002 (26.72)	8906 (39.25)	6791 (84.92)	10165 (83.94)
Value of draught power loss	11855 (63.31)	10074 (44.40)	---	---
Treatment costs	1800 (9.61)	1871 (8.25)	1110 (13.89)	1725 (14.24)
Loss due to mortality per farm	67 (0.36)	1837 (8.10)	95 (1.19)	220 (1.82)
Total	18724 (100.00)	22,688 (100.00)	7996 (100.00)	12,110 (100.00)

Note: *(Rs./animal)
Milk loss corresponds to adult female animals.
Draught power loss corresponds to adult male animals.
Treatment costs and loss due to mortality correspond to all animals at the farm.
Figures in parentheses indicate percent to total.

The results show clearly that the disease influenced mostly the crossbred cows and upgraded buffaloes, as they are the high milk yielders. In case of indigenous bovine, it causes losses mainly on account of loss of draught power. In general, it affected cattle more than buffaloes, which require relatively treatment expenses.

The total economic loss per farm was found to be Rs. 41,482 and Rs. 63,768 due to FMDV in CP and non-CP districts; reduced in the state of Andhra Pradesh to Rs. 22,286 per farm during outbreak. Among the components of economic losses considered in this study, the loss due to the value of milk lost was the major factor in all categories of animals, followed by value of draught power lost (only in cattle), loss due to treatment and the loss due to mortality of livestock (only in crossbred cattle). It was found that the impact was more in non-CP district than in CP district.

Factors Influencing Compliance to Vaccination

Various factors influencing the farmers to go for vaccination against FMDV and their extent and relationship in its influence were presented in Table 5.

It is observed from the table that the farmers dependent factors such as; education, experience in dairy farming, and total income positively influenced their urge to go for vaccination of their animals against FMDV. If the farmers belong to the caste of OBC or ST, they were found not getting covered completely by the vaccination programme. Hence, the negative relationship on the vaccination compliance by them. The smaller the farm size was, the better compliance to vaccination, though the relationship was statistically found significant at levels more than 10%.

Table 5 Factors influencing vaccination of animals against FMDV in Andhra Pradesh

Variable	Coefficients	't' values	'p' values
Constant	-0.1886	-0.532	0.5945
Age	0.0045	0.756	0.4496
Education (No. of years)	0.0647***	4.172	0.0000
Family size	-0.0405	-1.276	0.2018
Experience in dairying (No. of years)	0.0445***	5.255	0.0000
Farm size	-0.0212	-1.587	0.1124
Total income (Rs.)	0.0005***	2.480	0.0131
Caste (D1): OBC	-0.5118***	-3.265	0.0011
Caste (D2): SC	-0.3158	-1.434	0.1516
Caste (D3): ST	-1.0154***	-3.805	0.0001
Log likelihood function	-299.17		
Number of observations	595		
Chi-squared	122.56		

* Significance at 10% level
** Significance at 5% level
*** Significance at 1% level

Non-Compliance to Vaccination

The notion 'milk production might fall' was the major reason for not vaccinating livestock, especially milch animals, against FMDV (Figure 3). This was attributed as the primary reason in all the districts, as the milk was the major factor for their livelihood and daily cash flow. The absence of regular vaccination services was the second major reason. Although Chittoor district was under FMDV-CP, this reason was stated to be prominent one as the vaccination was carried out only during specific periods, not as, and when they bought the animals from neighboring FMDV non-CP areas (Ref). The reason, 'too expensive' was reported prominently in FMDV non-CP areas, as the farmers had to go for vaccination privately. Other reasons for non-compliance of vaccination included; 'don't know FMDV' and 'too expensive to transport the animals to veterinary hospitals'.

All these reasons expressed by the farmers indicate that their knowledge level on the importance of vaccination in controlling the FMDV was very weak. Therefore, efforts should be made to create awareness about the scientific approaches available for effective control and ultimate stamping out of the disease from the state of Andhra Pradesh.

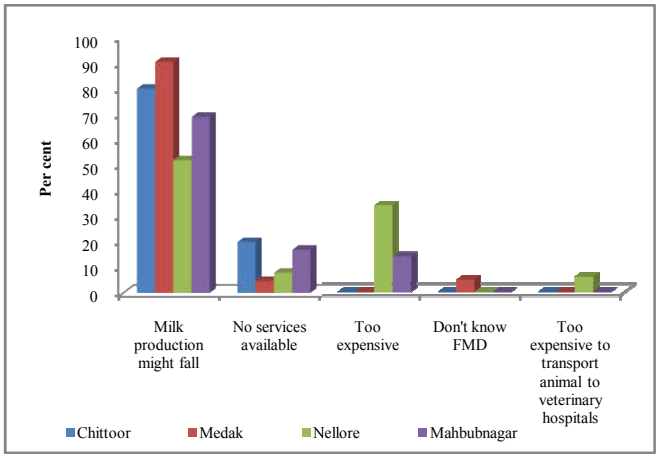

Figure 3 Reasons for not vaccinating against FMDV by farmers

Projections of Estimated Total Direct Loss due to FMDV in Andhra Pradesh

All the results obtained in the study and presented in this report refer only to the outbreaks and farms sampled for the study in the chosen four districts of the Andhra Pradesh State. Hence, the losses estimated would not indicate what would

have been exactly lost in the whole state, had control programs not been implemented. Nevertheless, an attempt was made to extrapolate the results obtained from the study to approximately understand the economic dimensions of FMDV outbreaks in the state and the country. As this extrapolation was made based on an assumption that the proportion of different species of livestock and the disease prevalence would be similar in other areas too, there could be an imminent possibility for error in accuracy and reliability of the results obtained. However, still they could offer valuable information in the absence of more comprehensive studies in those areas.

From the results that are presented in Table 6, it could be recognized that the estimated loss due to; reduced milk output, reduction in draught power, treating the ailing animals, and mortality and culling would be Rs. 388.58, Rs.398.79, Rs.351.41 and Rs.8.53 crores, respectively. Thus, the total economic loss estimated could be Rs.1147.31 crores per year in the state of Andhra Pradesh due to FMDV outbreak.

Table 6 Projections of estimated total direct losses due to FMDV in Andhra Pradesh

No.	Impact	Loss / animal (Rs.)	Susceptible Population (n)	Incidence rate (%)	Total loss(Rs. in crores)
1.	**Loss due to milk yield reduction**				
	Indigenous cattle	5085	1530651	0.09	71.98
	Crossbred cattle	9256	642362	0.23	137.92
	Buffaloes	8742	4682371	0.04	178.68
		Sub-total			**388.58**
2.	**Loss due to draught power reduction**				
	Indigenous cattle	11044	3897284	0.08	361.42
	Crossbred cattle	9658	166866	0.23	37.37
		Sub-total			**398.79**
3.	**Treatment costs**				
	Indigenous cattle	2455	13850121	0.06	215.89
	Crossbred cattle	3516	1516264	0.13	102.86
	Buffaloes	1254	9614938	0.03	32.66
		Sub-total			**351.41**
4.	**Loss due to mortality**				
	Indigenous cattle	114	16338975	0.002	0.33
	Crossbred cattle	1596	2305179	0.02	7.55
	Buffaloes	191	15379360	0.002	0.65
		Sub-total			**8.53**
		Grand Total			**1147.31**

Note:

- The population of in-milk animals was taken for calculating the loss due to milk yield reduction.
- The population of male animals used for breeding, agricultural operations and bullock cart pulling was taken for calculating the loss due to draught power reduction.
- The population of 50% of the adult animals was taken for calculating the treatment costs.
- The total population of animals was taken for calculating the loss due to mortality.

It becomes imperative to note that, of the total losses due to reduced milk production (Rs.388.58 crores), the major contribution was due to buffaloes (Rs.178.68 crores), followed by crossbred cattle (Rs.137.92 crores) and indigenous cattle (Rs.71.98 crores). However, the perusal of table indicates that the total loss due to draught power reduction (Rs.398.97 crores) was primarily due to indigenous cattle (Rs.361.42 crores), followed by crossbred cattle (Rs.37.37 crores), where no buffalo was found used for draught purpose by the study sample. Similarly, the total loss due to treatment of FMDV affected animals (Rs.351.41 crores) was primarily due to indigenous cattle (Rs.215.89 crores), followed by crossbred cattle (Rs.102.86 crores) and buffaloes (Rs.32.66 crores). Yet, on looking into the total losses (8.53 crores) due to mortality and culling of FMDV affected animals, the major contributors were crossbred cattle (Rs.7.55 crores), followed by buffaloes (0.65 crores) and indigenous cattle (0.33 crores).

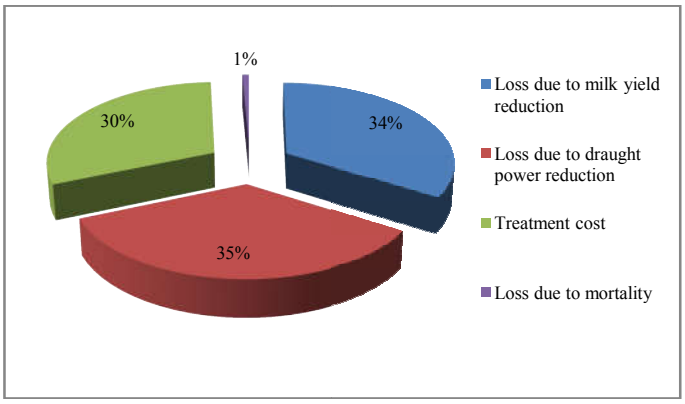

Figure 4 Components of estimated direct losses due to FMDV in Andhra Pradesh

Of the components of total direct losses estimated for the State (Figure 4), the loss due to draught power reduction contributed to about 35% of total losses, followed by the loss due to milk yield reduction (34%), the loss due to treatment of FMDV affected animals (30%) and the loss due to mortality and culling (1%). The contribution of draught power to the total loss was found to be high in Andhra Pradesh, as still farmers rely on the animals for the cultivation operations, which might be because of their fragmented landholding pattern.

Using the same farm-level estimates and with the same assumptions taking into the national level statistics, it was estimated that the country would stand to lose a staggering amount of Rs. 15575 crores because of FMDV outbreak in a year. Singh *et al.* (2007) also stated that in India, the direct losses due to FMDV were estimated to be US$ 1230.32 million annually. The enormous socio-economic impact FMDV caused on the producers alone, notwithstanding the indirect impacts on the other players in the livestock sector as well as the whole lot of related sectors of the economy. It can be understood from the findings of the study that India is in Stage III in the Progressive Control Pathway of OIE, which states that the country is implementing control strategy to eliminate FMDV irculation.

CONCLUSIONS

It is empirically evidenced that in spite of having control programme against the FMDV, the farmers continue to suffer huge losses due to outbreaks. Hence, FMD-CP should be expanded to the whole country / endemic region, in addition to, ring vaccination and animal trade restriction into FMDV-free zones, so that the disease could be completely stamped out. Incentive system should be thought of for effective and complete compliance to vaccination. By encouraging and educating the farmers, the control programme could be made more effective in reducing the outbreak of the disease. Recognizing the fact that movement of animals and their products across the world have contributed substantially to the spread of FMDV, provisions like adoption of sanitary and phytosanitary (SPS) measures need to be introduced. To be able to trade livestock and livestock products across the world, we should be able to demonstrate that our animals are free of certain diseases, especially FMDV and to get the disease free status, by having a reliable disease surveillance and reporting

systemand a reliable disease control and eradication programme.

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