Estimation of economic losses due to classical swine fever in pigs in Mizoram

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ABSTRACT

Classical swine fever (CSF) also known as ‘hog cholera’ is an important viral disease of pigs in India with serious economic concern due to morbidity and mortality, and affects a vast section of the pig population in India. In present study, a structured sampling design was adopted, which covered the major regions of the Mizoram, to ascertain the economic losses due to CSF in pigs. Available estimates of the economic losses of Mizoram due to CSF are based on single values of various epidemiological and economic parameters. Overall annual morbidity, mortality and case fatality rates of CSF in Mizoram were 8.35, 5.07 and 60.70% respectively. The expected annual economic loss due to CSF in pigs in Mizoram was ₹16,69,34,465. Losses due to mortalities contributed the most to the total economic loss caused by CSF in pigs, followed by loss in body weight. This study revealed significant losses due to the incidence of CSF in pigs of Mizoram.

Key words: Classical swine fever, Economic losses, Logistic regression, Mizoram, Morbidity rate, Mortality rate

Classical swine fever (CSF) or hog cholera is a highly contagious pig disease that causes serious economic losses directly due to mortality, retardation of growth, reproductive problems of affected pigs and indirectly by bringing restrictions on exports of pork and pork products from the affected countries (Sarma et al. 2008). The loss accounted for more than ₹2 billion every year in a limited participatory epidemiological study conducted in three states (Asom, Mizoram, Nagaland) in the northeastern region of India, which is the hub of pig production in the country (Bett et al. 2012). High sero-prevalence of CSF in India (63.3%), suggest that the disease is endemic in the country (Nandi et al. 2011). Ahuja et al. (2014) reported the mean prevalence of CSFV antibodies from Meghalaya (52.27%) and Manipur (38.49%). In earlier studies, the attempts were made to estimate economic losses due to CSF in India (Singh et al. 2016). The disease is enzootic in most of the pig producing states and particularly in the north eastern states of India. Improving the surveillance system for CSF and understanding the epidemiology of the disease are important not only to prevent the spread of the disease but also to evolve suitable strategy to control the disease. In this study, an attempt has been made to evaluate the economic losses using the sample survey data from Mizoram of India.

MATERIALS AND METHODS

Sampling design: Districts (8) of Mizoram were divided into two agro-climatic zones. By taking two agro-climatic zones as strata, two districts each from zone 1 and zone 2 were selected randomly. From each selected district, two blocks and from each selected block, two villages were selected by simple random sampling without replacement scheme. A total of 15 pig owners were selected from each village and cumulatively 240 pig owners constituted the ultimate sample from 16 villages and 8 blocks for the study. The sampling scheme followed in the present study was stratified three-stage random sampling (Chaudhary et al. 2013).

Data: Data were collected on the epidemiological and economic parameters of CSF using a questionnaire, supported by a disease identification checklist based on clinical symptoms and photographs. The researchers contacted the local Government Veterinary Officer in each of the administrative blocks where the survey was being carried out, to explain the objectives of the survey. The Veterinary Officer then nominated several farmers based on his or her information in the selected villages. The questionnaire was divided into 5 sections. The first section asked for a description of the sample household and its characteristics. The second section covered the household’s livestock holding and details of breedable animals (pig population). The third section dealt with the
details of live animals, their produce and sales (yield, uses, amount of produce or number of livestock sold, sale and livestock). The fourth section covered animal health management and details of any infected animals (species, sex, age). The fifth section dealt with the effect of the disease (mortality and morbidity) and contained questions on the market value of the animal, disease duration, loss of body weight, abortion, increased inter-farrowing period, the price of any new-born animals, and the costs of treatment and vaccination (Bardhan et al. 2017). The questionnaire was comprehensive and pre-tested. Data were collected between September 2017 and July 2018.

**Statistical analysis:** To measure the agreement between actual counts and expected counts assuming the null hypothesis, chi-square test and for identifying the factors responsible for disease occurrence, logistic regression analysis was used by using SPSS version 17 program.

**Economic losses due to CSF in pigs:** The total economic loss (T_L) due to CSF in pigs was worked out as sum of loss from mortality (A), losses due to reproductive failure in affected pigs (C), loss in body weight (D), cost of treatment of affected pigs (F) and opportunity costs (G).

\[
T_L = A + C + D + F + G
\]

**Loss due to mortality:** The losses (₹) due to mortality were estimated by multiplying the number of animals died in respective age groups with the price of the animals of the respective age group.

\[
A = D_p P_p + D_y P_y + D_A P_A
\]

where A, loss (₹) due to mortality; D_p, number of piglets died; D_y, number of young population died; D_A, number of adult population died; P_p, average market value (₹) of piglet; P_y, average market value (₹) of young animal; P_A, average market value (₹) of adult animal.

**Losses due to reproductive failure**

\[
C = C_1 + C_2
\]

**Body weight loss due to increased inter-farrowing period:** The loss due to reduction in body weight owing to less number of piglets born because of prolonged inter-farrowing period, caused due to delayed conception, was estimated with the following formula:

\[
C_1 = \left( \frac{12}{K_1} - \frac{12}{K_1^{w+5}} \right) (1-D) P_p N_k B_w P_w
\]

where \(K_1\), inter farrowing interval (months); \(w\), delay in next conception (months); \(I\), number of infected animals; \(D\), number of died animals; \(P_I\), proportion of sick animals in lactation; \(N_k\), average number of live piglets per litter; \(B_w\), average birth weight of a piglet (kg); \(P_w\), price of live weight per kg (₹).

**Body weight loss due to increased abortions:** The loss (₹) due to reduction in body weight owing to increase in number of abortions was estimated with the following formula:

\[
C_2 = \left( \frac{12}{K_1} - \frac{12}{K_1^{w+5}} \right) (1-D) P_p N_k B_w P_w
\]

where \(K_1\), inter farrowing interval (months); \(w\), delay in next conception (months); \(I\), number of infected animals; \(D\), number of died animals; \(P_I\), proportion of sick animals in lactation; \(N_k\), average number of live piglets per litter; \(B_w\), average birth weight of a piglet (kg); \(P_w\), price of live weight per kg (₹).

**Direct loss in body weight:** The direct body weight loss due to CSF was estimated by using the formula:

\[
D = (I-D) (1-P_L) W_L W_I P_W
\]

where \(I\), number of infected animals; \(D\), number of died animals; \(P_I\), proportion of sick animals in lactation; \(W_I\), proportion of body weight loss; \(W_L\), average body weight of animal; \(P_W\), price of live weight per kg (₹). Assuming the time for abortion as 2.5 months from conception and a delay of another 1.5 months in the next conception, the inter-farrowing period gets increased by 5 months in abortion cases.

**Cost of treatment**

Cost of treatment \(F = I T_C\) where \(I\), number of infected animal; \(T_C\), treatment cost of an infected animal.

**Opportunity costs (G):** The opportunity cost comprising high cost of feeding, high cost of rearing due to longer rearing time, treatment cost, transport cost, extra labourers engaged for nursing sick animals, and disinfection of shed etc., were difficult to quantify due to lack of record, and were thus assumed approximately as 20% (0.20) of the cost of animals and was estimated by the following formula:

\[
F = (S_p P_p + S_y P_y + S_A P_A) \times 0.20
\]

where \(F\), opportunity cost (₹); \(S_p\), number of piglets survived; \(S_y\), number of young animal survived; \(S_A\), number of adult animal survived; \(P_p\), average market value (₹) of piglet; \(P_y\), average market value (₹) of young animal; \(P_A\), average market value (₹) of adult animal.

**RESULTS AND DISCUSSION**

The overall annual morbidity, mortality and case fatality rates due to classical swine fever in Mizoram was estimated from this sample as 8.35, 5.07 and 60.70% respectively. The incidence rate varied across age group and season. Among the three age groups, young animals had highest morbidity rates followed by piglets and adults. The chi-square analysis revealed that there was significant difference (P<0.01) among age groups of pigs. The mortality rate was also highest for young animals followed by piglets and adult animals. The mortality rates also differed significantly (P<0.01) among different age groups (Table 1).

Among the three seasons, the morbidity rate for classical swine fever was higher in rainy season followed by summer and winter season. The chi-square analysis revealed that there was significant difference (P<0.01) among different
seasons. The mortality rate was also higher in rainy season followed by summer and winter season. The mortality rates also differed significantly (P<0.01) among different seasons (Table 2).

The logistic regression analysis with respect of classical swine fever revealed significant (P<0.01) difference in morbidity and mortality rate. The logistic regression analysis revealed that young animal and male animal were at higher risk of morbidity (Table 3), and young animal and female animal were at higher risk of mortality. The analysis showed that mortality was more in rainy season than summer and winter season (Table 4).

Nandi et al. (2011) also reported that 63.3% of the samples collected from 12 states in India had CSFV antibodies while 76.7% of the samples collected from 13 states had CSFV antigens. The case fatality rates obtained from this study approximate those published by Kumar et al. (2007) but the incidence estimates vary because they measure different but related events. Incidence estimates published by Kumar et al. (2007) represent the number of animals affected in the CSF outbreaks studied while those obtained from this study represent the rate at which villages are affected by CSF outbreaks over a period of one year. All these findings show that young pigs suffer heavier mortalities compared to older animals.

Total economic loss due to CSF in Mizoram was `16,69,34,465. Out of the total loss, mortality accounted for 57.17%, while morbidity accounted for 42.83%. Total loss due to reduction in body weight accounted for 30.56%, comprising direct loss of 29.13% due to reduction in body weight, besides loss of 1.18% due to increase inter-farrowing period and loss of 0.26% due to abortions. Treatment and opportunity cost accounted for 4.91% and, 7.36% respectively (Tables 5, 6).

The morbidity loss emerged as the major contributor to the total loss due to CSF in pigs as per the data recorded by Government of India but mortality loss accounted for major share of total loss due to the same disease when economic loss was calculated as per the data obtained from sample survey study. Our results support earlier reports on CSF outbreaks, which have documented high morbidity and mortality rate as compared to Government of India reports. Singh et al. (2016) reported that economic losses due to CSF in pigs were 74.07% due to mortality and 25.93% due to morbidity, which was similar to our findings.

The present study was planned to generate information about the economic losses caused by classical swine fever

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### Table 3. Logistic regression analysis of morbidity rates due to CSF

| Factor   | B     | SE   | Wald | df | Sig. | OR   |
|----------|-------|------|------|----|------|------|
| Age      |       |      |      |    |      |      |
| Piglet   | -3.492| .249 | 197.37 | 1  | .000 | .030 |
| Young    | .634  | .310 | 4.180 | 1  | .041 | 1.885|
| Adult    | Ref.  | -    | -    | -  | -    | 1    |
| Male     | .514  | .199 | 6.679 | 1  | .010 | 1.672|
| Female   | Ref.  | -    | -    | -  | -    | 1    |
| Season   | -     | .248 | 8.383 | 2  | .004 |     |
| Summer   | -     | .269 | 2.232 | 1  | .139 | .879 |
| Winter   | -     | .226 | 1.106 | 1  | .744 | .929 |
| Rainy    | Ref.  | -    | -    | -  | -    | 1    |
| Constant | 1.718 | .270 | 19.036 | 1 | .000 | 3.247|

Nagelkerke R Square, 0.604; OR, odds ratio; Ref, Reference category =1

### Table 4. Logistic regression analysis of mortality rates due to CSF

| Factor   | B     | SE   | Wald | df | Sig. | OR   |
|----------|-------|------|------|----|------|------|
| Age      |       |      |      |    |      |      |
| Piglet   | -      | .548 | 1.063 | 1  | .303 | .578 |
| Young    |       | .314 | 22.930 | 1 | .000 | 22.509|
| Adult    | Ref.  | -    | -    | -  | -    | 1    |
| Male     | -      | .721 | 7.972 | 1  | .005 | .486 |
| Female   | Ref.  | -    | -    | -  | -    | 1    |
| Season   |       | .690 | 2.928 | 2  | .004 |     |
| Summer   | -      | .818 | 6.822 | 1  | .009 | .441 |
| Winter   | -      | .360 | 13.646 | 1 | .000 | .257 |
| Rainy    | Ref.  | -    | -    | -  | -    | 1    |
| Constant | -     | .227 | .183 | 1  | .669 | .797 |

Nagelkerke R Square, 0.331; OR, odds ratio; Ref, Reference category =1
loss due to mortality and morbidity of the animals. Thus, CSF should be considered an important disease from a policy perspective when it comes to mitigating losses due to disease in livestock. This calls for investments in research on CSF and the implementation of vaccination schedule, identification and recording systems, public awareness, hygiene and bio-security, and movement control as preventative measures.

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