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COVID-19 pandemic challenges in piggery sector and economic losses due to classical swine fever in southern India

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Abstract
Classical Swine Fever is a highly contagious multi-systemic viral disease of swine. It caused major economic losses in pig producing countries around the world. The study was carried out to know the morbidity and mortality patterns, economic losses due to Classical Swine Fever in India. The study was conducted using descriptive research design in four districts where the highest pig population in southern Indian state of Tamil Nadu. It covering total of 240 piggery farmers by cluster and multistage random sampling. A total of 2455 animals were covered under study. Results revealed that overall rates of morbidity, mortality and case fatality rates among swine folk was estimated to be 20.24 percent, 16.42 percent and 81 percent respectively. Morbidity and mortality rates were reported higher in case of pigs less than 4 months of age than pigs more than 8 months of age. Females were found more susceptible for CSF disease than males in case of all breeds. Prevalence of CSF was observed higher during summer season. Morbidity and mortality rates was higher in case of crossbred pigs has compared to indigenous pigs. The total economic losses due to CSF in Tamil Nadu was worked out INR 1.89 million where mortality accounted highest share (82.4%) followed by morbidity (17.56%). Study suggests proper animal health care system to prevent occurrence of CSF disease in pigs and to adopt prompt safeguards against disease infection and economic loss due to CSF disease. Government and Animal husbandry departments should focus more attention towards proper livestock policy and animal development programmes accordingly.

Keywords: Classical swine fever, economic losses, Tamil Nadu

Introduction
CSF is a highly contagious viral disease of swine and its cause huge economic losses to those countries with dense population of desi pigs. Pig farming is one of the significant factor for improving the socio-economic status of the farmers in India (Bernard *et al.* 2012) [1]. CSF is listed in World Organization for Animal Health (OIE) announced highly contagious diseases list. Reports of outbreaks of the disease (Saini *et al.* 2000**)** [2] from the states of Uttar Pradesh, Tamil Nadu, and Punjab, respectively. CSF causes economic losses due to higher reproductive problems and mortality in affected pigs. During past few years the outbreaks of swine fever have been recorded from the states of Nagaland, Manipur, Tripura, West Bengal and Tamil Nadu (Rahman, 2011) [3]. In India, (Singh *et al.*, 2016) [4] calculated the total economic losses due to Classical Swine Fever was economic loss due to CSF (9.085 million INR) as per govt. of India reports was much less than the estimated economic loss (4.299 billion INR) as per survey statistics. With this inference, this study reveals the mortality & morbidity patterns and estimation of annual economic losses due to Classical Swine Fever along with influencing factors for it and its causing economic losses in Tamil Nadu State of India. So for this study we take two objectives *viz*. to study the incidence pattern of Classical Swine Fever disease on pig farms and to estimate economic losses due to Classical Swine Fever.

Materials and Methods
Disease Investigation
The study was conducted using descriptive research design in four districts having highest pig population *viz*- Salem, Cuddalore, Vellore and Namakkal districts of Tamil Nadu where there was a suspected outbreak of classical swine fever among the indigenous pigs reared under in-house farming system. The detailed history of the feed and housing, number of pigs affected,

mortality pattern, vaccination status and clinical findings were recorded and covered total of 240 piggery farmers in Tamil Nadu state alone. The post mortem examination was carried out in three pigs. All primary data were collected by using a comprehensive interview schedules. This study aimed to covered incidence of CSF in one complete year from 1, January 2017 to 31, December 2017.

Histopathology

Pieces of tissues from liver, spleen, kidney and mesenteric lymphnode were collected and fixed in 10 percent formal saline. The tissues were subjected for histological processing and finally embedded in paraffin. Paraffin embedded tissues were sectioned at 5 µm thickness and stained with haematoxylin and eosin (H & E) for histological examination (Bancroft and Stevens, 1996) [5].

Parameters for economic loss calculation

The parameters used for calculating the incidence rates and economic losses were taken from secondary sources, *viz*., published information in scientific journals.

Assessing morbidity and mortality rates of CSF

Morbidity rates: It measures the proportion of affected individuals in a population or the risk of an individual in a population of becoming affected. The following formula is used to ascertain the morbidity rates.

$$Morbidity\ Rate\ (\%) = \frac{No.of\ cases\ observed\ during\ study\ period}{Total\ pig\ population}\ x\ 100$$

Mortality rates: It measures the proportion of animals dying in a population, i.e.

$$Mortality\ Rate\ (\%) = \frac{No.of\ deaths\ observed\ during\ study\ period}{Total\ pig\ population}\ x\ 100$$

Case fatality rate: It is the number of deaths from a specified disease in a specified population during a specified period, divided by the number of cases of that disease in that population during that time period, i.e.

$$Case\ fatality\ rate\ (\%) = \frac{No.of\ animals\ died\ during\ study\ period}{No.of\ cases\ of\ diseases\ during\ study\ period}\ x\ 100$$

Estimation of economic losses due to Classical Swine Fever in swine: The total economic loss (T_L) due to CSF were estimated with the help of the following formula as making some modification in previously suggested model of Singh *et al.* 2016. $T_L = A + B + C$. Where, A = loss due to mortality; B = loss due to reduction in body weight; C = opportunity cost.

Mortality Loss: The mortality loss was calculated by $A = D_P P_P + D_Y P_Y + D_A P_A$. Where, A = Annual economic loss due to mortality, D_P = Population below 4 months of age died, P_P = Average price of animal below 4 months of age, D_Y = Population between 4 and 8 months of age died, P_Y = Average price of animal between 4 and 8 months of age, D_A = Population above 8 months of age died, P_A = Average price of animal above 8 months of age. The cost of loss of animals due to mortality were estimated by multiplying the number of animals died in respective age groups with the price of animals of respective age group.

Loss due to reduction in body weight: The loss due to reduction in body weight due to retardation in growth (Direct loss), increased inter-farrowing period and increased number of abortions. The direct loss due to reduction in body weight was calculated by the formula of $B_1 = (I - D) * W_L * W_A * P_W$. Where, B_1 = loss due to reduction in body weight, I = Number of animals infected, D = Number of animals died, W_L = Proportion of body weight lost in %, W_A = Average body weight of animal in kg, P_W= Price of live weight per kg in₹.

Increased inter-farrowing period: The loss due to reduction in body weight due to the increased inter-farrowing period, was calculated with the following formula of $B_2 = [(12/F_I) - \{12/(F_I + W)\}] (I-D) * N_P * B_W * P_W$. Where, B_2 = loss due to reduction in body weight due to increase in inter-farrowing period in₹, F_I = Inter-farrowing period (months), W = Delay in next conception (months), I = Number of animals infected, D = Number of animals died, N_P = Average number of live piglets born per farrowing, B_W= Average birth weight of the piglets (in Kg), P_W= Price of live weight per kg in₹.

Increased abortions: The loss due to increase in the number of abortions was calculated by the following formula: $B_3 = [(12/F_I) - \{12/F_I + 5)\}] (I - D) * A * N_P * P_W * B_W$. Where, B_3 = Loss due to reduction in body weight due to increased inter-farrowing period, F_I = Inter-farrowing period (months), I = Number of animals infected, D = Number of animals died, A = Increased abortion rate, N_P = Average number of live piglets born per farrowing, P_W = Price of live piglet per kg, B_W = Average birth weight of the piglets

Opportunity Cost: The opportunity cost consists of high cost of feeding, high cost of rearing due to longer rearing time, treatment cost, transport cost, extra labourers required for nursing of sick animal and disinfection of shed etc. Formula: $F = F_D + L_R + T_C + T + L_L + D_L + O_C$. Where, F = Opportunity cost (₹), F_D =Additional feeding cost (₹), L_R = Cost of rearing due to longer time (₹), T_C = Treatment cost (₹), T = Transport cost (₹), L_L= extra labour (₹), D_L = disinfectant of shed (₹), O_C = other cost such as electricity charge, drinking water etc. (₹)

Result and Discussion

Classical swine fever may occur in all four forms *viz*, peracute, acute, subacute, and chronic forms. In that majority investigations results the acute form prevelence with signs of high fever, depression, anorexia, and conjunctivitis followed by vomiting, tremor, and convulsions. Rest of pigs showed clinical signs such as high fever, staggering gait, frothy excessive salivation, severe respiratory distress, paddling of legs with convulsions. Nearly all pigs in a unit become affected within 1 to 2 weeks. Overall rates of morbidity, mortality and case fatality rates were estimated to be 20.24 percent, 16.42 percent and 81 percent respectively are presented in the Table 1. According to the different category of animals, sex-wise and across season the morbidity and mortality due to CSF was calculated separately were represented in Table 2. Table 1 reveals general incidence rates of CSF

Table 1: Morbidity, Mortality and Case fatality rates across breeds

S. No.	Breed	Morbidity Rate	Mortality Rate	Case Fatality Rate (%)
1	Desi pigs	189 (13.5)	134 (9.6)	71%
2	Crossbred	308 (28.9)	269 (25.2)	87%
	Total	497 (20.24)	403 (16.42)	81%

Note: Figures in parenthesis indicate incidence rates in percentage

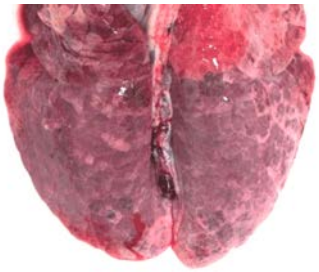
Singh *et al.* (2016) who had reported morbidity (61.58%), mortality (92.06%). Jindal *et al.* (2008) [6] who had reported from Ambala and Hissar districts of Haryana, morbidity, mortality and case fatality rates to be 54.9%, 36.6% and 66.6% respectively. Kumar *et al.* (2007) [7] who reported in Punjab state the overall morbidity (88.2%) in pigs less than 3 Month and 20.5% in older pigs (> 8 Month). Saini *et al.* (2000) who had reported from Sanganur district of Punjab, mortality rates of 80% and 90% in adult and young pigs. Rathnapraba *et al.* (2012) [8] reported up to 100% morbidity. Barman *et al.* (2014) [9] had reported that mortality in pre-weaned and weaned piglets was 50% while 10% in pigs above 1 year of age. However, in study area the result indicated that morbidity and mortality due to CSF in Tamil Nadu is much lesser than previous literature.

Table 2: Morbidity and Mortality due to CSF in Tamil Nadu

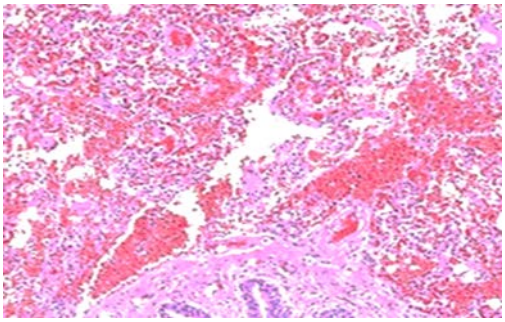
	Morbidity (%)				Mortality (%)			
Breeds	**Desi pig**		**Crossbred**		**Desi pig**		**Crossbred**	
Sex	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Category of animals								
< 4 months	0.22	6.25	3.48	11.65	0.22	3.67	3.29	9.59
4-8 month	0.58	2.66	0.75	3.29	0.58	2.23	0.75	3.01
> 8 months	0.65	3.24	1.41	8.36	0.5	2.44	0.94	7.71
Sex-wise								
	1.4	12.14	5.63	23.3	1.2	8.3	4.98	20.8
Season-wise								
Summer	7.2		2.8		6.5		17.1	
Rainy	5.6		6.5		2.8		5.9	
Winter	0.7		2.8		0.21		2.25	

In necropsy severe congestion was noticed in lung and petechial haemorrhages were noticed in spleen, kidney, and lymphnode. The lymphnodes were enlarged and haemorrhages were observed. Similar observations were reported by Murphy *et al.* (1999) [10]. Wherever pathological lesions found those samples sent for Histopathological observations that shows congestion, inflammation and infiltrations in lung, spleen, kidney, and lymph nodes were correlated very well with the findings of Govindarajan *et al.* (2003) [11] and Palanivel *et al.* (2012) [12].

1) Lung

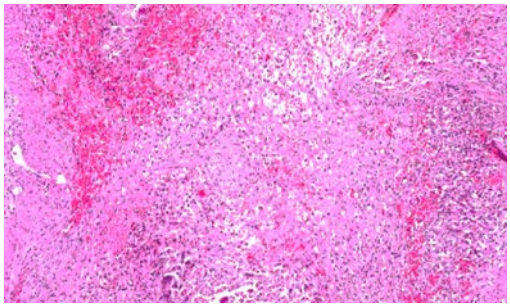


2)



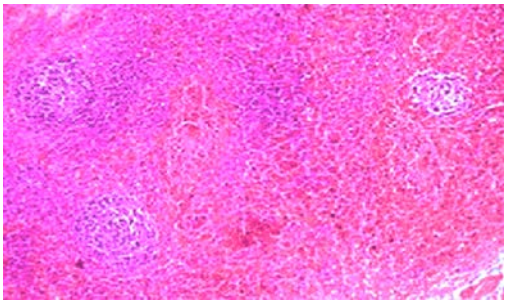
3) Spleen

4)



5) Kidney

6)



7) Lymph node

8)

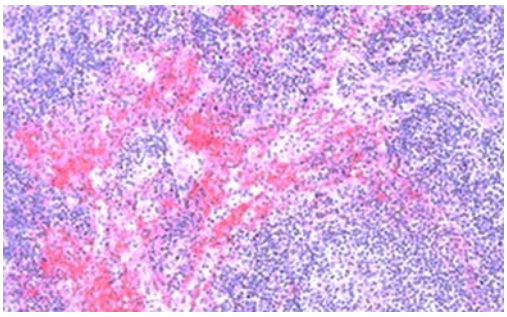


Figure 1, 3, 5, & 7: Classical Swine Fever pathological leasions shown in Lung, Spleen, Kidney & Lymphnode

Figure 2, 4, 6 & 8: Histopathological leasions: inflammatory infiltrates shown in in Lung, Spleen, Kidney & Lymphnode (40X magnification)

Based on sample survey, the total annual economic loss due to CSF in swine in sampled area from Tamil Nadu was estimated INR 1.89 million. Mortality loss contributed INR 1.56 million (82.44%). Direct loss contributed INR 0.27 million (14.3%) followed by loss due to increase in inter farrowing period INR 0.047 million (2.47%); loss due to increased abortion 0.010 million (0.5%) and opportunity cost INR 0.0018 million (0.09%). Disaggregated analysis was represented in Table 4 breed wise annual economic loss due to CSF in Tamil Nadu. The maximum loss of about 82.5% was accounted due to mortality and 17.5% due to morbidity in swine.

Table 3: Estimates of parameters for computing economic losses due to CSF

Parameter (Unit)	Notation used	Desi pigs	Crossbred pigs
Total pig (Sampled area) (Nos.)	N_S	1391	1064
No. of animal infected (Nos.)	I	189	308
No. of animal died (Nos.)	D	134	269
Increased abortion rate (%)	A	11.23	16.48
Farrowing interval (Months)	F_I	7.9	7.25
Delay in next conception (Months)	W	2.4	2.98
Price of live weight per kg (₹)	P_W	120	120
No. of piglets per farrowing (Nos.)	N_P	7.5	9.9
Birth weight of piglet (Kg)	B_W	0.87	1.41
Average body weight (Kg)	W_A	62.3	74.7
Proportion of body weight lost during sickness (%)	W_L	29.1	43.2
Average price of pig ‹ 4 Months age (₹)	P_P	1340.9	1990.5
Average price of pig 4-8 Months age (₹)	P_Y	3127.3	3979.25
Average price of pig › 8 Months age (₹)	P_A	6483.4	7219.43
Average duration of disease occurrence (Days)	-	9.01	10.15
Wage rate per day (₹)	-	245.5	245.5
Average Extra family labour required per day calculated (Hours)	L_L	1.57	1.57
Rate of concentrate per Kg (₹)	-	28	28
Rate of waste material from kitchen etc. per Kg (₹)	-	2.5	2.5
Additional feeding cost per animal (₹)	F_D	300	300
Average cost of rearing for longer period (₹)	L_R	400	400
Average disinfectant calculated (₹)	D_L	35	35
Average overhead expenses calculated (₹)	O_C	76	76
Average Treatment cost calculated (₹)	T_C	78	78
Average Transport cost calculated (₹)	T	47	47

Table 4: Total Annual economic losses due to Classical Swine Fever in surveyed population of Tamil Nadu

Component of economic loss	Desi pig	Crossbred pig	Total
A - Mortality loss(₹)	460192.7 (76.85%)	1096056 (85.13%)	1556248.7 (82.44%)
B+C - Morbidity loss(₹)	138612.1 (23.15%)	191503.22 (14.87%)	330115.32 (17.56%)
B - Loss due to reduced body weight (B1+B2+B3) (₹)	137672.23 (22.9%)	190563.35 (14.8%)	328235.58 (17.4%)
B1 - Direct loss due to reduction in body weight(₹)	119653.38 (19.98%)	151025.5 (11.73%)	270678.88 (14.3%)
B2 - Loss due to increased inter-farrowing period(₹)	15242.37 (2.55%)	31498.08 (2.45%)	46740.45 (2.47%)
B3 - Loss due to increased abortions(₹)	2776.48 (0.46%)	8039.77 (0.62%)	10816.25 (0.5%)
C - Opportunity cost(₹)	939.87 (0.16%)	939.87 (0.07%)	1879.74 (0.09%)
A+B+C - Total economic loss in sampled area(₹)	598804.81 (100%)	1287559 (100%)	1886363.81 (100%)
Per animal economic loss per annum(₹)	430.48	1210.11	768.37
Average household economic losses per annum(₹)	2495.02	5364.83	3929.5

Note: Figures in parenthesis indicate incidence rates in percentage

Conclusion

This study concluded that the morbidity and mortality of pigs in the suspected areas were due to CSF. The mortality loss accounted for major share of total economic losses due to CSF in Tamil Nadu. This CSF causes economic losses per animal and per household annually were estimated respectively INR 768.37 and INR 3929.55 in Tamil Nadu state. Along with these, covid-19 pandemics are alarming the piggery enterprise and warns policy makers to take prompt preventive and remedial measures against this fatal disease (CSF diseases) have an adverse effect on state economy and ruining the farmers economically.

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