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Economic analyses of haemorrhagic septicaemia in Assam

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Abstract
The present paper was analysed the economic losses due to Haemorrhagic septicaemia (HS) and cost benefit analysis of control programme in Assam. For the study data were collected from Kamrup and Karbianglong districts of Assam covering total of 240 livestock owners by using purposive and multi-stage random sampling. A total of 1421 animals were covered in this study, among which 676 were Indigenous animals, 704 were Crossbred animals and 41 were Buffaloes. The total economic loss due to HS in Assam was INR 12217 lakhs among which maximum contribution was by mortality of the animals (60%) followed by treatment cost (30.85%). Direct losses (65%) was maximum than indirect losses (35%). The total avoided losses by existing intervention was INR 5211 lakhs and the targeted intervention can be avoid INR 3825 lakhs of losses due to HS in targeted population. The Benefit-Cost Ratio calculated for the both existing and targeted interventions indicated that control programme was economically feasible in the state of Assam.

Keywords: Economic losses, feasibility of control programme, Haemorrhagic septicaemia

Introduction
Livestock sector plays an important role in socio economic development and contributes significantly to the Indian economy as an important component of agricultural sector. India's livestock wealth is enormous and the country has made significant progress towards attaining self-sufficiency in the production of most livestock products. The contribution of animal husbandry to agricultural output of the country has consistently increased since the last few decades and at present contributes 24.8% to agricultural gross domestic product of the country in 2013-14. The overall contribution of Livestock Sector in total GDP of the country is nearly 3.9% at current prices during 2013-14 (BAHS, 2015) [1]. Besides a huge contribution, the bovine population in India was declining by 1.57 per cent comparing to the previous population. Even though India is having vast livestock resources the disease outbreaks makes considerable reduction in quantity of outputs from livestock and poultry and also it's create a negative impact on Human health and livestock trade throughout the World. One of the major obstacles in achieving the targeted growth rates in the livestock sector is the prevalence and outbreaks of diseases, particularly diseases like FMD, HS, Mastitis, and Brucellosis in cattle. Department of Animal Husbandry, Dairying and Fisheries, Government of India [2] reported that on an average 2416 numbers of cattle and 825 numbers of buffaloes are infected by HS during the year 2007 to 2011. Around 97% of the HS outbreak is reported in large ruminants in which 98.6% of infection encountered in cattle and buffaloes (Gajendragad and Uma, 2012) [3]. The Annual report (2014) of Department of Animal Husbandry, Dairying and Fisheries, Government of India [4] reported that the highest cases of HS infection in cattle were reported from the eastern region (43.71%) of India, followed by western (27.06%), southern (22.42%) and northern (6.81%) regions of India.
Haemorrhagic septicaemia (HS) is acute, fatal and Septicaemic disease of cattle and buffaloes caused by the bacteria called *Pasteurella multocida* and it is a contagious infection in cattle and buffaloes with proven endemicity in India. Total economic losses due to HS in India were estimated at Rs.5255 crore per annum (Singh *et.al* 2014a) [5]. HS has emerged as a disease of great economic importance and it features as the second most reported disease in India. There is very little research attention has been paid to study economic impacts and epidemiology of Haemorrhagic septicaemia in Assam.
In spite of the economic significance of the disease, scant literature is available in Indian

context documenting the feasibility control programmes and economic losses caused by Haemorrhagic septicaemia. The present study will be helpful in estimating the morbidity & mortality patterns, Economic losses, and economic feasibility of control programme of Haemorrhagic septicaemia in Assam.

Materials and Methods

The study was carried out in the state of Assam which is having livestock population of 19.08 million. A combination of purposive and multistage random sampling technique was adopted for the selection of districts, blocks, villages and households. Kamrup and Karbianglong were the two districts selected for data collection in the plain and hilly region, respectively. In the next stage, 2 blocks were selected from each district, randomly. Three villages were selected from each block and from each selected village 20 livestock owning households was selected for the study. Thus, a total of 240 livestock rearing households were covered in the survey from a total of 12 villages in 4 administrative blocks from 2 districts of the state. Primary data was collected with the help of pre-tested questionnaire specifically designed for this study and the data pertaining to HS for the reference period of January-December, 2016.

Analytical framework

The total economic loss due to HS in bovines was worked out as sum of mortality loss (A), direct loss in milk yield (B), losses due to reproductive failure (C), loss in animal draught power (D), cost of treatment of affected animals (E) and labour costs (F). The models used to estimate the different components of economic losses for cattle and buffalo are given as under:

A. Mortality Loss

This was worked out as the product of number of died animals (separately for calves, young and adult animals) due to HS and their respective market values. Mortality losses were divided as per losses in males (AM) and females (AF). For both males and females, the mortality losses were obtained across different age groups (young and adult animals for

A = AF (Mortality loss in females) + AM (Mortality loss in males)

AF = PF1 x D1 x V1 + PF2 x D2 x V2 + PF3 x D3 x V3

Where PF1 = Female Calves Population, PF2 = Young Female Population, PF3 = Breedable adult female population, D1 = Proportion of female calves died, D2 = Proportion of young females died, D3= Proportion of adult breedable females died, V1 = Average market value of a female calf, V2 = Average market value of a young female animal and V3 = Average market value of an adult breedable female animal.

AM = PM1 x D4 x V4 + PM2 x D5 x V5

Where PM1 = Young Male Population, PM2 = Adult Male Population, D4 = Proportion of young males died, D5 = Proportion of adult males died, V4 = Average market value of a young male, V5 = Average market value of an adult male

B. Direct Milk Loss

The direct loss from milk in a year is quantified by identifying the quantity of reduction in milk yield and through the price of milk the quantity loss is converted into monetary terms. The loss due to direct decline in milk production was calculated using the formula:

B = PF3 x PL x C1 x D x ML x P

Where PL = Proportion of adult Breedable female animals in-lactation (%), C1 = Proportion of in-milk animals infected (%), D = Average duration of the disease (days), ML = Milk loss per day per animal (Litre) and P = Price of milk (INR)

C. Losses due to increased abortions

$C = C_1 + C_2$

C_1: Milk Loss due to increased abortion

The disease can cause abortions, particularly in the late pregnancies and leads to increase inter calving period, besides loss of calves. Given the time of abortion (LS months) from conception and a delay in next oestrus (DE months), the inter calving period gets increased by (LS + DE months) in aborting cases, and the milk loss due to increased abortions was estimated from following equation:

$$C1 = \left[\frac{12}{ICP} - \frac{12}{ICP + LS + DE}\right] PF3 \times PL \times C1 \times A \times L \times MY \times P$$

Where A = Increased abortion rate (%), L = Average Lactation length (days), MY = Average per day milk yield (litre), ICP = Inter-calving period (months), LS = Stage at which abortion occurred (months), DE = Delay in next oestrus (months)

C2: Value of calves lost due to increased abortion

Reduction in the number of calves due to more abortions in animals after infection with a disease caused loss, which was estimated by the formulae

$$C1 = \left[\frac{12}{ICP} - \frac{12}{ICP + LS + DE}\right] PF3 \times PL \times C1 \times A \times VC$$

VC= Average value of new born calves (INR)

D. Loss in animal draught power

In work animals, HS causes significant loss to the farmers by making them unavailable for ploughing, traction and other draught animal led crop farm works. This loss is worked out using the formulae:

D = PM2 x C2 x DW x HW

C2 = Proportion of adult males (> 1.5 y) affected (%), DW = Average duration of disease in adult males (days) HW = Average hiring charges per day (INR)

E. Treatment Cost

E = PA x PT x TC

PT = Total Population PA = Proportion of animals infected (%) TC = Average Treatment cost of an infected animal

F. Extra labour Cost

This was computed by multiplying the number of diseased animals with the product of duration of disease, per day per animal extra labour hours given in taking care of the animals and the wage rate prevailing in the region.

F = PA x PT x LH x WR x DA

LH = Total no. of extra labour hours devoted by family members/day/animal, WR = Wage rate prevailing in the region (INR) / 8DA = Duration of the disease in affected animal (days)

Cost benefit analysis

Total population was divided into vaccinated and unvaccinated animals, and the morbidity, mortality rate and economic losses were calculated for both the population separately. Cost and benefit between vaccinated and unvaccinated animals were estimated and how much loss had been reduced in vaccinated comparing to unvaccinated population was analyzed. The Benefit-Cost Ratio calculated under these circumstances indicated whether investments for the targeted interventions would make economic sense for both plain and hilly areas and summarized with additional cost required to eliminate the financial burden in the targeted population.

Results and Discussion

Economic loss due to Haemorrhagic Septicaemia

The total annual economic loss due to HS in bovines in Assam as estimated in this study was INR 12217 lakhs (Table 1), Singh *et al.* (2014b) [6] have reported a total loss of Rs 10 lakhs in central India. Mortality loss contributed INR 73.3,78 lakhs; which is higher than the earlier finding of Singh *et al* (2014a) [5] who reported mortality loss of Rs 8.07 lakhs in central India and also higher than the previous finding of Singh *et al.* (2014b) [6] who have reported 3.5 lakhs in in Uttar Pradesh, India. Direct milk loss contributed INR 616 lakhs followed by milk loss due to increased abortion INR 3.83 lakhs; Value of calves lost due to increased abortion (INR 4792), treatment cost (3769 lakhs) and extra labour cost INR 488 lakhs. Thus, the maximum loss of about 60 per cent was due to mortality and 40 per cent due to morbidity in bovines which is in consonance with the earlier findings of Singh *et al* (2014a) [5] and Singh *et al.* (2014b) [6] who reported that mortality and morbidity loss contributed 76.86%, 94.43% respectively and 23.14%, 5.5%. Among different components of morbidity losses, the highest loss were due to treatment cost (31%), followed by direct milk loss (5%), extra labour charges (4%). Loss due to abortion was insignificant (0.03%).

Table 1: Total economic loss due to HS (in lakhs)

Models	Particulars	Indigenous Cattle	Crossbred Cattle	Buffalo	Total
A	Mortality loss	1116 (33)	4127 (77)	2094 (61)	7337 (60)
B	Direct milk loss	110 (3)	211 (3.8)	295 (9)	616 (5.04)
C_1	Milk loss due to increased abortion	0	3.8 (0.03)	0	383587 (0.03)
C_2	Value of calves lost due to increased abortion	0	0.04	0	0.04
D	Loss in draught power	0	0	0	0
E	Treatment cost	1903 (56)	910 (17)	955 (28)	3769 (30.85)
F	Extra labour cost	285 (8)	119 (2)	83 (2)	488 (3.99)
	Total	3415 (27.95)	5373 (44)	3428 (28.06)	12217

Parenthesis is in table are percentage to total

Disaggregated analysis across different breeds/species revealed that the total economic losses due to HS in case of crossbred cattle, buffaloes and indigenous cattle were INR 5373 lakhs, INR 3428 lakhs, and INR 3415 lakhs, respectively. Thus, buffaloes and indigenous cattle accounted for almost equal shares of total economic losses caused by HS (28% and 29%, respectively). Crossbred cattle accounted for 44 per cent of the total economic loss due to HS. The above finding is in contrast to that of Singh *et al*. (2014a) [5] who had reported higher share of losses due to HS from buffaloes (INR 272805) as compared to crossbred cattle (INR 61342) and indigenous cattle (INR 37692.5). The finding of Singh *et al.* 2014b) [6] also states that buffaloes (INR 3506 crores) contributed maximum in economic loss than cattle (INR 1748 crores). Among Indigenous animals, maximum contribution to economic loss was by treatment cost INR 1903 lakhs (16%), followed by mortality loss INR 1116 lakhs (9%) and then by extra labour cost INR 285 lakhs (2.3%). The above findings differed from earlier finding of Singh *et al.* (2014a) [5] who had reported that mortality loss (88.47%) in crossbred was highest share of economic loss due to HS.

In case of crossbred animals, maximum contribution to total losses was by mortality (34%) followed by treatment cost (7.4%). Distribution of economic loss among buffaloes revealed that maximum loss was accounted for by mortality (17.14%) which was followed by treatment cost (7.8%). The above findings are in consonance with that of Singh *et al.* (2014a) [5] who had reported that mortality loss for crossbred animals (92.51%) and buffaloes (95.69%) accounted for the highest share of total economic losses which was followed by treatment cost.

Table 2: Avoided loss/benefits of targeted intervention in Indigenous and Crossbred animals

Category	Indigenous	Crossbred
Morbidity (%)	2.6	8.7
Morbidity avoided (No. of. Animals)	44454	4917
Morbidity loss per survived animals	3148	5221
Avoided morbidity losses (in lakhs)	1710	256
Mortality (%)	1.52	2.65
Mortality avoided (No. of. Animals)	49479	2416
Mortality loss per animal	4000	7899
Avoided mortality losses (in lakhs)	1979	190
Total Avoided loss (in lakhs)	3689	447
Cost of Vaccination (in lakhs)	231	12.8
B:C ratio	14.5	34.8

The morbidity rates among unvaccinated animals were 2.66 per cent in indigenous cattle and 8.77 per cent in crossbred animals, which is higher than vaccinated animals, i.e. the morbidity was 1.45 per cent in indigenous cattle and 6.4 per cent in crossbred cattle but in case of mortality it is vice versa (Table 2). The mortality rates of unvaccinated animals were 1.52 per cent in indigenous and 2.65 per cent in crossbred cattle was higher than mortality rates of vaccinated animals which was 0.24 per cent in Indigenous cattle and 1.52 per cent in crossbred cattle. The cost of targeted intervention Rs 231 & 12 lakhs will required to eliminate the total losses of Rs 3378

& 447 lakhs in indigenous animals and crossbred animals, respectively (Table 2).

Financial burden of Haemorrhagic Septicaemia

The financial burden of HS was Rs 2764 lakhs and 7636 lakhs in vaccinated and unvaccinated population respectively in Assam (Table 3), based on combination of mortality, milk loss, treatment and extra labour cost, within which losses of the disease was very high in mortality losses in both the population. The model output indicates that the losses in the vaccinated population was highest due to mortality (52%) followed by direct milk loss (23%), treatment cost (21.5%), and extra labour cost (3.5%).

Table 3: Financial burden of HS in vaccinated and unvaccinated population of Assam (in lakhs)

	Direct Losses	Vaccinated population	Unvaccinated population
1	Mortality	1437	3512
2	Direct milk loss	635	839
3	Treatment	594	2825
4	Extra labour cost	96	458
	Total	2764	7636

In case of unvaccinated population losses pertaining to the disease was mostly accounted for by mortality (46%) followed by direct milk loss (11%), treatment cost (37%) and extra labour cost (16%). Distribution of economic losses among unvaccinated population was maximum for treatment cost followed by extra labour cost when compare to the vaccinated population. The financial burden of disease in the unvaccinated population was Rs 7636 lakhs. It is envisaged that the targeted intervention may reduce the losses of 4871 lakhs (63%) in the targeted population. An additional investment Rs 2447 lakhs will be required to eliminate the losses associated with this disease.

Benefits and cost

An evident from Table 4 shows that the Benefit-Cost Ratio (BCR) calculated for crossbred cattle was 35, whereas 14.5 in case of indigenous cattle. It indicates that the targeted intervention will be economically profitable in both indigenous and crossbred cattle. The cost of targeted intervention was economically justifiable up to removing the 10 per cent of losses avoided due to this disease in indigenous cattle whereas in crossbred cattle, BCR was economically feasible upto eliminating the 3 per cent of disease loss.

Table 4: Additional benefits, additional costs, net benefits (INR) and BCR of targeted interventions against HS (in lakhs)

Cost and Benefits	Indigenous	Crossbred
Additional benefits	3378	447
Additional costs	231	12.8
Net benefit	3146	434
BCR	14.56	34.89
90%	13.11	31.40
70%	10.19	24.42
50%	7.28	17.44
10%	1.45	3.48
5%	0.72	1.74
3%	0.43	1.04

The net benefit of targeted intervention will be Rs 3146 lakhs in indigenous animals and in Rs 434 lakhs in crossbred animals. The cost of targeted intervention was economically justifiable up to removing the 10 per cent of loses avoided due to this disease in indigenous animals whereas in crossbred animals. BCR was economically feasible upto 3 per cent of disease loss. The above findings are relevant to the earlier findings of Fadiga *et al.* (2013) [7] who calculated the BCR for five important diseases in Nigeria, and found that targeted interventions would be most beneficial.

Conclusion

The present study was carried out to estimate the economic losses due to Haemorrhagic septicaemia and economic feasibility of control programme in Assam. The total annual economic loss because of HS in Assam was INR 122.17 crores. Among that mortality loss accounts for 60 per cent and treatment cost accounts for 30 per cent. Breed wise share of economic loss accounts INR 34.15 crores, INR 53.73 crores and INR 34.28 crores for indigenous (28%), crossbred animals (44%) and buffaloes (28%) respectively. Direct losses contribute maximum of 92.7 per cent and indirect losses contribute 7.3 per cent of economic loss. The financial burden of HS is amount INR 27.64 crores in vaccinated population and INR 76.36 crores in unvaccinated population, the targeted intervention may reduce the losses of INR48.71 crores (63%) in the targeted population. An additional investmentINR2.44 crores will be required to eliminate the losses associated with this disease. The total avoided losses by existing intervention wereINR46.31 crores, INR5.80 crores in indigenous and crossbred cattle, respectively. The BCR calculated was higher in crossbred animals (53) than indigenous animal (12.7), in the existing intervention. It indicates that control programme was economically more profitable in crossbred cattle than in indigenous cattle. The cost of existing intervention was economically justifiable up to removing the 10 per cent of losses avoided due to this disease in indigenous cattle whereas in crossbred cattle BCR was economically feasible up to eliminating the 2 per cent of disease loss.

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