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Short communication

Economic losses occurring due to brucellosis in Indian livestock populations

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ABSTRACT

Brucellosis is a serious public health issue in India. Estimation of economic losses occurring due to brucellosis is required to help formulate prevention and control strategies, but has not been done in India. We estimated economic losses due to brucellosis by sourcing prevalence data from epidemiological surveys conducted in India. Data for livestock populations were obtained from official records. Probability distributions were used for many of the input parameters to account for uncertainty and variability. The analysis revealed that brucellosis in livestock is responsible for a median loss of US $ 3.4 billion (5th–95th percentile 2.8–4.2 billion). The disease in cattle and buffalo accounted for 95.6% of the total losses occurring due to brucellosis in livestock populations. The disease is responsible for a loss of US $ 6.8 per cattle, US$18.2 per buffalo, US $ 0.7 per sheep, US $ 0.5 per goat and US $ 0.6 per pig. These losses are additional to the economic and social consequences of the disease in humans. The results suggest that the disease causes significant economic losses in the country and should be controlled on a priority basis.

1. Introduction

First recorded in India in 1887 (IVRI, 1977), brucellosis has now become endemic throughout the country with prevalence of the disease ranging from 6.5% to 16.4% in different species of livestock (Aulakh et al., 2008; Kollannur et al., 2007; Lone et al., 2013; Shome et al., 2006; Thoppil, 2000). Many factors such as absence of a control policy, failure to vaccinate young female calves, non implementation of test and slaughter, ban on cow slaughter in many Indian states, absence of treatment regimen and usual practice of selling positive reactor animals to other farmers are responsible for the spread of this disease among livestock in India.

The disease is a serious occupational hazard for humans, and has been found to be associated with farm workers, veterinarians, veterinary pharmacists, animal attendants, abattoir workers and laboratory attendants (Young, 1983). The seroprevalence of the disease in India has been found to be as high as 6.3% in veterinarians, 7.9% in veterinary pharmacists, 8.8% in animal attendants, 20.0% in laboratory workers, 10.5% in dairy farmers and 6.4% in abattoir workers (Bedi et al., 2007; Deepthy et al., 2013).

Brucellosis is being considered as an important economic concern (ILRI, 2012) with losses occurring in the human, livestock and wildlife populations. However, most data and evidence on the economic burden of brucellosis and benefits of its control are from the developed world even though the losses are believed to be higher in the developing countries (McDermott et al., 2013). The present paper presents economic losses occurring due to brucellosis in India.

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2. Methods

Losses occurring due to brucellosis as per Bennett (2003) and McInerney, (1996) were estimated for sheep, goat, cattle, buffalo and pigs. The disease prevalence data were obtained from serological surveys (Aulakh et al., 2008; Kollannur et al., 2007; Lone et al., 2013; Shome et al., 2006; Thoppil, 2000) and livestock population data from official records (Table 1 – supplementary material, Banerjee, 1991; Gomez, 1986; Phaniraja and Panchasara, 2009) (DAHD & F, 2010). Many input parameters such as decrease in carcass weight, milk production and draught power, life expectancy and reproductive rates were obtained from the published scientific literature (Table 1 – supplementary material). The prices of animal carcasses and milk were obtained through market surveillance or from published scientific literature (Table 2 – supplementary material, NABARD, 2010; Ranjan and Rawat, 2011; Wright et al., 2010). All the analyses were conducted using R-statistical program (R statistical package version 3.0.1. R Development Core Team, http://www.r-project.org). The detailed assumptions and the equations used in the analysis are presented as supplementary material in Tables 1 and 3, respectively.

Production losses for each species were calculated as losses occurring due to abortion in pregnant animals (Eqs. (1)–(5)), sterility (Eq. (6)) and temporary infertility in animals that aborted (Eqs. (7) and (8)). Losses for each species were added to estimate total animal production losses.

Product losses were estimated by estimating and adding the losses due to decrease in milk production and carcass weight. Losses in milk production were estimated for the cattle, buffalo and goat industries as shown in Eqs. (9)–(13) and then added. The losses in carcass weight were estimated for all the selected species considering the number of infected animals being slaughtered and the reduction in carcass weight (Eqs. (14)–(17)).

Forgone production due to fecundity reduction was estimated by accounting for foregone meat, milk and draught power in cattle; foregone milk and meat in buffalo; foregone milk and meat in goat; foregone meat and wool in sheep and foregone meat in pigs (see Eqs. (18)–(41)). To avoid double counting of losses, we only estimated foregone losses in the 85% of the breedable infected females that did not abort or become sterile but were infected with *Brucella* species. Foregone draught power for bull cattle was estimated by calculating the time required for an animal to cultivate a hectare of land and using market values for rent charged by tractor owner to work 1 ha of land. This enabled us to estimate the cost of average draught power equivalence bull cattle per hour which was extrapolated to estimate draught energy produced per animal over lifetime.

Death losses included losses due to perinatal mortality in young animals and mortality in adult animals that aborted. The numbers of young ones with perinatal mortality were estimated as per Eq. (42) for each species. For estimating losses occurring due to death of adult females, the losses for the remaining productive life of the animal were estimated similar to the estimation of foregone losses due to unborn animals. Total producer losses due to death in animals for each species were estimated and summed up to estimate total producer losses due to death in all the livestock populations.

Beta probability distributions were applied to account for uncertainties in the prevalence of livestock brucellosis. Uniform distributions were used for estimating number of aborted animals, aborted animals that become sterile, perinatal mortality and mortality rate in aborted animals which are infected with brucellosis (Bernues et al., 1997). We also applied triangular distributions for estimating decrease in fecundity, carcass weight, milk production, draught power and wool output. To estimate actual farmer profits due to decrease in fecundity, uniform distributions were applied in the range of 10–20% as benefits could vary under different rearing conditions. The 5th and 95th percentiles for the estimates were calculated by running Monte Carlo simulations for 10,000 iterations.

3. Results

Results presented in Table 1 suggest that brucellosis caused a loss of US $ 3.4 billion in total (Fig. 1 – supplementary material). The losses in cattle and buffalo industries accounted for 95.6% of the total losses. The median production losses due to abortions, temporary infertility and sterility in adult animals were found to be US $ 735.7 million and US $ 985.4 million in cattle and buffalo, respectively. These losses significantly contributed toward losses occurring in cattle and buffalo industries. The loss in meat and milk resulted in a loss of US $ 292.9 million and US $ 557.1 in cattle and buffalo industries. The loss in meat resulted in a median loss of US $ 1.8 million in pig industry. Foregone milk, meat and draught power due to reduction in fecundity resulted in a median loss of US $ 131.7 million in the cattle industry. Foregone milk and meat due to reduction in fecundity in buffalo resulted in a median loss of US $ 145.8 million in buffalo industry. A median loss of 185.4 million and 210.8 million occurred due to death of adult animals and perinatal mortality in cattle and buffalo, respectively. The disease was found to be responsible for a loss of US $ 6.8 per cattle, US $ 18.2 per buffalo, US $ 0.7 per sheep, US $ 0.5 per goat and US $ 0.6 per pig in India.

4. Discussion

This is the first systematic analysis of economic losses occurring due to brucellosis in livestock populations in India. The losses were found to be as much as 18.7 times higher than that reported for cystic echinococcosis in livestock species in previous studies (Singh et al., 2014). Brucellosis is also a serious economic concern in several other countries (Samartino, 2002, Roth et al., 2003, Santos et al., 2013) suggesting that brucellosis causes huge economic losses in the developing countries.

The decrease in milk production most significantly contributed toward foregone production due to fecundity reduction associated with brucellosis. This is a serious issue as a large Indian human population is dependent on the dairy industry for their livelihood. On the other hand, losses in the cattle meat industry were fairly low. As discussed in