

Socio-economic Impact of Brucellosis on Livestock Farmers in Southern and Western Provinces, Zambia

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Abstract— Brucellosis is a highly contagious zoonotic and devastating disease that affects households' potential to improve their well-being through trade in livestock and livestock commodities. Despite the disease being endemic in Zambia, there is inadequate information, on its socio-economic impact on the well-being of households rearing livestock. Therefore, a cross-sectional study was conducted in Western and Southern provinces of Zambia to determine the impact of brucellosis on socio-economic well-being of livestock farmers at households. The specific objectives of the study were to determine losses and costs associated with brucellosis in livestock; determine socio-economic wellbeing levels at the household; evaluate the linkages between brucellosis and socio-economic wellbeing status; assess the extent to which the current health policies address One Health practice and the attitude towards One Health practices among policy makers. Structured questionnaires, focus group discussions and in-depth interviews with key informants were used to collect both quantitative and qualitative data in this research. All monetary losses were estimated in both domestic currency; the Zambian Kwacha (ZMW) and the equivalent international currency (USD); the exchange rate was 1 USD to 1145 ZMW Zambian Kwacha (ZMW). The overall total losses attributed to brucellosis-related calf mortality, in the studied households was 1,535,800 ZMW (USD 134,131); 77,700 ZMW (USD 6,786.02) was due to milk losses and 13,240 ZMW (USD 1156.33) due to vaccination costs. Lack of money to pay for livestock health services was significantly associated with poor household socio-economic well-being ($p = 0.003$), while level of education of the household head was associated with the highest positive brucellosis impact ($p = 0.005$) on socio-economic well-being. Further, the alternative hypothesis that socio-economic wellbeing levels differ significantly where there is less impact of brucellosis in livestock and where such impact is higher, was confirmed ($F = 11.268$, $p = <0.001$). Consequently the null hypothesis was rejected. On the basis of these findings, it can be concluded that reduced cost of disease prevention and losses due to brucellosis can improve socio-economic well-being of livestock farmers in Western and Southern provinces of Zambia. Accordingly, in order to reduce costs and losses attributed to brucellosis, livestock services and surveillance systems for brucellosis should be prioritised and One Health collaboration framework should be adopted.

Keywords— Brucellosis, socio-economic well-being, costs and losses.

I. INTRODUCTION

Brucellosis is consistently ranked among the most economically important zoonoses globally and it is multiple

burden disease with economic impacts attributable to human, livestock and wildlife disease [1]. The epidemiology and economic impact of brucellosis vary by geography and livestock system [2]. Low income countries tend to report the greatest number of outbreaks and animal losses [3]. Economic impacts vary depending on the main livestock species, management systems, and on the capacity of the country's veterinary and medical systems. In low-income countries, brucellosis is endemic and neglected, with large disease and livelihood burdens in animals and people and almost no effective control [4].

In global terms, the majority of human and animal brucellosis is found in sub-Saharan Africa [5]. With large pastoral communities, and the demand for meat and livestock products expected to double by 2050, therefore, brucellosis poses a major threat to this region and serious control efforts must be developed [6]. Brucella infection rates in some developing countries can reach greater than 10% in human populations, making it a serious public health disease [7]. Humans are almost exclusively exposed to brucellosis through contact with infected animals and consumption contaminated food of animal origin. The disease is transmitted to humans through contact with animals secretions, predominantly during calving and abortion. Brucellosis can also be spread through the consumption of contaminated, unpasteurised dairy products. The disease is characterised by febrile illness in humans and is often difficult to diagnose solely from the clinical picture, due to its similarities to other febrile diseases, such as malaria or typhoid fever [8]. Although brucellosis in livestock and its transmission to human population has significantly decreased following the instigation of effective vaccination based control and prevention programmes in developed countries, it remains an uncontrolled problem in regions of high endemicity such as the Sub Saharan Africa, Mediterranean, Middle East, Latin America and parts of Asia [9]. Moreover transmission from human to human, mainly mother to child, has been reported but is very rare [10].

In livestock, brucellosis results in reduced productivity, abortions and weak offspring and is a major impediment for trade and export [11]. This, in many ways, condemns the endemic communities (usually resource poor) to further poverty because of the losses and limited market opportunities, thereby depriving the farmers of the much needed household income, food availability for consumption and limited

economic growth at national level [12]. As regions within sub-Saharan Africa (SSA), Zambia has a potential to improve socio-economic well-being of livestock farmers through trade in livestock and livestock commodities. However, such potential is hampered by the presence of numerous disease challenges including brucellosis. Brucellosis is endemic in many parts of Zambia, including Western and Southern provinces, thereby hindering the economic exploitation of livestock resource. In these resource poor communities, more than 70 percent of the population are dependent on agriculture for their livelihood. There is therefore a need to assess the socio-economic impact of brucellosis at household level and at the same time design a framework of collaboration for all major players in the control of the disease to increase the effectiveness of interventions. It envisaged that this will result in a better socio-economic wellbeing of the livestock farmers.

II. SOURCE OF DATA FOR THE RESEARCH

A cross sectional study was conducted in Western and Southern provinces of Zambia for a period of three (3) months, from October to December 2015. This design was chosen because it entails collection of data on a number of cases at a single point in time in order to collect a body of quantitative and/or qualitative data about many variables, which are then examined to detect patterns of association [13]. Western province has seven (7) districts while Southern province has eleven (11) districts, with about 180,179 and 292,179 households, respectively [14]. The provinces were selected purposively on the basis of dominant livestock production and previous history of brucellosis [15]. Two districts were selected from each province. In Western province, Mongu and Senenga were selected while in Southern province Namwala and Monze were included in the study. Both provinces are dominated by pastoralism and crop production. Choosing areas with pastoralism and mixed farming systems was aimed at comparing impact of disease on livestock farmers in the areas.

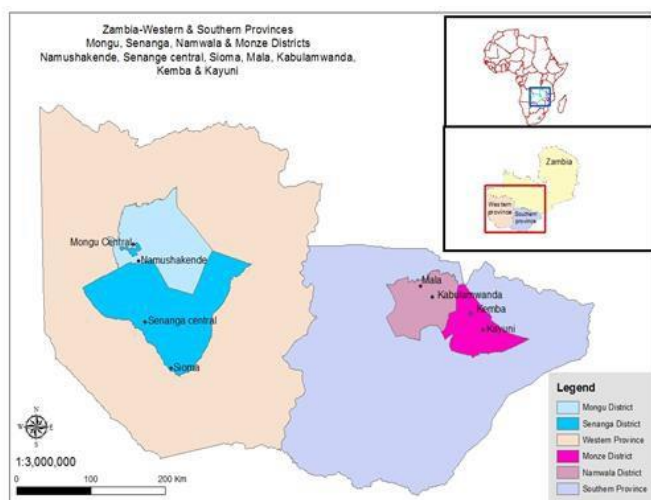


Figure 1: Map of Zambia showing study provinces (A) and districts of research (B)

A. Sample Size Estimation

The households sample size was estimated based on the formula by Eng. [16] for estimation of a sample size for a proportion with the following assumptions:

$$n = 1.96^2 p (1 - q) / d^2$$

Standard normal deviation set at 1.96 corresponding to 95% confidence level

Where n = sample size;

p = estimated prevalence (Estimated to be 15 percent)

q = 1-p, and

d = the desired absolute precision of the estimate (Assumed desired absolute precision was 5 percent.

$$\text{Therefore, } n = \frac{(1.96)^2 0.15(1 - 0.15)}{(0.05)^2}$$

This gave an estimated sample size of 196 households for each province making a total of 392 households for two provinces to be included in the questionnaire survey. However, in order to increase the precision sample size was adjusted to 400 households. The sampling frame (list of households in each village) was drawn using local leaders. From the sub-sampling frames, simple random sampling was used to select households that were actually included in the research. Questionnaires were administered to obtain information about the occurrence of brucellosis in cattle in each household and other variables under investigation. A household was described as having had brucellosis if there were reports of abortions during the trimester periods in the cattle herd and was diagnosed as such by district veterinary officials. Therefore, all information that was collected on presence or absence of the disease for each household was cross-checked with the data at the district veterinary offices. Other information collected in the questionnaire included household losses and expenditures, socio-economic well-being levels, attitude towards using livestock health services, extent to which livestock health services were affordable, household size and education levels of household heads. All the data were analysed using Statistical Package for Social Sciences (IBM-SPSS) programme version 22 to compute: descriptive statistics including frequencies, means, standard deviations, and minimum and maximum values of individual variables.

B. Evaluation Of Attitude

In order to determine attitude, the questionnaire incorporating a 60-point Likert scale was used, which comprised 12 statements, 6 of which had positive connotations while the other 6 had negative connotations. One would score a minimum of 12 points, if one replied strongly disagree (1 point) to all the statements, and one would score a maximum of 60 points if one replied strongly agree (5 points) to all the statements. The other alternative answers were disagree (2 points), undecided (3 points) and agree (4 points). However, during data analysis, three options were used by collapsing strongly disagree and disagree into disagree, leaving undecided intact and collapsing agree and strongly agree into agree. Overall, 12 to less than 35 points scored denoted unfavourable attitude, 36 points scored denoted neutral attitude and more than 36 points scored denoted favourable attitude.

C. Determining The Socio-Economic Well-Being Levels Of Households In Terms Of Human Capabilities

Socio-economic well-being was determined by using eight indicators of human capabilities that were: being able to eat 3 meals per day; being well sheltered; being able to escape avoidable morbidity; households having at least any household members having a self or salaried employment; being able to sell livestock and or crop products whenever one liked; being able to pay school fees for secondary school children belonging to the households; having been able to buy new (not second-hand) clothes during the previous 12 months; and having the freedom to live the way they would value, so long as they do not break the laws. On meals eaten per day, one would score 1, 2, or 3 if one's household members had the ability to eat 1, 2, or 3 meals per day, respectively. On each of the other indicators of capability, one would score 0 or 1 depending on whether one's household lacked or had the relevant ability, respectively. The eight indicators of human capabilities were used to compose an index with 10 points, which were subsequently grouped into five categories of 2 point-intervals, the first one being that of the very poor (1 to 2 points). The other categories were for those who were poor (3 to 4 points), neither poor nor rich (5 to 6 points), rich (7 to 8 points), and very rich (9 to 10 points). Then the F-test test was used to determine whether there was significance different socio-economic well-being levels in the households where costs and losses due brucellosis was high and where the cost was low. The ordinal regression model [17] was used to determine which set of variables had a significant effect on the socio-economic economic well-being of a household. The predictor variables under consideration were education level of household head, household size, household monetary costs and losses due to brucellosis, attitude towards using health care services for livestock, household per capita losses, and affordability of livestock health services and lack of money to pay for livestock health services. The signs of the regression coefficients (estimates) were used to interpret the model [18]. All statistical tests were considered significant at $p \leq 0.05$.

D. Ethical Clearance Of The Study

Ethical clearance for this work was granted by ERES Converge IRB (Ref. No. 2015-May-010). Only those households that concerted to this research were included in the study. Confidentiality was upheld at every stage of the research; therefore, names of respondents or any information that could be used to identify them were not included. In addition, before interviewing any one, they were informed of the following: purpose of the study; what participation involved; confidentiality in the research; risks of participation; and their rights to ask questions to the researchers and withdraw from participation if they were not comfortable.

III. EMPIRICAL FINDINGS FROM THE RESEARCH

A. Socio-Demographic Characteristics Of The Respondents

The ages of the respondents ranged from 22 to 76 years, with an average of 44.3 years (95% CI: 43.2 to 45.4 years). Ninety four and half percent (94.5%) of respondents were male and

5.5% female. Almost half of all respondents (40.3%) had primary education, 38.6% had secondary education and 14.5% had tertiary education. Only thirty four respondents (6.6%) had not gone to school at all. The maximum number of persons per household in the study area was 25, and the minimum number was 3 with an average of 10 (95% CI: 10 to 11). A minimum number of cattle owned by a single household was five; and the maximum number was 900 with an average of 59 (95% CI: 52 to 67). However, in this research, the number of goats owned by a household ranged from 0 to 114 with an average of 17 (95% CI: 15 to 18) while the number of pigs ranged from 0 to 53 with an average of 4 (95% CI: 3 to 5). It was found that 60.5% of all respondent kept their livestock in the village residence while 39.5% kept their livestock in both village residence and in the flood plains, some 10-20 km away from the homesteads.

B. Household Expenditures, Costs And Losses Due To Brucellosis

Households' expenditures, costs and losses associated with brucellosis were estimated by asking the household heads to estimate the losses and expenditures that they had incurred during the past 12 months (one year) from the losses due to abortions, calf mortality, loss of milk production, and costs of vaccination. The costs were estimated in both domestic currency; the Zambian Kwacha (ZMW) and the equivalent international currency (USD) at the prevailing exchange rate. It was estimated that 23.7% of households had lost an average of 4,090.68 ZMW each (equivalent to USD 357.26) per year, due to calf mortality, which were attributed to brucellosis. The remaining 76.3% of households were not sure whether brucellosis caused the death of their calves despite having some similar symptoms of the disease. Moreover, seventy per cent (70%) of respondents had experienced at least one abortion of their cattle during the past two years; with symptoms indicative of brucellosis. The total estimated monetary loss due to abortion was estimated at 1,535,800.00 ZMW (equivalent to USD 13, 4131.00) with an average of 5,485.00 ZMW (equivalent to USD 479.03) per household. Only 13.5% of all households spent 13, 240.00 ZMW (equivalent to USD 11, 56.33) per year to buy vaccines for brucellosis. These results revealed that a big percentage (86.5%) of livestock farmers in the area did not vaccinate their livestock against the disease. Reasons advanced for failure to vaccinate their animals included lack of money to buy vaccine and poor access to livestock services. Moreover, 6% of households discarded an estimated 27,750 liters of milk per year due to confirmed brucellosis infection in their cattle herds. Monetary value of milk discarded by the households per year was estimated at about 77,700.00 ZMW (equivalent to USD 6,786.02). Furthermore, the maximum households' per capita loss due to brucellosis was 5000.00 ZMW (equivalent to USD 436.68) with an average of 1,000.00 ZMW per capita-per household and the minimum per capita loss was 750 ZMW.

C. Attitude Of The Respondents Towards Using Livestock Health Services

The results revealed that the average score by all the respondents on the 12 statements was 37.4; while the minimum point scored was 33 (1.8%) and the maximum was 42 (1.0%).

Since the average score was more than 36, it can be said that the respondents had an overall favourable attitude towards using livestock health services.

The scores by all the respondents on all the statements are presented in Table 1. All the respondents were of the view that it is important to take samples for correct diagnosis of livestock diseases to know which medicines to use. All respondents also agreed with the statements that " Private and Government animal health workers provide scientific treatment unlike traditional healers of livestock diseases " (100.0%), while 99.0% agreed with the statement that " Although traditional livestock services providers charged low amounts of money, their services were not reliable ", and 100.0% of the respondents agreed with the statement that " Most livestock diseases could be cured by modern veterinarians, and not traditional healers of livestock diseases".

The respondents also had reasonable responses to the statements that had negative connotations. For example, some of them responded negatively to the statements that " No need of getting livestock treated because fake medicines are used " (100.0%); " No need of getting livestock dipped/treated because the costs are very high " (88.2%), and "Livestock health services are too far from home" (96.0%). The other proportions of the respondents, who disagreed, were neutral or agreed with the statements of the Likert scale used are as seen Table 1.

Table 1: Respondents' scores on the items of the Likert-scale (N= 400)

Attitudinal statement	Disagree (%)	Undecided (%)	Agree (%)
1. No need of getting livestock treated because fake medicines are used	100.0	0.0	0.0
2. No need of calling veterinarians because traditional livestock services treat livestock better	100.0	0.0	0.0
3. No need of getting livestock dipped/treated because the costs are very high	88.2	11.8	0.0
4. Livestock diseases are not very serious	100.0	0.0	0.0
5. No need of going for Veterinary Investigation Centre and other Government services because there are poor facilities	86.7	13.3	0.0
6. Livestock health services are too far from home	96.0	3.0	1.0
7. It is important to take samples for correct diagnosis of livestock diseases to know which medicines to use	0.0	0.0	100.0
8. Private and Government livestock health facilities provide scientific treatment unlike traditional healers of livestock diseases	0.0	0.0	100.0
9. Although traditional livestock services charge low amounts of money their services are not reliable	0.0	1.0	99.0
10. Most livestock diseases are cured by modern veterinarians, and not traditional healers of livestock diseases	0.0	0.0	100.0
11. Traditional healers guess diagnoses of livestock diseases	0.0	0.0	100.0
12. Traditional healers claim to know even livestock health problems which they don't know about	0.0	0.0	100.0

E. Socio-Economic Well-Being Levels At Household Level In Terms Of Human Capabilities

The results of the households' socio-economic well-being levels demonstrated that 59.3% of households were poor; 8.3% were poorest and 22.3% were neither poor nor rich. Only 1.1% of households were classified a rich (Figure 1).

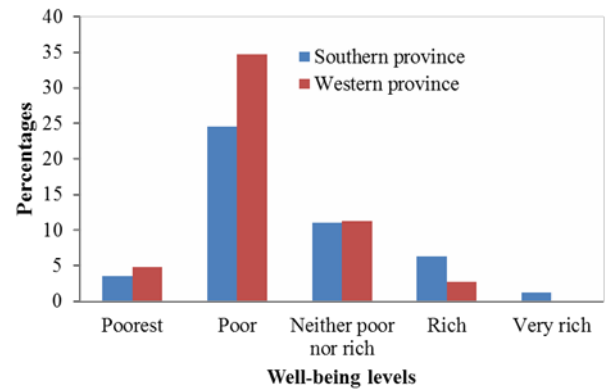


Figure 2: Households socio-economic well-being levels in Southern and Western provinces of Zambia, 2015-2016.

This result confirms that most of the livestock farmers in Southern and Western provinces keep livestock for prestige purposes; hence a big proportion (67.6%) of households had poor socio-economic wellbeing classification despite having large number of livestock as their main economic activity.

3.4. Socio-economic well-being levels and household costs and losses

Households' costs and losses were compared across the socio-economic well-being levels using One-Way ANOVA to find whether households with lesser or higher costs and losses of brucellosis had different socio-economic well-being level. The comparison results are presented in Table 2 and show that there was significant difference between socio-economic well-being levels and costs and losses due to brucellosis ($F = 11.268$, $p = 0.000$). This finding shows that, the first hypothesis, which was about whether households with less and those with high costs and losses due to brucellosis had different socio-economic well-being levels, is confirmed (Table 2).

Table 2: Costs and losses according to socio-economic well-being of a household

Socio-economic well-being level	n	Mean points scored	95% Confidence Interval for mean		p-value
			Lower Bound	Upper Bound	
Very poor	33	10924.24	8816.36	13032.12	0.000
Poor	237	8267.89	7454.71	9081.07	
Neither poor nor rich	89	4902.58	4103.10	5702.07	
Rich	36	4788.33	3466.54	6110.12	
Very rich	5	4562.00	-329.97	9453.97	
Total	400	7378.78			

F. Impact Of Brucellosis On Socio-Economic Well-Being

Ordinal logistic regression was used to determine predictors of the household's socio-economic well-being, and the results are presented in Table 3. It was found that lack of money to pay for livestock health services, household per capita losses and household losses and costs were the variables which had a negative impact on socio-economic well-being of a household. The variables which had the a positive impact on socio-economic well-being of a household were education levels of household heads, household size, attitude towards using livestock health care facilities and extent to which the livestock health service was affordable. The other variables did not have an impact on the socio-economic status of a household.

Table 3: Ordinal regression results on the impact of brucellosis on socio-economic well-being

	Variables	Estimate	Std. Error	Wald	df	P-value
Threshold	[SOCIOECNMLEVELS = 1]	.658	0.616	1.143	1	0.285
	[SOCIOECNMLEVELS = 2]	4.795	0.670	51.162	1	0.000
	[SOCIOECNMLEVELS = 3]	6.697	0.708	89.515	1	0.000
	[SOCIOECNMLEVELS = 4]	9.365	0.867	116.796	1	0.000
Location	Household size	0.133	0.032	17.324	1	0.000
	Household costs and losses	-0.000	3.509E-5	27.606	1	0.000
	Household per capita losses due to brucellosis	-0.001	0.000	17.399	1	0.000
	Lack of money to pay for livestock health services	-1.719	0.588	8.559	1	0.003
	Education level of household head	1.129	0.404	7.795	1	0.005
	Affordability of livestock health services	0.667	0.267	6.225	1	0.013
	Attitude towards using livestock health services	0.139	0.411	.115	1	0.734

IV. DISCUSSION

This study investigated the socio-economic impact of brucellosis in Western and Southern provinces of Zambia. It was revealed that every member of affected household would have benefited with an extra one thousand Zambian kwacha per year if brucellosis had not affected their cattle. These results are comparable to those obtained by [19] who estimated brucellosis losses of 12.6 million Nigerian naira (equivalent to USD 63,300.67) in the grazing reserves of Wase and Wawa-Zange of Nigeria.

It was observed that a big percentage (86.5%) of livestock farmers in the area did not vaccinate their livestock against the brucellosis. Reasons advanced for failure to vaccinate the animals included lack of money to buy the vaccine and poor access to livestock services. This situation could be also attributed to the fact that the Government of Zambia does not provide free vaccine for brucellosis to farmers as it does to other diseases like Food and Mouth Disease (FMD) [20]. However, studies conducted in Kirghizia by [21] revealed that brucellosis vaccination campaign has the potential to reduce losses of the disease considerably. In addition, studies conducted in Chad and Cameroon by [22] indicated that control with vaccination potentially increased profitability of cattle rearing in brucellosis endemic areas.

The study found that the respondents had an overall favourable attitude towards using livestock health services. These results means that if the Government invested in the control the disease by increasing accessibility of animal health services, livestock farmers were likely to support the initiative. As such, diseases like brucellosis would easily be controlled, hence increasing the economic well-being of the households.

It was found that household size had a positive impact on socio-economic well-being of a household, meaning that bigger families were more likely to have a favorable outcome. This could be because in pastoral communities, the number of people in a household could determine the amount of labour force available to work in the fields, since most of the rural people use members of households for labour. Therefore, the more the members a household had the higher the production

was likely to be. Similar results have been reported in Tanzania [23].

Although most of the livestock farmers in Southern and Western provinces kept livestock as their main economic activity, a big proportion (67.6%) of households were classified as having poor socio-economic status. The above results are in agreement with the Zambia Millennium Development Goals [24] and Zambia human development report [25].

Further, the first hypothesis which was about whether households with less and those with high costs and losses due to brucellosis had different socio-economic well-being levels was confirmed to be true ($F = 11.268$, $p = 0.000$). This result means that the higher the impact of brucellosis the worst the socio-economic well-being of a household. This situation could be contributed by the fact that most of households depend on livestock keeping as the main economic activity; hence anything to do with livestock can have a major impact on socio-economic well-being of livestock farmers.

Conclusion

This study has demonstrated that households lost a significant amount of money 1,626,740 ZMW (equivalent to USD 142, 073.36) due to abortions, calf mortality, milk loss and costs of vaccination. Further, brucellosis had a major impact on livestock production hence affecting socio-economic well-being of livestock farmers due to the fact that 70% of households had experienced abortions at least once for the past two years. Therefore, Government should improve livestock health services in order to maximize livestock production which will improve socio- economic well-being status of farmers.

Moreover, 86.5% of farmers did not vaccinate their animals against brucellosis; therefore, a big number of cattle are at risk of being infected, hence; this would affect productions and trade in terms of animal and animal products. It is therefore, recommended that vaccination against brucellosis should be free of charge so that each farmer can have access, considering that brucellosis is a zoonotic disease.

On the view that the overall attitude of respondent towards using livestock health facilities was positive, it is concluded that livestock farmers are willing to use livestock health facilities to make sure that their livestock are in better condition. From this conclusion it is recommended that the Government should invest more in livestock health facilities and services in order to have sustainable livestock production.

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Conflict of interest

The authors declare that there are no conflicts of interest.

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