Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/ 21591
DOI URL: http://dx.doi.org/10.21474/IJAR01/ 21591

RESEARCH ARTICLE

SOCIO-ECONOMIC SIGNIFICANCE OF BRUCELLOSIS IN POST CONFLICT NORTHERN UGANDA

Harriet Nabirye-Muloki [1,2], Joseph Erume[1], George William Nasinyama[3], David Okello Owiny[2], Duncan Ongeng, Jesca Nakavuma[1] and Joseph Kungu[1]

1. College of Veterinary Medicine, Animal Resources and Biosecurity (COVAB), Makerere University, P. O. Box 7062, Kampala, Uganda.
2. Faculty of Agriculture and Environment, Gulu University, P. O. Box 166, Gulu, Uganda.
3. Uganda Martyrs University, Lubaga Campus, P.O. Box 5498, Kampala – Uganda.

Manuscript Info

Manuscript History
Received: 11 June 2025
Final Accepted: 13 July 2025
Published: August 2025

Key words:-
Human, Bovine Brucellosis, Social, Economics, Impact, Zoonoses, Uganda.

Abstract

Brucellosis is a zoonotic disease with significant social and economic impacts.
Aim: This study aimed at investigating the social and economic impacts of hu man and bovine brucellosis in post-conflict northern Uganda.
Method: A total of 46 households where individuals who previously tested positive for brucellosis using indirect Enzyme-Linked Immunosorbent Assay (iELISA) live. Each of these households kept a minimum of one adult cow (> 3 years) that had at least calved once. Both primary and secondary data was used. A semi-structured questionnaire was used to collect primary data. Data on social effects of brucellosis was analyzed with SPSS (Version 16) using descriptive statistics. The burden of brucellosis on the health of people in northern Uganda was determined by calculating Disability-Adjusted Life Years (DALYs). The economic significance of brucellosis was calculated using primary and secondary data, in a mathematical model.
Results: The mean age of participants was approximately 37 (18-73; mean age 36.6± SE 0.86). There were significant delays in the diagnosis (71%; n=46) and treatment (93.5%; n=46) of brucellosis cases. Over 90% (n=46) of cases suffered from brucellosis symptoms after completing treatment. DALYs calculation indicated an individual suffering from brucellosis to lose 0.65 full healthy life years due to living in a less-than-optimal health state. A total of $68.56 USD **(**Ug shillings 240,000/ -) was estimated to be the cost of managing human brucellosis per case and approximately $244.40 USD (Ug shillings 855, 410.40/-) income was lost per household with cattle infected withbrucellosis.
Conclusion: The socio economic significance of brucellosis is indisputable, and the monetary burden of the disease requires urgent action. Bovine brucellosis control and challenges of human brucellosis detection and management need to be addressed to mitigate impacts of the disease in post conflict northern Uganda.

CorrespondingAuthor:- Harriet Nabirye-Muloki
Address:- 1. College of Veterinary Medicine, Animal Resources and Biosecurity (COVAB), Makerere University, P. O. Box 7062, Kampala, Uganda. 2. Faculty of Agriculture and Environment, Gulu University, P. O. Box 166, Gulu, Uganda.

Introduction:-

Brucellosis is a prevalent zoonotic disease that significantly impacts the socio-economic development of many regions across the globe (Franc et al., 2018). Its impact extends to both human populations and the livestock sector, resulting in negative implications for local and national economies (Dadar et al., 2021). The disease causes ill health in people of all age groups causing physical pain and emotional suffering.

Brucellosis reduces livestock productivity, causing farmers to feel hopeless, depressed, and may lead to suicidal ideation (Franc et al., 2018). Economic losses due to human brucellosis arise from the cost of hospital treatment, cost of drugs, patient out of pocket treatment expenses, loss of work and income due to illness (McDermott et al., 2013; Franc et al.,2018). The situation is more complicated particularly in rural areas where diagnostic services are often lacking (Kunda et al., 2007).

In New Zealand losses of up to NZ$3,181 per case and in Spain, an average loss of 787.92 per patient were attributed to brucellosis (McDermott et al., 2013). In Sudan, the cost per person infected with brucellosis was estimated at USD 48.1 (Angara and Adil, 2014). Bovine brucellosis causes spontaneous abortions in approximately 20% of cows in herds with over 30% seroprevalence, and in 5% in herds with less than 5% seroprevalence (McDermott et al., 2013, Angara and Adil, 2014).

Aborting milking cows produce 20-25% less milk and non-aborting cows yield 10% less in herds with over 30% brucellosis seroprevalence (Mcdermott et al., 2013). Brazil attributes annual losses of R$ 892 million to bovine brucellosis (Clementino and De Azevedo, 2016). In India, losses due to the disease were estimated at USD 6.8 per affected cattle(Singh et al., 2015). Estimates from Kiku dairy scheme in Sudan indicated losses of approximately USD 247,284.0 due to milk loss and USD 1,981.8 due to infertility, reflecting the serious economic consequences of bovine brucellosis (Angara and Adil, 2014).

In Uganda, brucellosis is widespread, affecting both humans and animals. Studies in the country estimate the seroprevalence levels of human brucellosis at 19% (Kansiime et al.,2015; Migisha et al., 2018; Ezama et al., 2019), while seroprevalence of brucellosis in individual cattle at 17.9% (Lolli *et al.,* 2016; Miller *et al.,* 2016; Ezama et al., 2019; Nguna et al., 2019). Reports in the country indicate high abortion rates of 23% in seropositive herds (Magona et al., 2009; Mugizi et al., 2015, Miller et al., 2016).

Abortion and associated complications can have devastating financial implications on households due to calves and milk loss. The most available data on the economic burden of the disease is for developed countries although losses due to brucellosis are thought to be more in the developing countries. This study focused on determining the socio and economic significance of brucellosis in the post-conflict region of northern Uganda.

Materials and methods:-

The study was carried out in the post-war conflict districts of Apac, Gulu and Lira, in Northern Uganda. The study area has an estimated human population of 1,059,600 people with Apac (234,100), Gulu (334,500) and Lira (491,000) according to the 2021 midyear projections (UBOS, 2021). The three districts combined were reported to have 371,655 cattle, (UBOS, 2024).

To determine the social and economic impacts of brucellosis, 46 households with cases who had previously tested positive for brucellosis using iELISA were studied. The inclusion criteria were (i) households with study subjects who tested positive for brucellosis with iELISA (ii) households with mature (>3 years old) cows which had calved at least once.

This study obtained data from both secondary and primary sources. Secondary data such as productivity of the different breeds of cattle, milk production, calf weight, costs for milk and beef were collected from relevant studies, textbooks, and websites. While primary data on the losses due to human and bovine brucellosis was collected using a pretested structured questionnaire.

The questionnaire was developed, drawing insights from studies conducted elsewhere (McDermott et al., 2013; Angara and Adil, 2014). Only financially accountable components were considered to quantify monetary losses due to brucellosis.

Human data collection:
Social and economic data from 46 participants who were previously diagnosed with brucellosis using iELISA (Muloki et al., 2018) was collected using a questionnaire. Data on adverse health impacts caused by brucellosis, like physical or emotional pain, worry, loss of energy and vitality to cope with daily activities were collected. Additionally, data on promptness to seeking medical attention when feeling symptoms of brucellosis as well as the period taken to diagnose brucellosis was collected.

Losses due to human brucellosis was estimated by considering medical costs paid for examinations, laboratory tests and treatment. As well, DALYs calculations were employed to measure the equivalent 'healthy' years lost because of suffering from brucellosis.

Animal data collection:
Animal data was obtained from both secondary and primary sources. Secondary data such as productivity of the different breeds of cattle, milk production, calf weight, costs for milk and beef were collected from relevant studies, textbooks, and websites. While data on milk production per cow and abortion experiences were collected using a questionnaire. Aspects considered to result in economic losses due to bovine brucellosis included reduced milk production and infertility (abortion experiences in study cows).

Data analysis:

Social significance and disability adjusted life years due to human brucellosis:-
The social effects of brucellosis were analyzed with SPSS (Version 16) using descriptive statistics. Categorical variables were presented as proportions and DALYs calculations were employed to measure the equivalent 'healthy' years lost because of disabilities due to suffering from brucellosis (Alumasa et al., 2021; Di Bari, et al., 2022).

The study considered only financially, accountable components to quantify monetary losses resulting from human and bovine brucellosis. The economic significance of the disease was determined using a model below developed according to Angara and Adil (2014).

Modelling of economic cost due to brucellosis:- A = B + C
Total financial loss: Total household financial losses= Losses due to bovine brucellosis (B) + Losses due to human brucellosis (C).
Losses due to human brucellosis:
Total loss = transport cost + examination + diagnosis fees + medication cost.
Losses to due to bovine brucellosis = Losses due to reduction of milk production + Losses due to infertility (calves lost resulting from abortion).

Economic losses due to human brucellosis:
Expenses resulting from human brucellosis included medical examination fees, laboratory fees, costs of medicines and transport costs. The costs were categorized into specific monetary ranges, including less than Ug shillings 10,000/- ($2.85 USD); up to Ug shillings 50,000/- ($14.29 USD) up to Ug shillings 100,000/- ($28.57 USD) and more than Ug shillings 100,000/- ($28.57 USD), table 2.

Economic losses due to bovine brucellosis:
Economic losses due to bovine brucellosis were estimated by considering losses from reduced milk and lost meat production resulting from abortion. Milk losses were considered as the cost of reduced milk from both seropositive aborted and non-aborted animals. While infertility losses were quantified based on the cost of calves lost due to data collected on abortions. Losses were estimated by considering meat prices, weaning weight, and reduced fertility of seropositive aborted cows.

Bovine production parameters were derived from Zebu cattle which is the major breed kept in the study area (Mugizi et al., 2015). An annual milk yield of 693 Kilogram (Kg) and weaning weight of 94.8 Kg at 6 months of age was used (Babigumira et al., 2018; Mulindwa et al., 2012). Market prices were used in the calculations including a cost of Ug shillings 1818/- ($0.52 USD) per liter of milk in northern Uganda as provided by the Dairy Development Authority (DDA, 2020), the average cost price for a Kilogram of meat was estimated at Ug shillings.

10,000/- ($2.86 USD) (FAO, 2019), at 15% reduced fertility of the seropositive cows (Angara and Adil, 2014). Ug shillings 3,500/- was equivalent to $1USD ($1 USD = Ug shillings 3,500/-).

Losses due to reduction of milk production:
Total quantity of milk lost = Milk loss of seropositive aborted animals + Milk loss of seropositive non aborted cows. Milk loss of seropositive aborted animals = Number of aborted seropositive animals x average annual milk yield x 20% (Mcdermott et al., 2013; Angara and Adil, 2014).

Milk loss of seropositive non aborted animals = Number of non-aborted seropositive animals x average annual milk yield x 10% (Mcdermott et al., 2013; Angara and Adil, 2014).

Cost of milk lost:
Losses due to reduction of milk production = Total quantity of milk lost **x** average price of milk/litre.
Losses due to infertility:
Number of calves lost due to infertility = Number of seropositive cows **x** 0.15 reduction in fertility of the seropositive cows (Angara and Adil, 2014).
Cost of infertility:
Number of calves lost due to infertility x weaning weight (Kg) x meat price (Kg /Lbw)

Results:-

Social significance of human brucellosis
These findings provide a foundational understanding of the demographics and disease-related effects among the brucellosis-afflicted individuals in the study area. Of the 46 participants, 76% were men and aged between 18-73 years (mean age mean age 36.6± SE 0.86). Detailed comprehensive overview of the study participants and their associated demographics can be found in Table 1.

Table 1: Proportions of brucellosis patients with the social variables

Social Variable		Proportion	Frequency
Gender	Male	35	76.1
	Female	11	23.9
Knowledge	Not Knowledgeable	29	63.0
	Knowledgeable	17	37.0
Consumption of pasteurised milk and milk products	Yes	10	21.7
	No	36	78.3
Period spent before visiting hospital after onset of symptoms	Less than month	15	32.6
	More than one month	31	67.4
Period taken to diagnose brucellosis after onset of symptoms	< 2 months	8	17.4
	> 2 months	38	82.6
Number of health facilities visited before brucellosis was diagnosed	One (1) facility	13	28.3
	> 2 facilities	33	71.7
Period taken treating the disease	< 2 months	5	10.9
	> 2 months	41	89.1
Period taken suffering the disease	< 2 months	3	6.5
	> 2 months	43	93.5
Times diagnosed with brucellosis	Once	16	34.8
	More than once	30	65.2
Visits to health facility before diagnosis was made	One	9	19.6
	More than one	37	80.4

Feeling when diagnosed with brucellosis	Not worried	18	39.1
	Worried	28	60.9
Sought help from traditional healer	Yes	10	21.7
	No	36	78.3
Resume normal work after treatment	Yes	40	87.0
	No	6	13.0
Gain normal health after treatment	Yes	34	73.9
	No	12	26.1

DALYs calculations:

This study estimated DALYs for brucellosis using techniques established by Devleesschauwer *et al.,* (2014). Data on fatalities due to brucellosis was not available and the YLL (years lost as result of premature death) part of DALYs' formula was omitted (Alumasa *et al.,* 2021). It is possible that some of the diagnosed cases could have had chronic brucellosis since results of this study showed delays in brucellosis diagnosis (90.3%).

While results here also indicate that some of the diagnosed cases could have been an acute febrile disease (32.6, n=46). This study considered the DW to range from 0.15 (for chronic brucellosis) to 0.211(for the acute, non-chronic disease) as provided by Dean et al., (2012).

This study adopted the Disability Weight (DW) of 0.18 to calculate the DALYs for this study as used in a study by Alumasa et al., (2021). The age of onset was considered to be 37 years and the median duration (L) of brucellosis of 3.11 years as provided by Di Bari et al., (2022). Additionally, this study calculated DALYs in relation to the number of cases and, due to lack of consensus on social weighting all the four scenarios of social weighting were considered including DALY (0; 0), DALY (1:0), DALY (0; 0.03), and DALY (1; 0.03).

Age weighting provides a view that a year of life lived at one age is worth more than another and time discounting shows that the costs and benefits of today are valued more than those in the future (Devleesschauwer et al., 2014).

Table 2: Years lived with disability (YLDs) and disability-adjusted life years (DALYs) for human brucellosis inpost conflict northern Uganda under different social value choices

Scenario (K; r)	Age Weighting	Discount Rate (%)	YLDs	YLLs	DALY (N=46)	DALY /CASE
DALY (0; 0)	No	0	25.75	0	25.75	0.56
DALY (1; 0)	Yes	0	35.2	0	35.2	0.77
DALY (0; 0.03)	No	0.03	24.59	0	24.59	0.53
DALY (1; 0.03)	Yes	0.03	33.62	0	33.62	0.73

Results of this study show that the total number of cases lost 24.6 years of their healthy life without applying age weighting and they lost 35 years when age weighting was applied. On average, every brucellosis infected person lost 0.65 full healthy life years due to living in a less-than-optimal health state (YLDs), table 2. This study also confirms how the subjective application of age weighting and time discounting can affect the DALYs results (Devleesschauwer et al., 2014).

Several assumptions were made while calculating the DALYs; i) The collected data indicated only the number of cases without providing the severity of the disease and since brucellosis has not been 'officially' assigned a disability weighting by the global burden of disease, the study adopted the weighting considered by Alumasa et al., (2021). Ii) Data on fatalities due to brucellosis was not available and the disease was considered non-fatal causing the YLL part of the DALYs calculation to be omitted. The lack of data to show mortalities due to brucellosis may indicate that fatal outcomes of the disease are rare but could also be due to inadequate reporting systems on the cause of death. Iii) This study calculated DALYs for patients who presented to study health care facilities and did

not quantify brucellosis for cases from other health facilities as well as those who did not present to any health care. Iv) The DALYs results here may be underestimated as the data used in this study were only for laboratory-confirmed cases.

Economic significance of human brucellosis:
These calculated figures illustrate the substantial economic strain experienced by households with brucellosis patients, highlighting the complexity of direct and indirect costs incurred during their illness. The cumulative estimated loss attributed to human brucellosis for the 46 confirmed patients amounted to Ugx 11,040,000/-, (equivalent to USD 3,154.29) with financial burden of Ugx 240,000/- (equivalent to USD 68.56) per household with any individual suffering from brucellosis. A comprehensive breakdown of the estimated financial costs associated with human brucellosis per patient is presented in Table 3.

Table 3: Estimated financial costs of human brucellosis per patient (Ugx 3,500/- = 1 USD)

Description	Average cost/ patient (Ugx)	Total cost (USD)	Percent (%)
Examination cost	10,000/-	2.86	4.2
Laboratory cost	100,000/-	28.56	41.7
Medicine costs	100,000/-	28.56	41.7
Transport costs	30,000/-	8.58	12.4
Total	**240,000**	**68.56**	**100.0**

Economic significance of bovine brucellosis:
Results here provide losses due to reduction of milk production and due to infertility leading to losing calves among aborting and non-aborting brucellosis seropositive cows (Table 4).

Losses due to reduction of milk production:
Of the 46 households studied 54.3% (n=46) had cattle herds that tested positive for brucellosis using i-ELISA (IDDEX KIT, USA). Out of the 311 female cows that were studied 19.3% tested positive for brucellosis. Among the seropositive cows, 70% (n=60) had experienced abortions.

Costs of milk Lost:
The sero-positive-aborted cows accounted for an estimated milk loss of 5.82 tonnes, while an additional 1.25 tonnes of milk were lost from the 30% (n=60) sero-positive non-aborted cows. Consequently, the cumulative annual milk loss totalled to 7.07 tons, amounting to Ugx 12,853,260 (equivalent to USD 3,672.36) in economic terms. This translates to an annual estimate of Ugx 514,130.4 (USD 146.89) due to milk loss per-household with a seropositive herd.

Table 4: Herd and individual-level sero-prevalence of brucellosis in cattle in the districts of Apac, Gulu and Lira

		Prevalence (%)	
Variable	**Category**	**Herd level (n=46)**	**Individual level (n=311)**
Study District	Gulu	4.3	0.96
	Apac	47.8	18
	Lira	2.2	0.03
Animal grazing	Communal	45.7	17.04
Method	Paddocks	4.3	1.28
	Tethering	4.3	0.96
History of	Yes	45.7	13.5
Abortion	No	8.6	5.5
Overall		54.3	19.3

Losses due to infertility:

According to Angara and Adil (2014), results of this study estimated the number of calves lost due to infertility to be nine (9). Monetary losses of calves due to infertility, was estimated at (9 x 94.8kgs x 10,000/-) Ug shillings 8,532,000/- (USD 2437.71) among the seropositive herds, which corresponds to a loss of Ug shillings 341,280/- (USD 97.51) per household with a brucellosis seropositive herd. Total estimated annual monetary loss attributed to bovine brucellosis per household was Ug shillings 855,410.40/- (USD 244.40).

Discussion:

This study represents a comprehensive assessment of the socio-economic consequence of brucellosis in the country, focusing specifically on the household level in northern Uganda. Our findings shed light on several critical aspects of the significance of brucellosis, with implications for both human and animal health. Notably, the majority (78.3%; n=46) of participants in this study reported consuming unpasteurized milk and milk products.

This behaviour presents a potential risk factor for acquiring brucellosis, as it aligns with previous studies that have linked raw milk consumption to a higher incidence of brucellosis in humans (Tumwine et al., 2015; Dadar et al., 2021). As well the consumption of unpasteurized milk products in this study could be related to cultural and social beliefs, for example Franc et al., (2018) who reported about the social misconception regarding the nutritive value of raw milk cousin.

Additionally, over 60% of the participants displayed a limited knowledge of transmission, symptoms, and control of brucellosis. This lack of knowledge highlights the need to create awareness and education about brucellosis within the study communities. Public health interventions should prioritize educating vulnerable communities about the epidemiology of brucellosis, emphasizing control of the disease transmission to humans through consumption of contaminated dairy products.

This study also revealed delays in seeking medical services with over 65% (n=46) of participants not seeking medical care for more than one month after the onset of symptoms. This behaviour of delayed healthcare seeking is consistent with findings from a study in Tanzania by Kunda et al., (2007), which reported a median delay time of 90 days for Brucellosis cases to go to the hospital after the onset of symptoms.

Also, Franc et al., (2018) reported that some women may miscarry and suffer various complications due to brucellosis without recognizing the need to seek treatment until when it may be too late for medical intervention. Such delays could be attributed to the geographical distance from healthcare facilities or lack of awareness about brucellosis, which hinder timely diagnosis and treatment of the disease.

Furthermore, this study reported delays in receiving brucellosis diagnosis with more than 82% (n=46) diagnosed over two months after experiencing symptoms. Yet, the diagnostic process was characterized by multiple visits to healthcare facilities, (71%, n=46) before receiving a brucellosis diagnosis.

This delay in diagnosis and treatment aligns with reports elsewhere, which underscore the diagnostic complexities of brucellosis, which often presents with nonspecific manifestations (Dean et al., 2012; Franc et al., 2018). Dean et al., (2012) indicated that inadequate health services and other social factors cause significant delays in human brucellosis diagnosis and treatment.

Also, the nonspecific symptoms of brucellosis, which mimic other diseases, often lead to misdiagnosis and delays in treatment (Franc et al., 2018). Kunda et al., (2007) reported that brucellosis was usually diagnosed and treated after cases failed to respond to malaria, typhoid or tuberculosis treatments. The persistence of brucellosis symptoms was also evident, as over 93% (n=46) of patients suffered from these symptoms for more than two months after completing treatment.

Equally concerning was the extended duration of treatment, as 89.1% (n=46) of participants received treatment for over sixty days with more than 65% (n=46) of them having experienced multiple diagnoses for the disease. All these factors cause a substantial number of infected people to suffer chronic brucellosis, making them lose quality life, productive time and money.

This study agrees with that of Dean et al., (2012) who reported delays in appropriate diagnosis and treatment of brucellosis. In Uganda brucellosis is not a notifiable disease and not funded by the government leading to many

public health facilities being unable to appropriately diagnose and treat the disease promptly. Additionally other socioeconomic factors such as the distance to the health facility and money required to pay for the diagnosis and treatment of brucellosis could keep back patients from visiting health facilities resulting in delays in appropriate diagnosis and treatment.

As well, this study showed that an individual suffering from brucellosis may lose up to 0.65 full healthy life years due to living in a less-than-optimal health state. This finding is relatable to study by Alumasa et al., (2021) who determined DALYs/case to be 0.68. This could be because both studies use the same disability weighting of 0.18.

Results of this study show that seeking medical care for brucellosis may cost up to USD 68.57 per patient, which significantly exceeds the average annual health expenditure of households in Uganda (USD 44.46). This finding highlights the disproportionate financial burden placed on households affected by brucellosis. These costs are notably higher than those reported in countries such as Sudan (Angara and Adil, 2014), where the estimated financial cost of human brucellosis was 48.10 USD per household annually. The high cost of managing human brucellosis may be attributed to the numerous appointments in which patients had to visit health facilities before a diagnosis was made.

Franc et al., (2018) reported that the higher costs of patients diagnosed with brucellosis arise from the diagnostic procedures, emergency clinic visits, laboratory tests, and the medications used as well as the period taken to treat the disease.
Furthermore, this study has shown that the economic depletion extends to livestock, with households experiencing an annual loss of USD 244.40 due to bovine brucellosis. According to the Uganda Bureau of Statistics - UBOS (2020), the average annual income per household in Northern Uganda is Ug shillings 2,765,376 (USD 790.11). Therefore, this loss represents a significant portion, accounting for 30.9% of the estimated annual household income.

These results confirm a report by FAO (2020), which indicated that diseases like brucellosis perpetuate poverty among farmers as livestock plays an important role in the livelihoods of rural populations. Considering human and bovine brucellosis, the estimated annual economic burden per household with at least one patient and seropositive cows stood at Ug shillings 1,095,410.40/- (USD 312.97) annually. These findings underscore the multifaceted economic consequences of brucellosis, shedding light on the substantial financial burdens faced by households in post-conflict northern Uganda affected by this zoonotic disease.

The most chronically poor people (21.6%) are reported to live in the Northern region (UBOS, 2020). In the financial year 2019/2020, the average monthly household expenditure in Uganda was estimated at Ug shillings 339263/-, while the average monthly household expenditure for northern Uganda was estimated at Ug shillings 230.448/- totaling to Ug shillings 2,765,376/- annually, and equivalent to $790.11 USD (UBOS, 2021).

On average, a household spends $44.46 USD on health-related issues (UBOS, 2020), but a household with an individual suffering from brucellosis spends an additional estimate of $68.56 USD due to the disease. The economic consequences of brucellosis are profound, with households bearing a substantial financial burden.

Conclusion and recommendations:-

The Socio-economic significance of brucellosis in northern Uganda is undeniable, and the economic burden posed by this zoonotic disease underscores the urgency of addressing its control. Brucellosis caused infected people to live in a less-than-optimal health state and caused substantial financial burdens to households in post-conflict northern Uganda. Brucellosis may be deepening poverty levels among livestock households in northern Uganda.

It is crucial to create awareness about transmission ways and the suspicious clinical manifestations of brucellosis to the rural communities in northern Uganda. As well, cost-effective interventions to control bovine brucellosis can help to alleviate the economic costs of the disease and foster improved public health and continued economic growth in post-conflict northern Uganda.

Limitations:-

i) This study considered only cattle in households with family members diagnosed with brucellosis. ii) There could have been an overestimation of the disease in both humans and cattle, since this study considered only patients who

had visited health facilities. As well, only cattle in households with cases were considered. iii) This study did not make corrections for potential underestimation of the brucellosis burden of disease, yet underestimation has implications in priorities settings and could undermine the value of this study as an advocacy tool. iv) Although accurate DALYs calculation of the burden of disease estimates requires having both YLD and YLL data, this study did not have data on brucellosis fatalities and did not attempt to use any indirect mortality data. v) During calculations for economic losses due to bovine brucellosis, costs that arise from repeat breeding, death of cows due to metritis, due to repeat breeding, as well as premature culling and costs of veterinary intervention.

Authors' contributions:
HMN was involved in the development of the concept, study design, data collection, analysis, and writing of the paper. JE and DOO helped to develop the concept, supervised the study, and critically revised the paper. GWN participated in the study design and data interpretation, revised the paper and approved the final version. JK participated in the acquisition of the data, revised the paper and approved the final version. DO and JN participated in the development of the concept study design and the drafting and final revision of the paper. All authors read and approved the final version of the paper.

Acknowledgments:-

This work was supported by Gulu University Enhancing Capacity for Agricultural Research and Training in Gulu University project [grant number NICHE-UGA 083]; funded by Netherlands Government through Netherlands Organization for Capacity Building in Higher Education (NUFFIC) and to International Centre for Development Oriented Research in Agriculture (ICRA), Netherlands, which managed the funds.

Ethical approval:
Ethical approval was obtained from Gulu University Research Council (Ref No: GU/ IRC/02/07/13) and the Uganda National Council of Science and Technology Reference No: HS 1442. Written consent was sought from all individuals before enrollment into the study.

Competing Interests:
The authors declare that they have no competing interests.

References:-

1. Alumasa, L., Thomas, L. F., Amanya, F., Njoroge, S. M., Moriyón, I., Makhandia, J., ... And Falzon, L. C. 2021. Hospital-based evidence on cost-effectiveness of brucellosis diagnostic tests and treatment in Kenyan hospitals. Plos Neglected Tropical Diseases, 15(1), e0008977. Https://doi.org/10.1371/journal.pntd.0008977
2. Angara T.E. and Ismail A. A. A. 2014. Socioeconomic Aspects of Brucellosis in Kuku Dairy Scheme, Khartoum State, Sudan. Indian Journal of Applied Research 4(8):685-687. DOI:www.doi.org/10.36106/ijar
3. Angara, T. E., Ismail, A. A. A., Ibrahim, A. M., and Osman, S. Z. 2016. Assessment of the economic losses due to bovine brucellosis in Khartoum State, Sudan. International Journal of Technical Research and Applications, 4(2), 85-90.
4. Clementino, I. J., and De Azevedo, S. S. 2016. Bovine brucellosis: Epidemiological situation in Brazil and disease control initiatives. Semina:Ciencias Agrarias, 37(4), 2021–2034.
5. Dadar, M., Tiwari, R., Sharun, K., and Dhama, K. 2021. Importance of brucellosis control programs of livestock on the improvement of Onehealth. Veterinary Quarterly, 41(1), 137-151.
6. Dean, A.S., Crump, L., Greter, H., Hattendorf, J., Schelling, E. And Zinsstag, J. 2012. Clinical manifestations of human brucellosis: a systematic review and meta-analysis. Plos neglected tropical diseases, 6(12), p.e1929. Https://doi.org/10.1371/journal.pntd.0001929.
7. Devleesschauwer, B., Havelaar, A.H., Maertens de Noordhout, C., Haagsma, J.A., Praet, N., Dorny, P., Duchateau, L., Torgerson, P.R., Van Oyen, H. And Speybroeck, N. 2014. Calculating disability-adjusted life years to quantify burden of disease. International journal of public health, 59, pp.565-569.
8. Di Bari, C., Venkateswaran, N., Bruce, M., Fastl, C., Huntington, B., Patterson, G.T., Rushton, J., Torgerson, P., Pigott, D.M. and Devleesschauwer, B. 2022. Methodological choices in brucellosis burden of disease assessments: A systematic review. Plos neglected tropical diseases, 16(12), p.e0010468. Https://doi.org/ 10.1371/journal.pntd.0010468
9. Ezama, A., Gonzalez, J. P., Sebhatu, T. T., Gabriel, T., Majalija, S., and Bajunirwe, F. 2019. Presumptive

diagnosis of brucellosis and determination of risk factors for seropositivity among members of cattle keeping households in a high cattle traffic area in the South Western region of Uganda. Global Journal of Infectious Diseases and Clinical Research, 5(1), 016-024. DOI: https://dx.doi.org/10.17352/gjidcr

10. Franc, K. A., Krecek, R. C., Häsler, B. N., and Arenas-Gamboa, A. M. 2018. Brucellosis remains a neglected disease in the developing world: a call for interdisciplinary action. BMC public health, 18(1), 1-9. DOI 10.1186/s12889-017-5016-y
11. FAO- Food and Agriculture Organization. 2020. The Uganda one health Legal framework: A livestock value chain perspective on emerging zoonotic diseases and antimicrobes
12. Kansiime, C., Rutebemberwa, E., Asiimwe, B. B., Makumbi, F., Bazira, J., and Mugisha, A. 2015. Annual trends of human brucellosis in pastoralist communities of south-western Uganda: a retrospective ten-year study. Infectious Diseases of Poverty, 4, 1-8. DOI 10.1186/s40249-015-0072-y
13. Kunda J Fitzpatrick J, Kazwala R, French N. P., Shirima G., Macmillan A., Kambarage S., B. M. And C. S. 2007. Health-seeking behaviour of human brucellosis cases in rural Tanzania. BMC Public Health, 7(31), 1471–2458.Http://doi.org/10.1186/1471-2458-7-315.
14. Lolli, C., Marenzoni, M. L., Strona, P., Lappo, P. G., Etiang, P., and Diverio, S. 2016. Infections and risk factors for livestock with species of Anaplasma, Babesia and Brucella under semi-nomadic rearing in Karamoja Region, Uganda. Tropical animal health and production, 48(3), 603-611. DOI: 10.1007/s11250-016-1005-x
15. Magona, J. W., Walubengo, J., Galiwango, T., and Etoori, A. 2009. Seroprevalence and potential risk of bovine brucellosis in zero grazing and pastoral dairy systems in Uganda. Tropical Animal Health and Production, 41(8), 1765–1771. Http://doi.org/10.1007/s11250-009-9375-y
16. Mcdermott, J., Grace, D., and Zinsstag, J. 2013. Economics of brucellosis impact and control in low-income countries Framework for the economic assessment of brucellosis. Rev Sci. Off Int Epiz, 32(1), 249–261. DOI: 10.20506/rst.32.1.2197
17. Migisha, R., Nyehangane, D., Boum, Y., Page, A. L., Zúñiga-Ripa, A., Conde-Álvarez, R., ... And Bonnet, M. 2018. Prevalence and risk factors of brucellosis among febrile patients attending a community hospital in south western Uganda. Scientific reports, 8(1), 15465. DOI:10.1038/s41598-018-33915-9
18. Miller, R., Nakavuma, J. L., Ssajjakambwe, P., Vudriko, P., Musisi, N., and Kaneene, J. B. 2016. The Prevalence of Brucellosis in Cattle, Goats and Humans in Rural Uganda: A Comparative Study. Transboundary and Emerging Diseases, 1–14. DOI: 10.1111/tbed.12332
19. Mugizi, D. R., Boqvist, S., Nasinyama, G. W., Waiswa, C., Ikwap, K., Rock, K., … Erume, J. 2015. Prevalence of and factors associated with Brucella sero-positivity in cattle in urban and peri-urban Gulu and Soroti towns of Uganda. The Journal of Veterinary Medical Science–8. DOI:10.1292/jvms.14-0452
20. Muloki, N. H., Erume, J., Owiny, D. O., Kungu, J. M., Nakavuma, J., Ogeng, D., and Nasinyama, G. W. 2018. Prevalence and risk factors for brucellosis in prolonged fever patients in post-conflict Northern Uganda. African Health Sciences, 18(1), 22-28. DOI: 10.4314/ahsahs. V1.4
21. Singh, B. B., Dhand, N. K., and Gill, J. P. S. 2015. Economic losses occurring due to brucellosis in Indian livestock populations. Preventive Veterinary Medicine, 119(3–4), 211–215. Http://doi.org/10.1016/j.prevetmed.2015.03.013.
22. Tumwine, G., Matovu, E., Kabasa, J. D., Owiny, D. O., and Majalija, S. 2015. Human brucellosis: sero-prevalence and associated risk factors in agro-pastoral communities of Kiboga District, Central Uganda. BMC Public Health, 15(1), 900. Http://doi.org/10.1186/s12889-015-2242-z
23. UBOS- Uganda Bureau of Statistics. 2020. Statistical Abstract. Uganda Bureau of Statistics.https://www.ubos.org/wpcontent/uploads/publications/11_2020STATISTICAL__ABSTRACT_2020.pdf
24. UBOS -Uganda Bureau of Statistics. 2024. The national livestock census 2021 report, Kampala, Uganda.
25. UBOS -Uganda Bureau of Statistics. 2021. Uganda National Household Survey 2019/2020. Kampala, Uganda.
26. Ukwueze, C.S., Kalu, E., Odirichukwu, E.O., Ikpegbu, E. And Luka, P.D. 2022. Overview of human and animal brucellosis in Nigeria and its economic impacts on production. African