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Prevalence of Fasciolosis in Cattle, Sheep, and Goats Slaughtered in Slaughter Slabs in Trans-Nzoia West, Kenya. and Knowledge of Livestock Handlers

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Abstract

Background: Fasciolosis is known globally to be an important helminthic disease of ruminants caused by liver fluke species of the genus *Fasciola*, and it is one of the most neglected tropical zoonotic diseases that can lead to human infection. It has the widest geographic spread of any emerging zoonotic disease, and it occurs in many countries of the world. **Objectives:** The study aimed at determining the prevalence of fasciolosis in ruminants slaughtered in Trans-Nzoia West. Specific objectives were to establish the trend of fasciolosis in ruminants, ascertain the relationship between fasciolosis prevalence and rainfall patterns and assess the knowledge of meat sellers and farmers about fasciolosis. **Methodology:** A 5-year secondary data retrospective study was carried out in Trans-Nzoia West, Trans-Nzoia County. The study population consisted of ruminants slaughtered, meat sellers and livestock farmers. **Results:** A total of 104,221 cattle, sheep and goats were slaughtered in the five-year period in which 6,098 (5.85%) were infested with fasciolosis with a prevalence of 6.52%, 6.08% and 4.10% in cattle, sheep, and goats respectively. Most meat sellers (72.2%) were able to identify fasciolosis in infested livers, 88.9% reported liver flukes infestation resulted in the loss of income while 58.3% were not aware of nutrition depletion associated with fasciolosis. Of the farmers interviewed, 52.9% grazed in swampy areas, 66.7% dewormed after 3 months, 78.4% had heard about fasciolosis and 80.0% did not know the cause of fasciolosis. The majority (95.0%) were not aware of the snail species spreading liver flukes while 77.5% did not know that fasciolosis was a zoonotic disease. **Conclusion:** Fasciolosis was prevalent in the area and caused great economic loss to the meat sellers. Most farmers were not aware of its cause and zoonotic nature. **Recommendations:** Fasciolosis control should be approached from a multidisciplinary angle and farmers should be educated on it and its zoonotic nature.

Keywords: Fasciolosis, Prevalence, Knowledge

1. Introduction

Fasciolosis is known globally to be an important helminthic diseases of ruminants caused by liver fluke species of the genus *Fasciola* and it is one of the most neglected tropical zoonotic diseases (World Health Organization, 2009). It has the widest geographic spread of any emerging zoonotic disease and it occurs in many countries of the world (Mas-Coma et al., 2009). *Fasciola hepatica*, which is a common species of cattle and sheep is the cause of the most reported cases of fasciolosis worldwide. The diseases is common in livestock as compared to humans but infested people have been reported to be more than 2 million (CDC, 2015)

Epidemiological studies in animals and humans in different regions worldwide have shown that around 91 million people are at risk of fasciolosis infection with 17 million people being already infected (Mekky et al., 2015). The disease is classified as a neglected tropical disease (NTD). The main two liver flukes species causing fasciolosis; *Fasciola hepatica* and *Fasciola gigantica*, are hermaphrodites and they live mainly in the bile duct and gall bladder of infested animals. The two species have a common life cycle and are associated with severe damage to the infested body organs. There effects are sometimes so severe that they lead to death of the affected livestock (Mahami-Oskouei et al., 2012)

The economic losses due to this disease in most parts of Sub-Saharan Africa is difficult to quantify because most of the livestock farmers are nomadic pastoralists who constantly shift from one area to another according to the prevailing climatic conditions and in search of water and grazing fields making the control of this diseases difficult. This infection is important and of great concern to livestock farmers because of the mortality of livestock, high cost of management, and reduction in milk and meat production associated with it (Olsen et al., 2015)

The incidence of fasciolosis in developing countries is sometimes as high as 77 percent. Fasciolosis is regarded as the most important helminthic zoonotic infection of bovines in tropical countries with a prevalence ranging from 30 to 90 percent being reported (Ashrafi et al., 2014).

The high consumption of meat globally has led to concerns about its hygiene and safety as a result of high fasciolosis infection prevalence (Odigie and Odigie, 2013). There is a lot of existing literature on fasciolosis infection in tropical regions with corresponding presence of *Lymnea spp*, the snail species responsible for its transmission. The possibility of transmission from livestock to humans is high where humans live in close proximity to livestock (Mas-Coma et al., 2005). Lack of the necessary knowledge is a major hindrance to the

efficient management of this infection. Unfortunately, in most of the least developed countries and developing countries of Sub-Sahara Africa faced with the burden of communicable infectious diseases and limited resources, human fasciolosis is rarely given attention and is mostly not reported (Mas-Coma et al., 2014).

Cases of human fasciolosis are hardly investigated in areas where livestock fasciolosis is highly prevalent hence having a negative impact on the health and well-being of the residents (Soliman, 2008). The most common direct economic impacts of fasciolosis infection are increased condemnation of livers, decreased productivity of livestock, reduced growth rate and low birth weight of calves born of infected livestock (Usip, et al., 2014).

The high cases of livestock infected leads to high economic losses to both farmers and business people in the sector. The zoonotic nature of this diseases is also a public health threat with billions of dollars lost yearly. Despite the huge losses associated with it, education and awareness creation among farmers on the disease is rare (Ozung et al., 2011)

There is limited data on fasciolosis prevalence and level of awareness among livestock farmers in Kenya and fasciolosis is a zoonotic disease that has been forgotten despite its enormous economic importance. This study provides an insight of the problem associated with this disease and this is a good One Health area of concern that requires collaboration between veterinary, medical, epidemiologists, ecologists and public health professionals in dealing with it hence the need for public health to be involved actively.

This study aimed at determining the prevalence of fasciolosis among ruminants slaughtered in Trans-Nzoia West, Trans-Nzoia County, establish the trend of fasciolosis in ruminants slaughtered, assess the relationship between fasciolosis prevalence in ruminants and rainfall pattern and assess the knowledge of meat sellers and farmers concerning fasciolosis

2. Methods and materials

2.1. Study area

The study was carried out in Trans-Nzoia West, Trans-Nzoia County in Kenya which has Machinjoni, Matisi, Kitalale, Maili Saba and Kisawai slaughter slabs. Trans-Nzoia West consists of the current Kiminini and Saboti Sub-counties with 11 wards namely; Kiminini, Waitaluk, Sirende, Hospital, Sikhendu and Nabiswa in Kiminini, Kinyoro, Matisi, Tuwan, Saboti and Machewa in Saboti. It lies between latitude $0^{\circ} 21'N$ and longitude $34^{\circ} 18'E$ and $35^{\circ} 23'E$. The total area is 753.5km^2 . It has an average height of 18000m to 24000 m above sea level. The area has a total population of 463,178 people with the municipality area leading with a population of 141,404 people. The total number of livestock kept in the area include 68,170 cattle, 42,618 sheep, and 101,811 goats according to the 2009 census. The region is flat undulating gently towards Mt. Elgon to the North West. The average rainfall is 1296.1mm which is biannual in pattern. The mean temperature is $18.6^{\circ}C$ and varies from $10-37^{\circ}C$. The main rivers in the area include Sabwani and Nzoia. The swampy areas covers 8% of the total sub-county which is approximately 20km^2 and they include, Kitalale, Namanjalala, Kipsongo, Pikeke, Wamuini, and Kibomet. Dairy farming is an enterprise that is practiced widely in the region. The region has Mt. Elgon National Park and Mt Elgon Natural Forest.

2.2 Study design

A 5 years secondary data retrospective study covering the period from 2011 to 2015 was carried out using daily postmortem meat inspection records at the Trans-Nzoia County veterinary department to determine fasciolosis prevalence. Cross-sectional study design was used to assess the knowledge of farmers and meat sellers on fasciolosis.

2.3 Study population and sample size.

The study population consisted of 104,221 ruminants slaughtered at the five slaughter slabs in Trans-Nzoia West (Machinjoni, Matisi, Kitalale, Maili Saba and Kisawai) from 2011-2015, livestock farmers, meat sellers and the meat inspectors in Trans-Nzoia West. All 36 meat sellers at Matisi slaughter slab, which was the main slaughter slab in the area at the time of study were selected to take part in the study.

2.4 Sampling technique

Purposive sampling was used to select Trans-Nzoia West as the study area as most of the residents were livestock farmers. Simple random sampling was used to select Kinyoro ward with 1,436 livestock farmers from the 11 wards in Trans Nzoia West for farmers' interview where 51 farmers were interviewed. Purposive sampling was also used to select Matisi slaughter slab for the interview with meat sellers as it was serving many meat sellers in the county at the time of study.

Slaughterhouse reports at Trans-Nzoia veterinary department from the 5 slaughter slabs; Machinjoni, Matisi, Kitalala, Maili Saba and Kisawai were used to calculate the prevalence of fasciolosis. Records of the total number of bovines, caprines, and ovines slaughtered and the number of those with fasciolosis were obtained.

Prevalence was calculated as the number of those found to be infested expressed as a percentage of the total number of animals slaughtered.

2.5 Data tools collection

Postmortem meat inspection records from 2011-2015 at the Trans-Nzoia veterinary department and rainfall data from Kitale Meteorological station were reviewed. Structured questionnaires were used to collect data from the meat sellers and livestock farmers. Key Informant Interview guide was used to carry out one-on-one interview with 2 meat inspectors working in the area.

2.6 Data analysis and presentation

MS Excel 2013 and SPSS version 20 were used for data entry, coding, cleaning, and analysis. Data was presented using graphs, tables, charts, photographs and prose sentences

2.7 Ethical considerations

Approval to conduct the study was sought from Moi University, school of Public Health. Permission to conduct the research was sought from the Department of Veterinary Medicine, Trans-Nzoia County, county administration and area sub-county commissioner. The nature and purpose of the research were explained to respondents before the study. Both oral and written Consent was sought from the respondents and consent forms issued to them for signing. Confidentiality of the information collected was safeguarded.

2.8 Eligibility criteria

Meat sellers bringing their animals for slaughter at Matisi slaughter slab and Meat inspectors within the former Trans-Nzoia West sub-county were included in the study while Meat sellers slaughtering their animals outside the slaughter slab were excluded.

3. Results

3.1 Fasciolosis prevalence

The total number of livestock slaughtered during the five years period (2011-2015) were 104,221 of which 6,098 were infected with fasciolosis. The total number of sheep slaughtered were the highest (52,573) followed by the number of cattle (32,385) with that of goats being the lowest (19,263). Similarly, total fasciolosis cases were highest in sheep (3,196) followed with cases in cattle (2,113) while being lowest in goats (789). See table 1 and 2.

Table 1: Number of livestock slaughtered and fasciolosis cases from 2011 to 2015.

Year	Number of cattle slaughtered	Fasciolosis cases in cattle	Number of sheep slaughtered	Fasciolosis cases in sheep	Number of goats slaughtered	Fasciolosis cases in goats
2011	5,587	487	10,135	712	2,936	141
2012	6,489	552	10,670	732	3,180	145
2013	6,796	442	12,062	715	4,673	205
2014	6,881	324	10,080	570	3,844	141
2015	6,632	308	9,626	467	4,630	157
TOTAL	32,385	2,113	52,573	3,196	19,263	789

Table 2: Total number of livestock slaughtered and fasciolosis cases from 2011 to 2015

Year	Total livestock slaughtered	Total Fasciolosis cases
2011	18,658	1,340
2012	20,339	1,429
2013	23,531	1,362
2014	20,805	1,035
2015	20,888	932
5 years total	104,221	6,098

The total five years fasciolosis prevalence was highest in cattle with a prevalence of 6.52% followed closely with prevalence in sheep at 6.08% while being lowest in goats at 4.10%. Prevalence in cattle, sheep, and goats was highest in 2011 with a prevalence of 8.75%, 7.03% and 4.80% respectively while being lowest in 2015. Total combined five years prevalence in the 3 livestock under study was 5.85%. See table 3 and Figure 1.

Table 3: Fasciolosis prevalence

Year	Prevalence in cattle (%)	Prevalence in sheep (%)	Prevalence in goats (%)	Combined Prevalence (%) {cattle, sheep and goats}
2011	8.75	7.03	4.8	7.18
2012	8.52	6.86	4.56	7.03
2013	6.5	5.93	4.39	5.79
2014	4.71	5.66	3.67	4.98
2015	4.64	4.85	3.39	4.46
5 years total	6.52	6.08	4.1	5.85

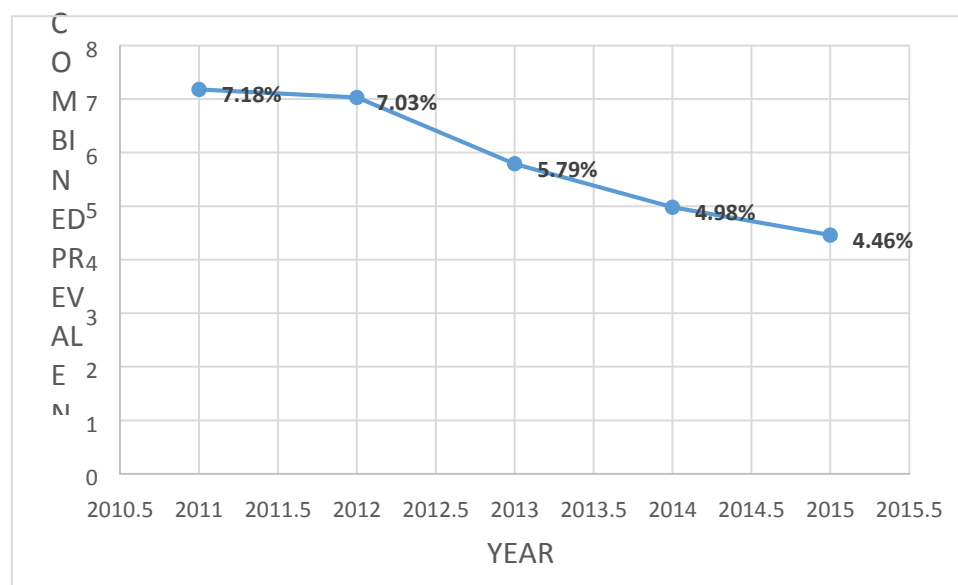


Figure 1: Yearly trend of fasciolosis

The average annual rainfall was highest in 2011 (127.83mm and lowest in 2014 (106.28mm) the relationship between rainfall and fasciolosis prevalence was not statistically significant ($p > 0.05$).

3.2 Meat sellers

Most (97.2%) of the meat sellers were male. Of the 36, 44.4% had attained primary education, 41.7% secondary with only 11.1% having attended institutions of higher learning. More than half (58.3%) had been in the business for more than 10 years, 27.8% for between 5-10 years while the rest for less than 5 years. Most (88.9%) brought less than 6 livestock for slaughter with the majority bringing cattle and sheep.

Of the 36 meat sellers, 80.6% had a butchery within Trans-Nzoia West and 83.3% bought their livestock within while the rest were sourced from West Pokot and neighbouring sub-counties. More than a half (66.7%) reported that infested livers were condemned by the meat inspector, 25.0% did not know what happens to it while 8.3% took them for sale.

When asked if they knew the cause of fasciolosis, 69.4% were able to explain correctly and most (72.2%) were able to identify infested livers; 88.5% by the presence of liver flukes and 11.5% by the colour of the liver. Most of them were not aware of low fats and liver lesions caused by liver flukes while a half were aware of loss of aesthetic quality of meat caused by liver flukes, 58.3% did not know that it causes depletion of nutrients in the liver and 88.9% reported that it had caused reduction in their income and yields.

3.3 Farmers

Of the farmers interviewed, 61.0% were between the age of 30-55 years, 60.8% were male, 66.7% were farmers by occupation while 13.7% had formal employment. All of them had gone to school; 49.0% had attained primary level of education, 27.5% secondary school and 21.6% college or university education. Most (54.9%) had been livestock farmers for more than 10 years, 35.3% for between 5-10 years while the rest for less than 5 years. Of these farmers, 56.9% kept cattle only, 21.6% cattle and sheep while the rest kept both cattle, sheep, and goats.

More than a half (66.7%) deworm after 3 months, 21.6% after 6 months, 7.8% after 1 year while 39% had never dewormed their livestock; 47.1% graze and water their livestock in swampy and marshy areas.

Most (78.4%) had heard about fasciolosis of which 45.0% got the information from the veterinary officer, 25.0% from friends, 20.0% from the media and 10.0% from family members. Of those aware of fasciolosis, 80% did not know the cause of fasciolosis, 95% were not aware of the snail that spreads liver flukes and 75% had never been educated on this disease but 65% had knowledge on control measures. Most (77.5%) did not know that fasciolosis is a zoonotic disease.

Most farmers were aware that fasciolosis causes decreased productivity, anaemia, reduced growth emaciation and death in livestock while few were aware of abortion, impaired immune system and swelling of the liver caused by it. See table 4.

Table 4: Awareness on effects of fasciolosis

N=40

Effect	Yes	No
Decreased productivity	87.5% (35)	12.5% (5)
Anaemia	72.5% (29)	27.5% (11)
Reduced growth	85.0% (34)	15.0% (6)
Emaciation	82.5% (33)	17.5% (7)
Impaired immune system	20.0% (8)	80.0% (32)
Swollen liver	40.0% (10)	60.0% (24)
Abortion	12.5% (5)	87.5% (35)
Death	80% (32)	20.0% (8)

3.4 Meat inspectors

Table 5: Key informants results

	QUESTION	KEY INFORMANT 1	KEY INFORMANT 2
1	Period at station	28 years	3 Years
2	Common fasciolosis species encountered during Post-mortem inspection	<i>Fasciola hepatica</i>	<i>Fasciola hepatica</i>
3	Origin of livestock slaughtered	Majority came from Trans-Nzoia West, with the rest from West Pokot and other sub-counties within	Majority came from Trans-Nzoia West, with the rest from West Pokot
4	Type of livestock with highest cases of liver flukes	Sheep and cattle	Cattle
5	Sex of livestock with highest cases of liver flukes	Female livestock	Female livestock
6	Challenges of fasciolosis control	Cost of dewormers, small land areas	Farmers not willing to deworm
7	Action on infested liver	Local condemnation or trimmed and passed depending on severity	Condemnation or passed depending on severity

Two key informants were interviewed on one-on-one basis. Both of them were meat inspectors in Trans-Nzoia West. One had been a meat Inspector there for 28 years while the other for 3 years. The two meat inspectors reported that *Fasciola hepatica* was the most common liver fluke species encountered during meat inspection. Both the two reported that they carry out total condemnation of livers with chronic fasciolosis while those not severely infested are trimmed and released to the owners.

They reported that most of the animals slaughtered at the slaughter slab come from Trans-Nzoia West while the rest come from West Pokot and other parts of Trans-Nzoia as confirmed by the movement permit. Sheep and cattle were cited as livestock with high fasciolosis cases according to their daily encounter during routine meat inspection. The cost of dewormers, small grazing area and unwillingness of farmers to deworm their livestock were the main challenges in fasciolosis control according to meat inspectors. See table 5.

4. Discussion

4.1 Fasciolosis trend

Results obtained in the study area indicates that fasciolosis occurred with cases being highest in sheep, followed by cattle and lowest in goats. Total prevalence of fasciolosis in the three livestock types under study was highest in 2011 reducing yearly. This was also the case in the prevalence in each of the three livestock types under study. This drop can be attributed to regular deworming as most farmers (66.7%) dewormed after 3 months regularly.

Fasciolosis prevalence in livestock during the five years period under study was 5.85% with a

prevalence of 6.52%, 6.08% and 4.10% in cattle, sheep, and goats respectively. In a similar study carried out in Dasht Room County Iran, the prevalence of infection in sheep was higher (17.71%) than in cattle (16.71%) and in goats which was 11.69% (Moshfe et al., 2016). The high prevalence in sheep and cattle can be attributed to their feeding habits as compared to that of goats which browse on shrubs.

Prevalence obtained in this study was lower compared to that obtained by Kithuka and colleagues from a retrospective study covering 10 years using postmortem records where fasciolosis prevalence rate in cattle across Kenya was 8% and a 9.3% prevalence estimate for the same from a 2-month meat inspection exercise at Kabete slaughterhouse. The part of Kenya with the highest prevalence of fasciolosis was the former Western Province of Kenya with a prevalence of 16% followed, in descending order, by Eastern Province, Nyanza Province, Rift Valley Province, Central Province, Nairobi Province and Coast Province having the least prevalence of 3.5% (Kithuka et al., 2002). Fasciolosis prevalence in live animals in central Kenya was estimated to be 34% using copro-parasitological worm egg counts (Waruiru et al., 2000). Trans Nzoia west is found within the former Rift Valley Province hence the prevalence of fasciolosis was likely to be reducing. Prevalence in western was highest most likely due to the fact that most of the livestock are taken to salt licks for watering and are produced extensively.

Similar studies in Zimbabwe, Ethiopia, and Tanzania established higher prevalence of 31.7% in zimbabwe, 24.44% in Dire Dawa Ethiopia, 17.8% and 94% in small-scale dairy and traditional cattle farmers respectively in Tanzania (Pfukenyi and Mukaratirwa, 2004; Swai and Ulicky, 2009; Gebreyohannes, 2013).

Annual rainfall was also reducing from 2011 in which it was highest to 2014 where it was lowest. Fasciolosis did not follow any rainfall pattern, and seasonal differences were not statistically significant as proved with the chi-square tests ($p > 0.05$). This was also the case in a study done in Iran (Khoramian et al., 2014). However, from other studies carried out in Africa, wetter years with annual average rainfall amounts of about 600mm and above showed significant increase and relationship with fasciolosis cases (Jaetzold and Schmidt, 1983). This study observation also differs with the observations from other studies in Kenya, Tanzania and Zimbabwe where significantly increased fasciolosis cases in both live and slaughtered cattles was reported following periods of high rainfall (Pfukenyi and Mukaratirwa, 2004; Keyyu et al., 2009, 2005).

The majority of the livestock slaughtered came from within as reported by the majority of meat sellers (83.3%) who bought them within. This was further confirmed by the meat inspectors' records from movement permits that showed that most of the livestock came from Trans-Nzoia West. All farmers responded that they sold their livestock within hence it's likely that the prevalence obtained was a reflection of the trend in Trans-Nzoia West.

Fasciola hepatica was the most common species of liver fluke identified in the infested livers. Distribution of *F. hepatica* and *F. gigantica* is associated with distribution of intermediate water snail host hence it is likely that *Lymnaea truncatula* and *L. rubiginosa* which are intermediate hosts of *F. hepatica* were the common snail species in Trans-Nzoia west. Development of *F. hepatica* miracidia and larva and reproduction of *L. truncatula* requires a temperature range of 10⁰c to 25⁰c and high level of moisture in the air. These conditions were found to prevail in Trans-Nzoia with a temperature range of 10⁰c to 37⁰c. This is different from what was observed in a study carried out in Kenya by Kithuka and colleagues which showed that *F. gigantica* was the liver fluke species identified in all infested livers and hence they concluded that it was the most common species in Kenya (Kithuka et al., 2002).

Results of a study in Arusha abattoir on bovine fasciolosis also found out that *F. gigantica* was the most common liver fluke species with all samples taken proving this (Mwabonimana, 2009). Phiri et al., (2005) found that *F. gigantica* was the leading cause of liver condemnation in Zambia. Mage and colleagues established that *F. gigantica* was the most common fasciola species found in Africa and is widely distributed in tropical and subtropical areas (Mage et al., 2002). However, Mekroud et al., (2004) reported *F. hepatica* as the major cause of liver condemnation in Algeria. This difference in species may depend on the common fasciola species circulating in the local environment, differences in climatic conditions that are conducive to the intermediate hosts and the type of intermediate host snail present in the locality.

Study by Mas-coma and colleagues showed that *F. hepatica* and *F. gigantica* coexists in Africa in areas of Nile drainage, great lakes mountain ranges and Rift Valley arms because such areas have alternating altitudes and climatic conditions favouring the survival of respective snail vectors (Mas-coma et al., 2009).

4.2 Knowledge of meat sellers and farmers

The majority of the meat sellers were male. This is similar to a study in Abeokuta Nigeria where more males were observed to sell meat (Idowu, et al., 2007). This can be attributed to the local cultural beliefs and practices where it is believed that selling of meat is men's job.

Most of the meat sellers were aware of what happens to infested livers. Most of the infested livers were condemned. This relates to the information from the meat inspectors who said that highly infested livers are totally condemned while those with few liver flukes are trimmed and passed for consumption. Condemnation

causes a lot of economic loss to the meat sellers as the yields reduce hence the income. Livers are a source of protein; vital nutrients needed by human growth. Condemnation leads to loss of nutrients from the food chain hence depriving people of the rich source of proteins (Idowu. et al., 2007).

Most (88.9%) of the meat sellers reported that fasciolosis had reduced their yields and income. A 10 years retrospective study carried out in seven former provinces of Kenya; Eastern, Western, Nairobi, Coast, Rift Valley, Nyanza and Central provinces showed that the country lost a total of US\$ 2.6 million for a ten years period. The loss was as a result of condemnation of fascioliasis infested livers (Kithuka *et al.*, 2002; Njeru *et al.*, 2004). Total global economic loss attributed to fasciolosis was estimated to be more than 3 billion US dollars annually (FAO, 1994). WHO's findings show that fasciolosis causes loss of nearly 9 billion US dollars annually (WHO, 2009). This is a lot of money hence the loss affects the economy of the country negatively with meat sellers and farmers bearing the greatest loss.

Some meat sellers admitted to selling fasciolosis infested liver. This was the case in Nigeria where most of the meat sellers admitted to selling infested liver to unsuspecting customers (Idowu et al., 2007). Infested livers are of low quality and are mostly condemned for aesthetic reasons. Most meat sellers are not ready for the losses caused by condemnation of the livers as they are marketable and fast selling hence sneak condemned livers back to the market.

More than half of the meat sellers (58.3%) were not aware of nutritional depletion associated with fasciolosis. In a similar research done in Nigeria, none of the sellers was aware of the nutrient depletion associated with fasciola infestation. The crude protein content of a normal liver was documented by (Osborn and Voot, 1978) to be 20g. A study in Nigeria by Idowu et al. (2007) recorded crude protein content of infected liver to be 14.5g compared to 21.5 g in the uninfected liver proving the depletion of the crude protein content of infected liver. This shows that fasciolosis has a reducing effect on the crude protein content of liver. Protein is known to be very useful human growth and for tissue repair. The crude protein of liver is known to be higher than that of meat (Osborn and Voot, 1978) and this explains why liver is fast selling than meat and some meat sellers sneak condemned livers to the market.

The majority of the meat sellers knew that liver flukes cause loss of meats aesthetic quality while most farmers were aware that fasciolosis causes decreased livestock productivity, anaemia, reduced growth, emaciation, and death. These results are in agreement to those of a similar research done in Nigeria which revealed that most farmers were aware of the above-mentioned effects of fasciolosis (Idowu *et al.*, 2007)

The majority of the meat sellers could be able to identify fasciolosis infestation in livers of infested livestock by observation of liver flukes in it or change in colour. These results are in agreement with the results of a research done in Nigeria that revealed that majority of the meat sellers were able to identify infested liver either through its colour or the presence of liver fluke (Idowu. et al., 2007). Presence of worms is the easiest way of identifying presence of fasciolosis as the worms can be seen with the eyes during inspection hence it is most likely that meat sellers were able to learn about this during their daily interaction with the meat inspector when their meat was being inspected,

Most of the farmers (78.4) were aware of fasciolosis and had heard about it. This was higher than that obtained in a study carried out in Switzerland where only 27.8%% of the farmers were aware of fasciolosis in their animals (Schweizer et al., 2005). This may also be attributed to high standards of livestock hygiene maintained by the farmers in the developed world and the farmers also usually produce their animals intensively, a practice which requires high financial inputs for high economic gains from their livestock. In Trans-Nzoia, most residents were originally pastoralists and they produce their animals extensively.

A survey done in Java Indonesia also found that the farmers' level of knowledge about fasciolosis was very low with only 22% of farmers surveyed knowing about the agent which caused fasciolosis as was the case in this study. After an extension program was implemented, farmers' knowledge increased in terms of the causal agent and how cattle were infested hence justifying the role of extension on awareness (Martindah, 1998). Similarly, in a study carried out in Northern Laos, south East Asia on farmers' knowledge on liver fluke and its management in ruminants, 93% of the farmers had no knowledge (Rast et al., 2015).

Most farmers in Trans Nzoia West dewormed their livestock regularly and were able to name some of the anthelmintic drugs used hence it's true that most had knowledge on fasciolosis control. In a study carried out in Laos, control or prevention measures were lacking, with none of the surveyed producers using effective anthelmintic treatments or grazing strategies to control *Fasciola* spp (Rast et al., 2017)

Of the farmers, 75.0% had never been educated on fasciolosis hence lacked any form of training about it. A study by Mungube and colleagues in Taita Taveta, Kenya showed similar trend where only 23.8% of the farmers reported having received training on proper animal husbandry and fasciolosis (Mungube et al., 2012). Lack of education and awareness presents an obstacle in fasciolosis management.

More than half of the farmers deworm after 3 months, 21.6% deworm after 6 months. This shows that most farmers knew the period after which they are supposed to deworm their livestock. In a cross-sectional survey in Taita Taveta, deworming was practiced in 57.1% of the herds but mostly on sick and weakly livestock

(Mungube et al., 2012). The percentage of deworming obtained in this study was nearly similar to that obtained from a study in Menz Gera Midr Woreda, Ethiopia where 87.5% deworm their flock twice a year (Gebreyohannes, 2013).

The majority of the farmers were not aware of the snail that acts as an intermediate host of liver flukes. Most were not even aware that it is associated with snails. It is likely that farmers had not been educated on transmission and development stages of the liver fluke. This is the likely cause why fasciolosis is still rampant in the region even though reduction had been noted.

Nearly half of the farmers grazed in the swampy and marshy areas. 8% of Trans Nzoia west is swampy providing a favourable environment for survival and breeding of snails species that are intermediate hosts of liver flukes. The majority of the farmers did not know that fasciolosis was a zoonotic disease. This confirms the fact that fasciolosis is a neglected disease of public health importance as stated by (WHO, 2009)

5. Conclusion

Fasciolosis prevalence in Trans-Nzoia West slaughter slabs was reducing yearly and this can be attributed to regular deworming. Prevalence was highest in sheep followed closely with cattle and lowest in goats. There was no significant relationship between annual rainfall and cases of fasciolosis. Liver condemnation due to fasciolosis had caused enormous economic income loss to the meat sellers. The majority of the farmers had heard about fasciolosis but were not aware of its cause and the fact that it can infect human beings proving that it has not been given the attention it requires making it a neglected disease of significant public health importance.

6. Recommendations

Vigilant surveillance and screening programs should be implemented in the areas, with an emphasis on interdisciplinary involvement across various professions

Further research should be carried out to ascertain the total amount of income lost due to liver condemnation and the amount of nutrients lost.

The Public should be enlightened about the disease and the role of snails in the life cycle of the parasite as well as associated health risks in animals and humans

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Conflict of interest

The authors declare no conflict of interests in the study

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