

Scoping visit to identify potential study sites for *Taenia solium* research in northern Uganda



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Executive summary

Taenia solium (pork tapeworm) is a key neglected zoonotic parasite that causes serious public health and socio-economic problems in the global south. *T. solium* infection results in three different illnesses: Porcine cysticercosis in pigs and Taeniasis and Neurocysticercosis in humans. Neurocysticercosis is the leading cause of preventable adult-acquired epilepsy in sub-Saharan countries, including Uganda. Although its control is not considered a key priority, *T. solium* infections have been listed among zoonotic diseases present in Uganda by the national One Health platform (Sekamatte et al., 2018). In Uganda, the endemicity of *T. solium* is aided by high household poverty rates, low coverage and use of appropriate sanitary infrastructure, rudimentary extensive pig production systems (free-roaming pig keeping), and poor public health systems.

Northern Uganda is a region located in the geographic north of the country, comprising 37 districts with a total projected population of 8,577,700 people (Uganda Bureau of Statistics 2021). Piggery enterprises are a key source of livelihood for the rural poor in the region, providing a source of income for basic household needs in addition to meat and manure. However, in northern Uganda, the pigs are kept in smallholdings in complex contexts, a characteristic of impoverished communities exacerbated by insurgency, shortage of appropriately skilled manpower, weak legal and regulatory framework, limited access to financial services, pork value chain not prioritized by public services, and diseases (Tatwangire 2014). The diseases that are particularly important to Uganda's pig industry are African swine fever, external parasites, helminthiasis, and pork cysticercosis (Ngwili et al. 2021; Tatwangire 2014).

While some baseline studies have been conducted in northern Uganda, most districts, including the proposed study sites have limited epidemiological and contextual data. The proposed study sites are Agago, Kitgum, Lamwo, and Pader districts. These were selected based on (i) confluence of risk factors such as latrine coverage, pig population and low socio-economic index as shown by an ongoing rapid risk mapping approach utilizing data from demographic health surveys and the Gridded livestock of the world (Figure 1) (ii) reports of endemicity by the meat inspectors trained under ILRI's **Boosting Uganda's Investment in Livestock Development (BUILD)** project, and (iii) an ongoing systematic literature review which has showed insufficient epidemiological data on which to design robust intervention trials. This scoping study was conducted to verify the endemic status of the districts, meet key stakeholders and ensure suitability of the proposed site for an in-depth baseline study prior to intervention design.

This scoping study determined *T. solium* infections may be endemic in the proposed study sites and meat inspection and disease surveillance is weak. Thus, interventions targeted at controlling *T. solium* infections would be of immense value to the pork value chain performance and profitability, simultaneously reducing the disease burden on humans and pigs and increasing household incomes.

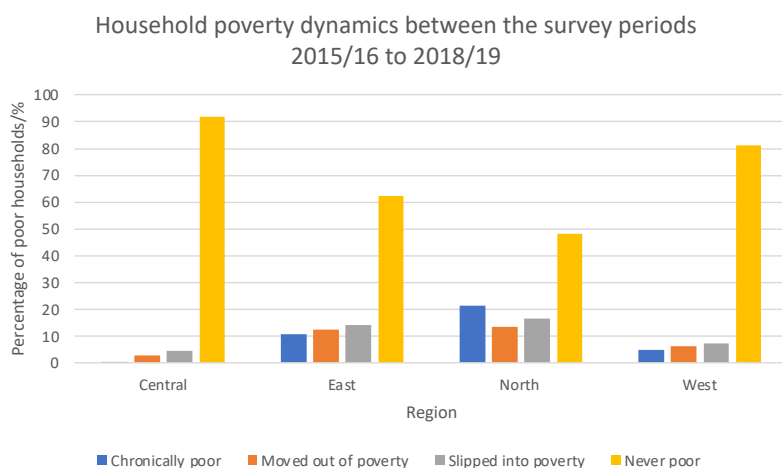
Background information

In Uganda, the production and consumption of livestock and livestock products have been growing rapidly, with the most significant growth observed in the pig sector (Tatwangire 2014). Uganda's pig population was estimated to be 3.2 million pigs in 2008, with the central region contributing 41% of the population (MAAIF and UBOS 2008). The pig sector is generally underdeveloped, although it has high growth potential, given the rising demand for pork domestically and in neighbouring countries such as South Sudan, Rwanda, and the Democratic Republic of Congo (Ouma et al. 2017).

Northern Uganda is a region located in the geographic north of the country comprising 37 districts that make up the subregions of Acholi, Lango, Karamoja and West Nile. As of 2021, the total projected population stands at 8,577,700 people (Uganda Bureau of Statistics 2022). Historically, the region has been a war zone in a conflict that lasted more than 20 years and only recently returned to normalcy. The brutal war between the infamous Lord's Resistance Army (LRA) and the government of Uganda resulted in the total collapse of societal systems, gross violations of human values and rights, destruction of public and private infrastructure, paralysis in economic activity, and a general social and cultural breakdown (Nannyonjo 2007). In addition to LRA, the north has also suffered the problem of cattle rustling by domestic and foreign rustlers. As a result of these challenges, northern Uganda remains a disadvantaged and impoverished region, even after multiple government initiatives to restore the socio-economic status of the area. Trends in recent years indicate that more people living in northern Uganda slip into poverty than those who come out of it (UBOS 2020), as shown in Figure 1 below.

As of the National Livestock Census 2008, northern Uganda had a hog herd size of 105,070 (UBOS and MAAIF 2009). In 2021, UBOS conducted another census to picture the current pig populations accurately, but the results are yet to be published. The key challenges to the piggery industry in northern Uganda are shortage of appropriately skilled manpower, weak legal and regulatory framework, limited access to financial services, pork value chain not prioritized by public services, and diseases (Tatwangire 2014).

Figure 1: Household poverty dynamics.



Source: UBOS (2020).

Taenia solium (pork tapeworm) is a key neglected zoonotic parasite that causes serious public health and socio-economic problems in the global south. *T. solium* infection results in three different illnesses: Porcine cysticercosis in pigs and Taeniasis and Neurocysticercosis in humans (Ngwili et al. 2021). Neurocysticercosis is the leading cause of a human degrading symptom known as epilepsy that is highly prevalent in sub-Saharan countries, including Uganda (Assana et al. 2012). On the other hand, porcine cysticercosis affects pigs' health and productivity, depriving the farmers of their incomes and compounding any efforts to alleviate poverty in this segment of the population.

As a zoonotic disease, *T. solium* control necessitates a trans-disciplinary and multisectoral One Health approach. One Health has been defined by the Food and Agriculture Organization of the United Nations (FAO)/ World Organisation for Animal Health (WOAH)/ World Health Organization (WHO)/the United Nations Environment Programme (UNEP) as an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals, and ecosystems. *T. solium* infections have been listed among zoonotic diseases present in Uganda by the national One Health platform though its control is not considered a key priority (Sekamatte et al. 2018).

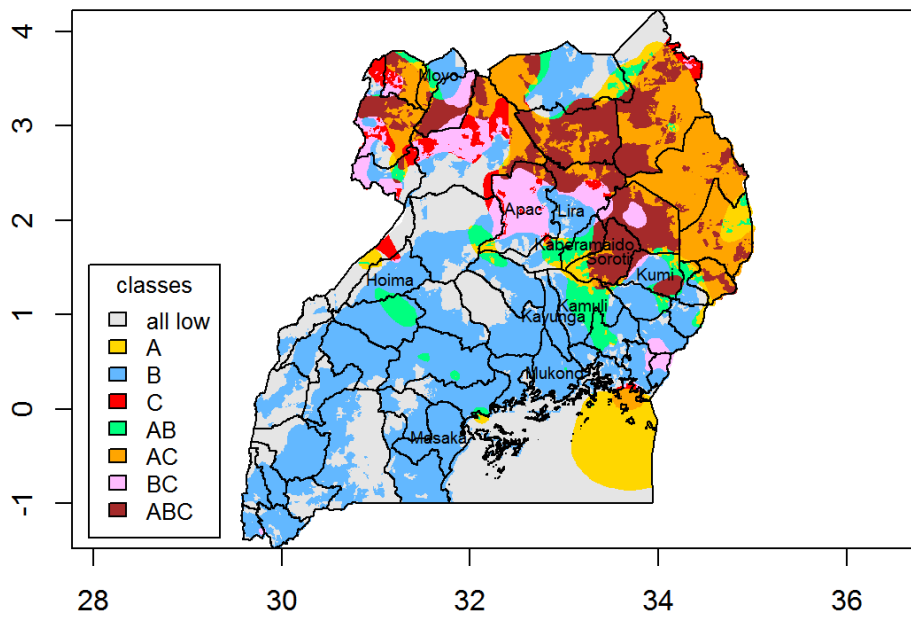
Epidemiology of porcine cysticercosis in Uganda

The transmission risk factors that have been found to significantly be associated with a high burden of porcine cysticercosis in Uganda are rearing of pigs, free-ranging pigs, open defecation, ignorance of the disease, absence of pork inspection services, district of origin, and keeping pigs in an urban setting (Alarakol et al. 2021; Kungu et al. 2019; Nsadha et al. 2010). On the other hand, human taeniasis has been associated with free-ranging pigs, absence of handwashing, lack of proper toilet, drinking unboiled water, and being male (Alarakol et al. 2017).

In Uganda, the endemicity of *T. solium* is aided by high household poverty rates, low coverage and use of appropriate sanitary infrastructure, rudimentary extensive pig production systems (free-roaming pig keeping), and poor public health systems. Studies in Uganda indicate that *T. solium* exposure ranges from 0.7-17% in humans and 0 to 42.9% in pigs and varies from one geographical area to another. According to recent studies, northern and eastern parts have a higher prevalence of *T. solium* infections than other parts of the country (Alarakol et al. 2021; Kungu et al. 2019; Ngwili et al. 2021; Nsadha et al. 2010).

The scoping visit sites were identified based on anecdotal reports from meat inspectors trained under the ILRI's Boosting Uganda's Investments in Livestock Development (BUILD) project who had been reporting cases of massive cyst infestation in slaughtered pigs during their routine meat inspection. A few epidemiological studies have also been conducted in some areas of northern Uganda particularly Gulu District. Additionally, a report mapping out the possible occurrence of porcine cysticercosis following the mapping of the three risk factors; poverty, poor sanitation and pig density which showed an overlap of the three in areas of northern Uganda was considered (Pfeifer 2017) (Figure 2). Based on these findings, the scoping visit was planned to further narrow down on specific study sites. Key demographic and socio-economic data from the proposed study districts are shown in Table 1 below.

Figure 2: Risk map where A = high poor sanitation, B= high pig density, C= high poverty.



Source: (Pfeifer 2017)

Table 1: Key demographic, socio-economic and pig population information

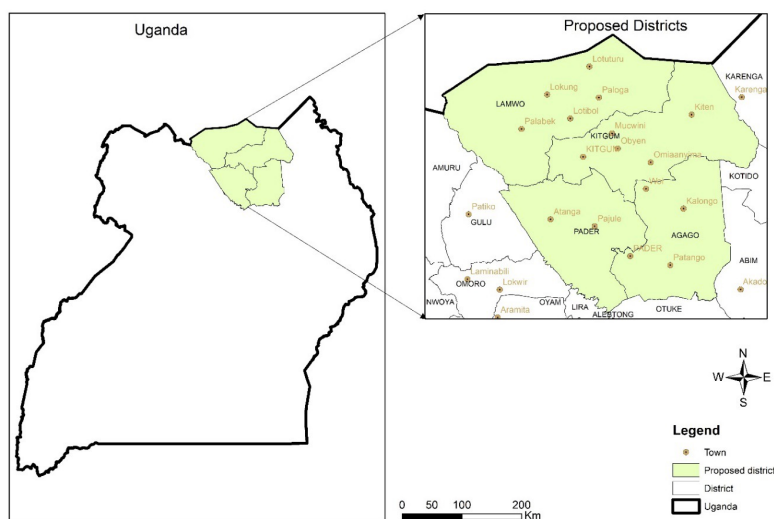
	Pig population ^a	Population ^b	Population growth rate ^c	Poverty index ^d	Open defecation rates (HH)	<i>T. solium</i> prevalence
Agago	N/A	258,800	1.8	68.4	19.3*	N/A
Kitgum	10.5 (38,440)	229,800	1.7	74.4	19.3*	N/A
Lamwo		146,800	1.3	67.1	19.3*	N/A
Pader	10.7 (39,430)	203,700	1.9	67.9	19.3*	N/A

* Estimate for the whole of northern Uganda (No facility/bush/ polythene bags/ bucket)

^a Extracted from the National Livestock Census 2008 (UBOS and MAAIF 2009)^{b, d} Retrieved as projected estimates for 2021 from a UBOS statistical report (Uganda Bureau of Statistics n.d.)^c Extracted from UBOS (UBOS 2020)

These factors are exacerbated by the collapse of public services, including veterinary, during the period of instability, disenfranchised value chain actors, high prevalence of informal marketing of pork, often without veterinary inspection and certification, and food insecurity (Atherstone et al. 2019; Ikwap 2014; Tatwangire 2014b). The interventions in northern Uganda would be of value to the welfare and health of pigs and result in improved health and socio-economic status of the people who live there, in line with the vision of Uganda's national development plan 2040 and the global sustainable development goals. The proposed study sites Agago, Kitgum, Lamwo, and Pader districts are indicated on the map below (Figure 3). In November 2021, a team of researchers from ILRI Kenya conducted a scoping visit in some of the districts listed above, and the findings are reported herein. Additionally, the district veterinary officers of the districts that were not visited (Lamwo and Agago) were conducted by telephone.

Figure 3: Map of proposed study sites.



Key findings of scoping visit

The scoping visit was conducted in Adjumani, Kitgum, Pader, and Gulu districts from 16–19 November 2021 by Lian Thomas, Nicholas Ngwili and Derrick Sentamu from ILRI, Kenya.

Districts where the DVOs were conducted on telephone: Agago and Lamwo

Table 2. Key informants

	Name	Occupation	Location
1	Alarakol	Lecturer, Faculty of Medicine	Gulu University
2	Maxwell	Meat inspector	Gulu Town Council
3	Silva Tani	Animal production officer	Adjumani
4	Nelson Okello	District veterinary officer	Adjumani
5	Alfred Kinyera	Veterinary officer	Kitgum
6	Alice Adong	Meat inspector	Pader
7	Okeny	District veterinary officer	Pader
8	Robert Okwera	District veterinary officer- conducted on the phone	Agago
10	Avudraga Stanly	District veterinary officer- conducted on the phone	Lamwo

Table 3. Analysis of key informant interviews using the One Health framework

One Health sector	Issues identified	Potentials/opportunities	Challenges/constraints
Humans	<p>Most households rear pigs</p> <p>Open defecation practised</p> <p>Low latrine coverage</p> <p>Contact with pigs</p> <p>Ignorance of the disease</p> <p>Epilepsy cases are rampant, but people ignorant of its likely causes</p> <p>Poor hygiene in pork joints</p>	<p>Ready market for the pigs/pork</p> <p>Potential for collaboration with Gulu university school of medicine for human clinical study.</p> <p>Ease of keeping</p> <p>Available laboratory infrastructure, particularly in Kitgum (central district)</p> <p>Well-treated healthy pigs fetch more money.</p>	<p>Diseases especially African swine fever and porcine cysticercosis</p> <p>Poor regulation of animal movement, welfare, and trade</p> <p>Poverty</p> <p>Lack of a framework for cysticercosis control</p> <p>Pork value chain is not included in government priorities</p>
Animal (pigs)	<p>Free-range piggery production system</p> <p>Pigs are kept in poor sanitary conditions/production systems</p> <p>PCC is endemic in northern Uganda</p> <p>Sometimes pork is sold to the public without veterinary inspection</p> <p>Understaffing of veterinary services</p>	<p>There is some level of awareness among farmers and traders on <i>Taenia solium</i> infections</p>	<p>Capacity gaps in the public veterinary services</p> <p>Failure to involve local people in control planning</p>
Ecosystem	<p>Environmental contamination with human faeces.</p> <p>Pigs roam more during the dry season (scarcity of feed, no crops to destroy)</p>		

Proposed study plan

The findings of the scoping visit informed the need to design a study in northern Uganda with the overall aim of developing and trialing a locally acceptable and appropriate value chain-based control program against *Taenia solium* codesigned with the local stakeholders to improve animal productivity, welfare and to reduce the burden of *Taenia solium* infections in humans. The specific objectives are outlined below and the activities to be undertaken are summarised in Table 4 below.

1. Assess, describe, and map the pig value chain in four districts (Kitgum, Pader, Lamwo and Agago districts) in northern Uganda and identify best bet interventions to control *Taenia solium* and improve the value chain.
2. Describe the epidemiological, socioeconomic, cultural and policy context in which *T. solium* control will be undertaken in northern Uganda.
3. Conduct social network analysis to map movement of pigs within the districts to understand where they (farmers, traders, transporters, pork joint operators, butchers) get pigs and where most of the pigs are slaughtered to enable proper targeting of the interventions especially those targeting pork joints and consumers.
4. Utilize social network analysis and 'net-mapping' techniques to identify stakeholders essential in the control of *T. solium* and understand their relationships, power-dynamics, motivations
5. Conduct an ex-ante impact assessment to understand the impacts of the proposed interventions
6. Implement a set of locally acceptable control strategies against *Taenia solium* infections targeted at various nodes of the pig value chain including market-based incentives to support uptake.
7. Conduct an ex-post impact assessment of the intervention in reducing the burden of *Taenia solium* infections and improving profitability of pig enterprises.

Table 4: Proposed research activities, goals and tool

	Steps	Activity	Goal/outcome	Study design	Tool type
1	Value chain overview and rapid mapping	Desk review and KII	Situational analysis, site selection (region and district).	Literature search and review (Scoping review protocol)	Desk review, KIIs and FGDs
2	Value chain description	Interview checklist for small groups of district level officials, producers, producer groups, trader representatives, market agents/middlemen, public health officials, and consumers	Overview of the VC and final site selection (district and sub county)	Value-chain mapping	KII and FGD
		Visioning exercise and first identification of best bets	Initial stakeholder view of the intervention (necessity and kind of intervention)		Mini workshop
3	Detailed assessment of specific components	Livelihood analysis	socio-economic status of the producers		FGD
		Purpose for and systems of piggery and Seasonal calendar	understanding piggery production systems and seasonality		FGD
		Activity clock and decision-making	Understanding gender roles in piggery systems		FGD
		Value chain mapping core and spatial mapping of the actors (pork joints, pig markets, slaughter points)	Understanding the organization and governance of the VC		FGD
		Analysis of context (traders, meat inspectors, health assistants-in charges HCIII, VHTs, consumers, DHO)	Understanding issues which might influence the implementation and adoption/uptake of the interventions		KII and FGD
		Animal health (participatory epi tool)	Understanding contexts at producer level		FGD
		Wrapping up: Constraints and solutions	Participatory development of final intervention		Workshop
4	Baseline studies	Biological sampling for pigs and humans, questionnaires, KAP studies	To understand the baseline prevalence/burden of TS and the risk factors at household level	Cross-sectional and community-based qualitative studies	Individual questionnaires, Meta data forms, KAPs guides
5	Implementation of the Interventions	Designed using a participatory approach involving local stakeholders and following the One Health framework.	Locally acceptable control interventions developed and rolled out		
6	Monitoring, Evaluation and Learning	This will utilize the process evaluation approach			

*FGD- Focus group discussion, KII- Key informant interviews, KAPs- Knowledge, attitude and practices, VC- value chain

Conclusion

The scoping visit verified the congruence of factors in the proposed area, and first hand reports of porcine cysticercosis indicates that the burden of *T. solium* illnesses in animal and human populations is likely to be high. The study site was accessible for a research team and there was a strong appetite for further work from key stakeholders. Interventions to characterize the burden and put in place necessary interventions will result in improved health outcomes for people and pigs, improved socio-economic status of the communities, and better welfare of the animals. However, further stakeholder engagement is required to select the final study sites and interventions to roll out. To improve the uptake and adoption of control interventions, an inclusive, participatory approach would ensure that all actors along the pork value chain are involved in control and prevention planning.

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