



# Why pigs are free-roaming: Communities' perceptions, knowledge and practices regarding pig management and taeniosis/cysticercosis in a *Taenia solium* endemic rural area in Eastern Zambia



Séverine Thys<sup>a,\*</sup>, Kabemba E. Mwape<sup>b,c</sup>, Pierre Lefèvre<sup>a</sup>, Pierre Dorny<sup>d</sup>, Andrew M. Phiri<sup>b</sup>, Tanguy Marcotty<sup>e</sup>, Isaac K. Phiri<sup>b</sup>, Sarah Gabriël<sup>d</sup>

<sup>a</sup> Department of Public Health, Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerp, Belgium

<sup>b</sup> Department of Clinical Studies, School of Veterinary Medicine, University of Zambia (UNZA), Great East Road Campus, P.O. Box 32379, Lusaka, Zambia

<sup>c</sup> Department of Veterinary Tropical Diseases, Faculty of Veterinary Science, University of Pretoria, P/Bag X04, Onderstepoort 0110, South Africa

<sup>d</sup> Department of Biomedical Sciences, Institute of Tropical Medicine, Nationalestraat 155, 2000 Antwerp, Belgium

<sup>e</sup> Veterinary Epidemiology Risk-Analysis and Diagnosis—Research and Development (VERDI-R&D), rue du Gravier 7, 4141 Louveigné, Belgium

## ARTICLE INFO

### Article history:

Received 4 March 2016

Received in revised form 18 May 2016

Accepted 23 May 2016

### Keywords:

Anthropology

Disease control

Focus groups

One health

Pig management

*Taenia solium*

Zambia

## ABSTRACT

*Taenia solium* cysticercosis is a neglected parasitic zoonosis in many developing countries including Zambia. Studies in Africa have shown that the underuse of sanitary facilities and the widespread occurrence of free-roaming pigs are the major risk factors for porcine cysticercosis. Socio-cultural determinants related to free range pig management and their implications for control of *T. solium* remain unclear.

The study objective was to assess the communities' perceptions, reported practices and knowledge regarding management of pigs and taeniosis/cysticercosis (including neurocysticercosis) in an endemic rural area in Eastern Zambia, and to identify possible barriers to pig related control measures such as pig confinement. A total of 21 focus group discussions on pig husbandry practices were organized separately with men, women and children, in seven villages from Petauke district.

The findings reveal that the perception of pigs and their role in society (financial, agricultural and traditional), the distribution of the management tasks among the family members owning pigs (feeding, building kraal, seeking care) and environmental aspects (feed supply, presence of bush, wood use priorities, rainy season) prevailing in the study area affect pig confinement. People have a fragmented knowledge of the pork tapeworm and its transmission. Even if negative aspects/health risks of free-range pigs keeping are perceived, people are ready to take the risk for socio-economic reasons. Finally, gender plays an important role because women, and also children, seem to have a higher perception of the risks but lack power in terms of economic decision-making compared to men.

Currently pig confinement is not seen as an acceptable method to control porcine cysticercosis by many farmers in Eastern Zambia, vaccination and treatment seemed to be more appropriate. Embedded in a One Health approach, disease control programs should therefore ensure a complementary appropriate set of control strategies by engaging new sectors such as agronomy, spatial ecology and finally consider the socio-cultural context, which is likely to enhance the development of control methods that could be accepted by the communities.

© 2016 Elsevier B.V. All rights reserved.

## 1. Introduction

*Taenia solium* taeniosis/cysticercosis is a neglected parasitic zoonosis prevailing in many developing countries. The adult tape-

worm lives in the small intestine of humans, causing taeniosis, while the metacestode larval stage (cysticercus) usually develops in pigs following the ingestion of eggs excreted with the stool of tapeworm carriers, causing cysticercosis. Cysticercosis may also occur in humans upon incidental ingestion of eggs via faeco-oral contamination and may cause severe neurological disorders when cysticerci lodge in the central nervous system (neurocysticercosis, NCC) (Murrell and Dorny, 2005). In endemic areas, NCC is the most important parasitic neurological infection, to which almost 30% of acquired epilepsy cases are attributed (Ndimubanzi et al., 2010).

\* Corresponding author.

E-mail addresses: [sthys@itg.be](mailto:sthys@itg.be) (S. Thys), [kemwape@yahoo.com](mailto:kemwape@yahoo.com) (K.E. Mwape), [plfevre@itg.be](mailto:plfevre@itg.be) (P. Lefèvre), [pdorny@itg.be](mailto:pdorny@itg.be) (P. Dorny), [andrew.phiri@unza.zm](mailto:andrew.phiri@unza.zm) (A.M. Phiri), [tanguy.marcotty@gmail.com](mailto:tanguy.marcotty@gmail.com) (T. Marcotty), [igkphiri@unza.zm](mailto:igkphiri@unza.zm) (I.K. Phiri), [sgabriel@itg.be](mailto:sgabriel@itg.be) (S. Gabriël).

Studies in Africa have shown that the widespread occurrence of free-roaming pigs and the underuse of sanitary facilities are the key factors for the transmission of *T. solium* (Ngowi et al., 2004; Sikasunge et al., 2007; Assana et al., 2010; Pondja et al., 2010).

According to Lekule and Kyvsgaard (2003), about 80% of pigs kept in East and Southern Africa are raised under the traditional free-ranging system. This system, though characterized also by lower fecundity rates, lower feed conversion and higher mortality rates, allows poor farmers to keep livestock without large capital investments (Thomas et al., 2013). This free-range practice contributes to the maintenance of *T. solium* transmission; whereby poor smallholders remain at risk for taeniosis/cysticercosis but also for Neglected Zoonotic Diseases (NZDs) in general. The NZDs are drivers for pushing these populations into more destitution (Seimenis, 2012). They also present unique control challenges as one needs to take into account the animal-human-ecosystem interface and because they inflict a dual burden on communities, affecting livestock and human health (Swanepoel et al., 2010). Several of the more cost-effective NZD control strategies involve reducing disease prevalence in the animal reservoir (Zinsstag et al., 2007), often profoundly impacting on the prevalent culture, livelihood and socio-behavioral patterns of the affected communities (Perry et al., 2002).

The present paper focusses on the social and cultural knowledge and practices relating to free-range pig keeping and *T. solium* infections, with the aim to study the complex relationships between different sociological and biological aspects and emphasising on who and what is responsible for population patterns of health, disease, and well-being (Krieger, 2001). Embedded in a One Health approach, the objective of this study was to identify possible barriers to pig related control measures, and eventually, adaptations of strategies to overcome cysticercosis locally.

## 2. Materials and methods

### 2.1. Study area

The research was conducted at Kakwiya Rural Health Centre (RHC) in Petauke district of the Eastern province of Zambia. The RHC has a catchment population of 11,344 (Clinic headcount records). People practice subsistence farming, growing mostly maize and groundnuts primarily for home consumption. Pig production is common; most households have owned pigs at least once mainly to resolve financial issues.

The main ethno-linguistic group in this area is the Nsenga, which has a matrilineal descent. The district was selected based on reports indicating high porcine cysticercosis prevalence of 14.6% in pigs (Sikasunge et al., 2008) and presence of a high number of free-roaming pigs (Phiri et al., 2002; Sikasunge et al., 2007). Only villages (n = 21) within a radius of 8 km from Kakwiya RHC were selected for this study consisting approximately 261 households (Thys et al., 2015).

### 2.2. Study design

Twenty-one focus group discussions (FGDs) were conducted as described in detail by Thys et al. (2015). There were 172 participants from seven villages comprising 56 men, 58 women and 58 children (below the age of 18). The villages were randomly selected among villages surrounding the health center. They were not included in biomedical surveys conducted prior to this study to avoid information and sensitization biases. Separate FGDs were held with men, women and children in each village because these groups have different tasks and responsibilities in the pig breeding system and therefore potentially different perceptions and behaviors regarding

**Table 1**  
Characteristics of the focus group discussions (FGD) (Thys et al., 2015).

FGD No.	Village	Category	Number of participants		
			Male	Female	Total
1	Wonzi	Children	4	4	
2	Wonzi	Women	0	8	24
3	Wonzi	Men	8	0	
4	Chimphanje	Children	4	5	
5	Chimphanje	Women	0	8	25
6	Chimphanje	Men	8	0	
7	Sikalinda	Children	4	4	
8	Sikalinda	Women	0	8	24
9	Sikalinda	Men	8	0	
10	Nyazowani	Children	4	4	
11	Nyazowani	Women	0	8	24
12	Nyazowani	Men	8	0	
13	Chimanja	Children	5	4	
14	Chimanja	Women	0	8	25
15	Chimanja	Men	8	0	
16	Chiludzu	Children	5	3	
17	Chiludzu	Women	0	8	24
18	Chiludzu	Men	8	0	
19	Mtuna	Children	4	4	
20	Mtuna	Women	0	10	26
21	Mtuna	Men	8	0	
			N = 86	N = 86	172

pig management. In addition, working with heterogeneous groups is likely to hamper the quality of the data (Morgan, 1998; Grudens-Schuck et al., 2004). For children, the FGDs were gender-mixed because, unlike adults, they were able to speak freely regardless of age and gender. According to our study design, focus groups participants included both pig keepers and non-pig keepers (Thys et al., 2015) (Table 1).

The number of FGDs conducted allowed us to reach data saturation (no additional data were found leading to more information related to our research questions) from the seven different villages and from the three different subgroups therefore ensuring the validity of the research.

### 2.3. Data collection

The data collection took place from July to August 2010. Participants were selected from the villages based on their availability and willingness to participate. Three facilitators (a female nurse, a male environmental health technician and a male community health volunteer), proficient in the Nsenga language, were identified and trained to moderate, observe and record the FGDs. All of them took place at the Kakwiya RHC because of its central geographical location and practical aspects (Thys et al., 2015).

The average duration of the discussions was about an hour. The following topics were covered (Table 2): the perception of pig breeding in the communities and its role, knowledge and perceptions of taeniosis/cysticercosis and related risk behaviors and opinions on control measures.

All discussions were recorded on video to facilitate the transcription. The use of a video camera was pre-tested and was not intrusive or affecting the discussions. A reporter always assisted the facilitator.

### 2.4. Data processing and analysis

The FGDs were transcribed and translated into English by two research assistants and two researchers who took turns in both tasks. To improve interpretation reliability, the transcripts were reviewed independently by the two same researchers before accepting them for analysis. The analysis of the transcriptions and the notes taken during the FGDs was supported by the NVivo 8®

**Table 2**  
Themes explored.

Themes	Perception of pigs	Pig management (direct contact)	Perception of risk behavior	Knowledge and perceptions of Taeniosis/Cysticercosis	Perception of control
Sub-themes	Positive and negative aspects of pigs Role of pigs	Management problems  Feeding of pigs Roles distribution in animal husbandry	When How Why	Knowledge  Treatment & prevention Impact (stigmatization...)	Confinement of pigs (producer)  Boiling meat (consumers) Meat inspections (producers)  Washing vegetables (consumers) Treatment/vaccination of pigs <sup>a</sup>

<sup>a</sup> The porcine cysticercosis vaccine is not yet available.

software (QSR International Pty. Ltd., Melbourne, Australia, 2008), which allows to classify and sort data and explore relationships and trends. The major themes were separately identified through coding by the two main researchers following an inductive approach. Any differences in coding were discussed until consensus was reached (Thys et al., 2015).

### 2.5. Ethical considerations

Ethical clearance was obtained from the University of Zambia Biomedical Research Ethics Committee (003-02-10) and from the Ethical Committee of the Antwerp University Hospital in Belgium (10 03 3 704). Further approval was sought from the local authorities and community leaders before commencement of the study. Finally, before the start of each FGD, permission was sought from the individual subjects to enter the research and to video record the discussion. Written informed consent was obtained from each participant and from parents (or guardians) for children under 18 years old. Participation in the discussion was voluntary and no names or pictures were recorded in the transcripts. Questions were appropriately phrased to avoid embarrassing people when addressing sensitive issues or taboos. FGDs with children took place after school hours.

## 3. Results

The two main risk factors identified in the literature, open defecation and free-roaming pigs, were also the two main themes that emerged from the discussions in our study. The first theme has been described by Thys et al. (2015). In order to identify and understand the potential obstacles to pig confinement and other control options for *T. solium* from a socio-cultural point of view, it was necessary to understand on the one hand, why people raise pigs, how pigs are managed, and what pigs' negative aspects are; and, on the other hand, what people's knowledge and perception are about pig's threats to human health and whether free-roaming pig management is considered as a risky practice.

The results highlight the different themes that emerged in the analysis (Fig. 1). To reflect as much as possible what was expressed in the discussions, the order used to present participants' perceptions in each section reflects the level of importance given by the participants to these topics (going from a strong to a weaker consensus). No substantial differences were observed between villages (very homogeneous).

Results are illustrated with anonymous quotes, selected on the basis of their representativeness, appropriateness and revealing quality.

### 3.1. People's perception and knowledge of pig keeping

#### 3.1.1. Why do people raise pigs?

Pig rearing was reported to be a transitory activity, launched when households needed to resolve financial issues, and often stopped after African swine fever outbreaks or shortage of feed. All households had owned pigs at least once, hence all focus group participants had a similar background knowledge about pig management.

The main purpose of rearing pigs was to "help when problems occurred" and as such played an essential socio-economical role by addressing financial, traditional and agricultural issues.

*"What we have just explained are the good things about pigs. Like using money to support school-going children by buying school uniforms for example; at agricultural fields as well, eating at funerals. After we have slaughtered it people can consume it, during celebrations or feasts, people eat such meat"* (Focus group\Women Wonzi village)

Selling pigs allowed the family to raise money to help with agricultural activities but also to replace materials.

Secondly, it allowed people to buy household goods and thirdly to pay for health care, transport, school fees and justice fines. Women and children were the ones who most perceived the role of pigs as financial, except for the hiring of field workers.

Traditionally, pork was mentioned to be the meat mostly cooked and served to guests during big celebrations (funerals, weddings, Christmas celebrations, initiation ceremonies). It was very much appreciated for its taste by men, particularly the fat from the neck area, while women mentioned it for its use as relish for hunger alleviation.

The perceived advantages of pigs were for men that they multiplied very quickly, grew faster and were easier to rear than cattle with regard to slaughtering and cooking. For women, the benefit was that pigs offered more meat than goats.

#### 3.1.2. How are pigs managed?

**3.1.2.1. Roles and responsibilities.** In general, the daily management of pigs was done by women and children because they were most often at home, while the men were responsible for building kraals to enclose pigs at night. The tasks attributed to the children were, feeding the pigs, bringing them into the kraal at night and catching them when necessary. By belief and superstition, these tasks were especially attributed to people (mainly children) who had a "good rearing hand":

*"In Nsenga land we have a belief that with a particular child who has a good rearing hand, the animals would usually multiply."* (Focus group\Men Chiluzu village)

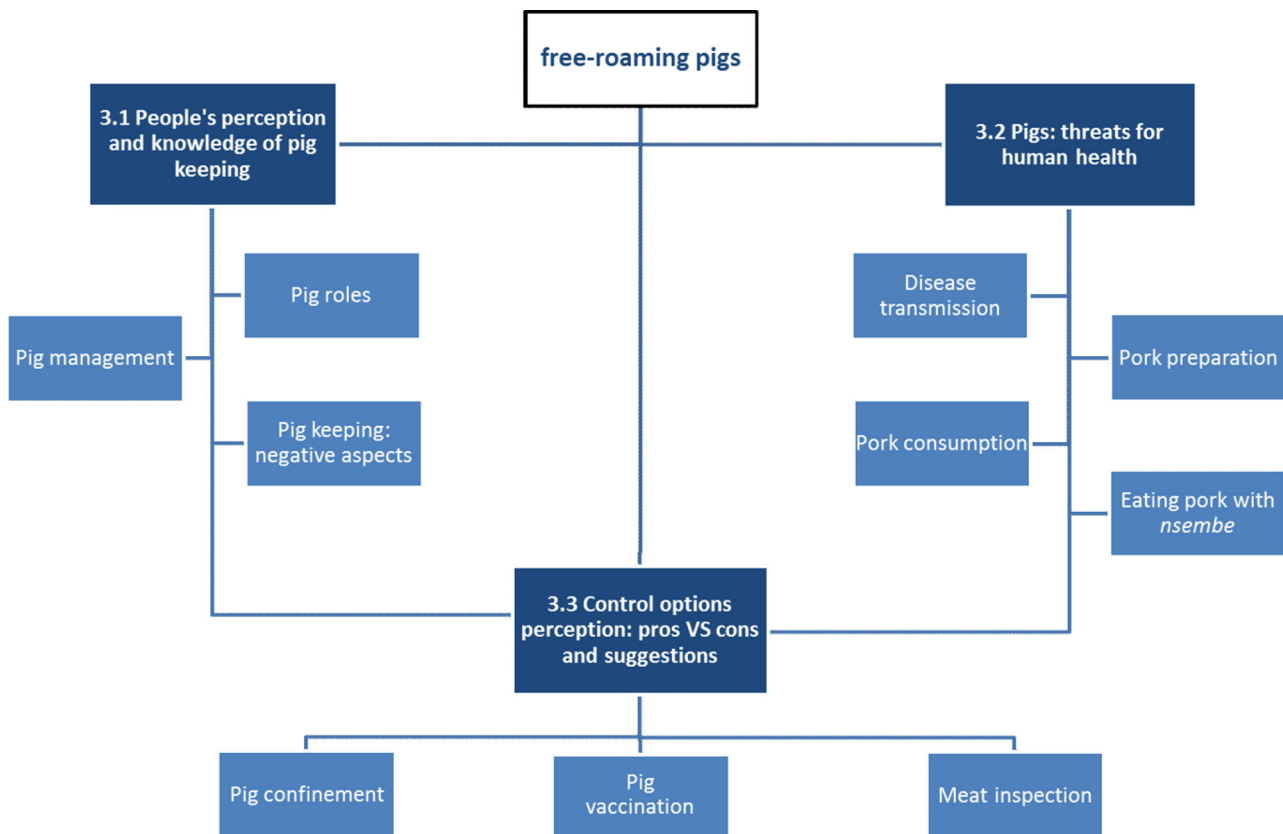


Fig. 1. Results structure.

Even though most of the tasks are managed by women and children, the final decision to sell or slaughter a pig or to seek care would be taken by men who are considered as the pig owners.

**3.1.2.2. Management problems: free-roaming versus confinement.** Among several problems identified by the respondents regarding pig management, the main and recurrent ones were all related to feeding issues, especially during the rainy season because food in general was very limited (Table 3). These problems were also the most discussed among the children groups.

*“Those that are without kraals just roam about scavenging on feces and whatever food they may find. Like at our home I call to feed them three times a day and after each feeding they go back and continue with the scavenging. The problem with pigs is that they never stop eating, but in the evening they come back to sleep.”* (Focus group\Children Nyazowani village)

According to the participants, even without kraals pigs should be fed three times per day with maize bran or leftovers. The disadvantages expressed of not being able to feed pigs properly were that they scavenged and ate (human) feces, they were less healthy (no gain of weight nor good breeding) and that they got lost (owned by another feeder or died). Few respondents mentioned that it also led pigs to eat their piglets and that it was more difficult to sell their pigs (better price for pigs that did not scavenge because of the perceived disadvantages raised above).

Feed shortage was therefore the main argument against pig's confinement, especially during the rainy season when there was no cropping. Though the perceived disadvantages of free-roaming pigs were more often discussed than its advantages, the majority of pig owners let their pigs roam free and men were the ones more in favor of this practice.

Besides feed shortage issues, the other reasons expressed for letting pigs roam freely were that even without confining pigs in a kraal, pigs would stay around the house if properly fed every day, that pigs were happier and less weak when free-roaming and finally that it allowed pigs to eat feces which was perceived as an efficient way of ridding the village of dirt.

*“The other reason is inadequate feed. We fear that if we enclose pigs, they may die. So, it's better to allow them to be free so that they can eat anything they find.”* (Focus group\Men Chimphanje village)

The danger to be attacked by wildlife or to be stolen by someone was not perceived as a threat and for some women the free-roaming practice avoided pigs to get diseases that made the pigs recumbent and locally perceived as *polio*.

*“Now to just decide that time and start to confine them, you may find all of them have a pig disease outbreak. Even the joints would become weak, fail to walk and get polio”* (Focus group\Women Mtuna village)

A few participants mentioned that pigs that were allowed to roam freely were usually pigs that were raised to be sold and not for household consumption presumably because of scavenging perceived risks.

Regarding the disadvantages of free-roaming pigs, the most important, and especially mentioned by the children was indeed that there was no control on what pigs fed on. The second argument against was that pigs were more inclined to contract a disease and thirdly, for women mainly, that it allowed pigs to bring diseases to humans.

*“That [pigs confinement] would be a good idea; since the pigs would eat the right food and would not go round scavenging. It*



**Table 3**

List of pros and cons for pigs free-roaming practice as expressed by participants.

Pros (more men groups)	<sup>a</sup> Cons (more children groups)
"Face food shortage"	Allow "bad" scavenging (feces, dirt)
"Pigs stay at home (if fed)"	Pigs have more risk to contract diseases
"Pigs more happy, less weak"	Allow pigs to bring diseases to humans
"Allow pigs to access feces"	"Create conflict with neighbors"
"No more need to be protected from wildlife"	"Not taking good care of pigs"
"Avoid pigs to develop Polio"	"Allow pigs to move a lot and disappear for days"
"Get fatter"	"Difficult to identify pigs"
"Alright for pigs raised not for our own consumption but just for sale"	"Nothing is good about roaming freely"
"More freedom for the owner (other priorities)"	"No protection against wildlife"
"Clean the village from dirt"	"Allow dirt (pig feces) in the village"
"Enough bush"	"Not easy to catch pigs for slaughtering"
"No threat of stealing"	"Bad rearing practice"

<sup>a</sup> More citations with cons than pros regarding free-roaming pig husbandry practice in general.

*also means that even us we would be protected from the diseases which affect pigs and humans; that would be very good.*" (Focus group\Women Chiluzu village)

Another issue raised by men was that it created conflict and juridical cases with neighbors as pigs were sometimes eating their maize or destroying their crops while roaming around. Rearing pigs this way was also perceived as not providing good care to pigs because "nothing was good about roaming freely". It also allowed pigs to move a lot, sometimes disappearing for days, making it difficult to identify them, especially when they were many. Additionally they were difficult to catch for slaughtering.

*"When they are many, they reproduce. In that case, I would sell some to buy maize bran. However, when they are many I don't know if a pig has been stolen or has died. Even when I would need to slaughter it, such as at a funeral, it may be difficult to find a pig. Even calling it to be fed, a pig can run away because it is not used to being fed."* (Focus group\Men Mtuna village)

**3.1.2.3. Pig health.** When a pig was found ill, generally participants first tried to isolate it from the others to avoid pig-to-pig transmission. The owner usually rapidly took the decision to slaughter the animal for human consumption before it died on its own.

Because they often did not know how to treat, what medicines were available as these could only be found with the local veterinary assistant or at the District Veterinary Officer's office, many kilometers away, they chose to slaughter the pig before it died on its own. If not, they would not be able to sell the meat door-to-door within the village as very few people would buy meat from a pig that they knew had died from a disease. Depending on how long the pig was sick before dying, the meat would or would not be eaten:

*"When a pig dies on its own, some of us don't eat it; some eat it depending on how the meat appears because sometimes the pig is sick for just two days and dies, such a pig is eaten. But one that has been sick for some time and loses weight is not eaten, it is just thrown away."* (focus group\Men Chimphanje village)

According to children, diseases can leave animals with the blood at slaughtering:

*"Yes because if it died on its own, we may not eat the meat but if I kill it before it dies all the disease in the blood would come out."* (focus group\Children Nyazowani village)

### 3.1.3. What are pigs' negative aspects?

Even if comments showed more people liking eating pork than disliking it, the negative aspects of pigs were much more discussed than their positive ones. In general, women and children expressed more negative aspects about pigs than men. The overall and main

perceived negative aspects about pigs were their insatiable appetite and eating habits, which especially included its coprophagous character of eating human feces (even if properly fed by the owners), crops, but also dirt, babies left on the ground without surveillance and cadavers not buried deeply enough.

*"Sometimes when a woman has a miscarriage, because they say that a still born child should not be buried very deep, the pig would go to the graveyard and dig out the foetus and start to eat it. Then we slaughter the same pig and eat the meat, which is very bad"* (Focus group\Women Mkopeka village)

Another negative aspect well mentioned in all groups but more especially among women was that pigs brought diseases mainly by contaminating kitchen utensils or water (see also below). Pigs were considered as carriers of germs:

*"Sometimes you would find that a pig comes directly from eating stool and finds a child eating something, it would go to the plate and eat from the plate and the child without realizing would just continue eating the food. Therefore, it is difficult to prevent diseases that are transmitted by a pig."* (Focus group\Women Mkopeka village)

Another issue with raising pigs was that they could all die at once because of African swine fever during the hot season, creating a big economic loss for the household.

The last main problem of raising pigs, mentioned almost only by men, was that pigs sometimes developed *nsembe*, which means "maize bran" in Nsenga. This word is commonly used to describe the *T. solium* cysts found in pork, under the tongue or in the eyes. These cysts were also called "Masese" because they also looked like the solid part remaining after brewage of a local beer, the small granules of maize not ground used to feed pigs, which was also the main perceived origin of their occurrence.

*"That residue, masese, from beer brewing, if you feed it to the pigs they get the nsembe."* (Focus group\ Men Chimphanje village)

Another strong belief was that cysts appeared in pigs when the feeder had "bad hands" (bad herd management) or because of something in their feed like oil. Few people acknowledged that cysts origin was unknown and very few women only, said that cysts appeared because of pigs eating human feces. On the question of how to prevent cysts in pigs, men and children first mentioned the use of vaccine or medicines, followed by avoiding to feed pigs with *masese*, replacing the person responsible for feeding the pigs, adding ash in the feed or buying commercial feed, and finally confining pigs.

However, in general, there was no consensus on whether cysts in pigs were preventable or not, curable or not, if treatment was available or not and on the potential effects on humans.

### 3.2. Pigs threats for human health

Pigs as a source of diseases were strongly acknowledged by almost all participants but there were discussions on the kind of diseases that were transmitted from pigs to humans and how.

#### 3.2.1. Disease transmission

For all participants the bad eating habits of pigs, in particular, the feeding on human feces was the source of disease.

This coprophagous behavior could infect people via contaminated water, food, plates (see above) or it could infect the pork and make people sick when they ate that meat.

Epilepsy (fitting) was the most common condition, mainly mentioned by women:

*“Yes and when they eat the feces, the feces go into the meat and then we eat the meat. And sometimes that is why you find worms in children and some suffer from fits because of eating pork.”* (Focus group\Women Chiluzu village)

For men, pigs were also responsible for diarrhea and for all the three groups, they were also responsible for worm infestations:

*“When I eat pork, the pigs will bring diseases. They bring diseases such as worms, and diarrhea. In nsenga, we just say ‘minyolo’ [i.e.worms].* (Focus group\men Sakalinda village)

*“... If I have bloody diarrhea, and that pig eats the feces. The following day we say let’s slaughter this pig, for sure those diseases are transmitted to those children who consume the pork. Even us who have consumed the pork, it means we have contracted such diseases. It is because of that pig that has brought the disease. That’s the badness of pigs.”* (Focus group\men Mtuna village)

A few men considered AIDS to be also transmitted to humans via the same transmission route as expressed in the citations above. A few children mentioned malaria and cholera transmission as occurring via this same way.

Getting *Mashabe*, a local expression of being possessed with evil spirits, was another negative factor of keeping pigs according to some children and eating pork when breast feeding was considered to be dangerous by a few women. Finally, pigs could also lead to human death according to a few women:

*“Pigs give worms and nsembe. All that; even death; worm infestation kills.”* (Focus group\Women Mtuna village)

#### 3.2.2. Pork preparation

Meat preparation (e.g. meat not well cooked or cooked too quickly, meat not well cleaned, especially the intestines, dirty cooking utensils) was also perceived as a threat to human health. More specifically, the methods of cooking meat were discussed. It could be roasted, roasted and then boiled, just boiled, *shokas*<sup>1</sup> (grilled), cooked, boiled and fried, thoroughly cooked or dried. Participants were mainly in favor of boiling meat because it killed the worms, germs and helped to protect against diseases. Finally, they also preferred this type of cooking because it made the *T. solium* cysts (*nsembe*) disappear. Drying the meat before boiling was considered to be even more effective to drain the water out of the cysts. However, according to women groups, roasting was the way the meat was mostly prepared and preferred by the men. Women said that men preferred roasted meat while drinking a beer, because there was no risk of overcooking and it was quicker. Roasted meat also allowed to conserve the meat longer and therefore to be eaten later

<sup>1</sup> “Shokas”, method of preparing pork at a roadside by young men. Pork is fried, and semi-cooked on a wide home-made pan.

or by customers who drank beer. However, for women, eating raw or roasted pork was perceived as a threat for human health.

#### 3.2.3. Pork consumption

To judge if the meat was eatable or not, participants referred to several criteria most generally linked to the overall meat appearance (color of the blood, smell, ...). The presence of fat (from the neck) was also an important criteria used to buy and eat pork according to men and women. How the pig died was an important concern for men before buying pork. For instance, mainly men explained that when the meat looked redder than usual it meant that the pig died on its own or was sick before being slaughtered. Checking for the presence of cysts (e.g. in the muscles, in the mouth on the tongue) was a third criteria mentioned equally by men and women.

*“It is important because nsembe suggests that the pig is sick. Nsembe shows if the pig is sick or not. So, the person who wants to kill a pig will have to use a wire to open the mouth and if there are whitish things under the tongue, you know that it is sick.”* (Focus group\men Sikalinda village)

Finally, eating uninspected meat was seen as a threat to health for a few participants.

#### 3.2.4. Eating meat with nsembe and epilepsy (“kunyū”)

Even if the zoonotic aspect of eating pork with cysts was targeted (especially by women), participants had poor knowledge on human cysticercosis in general and did sometimes confound it with other infections. A few women perceived human cysts as a disease of witchcraft from which only women suffered in the form of vaginal cysts called “*masale*” in Nsenga.

There were also more comments mentioning occasions when meat with cysts was eaten. The cyst was considered comestible, tasting like rice (popping sound) for some and for others not that tasty but giving a “*burst in the mouth*”.

*“Nsembe are very nice. When one is eating, the person feels very nice. They mix with fat, in fact, pork is just irresistible. Even if you wanted to refuse, you end up saying that I will only eat for today, and tomorrow I will not eat. Today I will eat since I have found it here.”* (Focus group\Men Sikalinda village)

Meat with cysts was also associated with drunk people to whom this kind of meat was usually sold. For men and children, meat with cysts was never thrown away even if it would take more time to be sold for a reduced price. People usually bought infected meat because of a craving for meat.

*“I had raised nineteen pigs then someone came from the Boma (nearest town). He bought one and took it to Boma. After slaughtering it he found the nsembe, he returned the following day with the meat and we were agreeable because he was not going to be allowed to sell that meat at Boma because he would be arrested. I gave him fifty percent of the money and he then sold the meat in the surrounding villages. But it should actually have been thrown away.”* (Focus group\Men Mkopeka village)

Almost all groups associated eating pork with *Kunyū* (fitting). However, this was not attributed to an eventual presence of cysts in people’s brain (neurocysticercosis).

*“Yes and when they (pigs) eat the feces, the feces go into the meat and then we eat the meat. And sometimes that is why you find worms in children and some suffer from fits because of eating pork.”* (focus groups\Women village Chiluzu)

Nearly all groups acknowledged the presence of an epileptic person in their village and sometimes in their own household. Two

main types of epilepsy were identified by all groups: a bewitched one (the most mentioned), and a natural one (congenital, hereditary, genetic).

*'Sometimes it happens that there are two people from the locality suffering from the same disease, they all go to the same hospital and one gets cured and the other continues to suffer from the same disease and eventually dies, we would therefore conclude that the other one was suffering from natural fits while the other had been bewitched.'* (focus group\Men village Nyazowani)

Other food stuffs mentioned that could make people suffer from epilepsy besides pork included meat from warthog, fat mice, anything that died on its own, cat fish, bush meat and eggs. Therefore, according to some women only, the prohibition of eating pork and certain other food was considered as a treatment against epilepsy.

*'I also have two children who had epilepsy but when I stopped them from eating pork they got better. They have not been fitting for the past 4 years now.'* (Focus group\Women Chimphanje village)

Perceived as a deadly disease (not treatable, fatal) according to women and children, mainly because of seizures, the main burdens impacting life of epileptics and their family in daily life were physical injuries (burns by falling in fire; drowning in a pond, falling from trees or bicycle), stigmatization (cannot get married or the marriage could not last long anyway, prohibition to eat some food, cannot be rich, cannot be greeted) and the unpredictable manifestations of the daily seizures (seizures while making love, cooking, eating, on the road, during celebration).

*'Sometimes it happens so often, that after feeling each other and when you are ready to make love then that is when you have seizures. After so many disappointments you give up and say let me go and try somewhere else, then the marriage breaks up.'* (Focus group\Men Chiluzu village)

### 3.3. Perception of control options: pros vs cons and suggestions

#### 3.3.1. Pigs confinement

The need for feeding pigs when they are enclosed was the main disadvantage perceived especially among men groups. A second important disadvantage raised mainly by children was the difficulty to build kraals (not manageable, lack of awareness, not enough skills, kraals wood preferably used for cooking).

The fact that pigs became lame, weak, unhappy and thinner when enclosed was an argument mainly expressed by women (*pigs need space*). The laziness or reluctance by men to build kraals was also raised by women. The laziness was attributed to a lack of care in general, other priorities and because they were not compelled to any law.

In addition to the list of pros for the practice of free-roaming pigs (see Table 3), few participants (among men and children) raised the fact that confining pigs was not a common practice in the area, that pig owners were not used to it and did not want to argue with their wives regarding the priority of wood use.

*'That's unfortunately the tradition we have copied from our parents. This trend has continued here in the village. For those whose parents used to confine pigs, goats etc, it is easier for the younger generation to continue the trend wherever they go. It is the same for those whose parents were not confining. It looks like people feel it is much easier to let the pigs roam than think of the trouble of looking for wood to construct kraals. Sometimes, when you make a kraal, women use the wood support for a kraal as firewood for cooking. Instead of arguing with them, I let it happen and think of not building another one in the future.'* (Focus group\Men Mtuna village)

Even if, in general, most participants were against it, advantages of enclosing pigs were mostly expressed by the children. Confining would avoid disease transmission, avoid pigs eating (human) feces, and allow a better control of pig feed. Furthermore, enclosing pigs was considered manageable and perceived as a good preventive measure against pigs bringing diseases and avoiding juridical cases (discussions with the neighbour).

Some people mentioned factors that should be dealt with in order to confine pigs: Confining pigs could not work with this breed of pigs or while there was a disease outbreak (e.g. African swine fever). The enclosure should be large enough to let pigs roam about; the confining should be combined with vaccination and drug support and finally, the cooperation between men and women should be more efficient in terms of task repartition and decision-making.

#### 3.3.2. Meat inspection

The main problem with meat inspection by veterinary or public health services, mainly expressed by women, was the lack of inspectors. They did not know where it could be done and there was no inspection for pigs slaughtered at home and for the pork served at funerals. However, men were the ones who mainly felt bad to throw meat away and were afraid of the consequences of inspection. Another problem with meat inspection, expressed by children, was corruption: inspectors could be accused of cheating, uninspected meat could be sold elsewhere in any case, and people selling meat could always lie that their meat had been inspected.

*'Others may cleverly announce that they were going to have meat inspected but turn back before having it inspected. On their return, they can lie that the meat was inspected when in fact not.'* (Focus group\Children Mtuna village)

The issue of transport, both for the meat inspectors and for farmers to take pigs for inspection, was also mentioned. Finally, a few children and men considered it as a waste of time and money.

The arguments in favor of official pig inspection were mainly raised among women groups. This control measure was welcomed as it would allow knowing if the meat had a disease or not (and what was its origin) and preventing people from getting sick. Destroying (burry or burn) infected meat was not perceived as a problem mainly by women. In general, participants would feel more free and happy to consume meat without concern if they knew that it was declared suitable for human consumption.

Finally, overall meat inspection was seen as relatively manageable but should preferably be done by a veterinarian. Alternatively, the participants were also prepared to learn how to do it themselves.

#### 3.3.3. Pig vaccination

There was a general fear among participants that the cost of vaccination would be too high or that the government would first offer the vaccination for free and after a while ask for contribution.

*'The problem is the small contribution. At first even with cattle the government was offering free service and teaching the people on good animal husbandry, but immediately they started asking for the same contributions. . . People started failing to pay. You notice now that there are more deaths in cattle.'* (Focus group\Men Chiluzu village)

The second problem expressed was transport of the pigs to the clinic to get the vaccine, especially if they were many pigs.

As a preventive measure, one or two participants flagged other problems: the safety of vaccination in general (suspicion), the need not to vaccinate pigs that were already sick (easy to diagnose and therefore too late to vaccinate), the difficulty to catch free-roaming pigs, and finally the need for appropriate sensitization.



Beside these disadvantages, participants, mainly men, were in favor of pig vaccination. Regarding their contribution for the vaccination expenses, participants, especially women, generally agreed, as it would protect pigs from diseases and assure them to eat good meat or avoid pig's owners to kill their pigs.

Few respondents suggested to combine vaccination with treatment if a pig was sick or to learn how to vaccinate pigs themselves.

#### 4. Discussion and conclusions

This study looked into the socio-cultural determinants of free-roaming pig management in eastern Zambia where *T. solium* taeniosis/cysticercosis remain endemic (WHO, 2015) and indicating high taeniosis and cysticercosis prevalence of 6.3% and 5.8%, respectively (Mwape et al., 2012).

It identified well established reasons for free-roaming but revealed also several key perceptions of pig owners explaining why this traditional low-input system is still maintained in this area, like in many other East and Southern African countries where both pig keeping and pork consumption have increased in the last three decades (Lekule and Kyvsgaard, 2003; Thomas et al., 2013; Mwang'onde et al., 2014; Zirintunda and Ekou, 2015; Lipendele et al., 2015).

Our results highlight the strong paradox observed between the resilience of the free-ranging practice and participants' perception of pigs. While pig's natural ability as a scavenger was obviously viewed as an advantage, their indiscriminate feeding habit was the main negative aspect of pigs commonly shared by the respondents.

From a socio-economical perspective, the lower fixed cost (savings in terms of feeds, pen construction and time management) explains why this pig production system is more resilient than others (Lekule and Kyvsgaard, 2003). It can be set up to offset unexpected or anticipated major expenses (help for agricultural field work, school fees, justice fines, funeral ceremonies) but can also be stopped if all pigs died (e.g. during African swine fever outbreaks), are sold, or are consumed by the household. In the eastern African context, the flexibility that this traditional management offers seems to be what resource-poor farmers are looking for. Even if it is less productive and finally leads to low profit, it solves the farmers' actual (financial) problems. Unlike what Lipendele et al. (2015) suggested for the Tanzanian context and Kagira et al. (2010) for Western Kenya, this poor pig management is opted for not only because of a lack of farming knowledge, but also because of pragmatism, habits and prioritization in a survival context.

These latter factors can mitigate the observed paradox. Participants were well aware that this free-roaming practice allows pigs to access and feed on human feces, and could therefore become a threat for human health. Despite the perceived health risk, pigs owners still chose to raise their pigs in a free-range system, as it is more practical and economical, given the availability and the high cost of feed. This expressed constraint was very often identified in other traditional and smallholder pig herding systems (Kagira et al., 2010) and is often mentioned in control programs for taeniosis/cysticercosis. In this area where humans and pigs compete for the same food source (maize milling), how sustainable could it be to ask pigs owners to enclose their pigs while feed at an affordable price with higher nutritive value is not steadily available? Furthermore, recent data have even shown that confinement of pigs is not the only solution to porcine cysticercosis as the confined animals may also get an infection from contaminated feedstuff (Braae et al., 2015).

The gender and the social structure of communities have both a strong influence on the way responsibilities and tasks are assigned to women and men, girls and boys, also in the sector of livestock management in developing countries (FAO, 2010). These traditional

gender roles explain why children, women and men in our study expressed a different perception regarding free-roaming pigs practice.

The responsibility of the kraal construction for pigs clearly belonged to men, while women are responsible for cooking, carrying water, fetching firewood and tending animals. However, like in many agro-rural patriarchal communities, the decision-making belongs to men, including decisions regarding pig management. Therefore, even if female participants were more in favor of enclosing pigs for hygiene and health reasons, this would not influence the current situation, as this position is not supported by the men. Children manifested a stronger willingness to enclose the pigs maybe because they are the main feeders. With fences it would be easier for them to manage this responsibility, be less disturbed by pigs and be considered as "good rearing hand".

The resilience to maintain free-roaming pigs despite the perceived risk for health is likely due to the fragmented and limited knowledge about cysticercosis (pig and human) and neurocysticercosis but also because of the long delay between exposure and possible clinical signs and symptoms. Participants acknowledged that people could get sick by eating pork (well-cooked or not) and also indirectly by eating food or drinking water contaminated with human feces brought by pigs. However, they blamed more the bad eating habits of pigs than the practice of free-roaming. The fact that some women mistook human cysticercosis with vaginal cysts confirms that even though fragmented knowledge seems to be present on *T. solium* and its related health risk, the level of knowledge and understanding of risk factors, transmission and prevention are largely insufficient.

Health education has a major role to play. Johansen et al. (2014) addressed the obstacles for obtaining a simple and meaningful health message with regard to a zoonotic disease such as *T. solium* cysticercosis/taeniosis. Because the scientific name itself is complicated, and being a zoonosis, health information needs to be provided to many different stakeholders across disciplines and sectors. As the life cycle of *T. solium* further complicates the message (one worm causing three diseases) (Johansen et al., 2014), the fragmentation and confusion of knowledge are understandable and could explain why some participants even believe that people could get AIDS or malaria while eating pork from pigs that ate feces from a sick person.

A potential limitation of this study, specifically regarding disease knowledge is that all the discussions took place in a room of rural health center, which could have influenced participants to share reminders on what they previously heard or have learned from the health personal about this disease. This could even more be the case for women who are usually targeted by health promotion because of their traditional gender role related to care and hygiene education. We tried to limit this influence by starting the FGD with pig related discussion points.

Regarding control options other than enclosing pigs, all the ones proposed seemed to be more or less acceptable for implementation. Main concerns were the cost and that the Zambian government would not subsidize adequately and permanently the cost of the vaccine nor the logistics for its distribution once it will become commercially available. On the other hand, pig owners were quite keen on being trained for vaccination or pig treatment in order to manage the prevention and control themselves in exchange of free vaccine and treatment.

What also needs more investigation is knowledge about slaughtering and meat inspection regulations because some citations suggested that pigs owners will not enclose their pigs nor adopt other preventive behaviors such as building latrines (Thys et al., 2015) unless they are forced by the law. Which suggests that if pig owners are not feeling obliged to do it or are not well informed



about the regulations, the control and meat inspection will not be correctly implemented.

For biosecurity purpose, the international institutions for human and animal health are not in favor of scavenging pig production systems in developing and transition countries because of the associated health risks and the difficulty for the farmers to introduce effective biosecurity measures (FAO, 2010). However, the debate on finding ways to keep pigs enclosed has been ongoing for some time. Lekule and Kyvsgaard (2003) suggested five possible strategies for the development of the pig industry in resource-poor communities. Among the identification of traits suitable for marginal environments and the genetic characterization of local breeds of pigs, the development of strategies based on cheap feed stuffs that are locally produced would be the most necessary solution to convince pig owners to abandon the free-roaming production system.

Engaging the agronomy sector into the elaboration of a community-based intervention in order to control *T. solium* in this particular socio-cultural-environmental context would help out disease control managers to develop more integrated, sustainable and appropriate strategies by solving the obvious competition between animal feed and food for the population in periods of food shortage.

Social epidemiology, a method to capture important information on the social distribution and social determinants of health (Berkman and Kawachi, 2014) could also be more often incorporated into studies of disease transmission in relation to the life-cycle of *T. solium* along with spatial ecology and movement data of pigs (Thomas et al., 2013). By investigating people's behaviors such as, the time and place of open defecation, meat preparation and cooking habits or patterns of pork consumption among men and during funerals, we could better answer why and when people get the most infected.

Finally, the role distribution according to gender is clearly a cultural feature that must not be underestimated when implementing a program in order to include the total targeted population and address these different groups (men, women, children) not only with specific messages but also with adapted communication methods following a participatory and integrated approach. Encourage them through standard health education would not be enough, however cultural norms, practices and beliefs can always be used as arguments going in favor of new control strategies and facilitate even more their respect. For example, the belief that children with "a good hand" can avoid pigs to get cysts while feeding them could be a very important entry point in order to build a more convincing dialogue with men who remain the decision-makers for pig management in this Nsenga community. Additionally, extension messages should especially focus on men since they are also the most exposed to undercooked meat, translating in a higher taeniosis prevalence in men in this region (Mwape et al., 2012) and hence presenting a risk of egg transmission to the rest of the household. Although this set of recommendations falls under the One Health umbrella which acknowledges the close relationship between humans, animals and ecosystems, their practical implementation in the Zambian health policy context should be the object of further investigations.

To conclude we advocate for more appropriate solutions regarding pig feeding, the integration of gender issues in adapted educational messages and also in the method to increase disease knowledge, the implementation of subsidized pig treatment and vaccination and finally for a more bottom-up multidisciplinary approach. There is indeed a dire need to overcome disjunctions between biomedical and social research and hence better integrate the socio-cultural barriers and local considerations identified into control interventions.

## Acknowledgements

Financial support for this investigation was provided by the Strategic Network on Neglected Diseases and Zoonoses from the Institute of Tropical Medicine (ITM, Antwerp, Belgium). The authors would like to acknowledge the University of Zambia (UNZA) and the School of Veterinary Medicine in particular for its supervision and collaboration in the field. The Focus Group Discussions were facilitated by Ruth Chirwa, Emmanuel Mwanza (MHSRIP) and Benjamin Mvula. Management at the Kakwiya Rural Health Center provided a room to host the participants during the discussions. Transcriptions and translations of the collected data were done by Mr Sakala and David Mwanza, an MSc student in the Department of Linguistics of the School of Education of UNZA.

## References

- Assana, E., Amadou, F., Thys, E., Lightowers, M.W., Zoli, A.P., Dorny, P., Geerts, S., 2010. Pig-farming systems and porcine cysticercosis in the north of Cameroon. *J. Helminthol.* 25, 1–6.
- Berkman, L.F., Kawachi, I., 2014. A historical framework for social epidemiology. In: *Social Epidemiology*, 2 ed. Oxford University Press, Oxford, UK.
- Braae, U.C., Harrison, W., Lekule, F., Magnussen, P., Johansen, M.V., 2015. Feedstuff and poor latrines may put pigs at risk of cysticercosis—a case-control study. *Vet. Parasitol.* 214, 187–191.
- FAO, 2010. *Good Practices for Biosecurity in the Pig Sector—Issues and Options in Developing and Transition Countries*. FAO, Rome.
- Grudens-Schuck, N., Allen, B.L., Larson, K., 2004. *Focus Group Fundamentals*. Iowa State University Extension.
- Johansen, M.V., Trevisan, C., Braae, U.C., Magnussen, P., Ertel, R.L., Mejer, H., Saarnak, C.F., 2014. The vicious worm: a computer-based Taenia solium education tool. *Trends Parasitol.* 30, 372–374.
- Kagira, J., Kanyari, P., Maingi, N., Githigia, S., Ng'ang'a, J.C., Karuga, J., 2010. Characteristics of the smallholder free-range pig production system in western Kenya. *Trop. Anim. Health Prod.* 42, 865–873.
- Krieger, N., 2001. Theories for social epidemiology in the 21st century: an ecosocial perspective. *Int. J. Epidemiol.* 30, 668–677.
- Lekule, F.P., Kyvsgaard, N.C., 2003. Improving pig husbandry in tropical resource-poor communities and its potential to reduce risk of porcine cysticercosis. *Acta Trop.* 87, 111–117.
- Lipendele, C.P., Lekule, F.P., Mushi, D.E., Ngowi, H., Kimbi, E.C., Mejer, H., Thamsborg, S.M., Johansen, M.V., 2015. Productivity and parasitic infections of pigs kept under different management systems by smallholder farmers in Mbeya and Mbozi districts, Tanzania. *Trop. Anim. Health Prod.* 47, 1121–1130.
- Morgan, D.L., 1998. *The Focus Group Guidebook*. The Focus Group Guidebook. SAGE Publications, Inc., Thousand Oaks, CA.
- Murrell, K.D., Dorny, P., 2005. World Health Organization, International Office of Epizootics, Food and Agriculture Organization of the United Nations. In: *WHO/FAO/OIE Guidelines for the Surveillance, Prevention and Control of Taeniosis/cysticercosis*. OIE (World Organisation for Animal Health).
- Mwangonde, B.J., Nkwengulila, G., Chacha, M., 2014. The risk factors for human cysticercosis in Mbulu District, Tanzania. *Onderstepoort J. Vet. Res.* 81, E1–E5.
- Mwape, K.E., Phiri, I.K., Praet, N., Muma, J.B., Zulu, G., Van den Bossche, P., de, D.R., Speybroeck, N., Dorny, P., Gabriel, S., 2012. Taenia solium infections in a rural area of Eastern Zambia—a community based study. *PLoS Negl. Dis.* 6, e1594.
- Ndimubanzi, P.C., Carabin, H., Budke, C.M., Nguyen, H., Qian, Y.J., Rainwater, E., Dickey, M., Reynolds, S., Stoner, J.A., 2010. A systematic review of the frequency of neurocysticercosis with a focus on people with epilepsy. *PLoS Negl. Dis.* 4, e870.
- Ngowi, H.A., Kassuku, A.A., Maeda, G.E.M., Boa, M.E., Carabin, H., Willingham, A.L., 2004. Risk factors for the prevalence of porcine cysticercosis in Mbulu District, Tanzania. *Vet. Parasitol.* 120, 275–283.
- Perry, B., Randolph, T., McDermott, J., Sones, K., Thornton, P., 2002. *Investing in Animal Health Research to Alleviate Poverty*. Tate, London.
- Phiri, I.K., Dorny, P., Gabriel, S., Willingham, A.L., Speybroeck, N., Vercauteren, J., 2002. The prevalence of porcine cysticercosis in Eastern and Southern Provinces of Zambia. *Vet. Parasitol.* 108, 31–39.
- Pondja, A., Neves, L., Mlangwa, J., Afonso, S., Fafetine, J., Willingham III, A.L., Thamsborg, S.M., Johansen, M.V., 2010. Prevalence and risk factors of porcine cysticercosis in Anzonia District, Mozambique. *PLoS Negl. Dis.* 4, e594.
- Seimenis, A., 2012. Zoonoses and poverty—a long road to the alleviation of suffering. *Vet. Ital* 48, 5–13.
- Sikasunge, C.S., Phiri, I.K., Phiri, A.M., Dorny, P., Siziya, S., Willingham III, A.L., 2007. Risk factors associated with porcine cysticercosis in selected districts of Eastern and Southern provinces of Zambia. *Vet. Parasitol.* 143, 59–66.
- Sikasunge, S., Phiri, I.K., Phiri, A.M., Siziya, S., Dorny, P., Willingham, A.L., 2008. Prevalence of Taenia solium porcine cysticercosis in the Eastern: Southern and Western provinces of Zambia. *Vet. J.* 176, 240–244.

- Swanepoel, F., Stroebel, A., Moyo, S., 2010. [The Role of Livestock in Developing Communities: Enhancing Multifunctionality](#). University of the Free State and CTA, Cape Town, South Africa.
- Thomas, L.F., de Glanville, W.A., Cook, E.A., Fevre, E.M., 2013. [The spatial ecology of free-ranging domestic pigs \(\*Sus scrofa\*\) in western Kenya](#). *BMC. Vet. Res.* 9, 46.
- Thys, S., Mwape, K.E., Lefevre, P., Dorny, P., Marcotty, T., Phiri, A.M., Phiri, I.K., Gabriel, S., 2015. [Why latrines are not used: communities' perceptions and practices regarding latrines in a taenia solium endemic rural area in eastern Zambia](#). *PLoS Negl. Trop. Dis.* 9, e0003570.
- WHO, 2015. Investing to overcome the global impact of neglected tropical diseases: Third WHO report on neglected tropical diseases. In: Professor Peter Holmes, C.S.-N. (Ed.).
- Zinsstag, J., Schelling, E., Roth, F., Bonfoh, B., de Savigny, D., Tanner, M., 2007. [TI—human benefits of animal interventions for zoonosis control](#). *Emerg. Infect. Dis.* 13, 527–531.
- Zirintunda, G., Ekou, J., 2015. [Occurrence of porcine cysticercosis in free-ranging pigs delivered to slaughter points in Arapai, Soroti district, Uganda](#). *Onderstepoort J. Vet. Res.* 82, 888.