

Porcine diseases of economic and public health importance in Uganda: Review of successes and failures in disease control and interventions



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Summary

In general, diseases of pigs are scarcely studied in Uganda and little information can be retrieved from most of the archives in the country. Most of the research in the animal industry is put on diseases of cattle. One can, with ease, declare the pig a neglected species by the ministry of agriculture, animal resources and fisheries. Even research institutions like the National Agricultural Research Organization (NARO) and universities have little work concerning pigs.

African swine fever (ASF) is the most devastating disease known to cause very high mortalities in the country and outbreaks are common in almost all pig rearing areas of the country. ASF is a very great disincentive to the development of the pig industry in Uganda. Many investments in the pig industry have failed because of ASF. Its control is long overdue and should be carried out if the pig industry is to develop and be a reliable economic venture for the farmers.

Other diseases of economic importance are caused by parasitic infections which cause loss of income due to the poor growth of pigs and their poor use of feeds. The economic sense of feeding little and earning much is lost as the pigs do not grow at expected rates. The internal and external parasites of pigs are not well studied and little documentation is available about their incidence. Parasite infections are very common and from the writer's experience as a veterinarian many pig flocks suffer from mange, lice and at times jiggers. It is necessary to study these diseases and produce proper and achievable measures to control them in Uganda.

Porcine cysticercosis is a reality in Uganda and many studies about its prevalence have been carried out. It causes economic loss as the affected pigs fetch less income. Cysticercosis is a zoonotic disease which can cause epilepsy in humans. It is paramount that the control of porcine cysticercosis takes centre stage in Uganda.

All in all, given the growing attention to pigs in Uganda, there is need for all concerned institutions and research organizations to engage in more research on diseases of pigs.

Materials and methods

The study purposively targeted people who have been dealing in pig health related studies, administration of the animal sector in the country, 20 farmers who have been in active pig farming for the last 3 or more years. Twenty simple open ended questionnaires were administered to those who could not have time for a face to face interview. Face to face interview was taken to probe for information from those respondents who availed some time for interview. Where possible reference was sought for some of the given information found to be critical. All records about some of the information were reviewed and analyzed for proper referencing. Information from international organizations, not found in the local archives, was evaluated by desk review of published information. The following places were visited for information acquisition: Makerere University (Professors Ojok, Kaddu and Rubaire), Ministry of Agriculture Animal Industry and Fisheries (MAAIF), (Dr Kyokwijuka and Dr Asimwe), NARO (Dr Kabi), Makerere University Library and the Internet.

Introduction

Pig keeping and the consumption of pork is increasing and becoming a popular source of livelihoods (Waiswa, Mubwoli *et al.* 2007; Ampaire and Rothschild 2010). This is because the demand for pork has increased and the rural and peri-urban communities have discovered the cost-effectiveness of keeping pigs (Phiri, Ngowi *et al.* 2003). There is deliberate policy by government to increase pig farming in the rural communities and the National Agricultural Advisory Services (NAADS) is putting a lot of effort into making the pig a viable enterprise. The pig inherently has characteristics that make it thrive under minimum input systems hence providing economic opportunities for rural smallholder pig farmers: (a) the pig is prolific, giving 6-10 viable piglets per farrowing, (b) the pig can grow to slaughter market size within 6 months, and (c) the pig is a scavenger and can thrive as a low-input enterprise. Smallholders exploit this scavenger ability to keep pigs in free range conditions.

Diseases can cause negative impact and at times make the pig enterprise a very risky economic venture. The development of the pig enterprise will hinge on the following: (a) reliable knowledge about the burden of particular diseases on the production of the pig industry, (b) proper knowledge about the predisposing factors for the spread and thriving of particular diseases which is key to mitigations, and (c) putting in place proper control practices that can prevent/reduce the occurrence hence the burden of the particular diseases on the pig industry.

This study is intended to evaluate the diseases of economic and public health importance, known burden, risk/predisposing factors and the successes and failures of any control approaches used to reduce the negative impact of these diseases on the pig industry in Uganda.

African Swine Fever (ASF)

Transmission of ASF

African swine fever is caused by the African swine fever virus (ASFV) of the *Asfarviridae* family. It is a very resistant virus which can maintain viability at -70°C. The virus is highly protected by organic materials. If it loses the organic material protection, it is inactivated by sunlight. The domestic pig is the most susceptible where 100% mortality can occur in infections with highly virulent ASF virus strains. Some pigs are thought to get some resistance and less mortality can occur with highly virulent strains (Penrith, Guberti *et al.* 2009). The wild pigs, bush pigs, warthogs and giant forest hog can get the infection but do not develop the clinical disease. The virus is found in the soft tick *Ornithodoros porcinus* (Jori and Bastos 2009). The virus causes an overt clinical disease picture in domestic pigs which almost all pig farmers are aware of. The pigs go off feed. There is cyanosis of the ears, groin and under the belly. Death occurs in very short time. There are three transmission cycles of African swine fever (Sánchez-Vizcaíno, Martínez-López *et al.* 2009) (Figure 1).

Domestic cycle

This is where direct contact of the infected pig with non-infected pigs through saliva, oral-nasal discharges, aerosols, faeces, urine and other body fluids from infected pig can infect pigs that come into contact. An infected pig in the acute phase of the disease sheds a lot of virus and can shed the virus for up to six months and can be a source of infection to new entrants in the pen for a long time (Costard, Wieland *et al.* 2009). The spread of the infection between flocks remote from each other is usually achieved by feeding swill of uncooked pork, contaminated fomites or poor bio-security of the personnel (Penrith, Guberti *et al.* 2009)

Intermediate cycle

The soft tick *Ornithodoros porcinus* is the vector for ASF to the pigs. The soft tick (loaded with the ASF virus) can live for long in an emptied pig pen. On re-introducing pigs to the pen, ASF infections can occur in the pig flock despite any bio-security and the fact that the pen was kept empty without pigs for four years (Ravaomanana, Jori *et al.* 2010).

The sylvatic cycle

The virus is maintained between the wild suids like the warthog and *Ornithodoros porcinus* (soft tick). There is neo-natal infection of young wild pigs by the soft ticks that live in the burrows where the wild pigs live. In instances where the wild pigs and the domestic pigs share some domains such as feeding and roaming grounds, domestic pigs can be infected with the virus shed by the wild pig. The soft ticks in the same grounds can feed on the roaming domestic pig and the infection carrying soft tick will infect the domestic pig. The sylvatic cycle can also be completed by the act of eating wild pigs. It is also possible that eating wild suids by hunting communities can spread the virus from wild to domesticated pigs as the infected wild pig meat is shared in the communities. Spilling infection from the wild meat to the domestic pig needs proper control (Björnheden 2011).

AFRICAN SWINE FEVER TRANSMISSION CYCLES

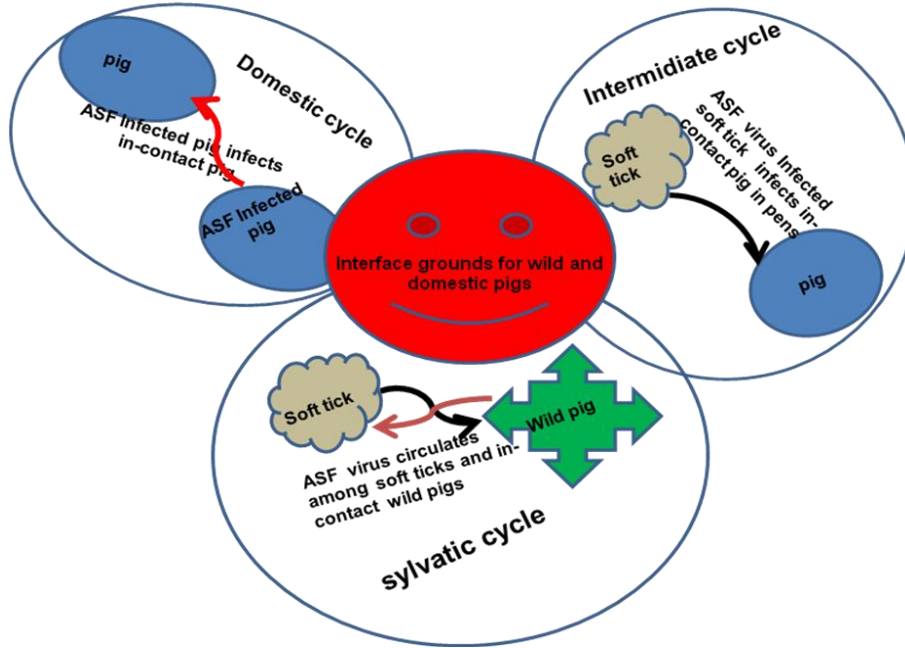


Figure 1: ASF transmission cycles and their possible interfaces

The burden of ASF from 2006 to 2012 in Uganda

Almost year around, there is an outbreak of ASF in some part of Uganda (Table 1 below). This makes the ASF an endemic disease in the country. In some instances the outbreaks occur in a whole district causing major disruption and losses. This happened in 2006 in all sub-counties in Adjumani District.

Date of Outbreak	District	Sub-county
3/2/2006	Adjumani	All sub-counties
10/5/2006	Moyo	Dufile and Metu
31/06/2006	Wakiso	Nsangi
24/10/2006	Kiboga	Surrounding sub-counties
31/10/2008	Manafa	Butiru and Bugobero
12/12/2008	Kapchorwa	Sipi and Gamoko
20/04/2009	Nebbi	Erussi
15/06/2010	Moyo	Moyo
26/04/2010	Kasese	Kitholhu, Karambi, Bwera, and Nyakiyumbu
30/08/2010	Gulu	Odek, Paicho and Lalogi
21/10/2010	Gulu	Lakwana, Bobi, Koro, Ongako, Lalogi and Odek
8/4/2011	Masindi	Pakanyi
9/5/2011	Nebbi	Erussi, Akworo, Parombo, Nyaravur, Kucwiny
4/5/2011	Kyankwanzi	7 parishes of Wattuba
15/06/2011	Nakasongola	
16/09/2011	Lwengo	
17/11/2011	Adjumani	Ofua, Itirukwa

28/11/2011	Wakiso	Wakiso
14/12/2011	Kabaale	Kyanamira
20/08/2012	Buikwe	Wakisi, najembe
17/09/2012	Kyankwanzi	Ntwetwe
24/09/2012	Zombo	Kango
20/11/2012	Kabala	Bufundi, muko, ikumba
5/6/2012	Kabarole	Kisomoro, Kibiito, bunyangabu
10/5/2012	Moyo	Metu
13/11/2012	Kyenjojo	
21/01/2013	Kiboga	Kibiga, Lwamata, Kapeeke, Bukomero
4/2/2013	Nebbi	Parombo, Erussi, Kucwiny, Ndhew

Table 1: ASF outbreaks February 2006 to 2013 (MAAIF records)

Economic impacts of ASF

ASF is endemic in Uganda and very fatal to many flocks. The mortalities are high, some 70-80%, which is very discouraging to possible investors. ASF can decimate a whole herd and the farmer has to start afresh which creates low interest for prospective farmers. ASF has been observed to reduce the number of pigs hence the number of piggeries in the country. Many resources are wasted in regular surveillance (Rutebarika and Ademun 2011). The strategy the farmers take to depopulate the flocks whenever there is a suspected ASF outbreak results in income losses as the market is flooded with pork or pigs. It also disrupts herd growth and farmers may lose their very good breeders, reducing breed quality (Muwonge, Hetron *et al.* 2012).

Risk factors for the occurrence of ASF

Pig husbandry practices

The main husbandry practices in Uganda are free range, tethered or semi intensive pig keeping (where the pigs are confined for part of the day but roam around homesteads some of the day (Rutebarika and Ademun 2011)). This exposes the pig to contacts with other pigs or feral animals that may be infected with the ASF virus. It also exposes them to feeding on uncontrolled, perhaps infected materials. Free range pig keeping creates a great chance for the sylvatic cycle to be completed where a domestic pig can get into contact with wild pigs, infected materials from the wild pigs, or soft ticks from the wild. Since the ASF virus is a contagion and not air-borne, the mode of husbandry is a risk factor in all three cycles of transmission. If good husbandry methods are encouraged, ASF transmission especially from the domestic cycle could be better controlled.

ASF carrier status of healthy looking pigs

Healthy looking pigs may be carriers of the ASF. Healthy looking pigs presented for slaughter at wambizi were found to carry ASF virus in their lymph nodes (Sajjakambwe, Okwee-Acai *et al.* 2011). It is possible that if materials from such pigs are fed to susceptible pigs, flare of disease can occur. It was observed that pigs with no recent history of ASF infection were PCR positive for ASF but were serologically negative for antibodies against ASF (Björnheden 2011). It is therefore possible that transmission of ASF virus can be done through the trade of clinically health pigs. In surveillance, PCR techniques need to be used to monitor the health of pig herds so that transit is allowed only to disease free flocks.

Interfaces with wild suids

In some parts of the country, wild pigs have a direct interface with domestic pigs. Especially in Masaka and possibly other areas where people live close to bush lands, wild pigs come into contact with domestic pigs (Björnheden 2011). This makes bridges between the sylvatic cycle and the domestic cycle leading to possible exchange of infective materials and flares of ASF.

Control of ASF tried in Uganda

In Uganda, ASF control is by carrying out quarantine where interception of pigs and pig products is carried out until the veterinary authorities are sure the disease has subsided. No pigs and pig products from the area of outbreak are allowed to leave the area.

Whenever ASF is detected in a neighbourhood, farmers, from fear of losing their investments to ASF, sell or depopulate their piggeries.

This method tries to limit infection to an area; authorities assume that ASF will not spread if the pigs/products do not move from the area of outbreak.

This depopulation approach causes losses to the farmer as flooding markets leads to drastic declines in selling prices. Usually, meat sales are not restricted. Pork is sold at the road side and someone in transit can buy the pork and take it to his/her destination which can transfer the ASF virus to distant locations. The stamping out approach disturbs the breeding system of an area and can reduce stocks of well acclimatized good breeding animals.

Proposed control approaches for ASF

Zoning areas

In this approach, ASF-free areas and ASF-endemic areas must be identified. Enforceable tight controls, which are proof against ASF must be put in place so the trade in pigs or their products is only allowed within the particular zone. This can be progression towards eradication of ASF from some parts of the country, which in the long run may pacify ASF country-wide.

Stamping out and disposal

In this approach, all the infected and in-contact pigs are slaughtered. The carcasses are destroyed by burying or incineration. The burying must be done on site so the farmers have confidence that the disease is the problem. It must be deep enough so feral animals do not exhume the buried pigs. The operation must be done in a very short time so the spread of the disease is halted very quickly and it also lessens environmental contamination and requires less logistical requirements. The stamping out will work best if there is early reporting and proper discouragement of clandestine slaughter for the local market or home consumption. This works best if there is adequate (quantity and proportionate value) compensation of farmers for the destroyed pigs. If the farmer knows that reporting an outbreak will result in replacement of the same amount and quality of pig stock, emergency clandestine slaughter will be discouraged, proper reporting will take place and proper disease control can be achieved.

Cleaning and disinfection of premises and other wares

Strict cleaning of pens, sheds and equipment including vehicles, personnel shoes and boots should be done on entry and exit of the farm premises. Legally approved disinfectants need to be used. Hypochlorides, alkalis and glutaraldehyde are internationally recommended.

Proper tick control

The soft tick is known for its resilience and can survive without feeding for very long time. It is valuable to destroy the ticks and not assume they are not living. This can be done by burning old sties if the loss of burning is economically viable. Spraying all the pig structures with an acaricide will help kill soft ticks.

Double fencing of piggeries

This is where a fence perimeter is created within another fence perimeter so the domestic pigs are kept within the inner perimeter and do not come in contact with feral or roaming pigs. To enforce/entice the farmers, only pigs from the double fence perimeter can be traded outside the area (Scoot 1965).

Trade of bush meat (wild suids)

It is common for hunters to bring their game from the wild to urban centres where it fetches a good price. This trade should be controlled and done in a manner approved to be safe and not likely to spread the ASF virus.

Continued ASF surveillance in the pig populations

The veterinary section should carry out surveillance even when outbreaks have subsided. This can allow the creation of early warning systems and pre-empt any looming outbreak, containing the disease before great losses due to outbreaks are realized.

Point of concern

The control of ASF is mainly associated to the behaviour of farmers who have to comply in full with the measures above. This is feasible when the state will compensate farmers for any ASF mortalities. Even the stamp out approach will work if the farmers are assured of compensation.

Recommendations

Total confinement-total closed system, where influence from outside-animals is minimized, will help control/stop the ASF flare in pig flocks. Construction of pig unit, even if it is un-roofed, which deters direct interface of domestic pigs with other pigs/animals outside the pig holding area of that particular animal unit, and allows practice of proper bio-security, will help in the control of ASF. We recommend the construction of piggery unit which follows the sketch below (Fig 2).

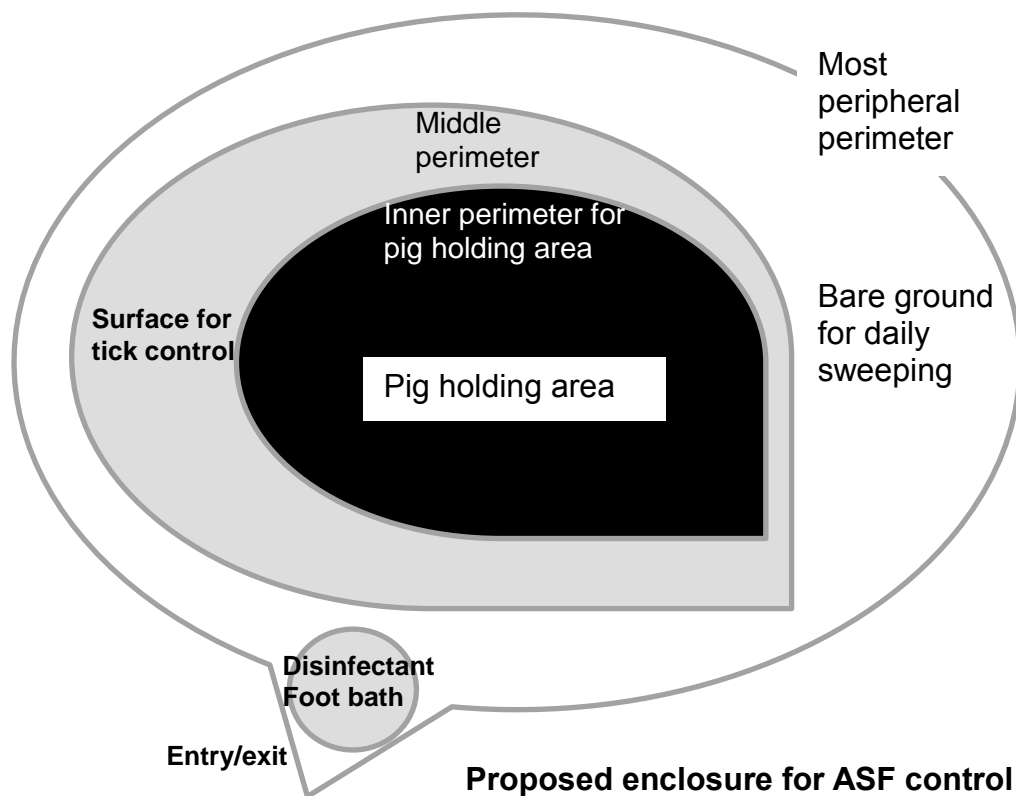


Figure 2: Three level enclosures that totally limit the domestic cycle and can prevent other cycles

Parasitic diseases of pigs in Uganda

Internal parasites of pigs

Intestinal worms are mainly the nematodes that cause debility in pigs, especially piglets and growers. The parasites reside in the stomach and the intestinal tract causing irritation, impaction, indigestion, ulcerations, blood loss and pain. There is loss of nutrients to the parasites as they feed on the nutrients in the intestinal tract. The gain: nutrient ratio is lowered in instances of worm infestation. Some worms found in the respiratory system cause respiratory distress and may cause verminous pneumonia.

Transmission of internal parasites in pigs

Internal parasite can be acquired from pastures. It is also common for pigs on rangeland to be infected from contact with soil that is contaminated with worm eggs. But the infective eggs of some of the parasites are found in places of confinement and are not easy to eradicate.

Some large round worms like *Ascaris* sp mainly affect young pigs; the sows have subclinical disease of the large worm and are reservoirs for the young pigs. The female large worm in the sow lays many eggs which are resistant in the environment for very long time. The eggs are sticky and easily transported by crawling insects, flies, and human footwear. The major clinical picture is the un-thriftiness of the pigs and their poor growth rate. The whip worm *Trichuris suis*, nodular worms and thread worms cause a lot irritation and ulceration in the small intestine resulting in scouring in piglets.

Risk factors associated with internal parasites in pigs

Poor sanitation of the piggery

The eggs laid by the adult worm contaminate the piggery, resist environmental pressure and can stay infective to a young pig. It is therefore advisable to have good cleaning practices in the piggery.

Scavenger practice of the pigs

Eggs of lung worms (*Metastrongylus* sp) of pigs are swallowed by the earth worms. If pigs dig up the soil and ingest the earth worms, they take in the eggs of the *Metastongylus* sp. which are passed to the lymphatic system into the lungs causing verminous pneumonia.

Insect load in the piggery

Crawling insects and flies are good transmitters of eggs from one place to another. It is therefore risky to have an insect-infested piggery.

Poor nutrition

Immunity is one of the inherent control measures that pigs use to reduce the negative impact of the worm burden. Poor nutrition will result in poor elicitation of immune response hence the impact of the worms can be seen to be great even if the worm burden is small in the herd.

Control of internal parasites in pigs

- Good sanitation in and around the piggery is key to reduce worm infestations;
- Good nutrition (quality and quantity) helps the pig use its ability to mount an immune response and carry on with good performance in the presence of worms in its body;
- Good cleaning of fomites and utensils in the piggery helps to reduce transmission of eggs by human activities. This helps to control roundworms and whipworms which have eggs that are easily transmissible through indoor facilities;
- Gilts should be kept off contaminated lots, and weaned pigs kept away from older breeding stock. Changing sites away from contaminated areas may reduce contamination for the pigs;
- Scavenger pig rearing where pigs can access earth worms should be discouraged since Kidney worms and lungworm larvae are found in earthworms.

Treatment of internal parasites in pigs

Clinical worm infestations can be controlled and eliminated from the pig's body by use of known chemotherapy. There are many de-wormers currently in use for the treatment of worms. The de-wormer used must be known to kill the particular worm infecting the pigs. Some of the de-wormers are broad-spectrum and treat against a wide range of worms. Fenbendazole, Dichlorvos, Ivermectin, Levamisole and Pyrantel are some of the drugs that can be used. The de-worming approach on the farm should include de-worming before breeding the females, de-worming before farrowing for gilts and sows. This reduces the piggery's parasite load for the incoming pig litter. *Strongyloides* and roundworms in baby pigs should be controlled by de-worming the piglet.

Internal parasites of pigs in Uganda

Very few studies have been carried out on intestinal parasites of pigs in Uganda. In Kabale district, 91% prevalence of nematodes infestation was observed. Poly parasitism was found to be common in pigs studied in Kabala district: *Strongyles*, *Ascaris suum*, *Trichuris suis* spiruroid, *Oesophagostomum* spp. *Hyostromylus rubidus*. In areas where some structures are provided for pigs, the nematodes were less prevalent to about 80% (Nissen, Poulsen *et al.* 2011). The mode of husbandry is a risk for the occurrence of intestinal parasites. Housed pigs were associated with fewer nematodes than free range pigs. The history of de-worming has also been associated with lesser worm burden in growing pigs (Nissen, Poulsen *et al.* 2011; Obonyo, Maingi *et al.* 2013).

Burden of intestinal parasites to pig farming

Most pigs in Uganda are free range. They get access to all the possible risks of getting infected with internal parasites. The worm burden, though not scientifically evaluated in Uganda, can be observed from the stuntedness/poor weight gain of piglets; this malnutrition makes them more prone to other disease infections. Worm infection is found to cause changed body composition of heavier plucks (infected lungs and livers) at slaughter hence less meat. *Ascaris suum* causes migratory lesions in the liver. *Ascaris suum* and *Trichinella suis* are zoonoses and closely related with *Ascaris lumbricoides* and *Trichinella trichiura* (de Silva, Brooker *et al.* 2003). In general there is economic loss due to worm infections in pigs in Uganda.

Control of internal parasites in pigs in Uganda

In Uganda, control of internal parasites is by sporadic de-worming by some farmers mostly on advice from veterinary personnel, supervising NGO etc. There are no formal measures by the authorities and no planned schedules are given to farmers. Wormcid (levamisole) tablets are commonly used to de-worm pigs. Injectable drugs like Ivermectin are also being used due to the convenience of administration and the drug's ability to control mange.

Conclusion

The internal parasite burden in pigs is not well elucidated in the pig farming in Uganda. More studies need to be implemented to have a clear picture the prevailing parasites in the pig system.

Recommendations

Adoption and putting in practices the following internal parasite control measures will help farmers reduce the burden on their pigs.

- Good sanitation in and around the piggery;
- Good nutrition (quality and quantity) helps the pig mount an immune response and perform in the presence of worm load in its body;

- Good cleaning of all fomites and utensils helps reduce the transmission of eggs by human activities. This helps to control roundworms and whipworms which have eggs that are easily transmissible in indoor facilities;
- Gilts should be kept away from contaminated lots, and weaned pigs kept away from older breeding stock. Changing sites away from contaminated areas may reduce the contamination for the pigs;
- Scavenger pig rearing where pigs can access earth worms should be discouraged since Kidney worms and lungworm larvae are found in earthworms.

External parasites of pigs

External parasites of pigs are in five groups: Lice, mites, flies, mosquitoes, and jiggers. The pig louse can transmit pathogens like swine flu viruses. Flies mechanically transmit pathogens directly from pig to pig, farm to farm or indirectly by contaminating feeds. Mosquitoes are known to transmit the deadly Japanese B encephalitis virus in Asia. Mites and lice and ticks affect growth of the pig and are a nuisance to the pigs and the pig attendants.

Mange

The main species of mites causing mange in pigs is the *Sarcoptes scabiei* var. *suis*. These are tiny organisms that are barely identifiable with the naked eye. Mites are species (host) specific and the species of swine cannot be found thriving on any other host. The mites are very susceptible to environmental hardships when it is off the host. The mites can only survive off the host if there is high humidity in moderate temperature. Temperatures below 0c and those above 37c are harmful to mites (Zhao, Guo et al. 2009).

Impact of mites on to the life of the pig

The main impact is to cause mechanical damage through irritation which leads the pig to aggressively scratch itself on any object. Male and female mites mate on the surface of the pig's skin. The female mite makes burrows in the outer layer of skin causing mechanical damage. The female lays eggs in the burrows in the skin. In less than a week the eggs hatch to larvae which develop into two nymphal stages in the burrows before becoming adults in about 10 days (Bogatko 1974). The clinical signs are mainly the hyperkerotic form common in adults and pigs more than 4 months old which include thickened, rough, encrusted, and raised skin lesions that are dull grey or brown in appearance. The lesions are commonly found on the ears, head, neck, shoulder or legs. Mites are usually present in very large numbers in these areas and diagnosis is done by scrapings the lesion to view the mites under a microscope.

In the hypersensitive form, found mainly in piglets, the lesion is of very intense itchiness, dermatitis and raised red papules on the rump, abdomen, flank, head and ears. In all the clinical presentations the animal tries to scratch itself on a wall or any object that it comes into contact (Cargill and Dobson 1979a).

Treatment and control

Acaricide sprays can be used to control mites (Johansson, Nilsson et al. 1980). The sprays can kill the adults, larvae and nymphs but the eggs and larvae are not susceptible. Serial sprays are needed for proper reduction of mite infestation. Injectable Ivermectin is useful to control all the infections except the eggs. A second dose of Ivermectin is needed for proper clearance of the infection (Courtney, Ingalls et al. 1983).

Lice

Haematopinus suis is the only species of lice affecting pigs. These are blood sucking parasites which pierce the skin many times a day to suck blood from the pig. They lay eggs on the skin and the eggs are glued to the hairs of the pig skin. Lice can crawl from pig to pig and are thought to be a potential

transmitter of pathogens to pigs. They cause a lot of irritation and blood loss. Lice are of great importance in piglets where they cause anemia which retards growth and can lead to un-thriftiness of the piglets (Hiepe and Ribbeck 1975).

Jigger

Tunga penetrans is the species which affects pigs. No documented information can be found about this parasite in pigs in Uganda.

Conclusions

There is almost no archive information about external parasites of pigs in Uganda. Most of the diseases mentioned above are commonly found in pigs in the rural settings and the people in the pig rearing communities know a lot about the diseases.

Control of external parasites in pigs in Uganda

Old engine oil

Farmers, at times, use old engine oil to smear pigs infected with mites and lice. This they presume helps remove the parasites from the pig's body. The use of old oil is a common practice in the rural communities.

Wallowing in muddy ponds for the pigs

The farmers dig shallow ponds where the pigs can wallow and the mud that mats the pigs is presumed to have a negative impact on the development of external parasites. Most farmers in the rural setting assume that pigs which do not wallow have external parasites.

Ivermectin injections

Some farmers use Ivermectin to treat mange. This is a better approach since Ivermectin is also a good de-wormer for the internal parasites.

Conclusion

There is need to study and control external parasites in the pig industry in Uganda.

Porcine Cysticercosis in Uganda

Transmission of porcine cysticercosis

Porcine cysticercosis is a disease of pigs caused by *Taenia solium* (pork tapeworm). *Taenia solium* is a zoonotic disease of pigs which is of great public health importance to humans. *Taenia solium* adult worm is found in the gastrointestinal tract of human beings where it produces eggs which are passed out with human faeces (Carpio, Escobar *et al.* 1998). Roaming pigs eat the infected faeces and the eggs hatch into larvae that are found in the muscles of the pig causing porcine cysticercosis (Carrique-Mas, Lihoshi *et al.* 2001).

When humans eat raw or poorly cooked pork from such a pig, the viable larvae will infect the human being and turn into adult worms (human taeniasis). In some instances the food for the human being can be contaminated with the *Taenia solium* eggs. These eggs hatch and larvae develop in the human body (human cysticercosis) as it would in the pig. If the human brain is infected then neuro-cysticercosis develops which is the main cause of adulthood acquired epilepsy hence the great public health risk of porcine cysticercosis (Deb Pal, Carpio *et al.* 2000).

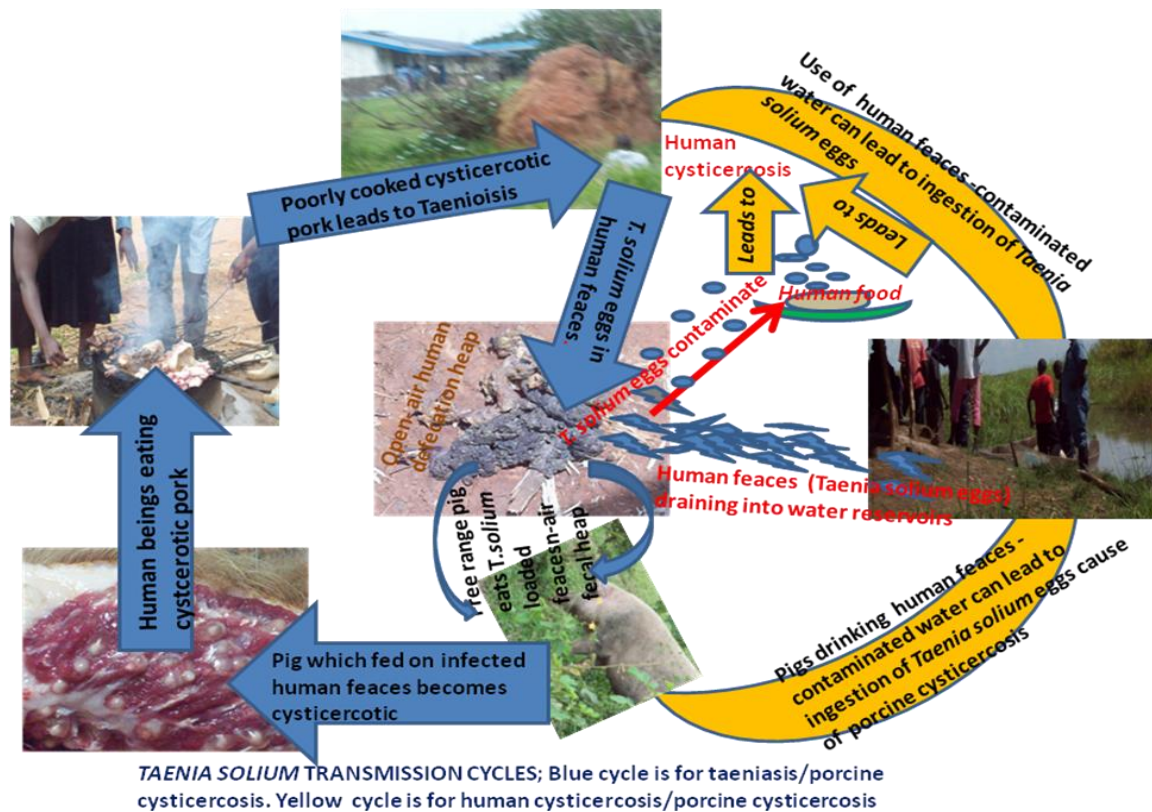


Figure 3: Transmission cycles of *Taenia solium* (Zachary Nsadha)

Prevalence of porcine cysticercosis in Uganda

Many studies have been conducted in different parts of Uganda on the prevalence of porcine cysticercosis.

Slaughter house/slab prevalence

Post-mortem studies at slaughter slabs carried out in three sub-counties in Moyo District found the prevalence to be 33.5%, 34.1% and 44.9% for Moyo town council, Moyo and Metu respectively (Anyanzo 1999). Post-mortem surveys at Wambizi slaughterhouse in 2002 found a prevalence of 9.4%. It was also observed that trans-placental infection of fetuses took place, hence congenital transmission, which had been an unknown, was observed (Kisakye and Masaba 2002). *Taenia solium* human cysticercosis has been confirmed in Uganda (Willingham III 2008).

Field survey prevalence

Prevalence in field surveys has been carried out using serological methods and lingual examinations. The first detailed survey for secretory circulating antigen sero prevalence of porcine cysticercosis was carried out in south-eastern districts of Kamuli and Kaliro and found to be 8.9% (Waiswa, Fevre *et al.* 2009). A survey by examination of the tongue for lingual cystic lesions observed the following prevalences in selected districts: 9.4%, 7.7%, 8.2%, 6.9%, 0%, 12.9% and 4.1% for Oyam, Apac, Amolator, Kaberamaido, Kayunga, Kamuli and Kaliro districts respectively (Nsadha, Saimo *et al.* 2010). Prevalence of porcine cysticercosis has also been observed in four major districts of active international trade of Arua, Busia, Kibale and Masaka to be 27%, 11%, 14.2% and 15% respectively (Nsadha, Saimo *et al.* 2011).

Risk factors for thriving of porcine cysticercosis/human taeniosis

Detailed studies on the risk factors for porcine cysticercosis/taeniosis have been carried out in many parts of Uganda. Below is the summary of the important risks that have been observed.

Pig husbandry

Pig husbandry has been identified as a factor exposing pigs to *Taenia solium* infective materials. Depending on the season, management of pigs is usually free range, intermittent free range or tethering, with a few intensive pig keeping units especially in schools or religious institutions. In the Lake Kyoga basin, only 2% of pigs are kept intensively. During the crop planting, growing and harvesting season, most of the pigs (80%) are intermittent free range or tethered some of the time. During the following season, fewer pigs are tethered increasing the percentage of free range pigs to 48%.

Tethering is carried out on the pasture/bushes where people can find privacy to defecate. It is also common for sows to be tethered but its young ones are left free range. It was also observed that even the intensively kept pigs are fed on vines and plant material harvested from bushes where possible human faecal contamination can occur (Nsadha, Saimo *et al.* 2011). A field study in Soroti district found 48% of the pigs were under the tethering, 46% were at free range and only 6% were kept intensively (Zirintunda 2011). With such high proportions of pigs kept at free range and tethering, some in the bushes, pig husbandry is a potential risk factor for pigs to acquire porcine cysticercosis.



Photo 4: Pig husbandry practices that promote *Taenia solium* transmission (Credit: Zachary Nsadha)

Inspection of pigs in livestock markets

Veterinary authorities in livestock markets, especially those north of Lake Kyoga do carry out lingual screening of pigs. The infected pigs are not allowed for sale in the markets. Owners of infected pigs are advised to take back their pigs (personal observation in Ocheru Market). Returning infected pigs to villages brings about clandestine slaughters and the unsuspecting/ignorant communities are exposed to cysticerotic pork. This maintains the source of infection to the humans hence the *Taenia solium* cycle.

Lack of inspection of pork from clandestine/home slaughtered pigs

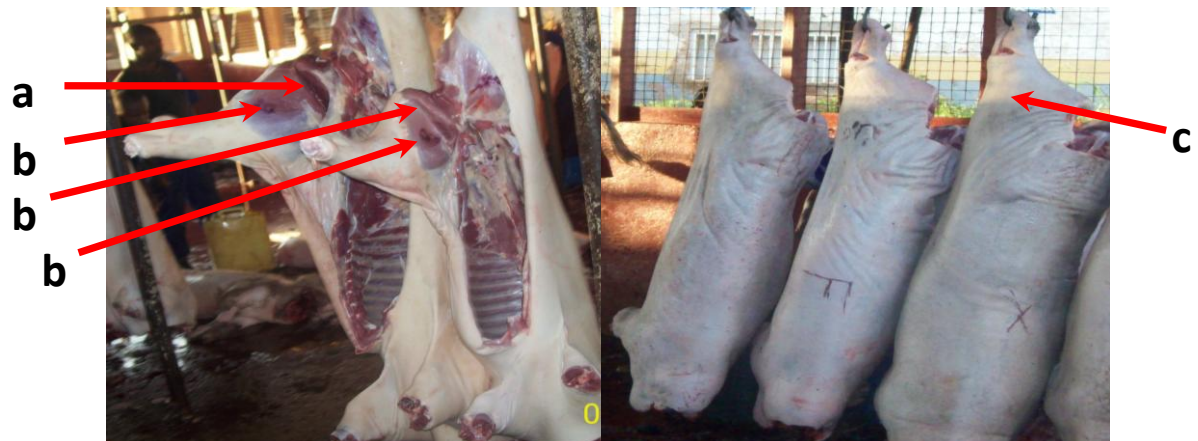
Regular pork inspection in Uganda is only carried out at Wambizi slaughterhouse at Nalukolongo, supplying the urban and peri-urban areas of Kampala. Most of the pork that is consumed in the country side is not inspected. A field study in the Lake Kyoga basin found 90% of the pork consumed is not inspected at all (Nsadha, Saimo *et al.* 2010). This is mainly due to home slaughter and slaughter in un-gazetted (clandestine) places making it difficult for inspection personnel to access the sites.

Poor pork inspection in Uganda especially at Wambizi pig slaughter house

Wambizi is the only pig slaughterhouse where regular pork inspection is carried out in Uganda. The meat inspection service is supposed to sieve out cysticerotic pork and deter it from reaching the human table. It seems the pork inspection carried out is deficient and too shallow to detect infected pork. The daily practices of meat inspection at the Wambizi pig abattoir were observed to be very superficial and at times insignificant for proper meat inspection. There are only two inspectors. Overload of work to the meat inspector is a possible cause of the poor inspection. It was observed that as the number of carcasses presented for inspection increases, fatigue to the meat inspector develops. The inspectors were observed to make very shallow incisions (fig. 3, arrows a) and at times no incisions (fig.3, arrows b) in the expected parts of the carcass. In most cases the deep layers of the muscles are not viewed for evaluation. Critical observation is ignored resulting in very superficial inspection.

Superficial inspection is known to have a negative toll on the efficiency of inspection in a slaughter place (Bui, Ahamed *et al.* 2006). The number of cysts and their location in the muscles of the pig vary from pig to pig (Gomes, Soares *et al.* 2007). Making shallow incisions at only particular points of the carcass is likely to miss positive cases if the lesions are not widespread at the shallow surface the inspector has looked at. Most of the services at the abattoir are under a traders' cooperative society. This may not tally well with good meat inspection as the traders crave profit. The depth of influence on

decisions made during meat inspection needs to be evaluated in case the traders are influencing how deep the incisions are made.



Medial and lateral views of inspected pig carcasses ready for the retail market at wambizi pig abattoir: (a) relatively deep incision, (b) very shallow incisions that may not reveal much of the lesions in the deep layers of the muscles, (c) lateral surfaces not attended to hence lateral muscles not covered in inspection.

Photo 5: Poorly inspected pig carcasses (Credit: Zachary Nsadha)

Sale of infected pigs within the communities

When a farmer hears that some of the pigs in the flock are infected, there is tendency to pass on the pig to unsuspecting persons. In a field study in the Lake Kyoga basin, 55% of farmers who had their pigs diagnosed positive for porcine cysticercosis sold off the pigs (Nsadha, Saimo *et al.* 2010)

Poor perceptions about the porcine cysticercosis by the communities

Very few community members know the epidemiological features of the *Taenia solium* infection in pigs and humans. In a field study in the Lake Kyoga basin (Nsadha, Saimo *et al.* 2010) only 12% of respondents knew that pigs get infected by eating human faeces, 26% had a conception that pigs get infected by getting into contact with another infected pig, 7% thought that eating of fellow pigs' faeces was the source of infection to the pig, 53% did not guess the source of infection to the pig and 2% thought that the pig gets infection from eating meat of another infected pig. About 50% of the respondents did not know the symptoms of the disease in the pig. In the same study, it was observed that most community members do not know how a human gets infected. Only 16% correctly understood that humans get infected by eating undercooked cysticercotic pork (Nsadha, Saimo *et al.* 2010).

Having wrong or poor perceptions about the disease in pigs does not allow the communities to carry out self-evaluation for cysticercosis of the pork before consumption. Ignorance about transmission of *Taenia solium* prevents the adoption of proper control measures.

Improper human faeces disposal

The infective material for porcine cysticercosis comes from adult tape worm in the gastro-intestinal tract of people and in human faeces (Carpio, Escobar *et al.* 1998). Open-air defecation is common in many parts of Uganda and is one of the risk factors for porcine cysticercosis. Some studies have shown that many households do not have latrines thus the household members relieve themselves in the bushes. In Soroti District, 54% of households do not have latrines (Zirintunda 2011). 36% of households were observed to have no latrines in the Lake Kyoga basin. Poor commitment to use latrines is a common occurrence whereby 38% of the latrines were not being used. Even the constructions of some latrines could not provide the privacy needed during day time (Nsadha, Saimo *et al.* 2010). This is a cause of intermittent latrine use. Proper human faecal disposal is needed in most of these areas.



Photo 6: latrine structures found in the rural settings in Uganda (Credit: Zachary Nsadha)

Handling and preparation of pork for human consumption

The handling of pigs and pork for human consumption poses a great risk to perpetuate porcine cysticercosis. Slaughter of pigs in the rural communities is not given the care needed for healthy pork. This is exhibited in photo 7 below, taken at Karachi market, Kaberamaido. Pig slaughter on the ground and in bush settings as seen in the photographs exposes the pork to contamination and the *Taenia solium* eggs can easily be some of the contaminants. The person who eats such pork is likely to develop human cysticercosis which is the most dreaded part of the burden of this disease especially if it involves the brain. Most of the pork in the rural settings is eaten at drinking joints. The demand of the day, the fuel source available, the state of consciousness of the consumers may, at times lead to the seller to release poorly cooked pork to drunken customers or those in a hurry. This under-cooking is common in most of the rural pork joints and those pork roasting areas along the road side of international trade routes (Nsadha, Kawuma *et al.* 2013)

Sources of water for domestic and animal use

During the rains, faeces/infectious materials can flow into water sources. In rural Uganda, 44% of the households do not have access to safe water. In the Lake Kyoga basin, 60% of households fetch drinking water from boreholes. Most of the other domestic water is fetched from other sources such as rivers, swamps, wells, lakes etc. This suggests that unsafe water is used for the most homesteads thus increasing their potential risk of infection. In some ethnicities, the first rains are given names indicative of washing away faeces into the water. The Langi call the first rains "Ogwa-cet" and the Japadhola call the first rains "koth marapena orwok ceth" all meaning washing away of the faeces defecated during the dry season. Having 44% of people using this water to which the faeces are drained, puts the animal and the human population at great risk acquisition of *Taenia solium* cysticercosis.



Unhygienic methods of handling pigs



Poor preparation of pork

Photo 7: poor pig slaughter and poor pork roasting methods carried out in Uganda (credit: Zachary Nsadha)

Control of porcine cysticercosis

Control measures tried in Uganda

Lingual Inspection of pigs

Inspection of live pigs is carried out in livestock markets especially those of northern Uganda (Ochero and Karachi markets in Kaberamaido, Awelo market in Amolator). Veterinary personnel inspect all the tongues of pigs presented for sale (Kyokwijuka 2013).



Photo 8: Ante-mortem inspection for *Teania solium* cysts using lingual observations (Credit: Zachary Nsadha)

This acts very well as a 'whistle blower' for the notification that the disease exists. The first 'alarm' that the disease is in the area is the cyst observation during lingual or meat inspections. This is a positive as it alerts communities, veterinary and medical authorities.

However, lingual examination of pigs at ante-mortem has had limited success in the control of porcine cysticercosis. On the contrary it seems to promote the disease in the villages since traders reject infected pigs. The rejected pigs are left with the farmers who have no enforceable obligation to destroy the pigs, hence clandestine slaughter/sale to unsuspecting community members is the immediate option. Clandestine slaughters have been observed to help in transmission of the disease (The-Cysticercosis-Working-Group-Peru. 1993; Zoli, Shey-Njila *et al.* 2003; Praet, Kanobana *et al.* 2010)

Pork inspection

Regular pork inspection is observed to be carried out only at the Wambizi pig slaughterhouse in Kampala. All pigs destined for the Kampala urban market are inspected here. In other places, irregular inspections occur. This is because most pig slaughtering is carried out in un-gazetted places that are poorly accessible to the veterinary/meat inspectors.

On the positive side, at the Wambizi slaughterhouse, meat inspection tries to detect infected carcasses at a percentage of less than 0.1% of the total pig slaughters in a year.

However, pork inspection carried out is often too superficial to detect lightly infected pigs (fig. 5). Superficial pork inspection allows false negatives to leak infected pork into the human food chain. Many antigen sero-positive pigs are declared free of porcine cysticercosis (Nsadha, Kawuma *et al.* 2013). Antigen sero-positivity is indicative of active cysticercosis infection in the pigs. The many sero-positives that are set free into the human food chain are indicative of failure of the pork inspection service in Uganda.

Control measures tried elsewhere

Community led total sanitation (CLTS)

The target to reduce the transmission of the disease is the change in behaviour and attitude of communities towards human faecal disposal. There is creation of the disgust about open faecal disposal by the communities and the whole community decides to make a stop to open-air defecation. The approach follows the health belief model and the principle of utility which explains that the "likelihood of someone adopting a given health behaviour is a function of that individuals' perception of the threat to their personal life (susceptibility and severity) and the belief that the new measure will reduce the threat" (Rosenstock, Strecher *et al.* 1994).

In implementation of CLTS, communities are sensitized about the dangers of open defecation and they decide to adopt an open defecation free (ODF) environment. After a participatory process, the community takes ownership of the change, it constructs latrines and organizes self-policing to ensure that all human faeces are deposited in latrines. Having no open-air defecation stops infection to the pigs which in turn stops infection to the humans. If the ODF status is maintained for some years, self-sanitation can occur and the environment becomes free of infective faeces hence cysticercosis-free pig flocks emerge, hence cysticercosis-free pork. Cysticercosis-free pork means *taeniosis*-free people.

CLTS is being promoted by many international agencies like Plan international, UNCEF and WaterAid (www.communityledsanitation.org). There are many success stories in other countries.

'Public health and pig management' education interventions

This approach uses mass education about good public health and improved pig husbandry practices. It uses educational materials that can be understood by everyone in the communities. Training materials that give an imaginable impact on the mind of the recipients are employed such as videos, leaflets, posters, booklets and training manuals. The training materials are more pictorial than text so they can be easily understood by all community members.

For this approach to succeed, communities must adhere to the eight cysticercosis fighter principles:

- Build pig pens and never allow pigs out of the pig pen.
- Dig and use an enclosed latrine with a closing door for all human defecations.
- Immediately dispose children's faeces in pit latrine.
- Thoroughly wash hands after latrine and before eating anything.
- Boil all water for domestic use.
- Never eat or sell infected pork.
- Consult a livestock extension officer whenever signs of cysticercosis are seen in pork.
- Consult medical services if signs of worms or epilepsy happen.

The approach can reduce infections if the education interventions are carried out over a long time. The open air human faecal disposal can go down, the roaming of pigs is also curtailed, hence the *Taenia solium* cycle is interrupted and the cysticercosis prevalence in pigs is also reduced since the pigs cannot access the infective human faeces. The control approach is being promoted by the Sokoine University of Agriculture in Tanzania (Ngowi, Carabin *et al.* 2008).

A point of concern about the approach is that success depends on the availability of incentives (pig feeds). The rural farmers will comply with the protocols used in this approach, especially to keep their pigs in pens, if the economic sense of keeping pigs is maintained (Ngowi, Carabin *et al.* 2008).

Chemotherapy to pigs

Some drugs have shown a reliable effect in the control of porcine cysticercosis. Oxfenbendazole can kill the larvae (cysts) of *Taenia solium* within the body of the infected pigs. This can deter infecting the human. It can be used pre-slaughter to treat infected pigs (Pondja, Neves *et al.* 2012).

The points of concern about chemotherapy are (a) that it helps to kill only the *Taenia* larvae in the treated pigs. The rest of the pig population which is not treated, if cysticercotic, causes infection to the human population hence infection can linger on in the community, and (b) re-infections of treated pigs can occur after chemotherapy if the pigs eat infective human faeces.

Combined mass chemotherapy carried in the human and porcine at the same time in an area

Mass chemotherapy (paraziquantel) for intestinal *Taenia* worms in humans and mass chemotherapy for porcine cysticercosis (oxfenbendazole) in pigs is a possible control strategy. The mass treatment in people is assumed to clear them of the *Taenia solium* worms which reduce the environmental contaminations and hence are less infective for the pigs. The mass treatment in the pigs is assumed to clear pigs of the larvae of *Taenia solium* which reduces infective materials for people. It also has an economic value in that the porcine meat is cleared of the cysts leading to fewer condemnations of pork (Garcia, Gonzalez *et al.* 2006). The treatment is carried out at the same time in the pig and the human populations. If all the human population is treated and the pig population is also treated, the drugs help clear the infections from both populations.

Limitations in this approach include:

- Inflammatory reactions develop around the dying cysts in the muscles making the meat unsightly and unsuitable for human consumption. The lesions can persist after treatment for approximately 6 months (Sikasunge, Johansen *et al.* 2008).
- Treated pigs remain susceptible and re-infections can occur and the re-infected pigs can transmit the parasite with in short time.
- Coordinating giving the drugs and slaughter before re-infection can be very problematic and can fail the exercise (Assana, Kyngdon *et al.* 2010)
- The drugs used to treat the people do not kill the infective eggs in the voided worm that is killed by the parazequantel. During the mass chemotherapy to the humans, massive contaminations of the environment with infective *Taenia solium* eggs, if open-air defecation is carried out, can occur due to the on-spot elimination of worms from all community members. Resilience of the *Taenia solium* eggs can result in a prolonged contaminated environment. The approach works best if open-air defecation has been eliminated.

Vaccination of pigs

This is where prepared materials are given to the pig to cause resistance (immunity) whereby even if the pig eats infective material, the cysts do not develop. Vaccination was identified as valuable approach for the control of cysticercosis by preventing transmission of *Taenia solium* (Lightwolers 1999). TSOL18 vaccine has been proven effective in trials in Mexico, Peru, Cameroon and Honduras with 99.3-100% protection against experimental challenge infections (Flisser, Gauci *et al.* 2004; Gonzalez, Gauci *et al.* 2005; Lightwolers 2006). In a field trial carried out in Mayo-Danay, Cameroon, the vaccinated pigs were protected from the field challenge (Assana, Kyngdon *et al.* 2010). The vaccine is being promoted by GALVmed.

Conclusion

A good and effective control program will need to involve a multi-disciplinary and multilevel approach due to the complex epidemiology of *Taenia solium*. This will demand full cooperation of medical, public health workers, veterinarians and the communities working in synergistic approach. Laxity of any of the actors will fail any control program (Murrell and Pawlowski 2005).

Recommendations

Mass public health and pig management education interventions are the best-bet to use in the control of *Taenia solium* porcine cysticercosis. It will also help to stop many other poor sanitation related diseases that are common occurrence in Uganda.

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