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Protecting Livestock – Improving Human Lives

## **A market scoping study for porcine cysticercosis vaccine calls for a one-health approach to sustain the control of the disease in Uganda**

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# Key Messages

- Farmers have a strong preference for a porcine cysticercosis vaccination that would be accompanied by premium prices when selling their pigs
- The current market is unlikely to meet these premiums without subsidies
- Farmers would prefer a vaccine with viability detector (showing the vaccine is effective), probably because there is generally high concern over low quality products
- Farmers prefer a single dose product (the current formulation requires at least two doses)
- For traders, the most important pig characteristic is weight, although they also reported being concerned about consumer health
- Consumers' preferences are primarily driven by characteristics that can be directly experienced, such as taste and price rather than by concerns over food safety.
- Entry of the accompanying de-wormer oxfendazole (Paranthic 10%™) in the market should be accompanied by creating awareness on its unique effectiveness against porcine cysticercosis as other de-wormers are more competitive on price
- A constraint for distributors is that the vaccine and de-wormers are not packaged together
- The 'added value' of the porcine cysticercosis vaccine will accrue more to the public health sector than the farmer. However, deworming could potentially give economic benefits to farmers through improved pig weight
- Farmers' lack of awareness about the benefits of vaccination in general (especially for pigs) is one of the biggest barriers to product entry into the market.

# Background



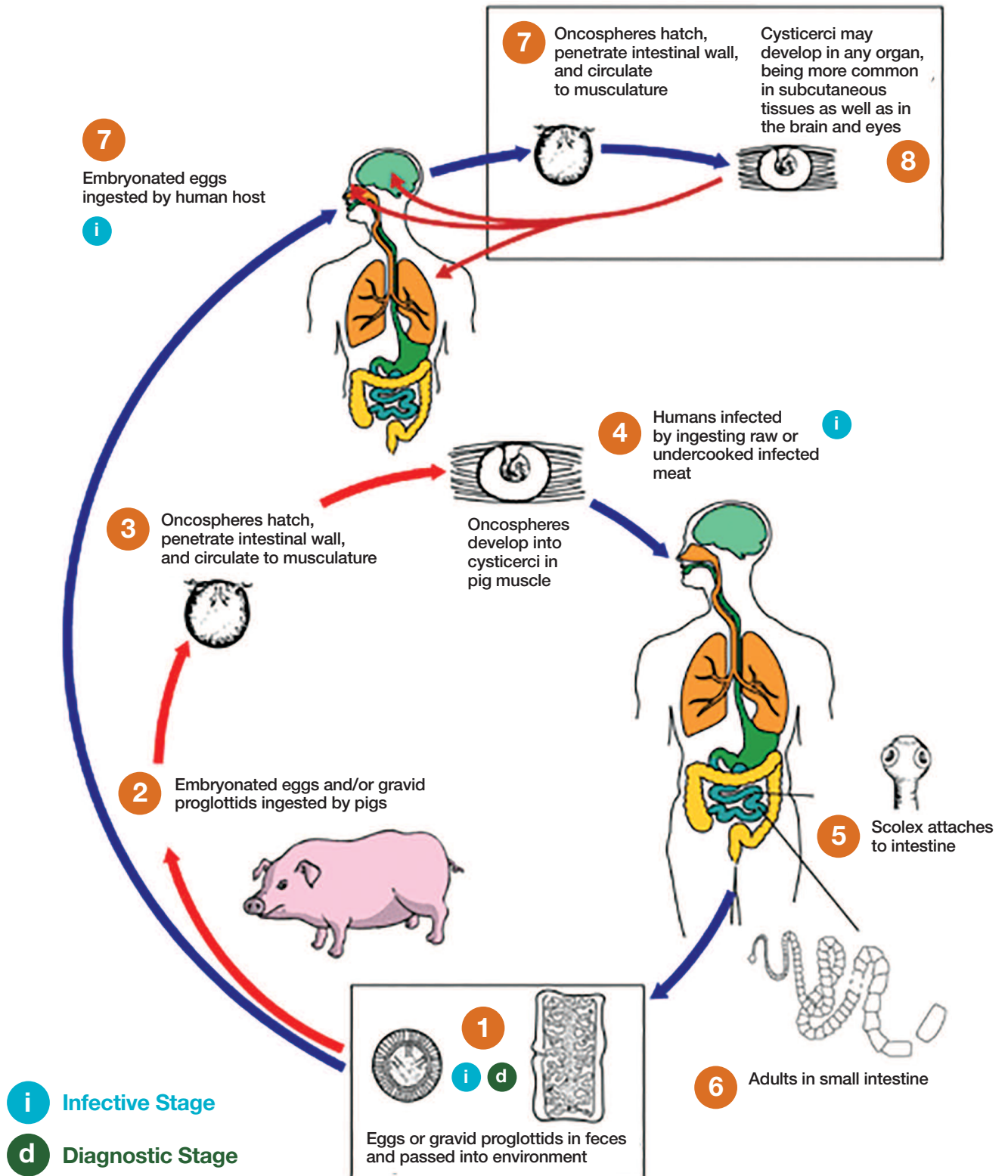
Pig health is a critical issue in modern Uganda. Not only does the country have the largest pig population in East Africa, it also has the most rapidly growing pig population in sub-Saharan Africa and the highest per capita pork consumption in Eastern Africa (FAOSTAT, 2010). Porcine cysticercosis (PC) is a disease of pigs caused by larval cysts of the human *T. solium* tapeworm. Pigs are infected when they eat tapeworm eggs shed in the faeces of a human tapeworm carrier. Humans are infected when they eat tissues from pigs that contain larvae (cysticerci). These larvae establish as tapeworms in the human gut and shed eggs in human faeces. However, if humans ingest tapeworm eggs in contaminated food or water, these can establish as cysts in the brain, eye or other tissues and these can have serious consequences such as epilepsy.

New tools have become available for the control of PC that could help to break the disease cycle, namely a recombinant vaccine antigen, TSOL18 (Cysvax™), combined with benzimidazole drug oxfendazole (Paranthic 10%™), a pig de-wormer. More recently, TSOL18 has been proven to be highly effective against naturally acquired infection with *T. solium* in pigs. Application of TSOL18 together with a single treatment of pigs with oxfendazole achieved the complete elimination of transmission of the parasite by pigs (Lightowlers, 2010).

These drugs, although licensed elsewhere, are not currently on the market in Uganda. GALVmed, a product development and adoption partnership focusing on livestock health, has carried out field trials in Uganda to control pig tapeworm through the combined use of vaccine and wormer. Results from the trials have confirmed efficacy. A market scoping study has also been conducted to assess the potential of marketing Cysvax™ and Paranthic 10%™ as private goods.

Picture 1: Confined sow in Hoima district, Uganda (Michel Dione/ILRI)  
Picture 2: Bottle of TSOL 18 vaccine (Indian Immunologicals Limited)  
Picture 3: Pork infested with cysts (Michel Dione/ILRI)

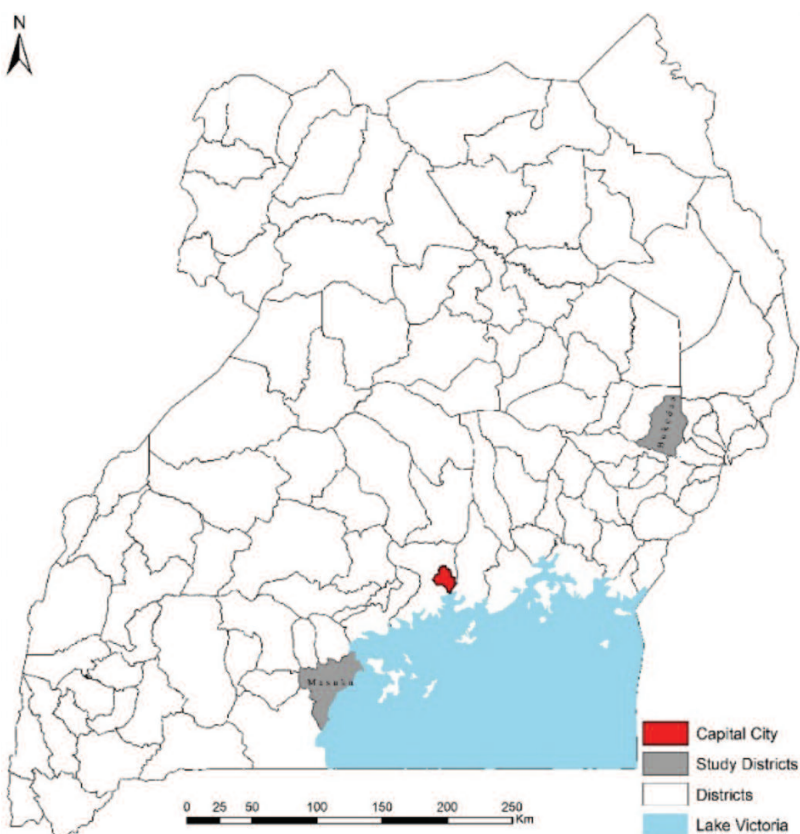
**Figure 1:** Life cycle of *T. solium* cysticercosis (source: CDC-DPDx: <https://www.cdc.gov/dpdx/cysticercosis/>).



# Different studies undertaken

It is difficult to estimate demand for products that are not yet marketed. For this reason, we conducted a range of studies in different sites with different actors. Eight separate market scoping studies took place in Uganda's Masaka, Kampala and Bukedea districts (Figure 2). Masaka was selected because it has the highest pig population density in Uganda, Bukedea was selected because it is a site for the GALVmed PC vaccine field trials and Kampala was selected because it has highest number of pork consumers in the country. The studies targeted at different nodes of the pig value chain:

- Farmers' willingness to pay for TSOL18 vaccine and oxfendazole
- Traders' willingness to pay for porcine cysticercosis-vaccinated pigs
- Consumer perceptions on porcine cysticercosis-free pork
- Consumers' preference for safe food from animal source
- Therapeutic product profiling
- Service providers' willingness to sell the TSOL18 vaccine and oxfendazole
- Potential for large drug distributors to market TSOL18 and oxfendazole
- Stakeholder consultation



**Figure 2:**

Map of Uganda showing the study sites

# Different studies undertaken

## Characteristics of TSOL18 and oxfendazole

**TSOL18 vaccine (Cysvax™):** Containing the *T. solium* oncosphere antigen (TSOL18), 150 ug/ml adjuvanted with mineral oil.

- Dose of 1 ml per pig administered by intramuscular injection (deep intramuscular injection behind ear).

**Oxfendazole (Paranthic 10%™):** Containing 10% w/v oxfendazole, oral suspension. Dosage of 3 ml/10kg body weight (30 mg/kg) administered orally (by drenching) concurrently with the vaccine primary and booster vaccinations, as well as re-vaccination to treat infected pigs.

- The TSOL18 vaccine is effective when both primary and booster vaccines are applied.
- Primary vaccination is given to pigs at least 2 months old.
- Booster vaccine can be given from three weeks after the primary vaccine.
- Immunity in pigs develops within two weeks of the booster dose.
- Re-vaccination is needed six months later if the pig is still on the farm (not yet sold).
- The vaccine is not thermostable and needs to be stored and transported at temperatures between 2°C and 8°C (thus requiring a cold chain).
- The withdrawal period for the vaccine is zero days, but oxfendazole requires a withholding period of 21 days.



# Results

The market scoping exercise was informative. Key findings include:

## Farmers willingness to pay for PC vaccine

Farmers indicated a willingness to pay US\$0.4 more for every additional dollar in price per pig (approximately of 40kg liveweight). This suggests that without a premium price for vaccinated pigs, uptake by farmers may not succeed. The choice experiment showed few of farmers (only 19%) selected the option of the vaccine with its current combination of attributes and were only willing to pay US\$2.6 per pig (including administration costs). They were willing to pay US\$1.7 more for a vaccine administered once versus three times. Many farmers (38 – 50%) selected choices options that had combinations of improved attributes of the vaccine and a higher price premium of vaccinated pigs. They were willing to pay between US\$12.0 and US\$17.0 for this combination (which does not currently exist).

## Trader's pig attribute preferences

Awareness about PC was high among pig traders who said they refuse to purchase pigs suffering from PC. Other studies, however, show that pigs affected with PC are bought by traders. Results show that the traders' most preferred attribute for pigs was liveweight, although they also reported concerns about consumer health. Weight gain can be enhanced through appropriate deworming regimes such as through the use of oxfendazole, although genetics and diet are probably more important determinants of weight.

## Consumers' perception of safe food

Consumer focus groups considered hygiene as the most important way of ensuring that pork is safe for consumption. They also noted willingness to pay more for pork certified to be PC-free as long as their safety is guaranteed. However, in a real-life proxy experiment using eggs rather than pork, when consumers had the option to buy eggs with different attributes, purchases were not driven by food safety. Although consumers may be aware of safe foods, they prefer products with taste, price, and accessibility benefits over those certified for food safety.

## Potential for market entry for oxfendazole

There appears to be substantial demand for livestock de-wormers in Uganda, and the market for de-wormers is relatively crowded. Animal health service providers preferred ivermectin, while farmers preferred levamisole and albendazole. Albendazole and Erafen 5 (active ingredient fenbendazole) are potential competitors for oxfendazole (note that neither have good efficacy against PC). It will be hard for oxfendazole to penetrate and capture market shares for pig deworming given that most other drugs are cheaper per dose than Paranthic 10%™ (active ingredient oxfendazole), an important consideration for farmers. Some are also more effective at managing other parasites which farmers are concerned about (e.g. ivermectin is effective against mange). Even though oxfendazole is comparatively expensive, there is an opportunity for it to capture some market share because it is a broad-spectrum de-wormer as well as being effective against PC. For the TSOL18 vaccine-oxfendazole combination to be competitive (viewed simply as a de-wormer), it should be priced between US\$1.6 and US\$6.0, per the drug stockist scoping study. However, the fact that the vaccine and de-wormer are not packaged together makes the combination unattractive to distributors because of anticipated challenges in acquiring both products at the same time when needed.

## **Market opportunities for TSOL 18 and oxfendazole**

About 1.1 million households' rear pigs in Uganda (UBOS and MAAIF, 2009). The survey also indicated that 68% of pig farmers deworm at least twice per year. The farmers that deworm are more likely to take up the vaccine since they can afford deworming, which would mean that these 748,000 households would be suitable for targeting. Districts with high PC prevalence would have higher penetration rates than those with low prevalence rates. Assuming a penetration rate of 1%, approximately 74,800 households would vaccinate their pigs. The highest market potential would be in Eastern Uganda (ex. Kumi, Iganga, Soroti, Kamuli, Mbale, Pallisa), with high the PC prevalence rates, which makes the prospect of vaccination attractive, although lower pig populations compared to the other regions such as those in central (ex. Masaka, Mukono, Wakiso, Luwero, Mpigi).

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## **Barriers for TSOL18 and oxfendazole market entry**

Some distributors in Uganda have exclusive agreements to distribute specific products from manufacturers. This type of agreement would be difficult to use in terms of the TSOL18 vaccine-oxfendazole combination, and some of these distributors have well-established sales routes and market share. The National Drug Authority has strict guidelines for registering vaccines that can sometimes be cumbersome. Additionally, farmers' poor attitude and lack of awareness about vaccination (especially pigs) is one of the biggest barriers. This can be illustrated by the case of free rabies vaccines that are also not readily taken up by farmers. Farmers are more used to deworming their pigs, and it is a cheaper option compared to the TSOL18 vaccine, meaning farmers might not use the vaccine since its price is high compared to conventional dewormers.

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## **Private vs Public good**

The 'added value' of the PC vaccine seems to be public health benefits rather than economic benefits, with the deworming component providing some economic benefits. Thus, the vaccine needs to be sold as a product solving a public health need. This would mean that there is a need to demonstrate PC correlation with cases of epilepsy in humans in Uganda to persuade policymakers. In the meantime, since deworming is an acceptable and routine animal husbandry practice, the value proposition could focus on reducing deworming times (though the vaccine only fights one type of worm). Another idea is to combine the vaccine with other vaccines for pig diseases of higher concern to farmers (such as African swine fever); for this, it would be imperative to rely on the private sector since the bulk of veterinary vaccination is through this sector, which has an established distribution mechanism.



# Conclusion

The efficacy of the TSOL18 vaccine has been demonstrated in technical studies. It has also been demonstrated that oxfendazole is effective against the cysts stage of the disease. However, in its current form, the TSOL18 vaccine-oxfendazole combination is not likely to achieve desirable market penetration as a private good. Substantial adoption of PC vaccine will require an integrated approach that will put the farmer at the center while considering other value chain actors. Long term education of value chain actors about the public importance of the disease, backed up with economic incentives such as marketing opportunities for quality animals can substantially improve adoption. Furthermore, a 'One Health' approach – Public Private Partnership forum for stakeholder engagement is necessary with the Government supporting intervention measures.

## Recommendations

**Product manufacturer:** Further development of the vaccine is needed to make it more cost-effective and reduce the number of injections required to achieve immunity. A smaller packing size of oxfendazole (ex.10 ml) would also be preferred. Other areas for development are inclusion of a viability marker and development of a thermos-stable vaccine.

**Drug distributors:** They should be supported (e.g. subsidized) by the Government to import the product, if this approach can be shown to be effective and cost-effective. Government should work hand-in-hand with the distributor to make the product accessible to farmers. There is also need to proactively build farmer's trust in drug distribution system and vaccine use. Market entry of oxfendazole should be accompanied by advertisement to show why oxfendazole is superior to the potential competing products.

**Animal health service providers:** They are the major source of information for farmers and should be involved in awareness campaigns about PC. They should also be trained in disease recognition and management of affected pig carcasses.

**Farmers:** The product packaging and cost of the TSOL18 vaccine and oxfendazole combination should be reduced so that farmers have easy access to it. Farmers should be sensitized about the effects of the disease on pigs and its public health importance.

**Traders/butchers:** this category of actors can be change agents, because they are highly connected to pig farmers and know all trading networks. They also have high awareness about the disease. They should be trained on the effects of the disease in humans and policy regulations about the disease.

## Recommendations

**Consumers:** There is need for consumer sensitisation campaigns to enhance appreciation of safe food.

**Government:** A major role should be played by the Government. This includes: (a) engagement and support to promote the TSOL18 vaccine-oxfendazole combination, as well as to lead disease eradication by facilitating market regulation to enable product entry and market growth and enabling the distribution environment by enforcing regulation on disease control; (b) support mass sensitisation about the control of PC amongst stakeholders at all levels.

**Researchers:** there is a need to carry out socioeconomic impacts studies of the disease to generate evidence for decision-makers to justify funding. Studies on the productivity losses associated with pig parasites and the cost-benefit of different de-wormers would help identify the most suitable de-wormers under different circumstances and the appropriate private-public cost sharing. There is also need to generate evidence on the different options for managing PC and their comparative cost, benefit, and feasibility.

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