

Pig diseases in Uganda: Impacts on pig production, human health and nutrition

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Key messages

- High burden diseases, such as African swine fever (ASF), hinder the development of pig production, as do the low capacities of value chain actors and stakeholders in this area and the lack of incentives for them to adopt and implement disease control measures.
- Given the high socio-economic impact of ASF on pig systems in Uganda, vaccine development and pen-side diagnostic tools are urgently needed to control the disease.
- Advanced and field research are both needed to address these issues as part of efforts to transform and sustain the smallholder pig value chain in Uganda.

Background

Pig keeping is an increasingly important livelihood strategy for rural households in Uganda. Whereas pork accounted for only 1–2% of the 11–12 kg per capita meat consumption in the 1960s, it now accounts for at least one third of the current 10 kg/year (FAOSTAT). The 2008 Livestock Census reported that 1.1 million Ugandan households (17%) kept an average of 1–4 pigs each. Most pigs are kept by smallholder households—managed by women—under extensive systems. The pig value chain was included in the CGIAR Research Program on Livestock and Fish due to the growth potential and competitiveness of small-scale pig production in sub-Saharan Africa. Over the last five years, scientists have significantly enhanced their understanding of the composition, structure and workings of the Uganda pig sector.

This brief brings together some of the most compelling evidence and best practices in animal and human health control from research by the Livestock and Fish program in collaboration with the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH).

Addressing ASF

Serwada Jane—a mother of three young children and a pig farmer since 2008—lives in Masaka district in central Uganda. Her one sow is tethered and its piglets roam. Until 2011, she earned enough from the sale of adult pigs for slaughter to pay for her children's school fees and buy food for the family. In 2011 and 2012, ASF outbreaks wiped out her litter. Before restocking, she sought more information on ways to prevent and control ASF. She joined a training course on ASF biosecurity organized by the District Veterinary Office and the International Livestock Research Institute (ILRI). She also received leaflets on ASF prevention and control. Before restocking, she constructed a pig pen and reported any signs of illness in her pigs to the local veterinary authorities. Serwada did not lose any pigs in 2013, despite several suspected ASF outbreaks reported in her village.

African swine fever in Uganda

Endemic to Uganda, ASF is a hemorrhagic fever affecting pigs. On a farm, it can kill all the animals within a few days. ASF outbreaks often lead to serious reductions in the socio-economic status of pig farmers with income losses pushing them into severe poverty. This makes it one of the main hurdles to a sustainable pig sector in Uganda. Given the absence of a vaccine, biosecurity measures adopted along the pig value chain are the only ways to control the disease. However, a lack of knowledge on ASF-control and the absence of effective prevention and management strategies coupled with high risk practices result in disease outbreaks.

Empowering value chain actors to improve prevention and mitigation responses to ASF is thus key to disease reduction in domestic pigs. From the beginning of the Livestock and Fish Program's work in Uganda, value chain actors and stakeholders prioritized ASF prevention and control as a key intervention.

Understanding the issues

The starting point of the research was a participatory value chain assessment that identified opportunities and constraints facing pig farmers. Fast, cheap and inclusive, participatory appraisals, focus group discussions and key informant interviews helped scientists interact with communities and facilitated group discussion on animal health issues in rural livestock communities. Not surprisingly pig farmers considered ASF as the most important disease (due to associated high mortality rates) followed by gastrointestinal worms and sarcoptic mange mites (Dione et al. 2014).

Various follow-up studies examined the prevalence of priority diseases to farmers, as well as manageable risk factors. National and international partners collected specimens on a range of different pathogens, some of which had never before been studied in Uganda (Alonso et al. 2016). Pathogens were selected based on their ability to act as a marker for farm-level biosecurity, yet-to-be researched pathogens which provoke clinical signs similar to those described by farmers in their pig herds, or pig zoonoses on which there was limited data available.

Findings showed evidence of healthy pigs carrying the ASF virus (Akol et al. *in progress*) and underlined positive correlations between the occurrence of ASF outbreaks and the prompt disposal of dead pigs on farms, the presence of wild animals and sourcing of drugs from stockists by farmers. Particularly important was the lack of compensation for ASF-related pig losses, prompting farmers to sell their pigs in response to rumours of outbreaks (Dione et al. 2015).

Findings also revealed that infection with gastrointestinal parasites is common in smallholder pig farms in Uganda. Almost two thirds of the pigs examined were infected with one or more of the parasites studied, predominantly strongyles followed by *Coccidia*. The most significant risk factors identified are relatively easy to control at farm level, such as litter and manure removal, and routine disinfection. These biosecurity-related practices may not only be effective against productivity-inhibiting parasites, but also against pathogens, such as ASF and respiratory pathogens (Roesel et al. 2016a).

In addition, samples were tested for salmonellosis (Tinega et al. 2016; Ndoboli et al. *in progress*), brucellosis (Erume et al. 2016), trichinellosis (Roesel et al. 2016a), toxoplasmosis (Roesel et al. *in progress*), as well as common zoonoses such as cysticercosis (Kungu et al. 2016) and trypanosomosis (Roesel et al. *in progress*). Research was also undertaken on diseases specifically mentioned by farmers during the rapid value chain assessment, such as diamond skin disease caused by *Erysipelothrix rhusiopathiae* which mostly affects handlers of raw pork, e.g. butchers and cooks (Musewa et al. *in progress*). Leveraging partnerships with organizations with strong laboratory capacities, scientists are carrying out further testing of pathogens using more sensitive assays.

Another serological multi-pathogen survey established high seroprevalence for *Streptococcus suis* and *Leptospira* spp., but also indicated the importance of porcine circovirus type 2, *Actinobacillus pleuropneumoniae*, *Mycoplasma hyopneumoniae*, Influenza A and porcine parvovirus. Porcine reproductive and respiratory syndrome virus and Aujeszky's disease virus were

less common. Observed patterns of multiple infections, related risk factors, biosecurity perceptions and practices of farmers provide important entry points to improve production systems and reduce the economic impact of common pig pathogens (Dione et al. 2016).

Further investigating ASF epidemiology, molecular characterization of ASF viruses has been used to track viruses causing outbreaks, helping understanding of spatial the temporal relationships between them (Bishop et al. 2015). This is not only important in tracking movement of the viruses, it helps recognize new ones, indicating a breach in transboundary disease control. The studies identified ASF transmission paths and nodes using social networks analysis (Lichoti et al. 2016) and have enhanced understanding of the role of pig value chain actors in transmitting ASF between farms. Farmers clearly sell sick pigs to other value chain actors, spreading the disease over long distances, including across international borders.

Combining knowledge and data from the various studies it was possible to estimate disease transmission dynamics using geospatial mapping and mathematical modelling to assess likely effectiveness of ASF control strategies (Barongo et al. 2015), providing evidence for national and international partners to conduct targeted surveillance of pig diseases, including important zoonoses. The evidence generated has also informed the development of an ASF control strategy for Africa.

To control all the identified pig diseases, project scientists also sought to understand the knowledge, attitudes, practices, capacities and incentives of value chain actors. This research revealed that traders were perceived to have the highest risk for ASF transmission. This suggests that while ASF biosecurity control interventions should target all value chain actors, more emphasis should be placed on post-farm nodes, especially trading (Dione et al. 2016b). Nantima et al. (2016) conclude that the adoption of specific biosecurity practices by smallholder farmers requires institutional support. There is, therefore, a clear need for government authorities to raise awareness of biosecurity practices among farmers so they actively participate in the design, planning and implementation of such practices, leading to enhanced adoption.

Just understanding the roles of different actors is insufficient for disease control, it is also necessary to understand intra-household dynamics. Gender research demonstrated the importance of involving the whole household in disease prevention and control activities, and particularly women in preventing the spread of zoonotic diseases. Women tend to take responsibility for home and farm duties, such as cleaning the compound and pigsties, feeding and watering pigs. Socio-cultural factors influencing the participation of men and women in pig husbandry training were identified. Research also pointed to the need to promote interventions which enable women to participate in the market, gain access to financial resources, and enhance investment in biosecurity (Dione et al. 2016a).

Research also found a strong association of viral infections with pig breeds, offering opportunities to produce ASF-tolerant breeds that can better survive outbreaks and provide subsequent replacement stock (Mujibi et al. *in progress*).

Diagnostics and vaccines

Reliable diagnostic tools are key to the rapid containment and management of disease outbreaks. Scientists in the Program thus helped validate ASF diagnostic tests developed by international partners. The value of properly validated diagnostic tests was highlighted in a cross-sectional study that included outbreaks areas but did not reveal samples with ASF antibodies (Gallardo et al. 2013). Scientists also evaluated the use of a rapid diagnostic approach using TETRACORE commercial real time PCR (Zsak et al. 2005; Leblanc et al. 2013). The test is applicable at the point of care and has proved useful in early confirmation of outbreaks in Kenya and Uganda.

In the absence of an ASF vaccine, the Program worked with Friedrich Loeffler Institute scientists on several vaccine development approaches. Attempts were made to generate an attenuated vaccine by changing the genetic code slightly, reducing the virulence of a pathogen, but still keeping it alive. This approach, however, was more difficult than expected and requires more work.

Instead, two modified viruses were developed—in two different genotype backgrounds, genotype I and genotype IX—based on the deletion of gene CD2v, a gene involved in the attachment of the virus to the host cells. The modified viruses are now ready to be tested in animal experiments. In preparation for these experiments the necessary laboratory methods for immunological and virological ASF work were optimized, which included developing an animal model using a Kenyan genotype IX isolate. Scientists also designed a way of inducing immunity to the same virulent strain by using a sequential immunization schedule with increasing doses. Five pigs treated in this way were rendered immune when subjected to a lethal dose of ASF virus. This new way of inducing ASF immunity could be very useful as it has been reported that attenuated viruses sometimes change disease patterns and immunological responses.

In parallel, scientists defined the immune responses to a Kenyan ASF isolate and have sequenced new indigenous pig MHC class I molecules¹ (Ilsoe et al. *submitted*) which bind the T-cell epitopes². This MHC-peptide complex is then recognized by the immune cells (T-cells). The MHC class I molecules have never been defined in indigenous pigs in Africa, so this is important in developing vaccines comprising particular proteins/genes. An additional 33 pig samples are currently being sequenced.

Capacity development

Based on findings from the various assessment studies, scientists and partners focused on action research and capacity development interventions to address challenges and generate evidence for wider application. Best-bet interventions have been identified, some of which were piloted, and include the application of biosecurity protocols at farm level to control ASF outbreaks and other pig diseases, and capacity building of butchers on appropriate pork slaughter and hygiene. An evaluation was undertaken to assess the effectiveness of the interventions against target indicators, such as changes in knowledge, attitudes and practices. It also identified and documented important

learning experiences for both wider applicability in the value chain and for use in future projects. Key impacts were³:

Training farmers in improved husbandry and biosecurity practices for ASF control: Capacity building interventions for farmers on ASF biosecurity were initiated in 2015. Baseline data was collected in 2015 and randomized control trials undertaken in Masaka and Lira districts, covering 960 farmers, equally divided between treatment and control groups. Two rounds of training were organized for farmers from the treatment group using ASF biosecurity training materials, and monitoring and end-line surveys were conducted in 2016 to assess changes in farmer knowledge, attitude and practices. The training in ASF control was effective in increasing knowledge of farmers on best practices for biosecurity. Farmers learned how to diagnose, prevent and control the disease. Although the application of recommended biosecurity measures differed considerably among individuals, most farmers implemented the practices and avoided further ASF contamination. More importantly, the training tackled negative perceptions about ASF control. Communities have been made aware that there is no cure or treatment for the disease, and they are increasingly willing to take preventive action. However, the associated cost and poor enforcement of ASF control regulations remains a challenge. To ensure sustainable behavioural change, the relevant authorities were advised to incorporate this training into their district extension activities (Dione et al. *in progress*).

Training butchers on appropriate pork slaughter and pork handling: Working closely with A4NH, scientists and partners organized workshops in 2015 to build the pig slaughter and meat handling capacities of pork butchers in Mukono district. Refresher workshops were conducted in 2016 and monitoring surveys undertaken to assess changes in knowledge, attitude and practices. Findings show that the training enhanced hygiene, carcass handling and biosecurity practices. The butchers who were trained are now aware of good hygiene and sanitation, including personal hygiene. They also know how and what to do when they come into contact with sick pigs or abnormal pork. Individually however, the application of biosecurity practices varies. Meat inspection and hygiene regulations are instrumental to sustain outcomes (Dione et al. *in progress*).

Pilot intervention study on the use of biogas to improve biosecurity and food safety. Management of the only pig slaughterhouse recognized by Ugandan authorities has for long been negatively affected by waste management problems. Bulk slaughter waste is largely disposed of in public waterways, or incinerated in a waste pit, further contaminating the air and posing great risk to public health and biosecurity. A biogas system was piloted for sustainable use of slaughterhouse waste and to meet energy needs of the abattoir. Its impact on pork safety is being monitored using biological indicators, such as the burden of a defined set of pathogens (*Salmonella*, *E. coli*, *Cryptosporidium*, *Giardia*, *Ascaris*). Slaughterhouse staff have been trained on basic hygienic practices. While the biogas plant has immense potential to resolve both the energy needs and waste management problem at Wambizzi, further regular training of staff is needed to reduce the public health risks (Roesel et al. 2016b; ILRI 2016).

¹ MHC molecules are tissue type antigens (SLAs) from pigs) which bind the T cell epitopes.

² T cell epitopes are small segments of a protein seen by the immune system. The immune system either reacts to or kills the infected cells when T cell epitopes appear on the surface of the cells.

³ ILRI produced a series of training manuals on different aspects of pig production and health. Anecdotal evidence indicates these materials have been useful to stakeholders. For instance, Pig Production and Marketing Ltd., a private sector partner, reported it was using the manuals in its training to pig farmers in Uganda.

Lessons learned

- a. The lack of incentives for disease reporting contributed to higher than necessary levels of losses. Incentive-based technologies for disease reporting, such as a mobile slaughter unit that purchases diseased pigs from farms at market price, should be tested. Further, the impact of training on value chain actors (i.e. effect of training, branding and certification) needs to be followed up, as well as identifying incentives for behavioural change.
- b. *Ex-ante* analysis studies of interventions to assess the willingness of value chain actors to adopt biosecurity protocols, as well as the potential socio-economic impact of a vaccine against ASF, should be carried out before rolling out any protocols and vaccines.
- c. Phase I of the CRP deliberately focused on ASF and parasite control, as these infections were identified as principal constraints by farmers and value chain stakeholders. Future research should also seek to gain a better understanding of the impact of other pathogens, productivity and public health-related zoonotic and non-zoonotic diseases. This could adopt a herd health approach and incorporate an analysis of the economic impact of these diseases.
- d. Gender was well mainstreamed in the research and able to influence interventions and protocols. It is recommended that gender research should continue to be taken into account in all activities to enable interventions reach most vulnerable community members, such as women and young people.
- e. Fruitful cross-CRP collaboration and a wide range of effective partnerships facilitated key outputs, such as a clear picture of the burden and impact of pig diseases in Uganda.

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