



Qualitative analysis of the risks and practices associated with the spread of African swine fever within the smallholder pig value chains in Uganda



Michel Dione*, Emily Ouma, Felix Opio, Brian Kawuma, Danilo Pezo

International Livestock Research Institute, P.O. Box 24384, Kampala, Uganda

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ABSTRACT

A study was undertaken between September 2014 and December 2014 to assess the perceptions of smallholder pig value chain actors of the risks and practices associated with the spread of African swine fever (ASF) disease within the pig value chains. Data was collected from 136 value chain actors and 36 key informants through 17 group discussions and two key informant interview (KII) sessions respectively using Participatory Rural Appraisal (PRA) tools.

Results from this study revealed that according to value chain actors and stakeholders, the transporting, slaughtering, and collecting/bulking nodes represent the highest risk, followed by the inputs and services (feeds and drugs) supply nodes. The processing, whole sale and consumption nodes represented the lowest risk. Value chain actors are aware of the disease and its consequences to the pig industry, however biosecurity measures are poorly implemented at all nodes. As for the causes, value chain actors pointed to several factors, such as inadequate knowledge of mechanisms for the spread of the disease, poor enforcement of regulations on disease control, and low capacities of actors to implement biosecurity measures, amongst others. Although traders, butchers and veterinary practitioners accepted that they played an important role in the spread of the virus, they did not perceive themselves as key actors in the control of the disease; instead, they believed that only farmers should adopt biosecurity measures on their farms because they keep the pigs for a longer period. Most of the recommendations given by the value chain actors for controlling and preventing ASF disease were short term, and targeted mainly pig producers. These recommendations included: the establishment of live pig collection centres so that traders and brokers do not have to directly access pig farms, capacity building of value chain actors on application of biosecurity, enactment and enforcement of by-laws on live pig movements and establishment of operational outbreak reporting mechanism at district level. Long term recommendations included the development of a vaccine, as well as pen-side diagnostic tests. This study suggests that interventions to control ASF disease through application of biosecurity measures should target all value chain nodes, while putting more emphasis on post-farm nodes especially the trading.

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1. Introduction

In Uganda, pork has become increasingly important over the past three decades; from 1985 to 2005, pork production had increased tenfold. Whereas in the 1960s pork accounted for only 1–2% of the 11–12 kg per capita meat consumption per year, it

now accounts for at least one third of the current 10 kg/person/yr (FAOSTAT, 2010). As with other livestock, keeping pigs helps both rural and urban households diversify their income, reduce financial risk and improve livelihood security. Pigs also serve as a source of cash in times of need, e.g. for household repairs, school fees, the leasing of agricultural land or purchase of seed, fertilizers and other farm inputs (Deka et al., 2007).

However, in Uganda, several constraints limit the productivity and development of the pig sector. These include the high burden of ASF disease and parasite infection, poor husbandry practices, limited capacities of farmers with regard to pig management, poor feeding practices, and limited access to veterinary services (Dione et al., 2014b). ASF has been prioritized by value chain actors and

* Corresponding author at: International Livestock Research Institute c/o Bioversity International, P.O. Box 24384, Kampala, Uganda.

E-mail addresses: M.Dione@cgiar.org, dionemichel@gmail.com (M. Dione), E.A.Ouma@cgiar.org (E. Ouma), opiofelix505@gmail.com (F. Opio), B.Kawuma@cgiar.org (B. Kawuma), pezodanilo@yahoo.com (D. Pezo).

stakeholders as the most important disease constraint in the pig industry in Uganda, because of the high pig mortality and morbidity rates it provokes (Dione et al., 2014b; Ouma et al., 2015). The disease is endemic in Uganda; with outbreaks occurring annually throughout the country (Muhanguzi et al., 2012; Atuhaire et al., 2013). Several smallholder farmers have abandoned the pig business due to a lack of capacity to re-stock their farms after an outbreak of ASF (personal communication from Masaka District Veterinary Officer). Furthermore, the absence of a vaccine and treatment has made the disease more difficult to control. In Uganda, it has been reported that the domestic cycle (pig-to-pig contact) is the main channel for the spread of the ASF virus (Tejler, 2012; Penrith et al., 2013); this suggests that current control measures should focus on the application of biosecurity measures along the pig value chain. However, given the complexity of the value chain with several actors involved in different activities at different nodes and times, a successful control strategy is difficult to implement. Added to that, most actors do not know to what extent they contribute to the spread of the disease through their practices. A better understanding of the roles of each actor in the value chain in relation to ASF disease can help gaining useful knowledge to design appropriate interventions for its control.

The objectives of this study were to assess the perception of smallholder pig value chain actors in regard to the risk of ASF disease; document key management and operational procedures that have the potential to affect the spread of the disease along the value chain; and to allow value chain actors and stakeholders identify approaches that could contribute to the reduction of the risk of ASF.

2. Materials and methods

2.1. Site selection

Since 2012, the International Livestock Research Institute (ILRI) has been implementing a Research for Development program aiming to sustainably improve food and nutritional security for poor households, improve livelihoods for value chain actors and better performance of smallholder pig value chain systems in Uganda (Pezo et al., 2014). The project is part of the CGIAR Research Program on Livestock and Fish. Five districts were purposively selected to serve as pilot sites for this program. The selection process for these districts was described in detail elsewhere (Ouma et al., 2015). In this study we focused on understanding the practices of value chain actors and their perception of the risk of ASF in the value chain. For that, two districts out of the five were purposively selected: Masaka district, located in the central region which has the highest pig population density in the country (>50 heads/km²) (UBOS, 2009); and Lira district, located in northern Uganda with a lower pig population density than Masaka, but constituting a large market for pork from Gulu, an adjacent district with high pig population and frequent devastating outbreaks of ASF (Fig. 1). ASF disease is endemic in both districts with several outbreaks occurring throughout the year (Atuhaire et al., 2013). Seven sub-counties that reported most cases of ASF to their District Veterinary Office were respectively selected in Masaka and Lira (Table 1). Given the fact that outbreak reporting is not systematic and consistent in these regions, in order to validate the choice of these locations, some key informants such as the para-veterinarians and lead farmers were consulted.

2.2. Participants' selection

An already existing pig value chain map of the study areas was used to identify all actors who took part in this study (Ouma et al., 2015). In each sub-county, value chain actors (pig

Table 1

List of sub-counties from where the actors were selected.

Lira	Masaka
Adekokwok (R)	Kyesiiga (R)
Barr (R)	Kyanamukaaka (R)
Ojwina Division (U)	Buwunga (R)
Ayago (U)	Kabonera (R)
Central Division (U)	Kimanya-Kyabakuza (U)
Adyel Division (U)	Katwe-Butego (U)
Lira Sub-county (U)	Nyendo-Ssenyange (U)

R = rural production; U = urban production.

Table 2

Value chains actors that participated in the study in Masaka and Lira districts.

Value chain actors	Masaka	Lira	Total
Key informants	20	16	36
Veterinary service providers	7	8	15
Drug stockists	8	5	13
Feed stockists	5	5	10
Farmers (rural)	9	9	18
Farmers (urban)	–	7	7
Boar keepers (rural)	6	9	15
Boar keepers (urban)	5	8	13
Traders	12	12	24
Butchers	12	9	21
Total	84	88	172

producers, communal village boar keepers, traders, butchers, veterinary service suppliers, drug stockists and feed stockists) were randomly selected from lists generated by local partners in each participating district. In each category of actors, up to 12 individuals were invited to participate in the group discussions. Also, up to 20 key informants per district were invited for separate meetings. Key informants comprised of community and expert opinion leaders who had responsibilities related to livestock in the district or were knowledgeable about pig production in their localities. Among these were District Veterinary Officers, local council members, area veterinary officers, District Commercial Officers, District Production Officers, sub-county police officers, pig farmers cooperative leaders, women leaders, community youth leaders, butcher and trader association leaders as well as representatives of NGOs working in the livestock sector. A total of 172 value chain actors and key informants participated in the interviews (Table 2). All participants were formally invited to participate.

2.3. Development testing and validation of the interview guide

Data was collected using a checklist developed through working group consultations. The tools were developed by the researchers and reviewed by a panel of experts for content validity. PRA tools such as listing and ranking were used as described by Catley et al. (2012). The thematic areas addressed in the interview were as follows:

(1) *Perception of actors on the risk of ASF and practices associated with its spread along the value chain*

Listing and ranking using proportional piling were carried out by value chain actors in order to apprehend the risk for ASF at each node of the value chain. Participants were then asked to justify their ranking by describing actors' practices that enhance the spread of the disease. They were also taken through a self-evaluation to help them identify common behaviours and habits of theirs or their peers, which directly or indirectly contributed to increased risk of the disease spread.

(2) *Constraints faced by value chain actors in the control of ASF*

Ranking using pairwise comparisons was carried out to guide participants through the identification of the main constraints to

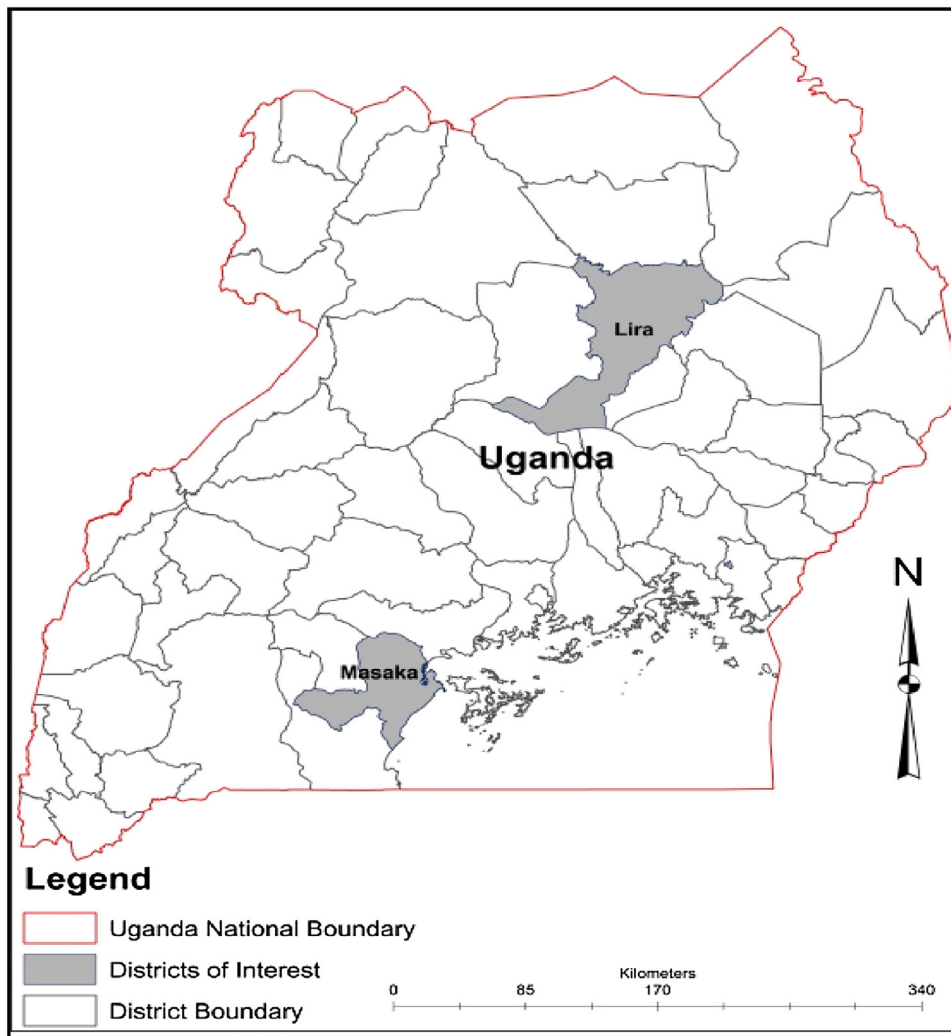


Fig. 1. Map of Uganda highlighting the districts of interest.

the prevention and control of ASF outbreaks. Five major constraints were selected by each group and reported.

(3) Recommendations of actors and stakeholders on ASF disease control

Participants were asked to discuss and recommend possible biosecurity measures against ASF, listing them and ranking them by consensus according to their effectiveness, ease of implementation and economic feasibility. For these parameters, the scale was high for positive ratings (i.e. very easy, very effective, very feasible), and low for negative ratings (hard to implement, ineffective, or expensive). Timelines were tagged to these measures illustrating how soon they could be implemented. The scale here was associated to short (for 0–3 years), medium (3–5 years) and long term (more than 5 years).

The interview checklists were further pre-tested in two villages of the study sites in order to assess their adequacy and applicability. The field testing exercise also helped to test for clarity and the logical flow of the questions and duration of the interview. Tools were refined and adjusted following field testing before data collection.

2.4. Identification and training of facilitators and note takers

Facilitators and note takers were identified in each district and trained by the research team to lead the group discussions in local dialects (Luganda in Masaka and Luo in Lira). Most of them had

taken part of previous ILRI project activities in their respective districts. This had exposed them to using PRA tools and interacting with the community more frequently. All facilitators had training background either in animal production, animal health or agriculture, and were either employed by the local government or engaged in own private agricultural related business.

2.5. Interview process

The meetings were carried out in the form of half-day workshops. Group interviews were organized with mixed gender groups categorized by type of actor, with each group having 5–12 participants except the key informants groups which were composed of 20 and 16 individuals. In each district, one day was reserved for the KII and two days for the group discussions with value chain actors. After each session, a plenary was organized with all the actors to discuss general issues on the control of ASF. In each group, a facilitator and a note taker were appointed to lead the discussions.

2.6. Data collection and analysis

Data quality was ensured through thorough training of enumerators and using enumerators who were proficient in the local dialects. Each group discussion lasted 5 h on average. Field note takers captured the discussion in the local dialects, translated into

English and then turned into the electronic version before the following group discussion. Team debriefs were held every day after the data collection exercise to share lessons and challenges so as to ensure a uniform interpretation of the questions.

Analysis of data involved extraction and linking information on the key aspects of the study. Collected field notes including transcribed interviews were compressed and sorted by key categories. Raw data was analyzed using conceptual matrices to facilitate identification of themes and patterns. For the interpretation of the ranking between value chain nodes using proportional piling, 100 counters were used by participants to ease the rating process. During data analysis, the proportion of counters was translated into scores, then ranks. The more the counters, the higher the score was. Scores ranged from 1 to 9 depending on the number of value chain actors in the corresponding node, with 9 being the highest risk and 1 the lowest risk. Scores were then summed and their average calculated for all groups. The rank was given in accordance to the score obtained by each group. Within value chain nodes, the ranking was based on group consensus. Narratives on practices were reported across groups.

3. Results

3.1. Perception of value chain actors on own practices associated to the spread of ASF

According to value chain actors' and stakeholders' ranking, the transportation, slaughter, and collection/bulking nodes represented the highest risk, followed by the input supply and services nodes. The processing, wholesale and consumption nodes represented the lowest risk (Table 3). Within the trading node, brokers and live pig traders were perceived as posing the highest risk, while at the slaughter node, backyard slaughterers were perceived as posing the highest risk. At the input supplier node, communal village boar breeders were perceived as posing the highest risk, followed by veterinary service providers and pig producers (Table 4). The roles of value chain actors in the spread of ASF as perceived by themselves are described below:

3.1.1. Piglet and grower producers

According to value chain actors, a number of farmers leave their pigs free to scavenge for feed, and this practice exposes pigs to diseases (Fig. 2). During an ASF outbreak, farmers attempt to get rid of their pigs by selling them in order to avoid economic losses due to mortality associated with the disease; this is referred in the manuscript as "panic sales". Farmers can also move pigs between farms or villages without movement permits. In urban and peri-urban areas, feeding pigs on non-processed swill was commonly reported and was also considered a potential source of transmission of ASF, especially for confined pigs. The risk associated with spread of ASF has been aggravated by a tendency of some individuals, including both pig keepers and non-pig keepers, to consume the carcasses of pigs that have died of ASF disease. Some farmers reported that carcasses of pigs that succumbed to unknown diseases were smoked before consumption by some community members, assuming that such meat treatment kills all germs and makes the meat safe for consumption. In case a member managed to bury the dead pig, some people would still use dogs to trace the buried carcasses, exhume them and prepare them for consumption, later disposing of the non-edible parts in places accessible to stray dogs. In Lira district, malicious actions such as leaving bones or meat of pigs which had died of ASF near neighbouring properties or places where roaming pigs and stray dogs could easily access them so as to intentionally infect neighbours' pigs, were widely reported. These practices were characterised as malice. It

was also noted that most farmers did not restrict entry into their piggery units by traders and other visitors. Furthermore, during the handling of animals, farmers and traders did not wear protective gears. Practices such as getting pork on credit and paying for pork especially from pigs that had just died were reported. Some farmers were accused of selfishness when they knowingly let their pigs scavenge, hence destroying fellow farmers' enterprises. In some areas, farmers attributed ASF outbreaks to acts of witchcraft by other communities, thus they did not take appropriate action to control the disease. Hatred among communities emanating from past conflicts in Lira has been largely responsible for bad behaviour, according to some key informants.

3.1.2. Communal village boar breeders

Most smallholder farmers do not have a boar in their own herd and artificial insemination is not common; therefore, most farmers rely on communal boars for breeding. According to these actors, boar sharing is a common practice that can significantly contribute to the spread of ASF. Moreover, due to the limited availability of improved boars in the community, very few are used to serve several sows from different farms. Sows are usually taken to the boar for mating; however, the boar could be transported to a client's farm if many sows need to be serviced. In all cases, animals are rarely inspected to establish their health status. Therefore, it is likely that sick sows or boars take part in mating, increasing the risk of spreading the disease.

3.1.3. Live pig traders, brokers and transporters

This category of actors was described by all value chain actors and stakeholders as the most likely cause of the spread of ASF. Due to their numerous movements and the absence of effective control of animal movements, live pig traders could transport infected pigs across several villages, spreading the virus on their way. There are no centralized live pig markets, hence traders often use hired vehicles, such as motorcycles for transporting pigs (Fig. 3). The same hired motorcycle could frequently transport live pigs and people on the same day without first being sanitized. When outbreaks occur, traders move more, visiting several farms in a day so as to buy pigs at a reduced price. They usually take advantage of the outbreak to impose lower prices on farmers, leaving them with no choice but to accept their offers. In Masaka district, some traders said that they check the temperature of the targeted pig by appending their fingers to the bottom of its ear; if they feel hot, they conclude the pig is sick and the price proposed to the farmer is drastically reduced. Because veterinary inspection of live pigs is very rare, traders buy and handle pigs of unknown health status. Reports from both districts indicate instances when traders circulate rumors of ASF outbreaks to instill panic among the farming community in order to lower pig prices, instigating "panic sales". After purchase, pigs sometimes stay at collection points for several days without treatment, huddled together. Leftover stock not sold for slaughter is often sold back to other farmers if the buyer makes a good offer. As they move across villages procuring pigs, the traders sometimes re-sell live pigs to other farmers if higher prices are offered. Some actors believe that traders are malicious and greedy, that they only care about making profit. Traders occasionally slaughter sick pigs in the villages in which they sourced them from and transport the meat to trading centres. This strategy is employed to hide the true health status of the purchased pig from butchers and consumers. In Lira district, farmers reported that there were instances whereby if they failed to agree on prices with traders, the latter would deliberately attempt to infect their pigs by dropping some parts of dead carcasses onto their farms in order to provoke an outbreak.

Table 3
Ranking of the perceptions of value chains actors regarding the risk of ASF between value chain nodes.

Value chain nodes	Key informants	Veterinary service supplier	Drug stockist	Feed stockist	Farmers ^a	Boar keeper ^a	Live pig trader	Butcher	Mean	Rank
Input supply and services	2.7	4.5	6.5	7.5	4.0	5.0	4.0	1.5	4.46	5
Pig production	2.7	5.5	5.5	7.5	4.7	3.8	2.5	3.0	4.40	6
Collectors/Bulking	3.0	5.5	4.5	7.0	5.3	6.0	9.0	6.5	5.85	3
Transportation	5.0	8.5	7.5	9.0	7.7	7.5	7.0	7.0	7.40	1
Slaughter ^b	5.3	6.5	6.0	6.0	7.0	7.5	4.0	6.5	6.10	2
Processing ^c	1.7	4.0	3.5	2.5	3.0	1.3	2.5	2.0	2.56	9
Wholesale (supermarket)	2.7	1.5	5.5	5.0	3.0	3.5	6.5	5.0	4.09	8
Retail (butchery)	2.7	4.5	4.5	3.5	5.3	5.5	2.5	7.5	4.50	4
Consumption	3.7	4.5	1.5	1.5	5.0	5.0	7.0	6.0	4.28	7

^a Average rates were used for the groups of farmers and boar keepers.

^b Backyard slaughter is most common.

^c Refers to formal processing.

Table 4
Ranking of the perceptions of value chains actors regarding the risk of ASF within value chain nodes.

Value chain nodes	Value chain actors	Mean score	Rank
Input supply and services	Boar service	7.8	1
	Vets and village vets	6.9	2
	Breeders	5.6	3
	Feed suppliers	4.5	4
	Veterinary service providers (including drugs)	3.5	5
	Private, government and para-vets	2.5	6
Production	Piglet producers	1.7	2
	Growers	1.9	1
Collection/Bulking	Traders (live pigs)	1.6	2
	Brokers	2.0	1
Transportation	Traders (live pigs)	1.4	2
	Transporters	2.2	1
Slaughter	Backyard slaughters	2.9	2
	Authorized Slaughter slabs	2.9	1
	Wambizzi abattoir ^a	1.5	3
Processing	Backyard butchery	2.4	1
	Processors, e.g. Fresh Cuts, Farmers' Choice ^b	1.5	2
Wholesale	Backyard butchery	2.2	1
	Pork joints ^c	1.5	2
Retailing	Butchers/pork joint	2.2	1
	Supermarkets	1.4	2
Consumption	Individual households	3.0	1
	Pork joints	2.6	2
	Restaurants	1.9	3

^a Wambizzi Cooperative Society is the only pig abattoir in Uganda, located in Kampala.

^b Fresh Cuts and Farmers' Choice are the best known pork processors in Uganda.

^c Pork joints are public places where pork is cooked or roasted and sold for consumption.



Fig. 2. Scavenging pig (credit: ILRI/Michel Dione).



Fig. 3. Pigs being transported by a trader from a rural area to an urban trading centre (credit: ILRI/Michel Dione).

3.1.4. Butchers (including pork retailers)

Pig slaughtering happens in backyards or in poorly constructed slaughter slabs with limited hygienic measures and poor pork handling practices, thereby leading to potentially unsafe pork (Fig. 4). Most butchers do not wear protective gear when slaughtering pigs, which makes them often at risk of contracting zoonotic diseases. The disposal of the slaughter waste and non-consumable pig parts is often not appropriate. Offal are commonly thrown in the bush where stray dogs readily access them. Dogs were described by butchers as being an important mechanical vector for ASF especially in urban areas. In cases where butchers detected sick pigs, they usually precipitated their slaughter. Ante- and post-mortem inspection is rare or non-existent in most sub-counties. Butchers pack the meat in bags and carry it on motorcycles to the trading centres; they frequently re-use the bags without disinfecting them. Some service providers, including those cleaning the slaughter slabs, declared that they were often rewarded in kind with body parts of sick pigs (head, hooves, offal). On occasion, pork retailers sell the meat of sick pigs at lower prices to attract more buyers.

3.1.5. Veterinary service suppliers (including village veterinarians and para-veterinarians)

Bad practices adopted by veterinary service providers included inter-farm movements without proper biosecurity measures and the use of equipment (i.e. needles) on several animals without disinfection. Para-veterinarians reported that farmers did not always comply with recommendations given by them due to lack of trust in veterinary service suppliers, especially during outbreaks of ASF. In both districts, farmers reported that some veterinarians and para-veterinarians told them that they had vaccinated their pigs against ASF, yet they had actually administered de-wormers or antibiotics and no vaccine available for ASF. Because of the high cost of the veterinary drugs, equipment, and services, coupled by lack of trust by farmers in some veterinary service suppliers, farmers frequently treat their own animals, leading to more risk of disease spread.

3.1.6. Feed stockists

According to value chain actors, the role of feed stockists in spreading ASF is minimal. However, they could be a source of infection if contaminated bags were reused for storing feeds having been used on farms with an ASF outbreak. Feed ingredients could also be contaminated when mixing the feeds. All these practices represent

a source of dissemination of ASF as feed stockists do not usually apply biosecurity measures.

3.1.7. Veterinary drugs stockists

The risk of spreading ASF by drug stockists is minimal because they only sell the drugs at their stores and do not go to farms to administer treatments and their products are usually properly packed, as reported by the value chain actors. However, some drug stockists may sell drugs previously handled and contaminated by field veterinarians or farmers who had visited their shops.

3.1.8. Consumers (pork joint managers, individual households and restaurants)

These actors belong to the low risk category. Pork is usually consumed at local restaurants referred to in the manuscript as “pork joints” (Fig. 5). When the meat is fried or roasted, the risk of spreading the ASF is low because the meat is usually well cooked. However, homesteads might buy infected meat for home consumption and could feed their pigs on leftover meat and kitchen waste. Similarly, if disposal of waste in pork joints is poor, there is an increased risk of disseminating the virus if meat from an infected pig were sold in those places. Consumers are usually not aware of disease outbreaks, therefore can spread the virus to other locations while transporting pork products.

3.2. Main constraints faced by value chain actors in the control of ASF

Several constraints hindering successful control of ASF have been identified by the value chain actors. The most cited constraints include: inadequate knowledge on mechanism of transmission and spread of ASF, limited capital for investing in housing and equipment, poor quality of veterinary services, poor management practices of value chain actors, and a lack of law enforcement in relation to disease control. Table 5 shows the list of top five constraints cited by actors at each node of the value chain. Among these, the top five across all actors are narrated below.

3.2.1. Inadequate knowledge of farmers with regard to best practices in pig management

Value chain actors, especially farmers, reported that they had inadequate knowledge of the transmission and spread mechanisms of ASF, as well as the related control measures. Also lack



Fig. 4. Pork handling in backyard slaughter (credit: ILRI/Michel Dione).



Fig. 5. Roasted pork ready for consumption (credit: ILRI/Michel Dione).

of knowledge on feeding and breeding strategies were highlighted. According to most actors, these knowledge gaps were partly associated with the absence of technical support to the above actors from the local government, as well as low levels of education, particularly of farmers. Very few NGOs support pig value chain actors in Lira and Masaka districts. The few training workshops offered are usually short and sporadic, mostly targeting only pig producers.

3.2.2. Limited investment capacity of value chain actors

Most actors reported that there was little access to loans to support their businesses. For example, the construction of pig pens and purchase of the required amounts of feeds, disinfectants and means of transport require a substantial investment that most farmers would not be able to possess. This situation discourages these actors, they reported, from investing in their pig business.

3.2.3. Poor quality veterinary and public health services

Most value chain actors and stakeholders perceived the veterinary services systems as weak because of the scarcity of qualified veterinarians and the poor delivery of services, resulting in delays in responding during outbreaks. Participants declared that there were

Table 5
Major constraints to ASF control as reported by actors at each node of the value chain.

Value chain actors	Major constraints
Key Informants	Breakdown in extension services due to the NAADS ^a restructuring Less prioritisation of pigs by value chain stakeholders Inadequate land for keeping pigs Failure to observe National Animal Movement Act Corruption of support staff in the process of law enforcement
Traders	Unregulated pig movement (transportation of pigs without movement permits) Poor biosecurity at farm level Inadequate knowledge of ASF disease Unfavourable policies (taxes on pork joints ^b are high, other charges are prohibitive)
Butchers	Inadequate capital leading to poor management of pigs Abundance of stray dogs in the community Lack of a centralized slaughter place Lack of organized groups/associations Inadequate knowledge of ASF transmission
Boar keepers	Unregulated slaughters and absence of meat inspection Lack of knowledge by farmers on pig production Improper housing/confinement High demand for boar of good breed/good genetic potential Inadequate breeding centres Social contract ^c
Pork joints	High affinity of consumers for pork Inadequate inspection of butchereries Unethical practices such as sale of meat from sick pigs Limited knowledge of disease transmission including zoonosis Improper disposal of non-edibles pig parts and food waste
Pig producers	Inadequate knowledge of ASF disease transmission Poor veterinary services offered to farmers Inadequate land for keeping pigs Malice by some farmers who deliberately spread the disease High conservativeness (some farmers are reluctant to change practices and attitudes)
Feed stockists	Poor quality feed ingredients Lack of capital to erect structures Absence of feed ratios Lack of knowledge of nutritive value of feeds Absence of inspection and quality control of feeds
Veterinarians and para-veterinarians	Lack of knowledge of farmers about best pig husbandry practices Limited access to credit for business expansion Low number of veterinarians in the field/on ground Limited stocks of drugs Low levels of trust by farmers
Drug stockists	Absence of treatment and vaccine for ASF High cost of drugs Poor facilities for drug storage Low return on drug sales High taxes imposed of the animal drug business

^a National Agricultural Advisory Services (NAADS): is a semi – autonomous public agency within the Ministry of Agriculture Animal Industry and Fisheries, responsible for public agricultural advisory/extension services.

^b “Pork joint” is a small local restaurant where pork is communed.

^c Social contract refers to the fact that farmers cannot refuse visits from their neighbor because of strong community networking.

Table 6
Recommendations by value chain actors for better control of ASF and their perception of its applicability.

Domain	Recommendation	Disease control	Ease of implementation	Cost-Effective	Timeline
Biosecurity	Farmers to construct fences around their farms	High	Medium	Low	Medium
	Use of disinfectant footbaths on farm	High	High	High	Short
	Restrict visitors on farm	High	Low ^a	Medium	Short
	Boiling of swill before feeding to pigs	High	Low ^b	Medium	Short
	Regular disinfection and cleaning of pig pens and farm structures	High	Low ^c	High	Short
	Have separate feeds formulation unit for mixing ingredients	Medium	High	High	Short
	Avoid recycling of feed bags	High	High	High	Short
	Observe quarantine during disease outbreak	High	Low	Low	Short
	Install police check points to control animal movement	High	Low	Low	Long
	Arrange training on bio-security measures	High	Medium	High	Short
Awareness	Launch a campaign against ASF (seminars, radio talk shows, posters)	High	Medium	Low	Short
	Put signposts with guidelines for visitors (farmers, veterinarians and traders) at gates of farms	High	High	High	Short
Communal breeding	Create parish information centres	High	Medium	High	Short
	Each farm should have its own boar	High	Low ^d	Low	Short
	Promote artificial insemination	High	Medium	Low	Medium
Collective action	Stop village boar service, especially during ASF outbreak	High	Medium	Low	Short
	Strengthen the existing farmer and trader associations for collective marketing	High	Medium ^e	Medium	Short
Disease surveillance	Establishment of centralized slaughter places at parish level and abattoirs at district level	High	Low	Medium	Medium
	Establishment of village biosecurity teams.	High	High	High	Short
	Develop rapid diagnostic kits for ASF	High	Medium	Low	Medium
	Put in place and enforce pig by-laws (e.g ban sell of meat from dead animals; control illegal movement; guidelines for buyers and vets)	High	Low	High	Short
	Campaign to control stray dogs	High	High	High	medium
	Regulation of enforcement on input service providers (drugs and feeds)	High	Low	Medium	Short

^a This could be low considering beliefs and social norms.

^b It has an associated cost of fuel and labour.

^c The cost may limit its implementation.

^d The majority of farmers have fewer than three pigs, so they would not invest in having their own boar because of lack of high cost of maintenance.

^e There is lack of trust among groups.

few meat inspectors in both districts, leading to inadequate pork inspection during and after slaughter. Most of the pork consumed is perceived as being potentially infected by pathogens because of poor handling and processing practices. Most butchers admitted that they tended to operate informally.

3.2.4. Poor enforcement of policies and regulations related to disease control

Key informants felt that there was less prioritisation of the pig-gery sector by decision makers. There are regulations such as the Animal Movement Act of 1964 revised in 2015, but enforcement is poor in both districts; consequently, pigs are moved freely within and between districts without permits. Interviewed police officers declared that they had never enforced a law related to the pig business since their appointment because they were not aware of these regulations; and even if they were aware, they would have lacked the logistical capacities to intervene. According to key informants, quarantine and movement of pigs during outbreaks of ASF are rarely implemented, and there is no compensation scheme to farmers who lose their pigs following an outbreak.

3.2.5. Uncoordinated activities in the value chain

The pig value chain is generally unorganised, with actors implementing activities independently. Collective marketing is very scarce or inexistent, which encourages pig brokers and collectors to move from farm to farm in search of low-priced animals. Because farmers have limited capacity to respond to the market pressures, when there are ASF outbreaks, most traders frequently end up cheating farmers by imposing significantly low prices on them. In

addition, none of the districts has a centralized pig slaughter place; butchers therefore slaughter the animals in their own backyards, without any veterinary control. Even though ASF outbreaks impact the business of many value chain actors, there are no joint efforts by them to combat the disease.

3.3. Recommendations of value chain actors and stakeholders on the control of ASF

Recommendations on biosecurity measures as generated by actors and stakeholder were documented (Table 6). Most recommendations targeted producers with a focus on farm hygiene, as well as movement control. In the case of government staff, emphasis was placed on effective enforcement of and compliance with regulations and policies. It was also emphasized that safer and sustainable ways of disposing pig carcasses should be explored, given that burying dead pigs is a taboo in some communities and burning them seems to be labour-intensive and increases the demand for charcoal or other source of fuel. Other general recommendations regarding the successful control of ASF included:

- Awareness raising and training of farmers on best practices of pig management and biosecurity measures.
- Promotion of centralized pig slaughters to facilitate meat inspection and proper waste management practices through the adequate disposal of non-edible pig parts.
- Put in place measures to control stray dogs in the community to prevent them from coming in contact with pig carcasses and offal.

- Education of farmers on the public health risks posed by consuming dead animals.
- Making butchers and pig traders aware of appropriate biosecurity measures and safe handling.
- Establishment of pig markets where farmers can sell live pigs so as to limit the movement of traders. This could also facilitate the control of permit issuance before loading the pigs for transportation to trading centres.

Specific recommendations for behavioural change and possible barriers were suggested by all value chain actors in both districts. These included: changes from individualism to working in groups which could catalyse behavioural change by peer influence; campaigns against negative practices; use of mass media for education; the use of model value chain actors as good examples for others and the organizations of study tours. The establishment of village biosecurity teams and taskforces for community surveillance and monitoring of ASF and other infectious diseases were considered critical. In the event of heavy losses during outbreaks, the counselling of those who lost animals was suggested in order to alleviate malice and jealousy. The development of by-laws designed to control the movement of pigs and to monitor outbreaks would support the value chain actors. Other recommendations include the involvement of religious leaders in disseminating messages on biosecurity measures; changes in attitude of value chain actors towards improved pig management was also considered as very important.

4. Discussion

Value chain actors and stakeholders recognized and accepted their involvement in the spread of ASF and unanimously agreed that traders, brokers and butchers represented the highest risk in the value chain. Actors under those categories accepted their responsibility, but they believed that the preventive and control measures are farmers' responsibility since they keep the pigs longer as compared to them. It is probable that traders, brokers and butchers do not want to bear the cost associated with applying biosecurity, and that is why they tend to push the control responsibilities to farmers. The most common practices of farmers that exacerbate the spread of ASF, as described in this study, have been previously documented in Uganda (Dione et al., 2014b; Kabuuka et al., 2014; Muhangi et al., 2014, 2015). Given the lack of centralized markets for pigs in the areas under consideration, the application of movement control and veterinary inspection is difficult. Consequently, the poor practices associated with pig trading and slaughtering were blamed to play a key role in the spread of the disease.

"Panic sales" during periods of ASF disease outbreaks were unanimously reported by all value chain actors and stakeholders as being a high risk, thus facilitating the movement of potentially infected pigs. Previous studies in Uganda reported that panic sales represent a strategy for farmers to avoid losses due to the disease, and it is also an opportunity for traders and butchers to increase their profit because the price of live pigs is intentionally lowered drastically (Dione et al., 2015). In Gulu, a neighbouring district to Lira; the majority of middlemen and butchers acknowledged having sold live pigs, carcasses or pork they believed infected with ASF disease (Chenais et al., 2014); the same was reported in Masaka district where nearly 20% of farmers who were affected by ASF outbreak declared to have had conducted panic sales of apparently healthy or sick pigs (Dione et al., 2015). The fear of losing their pigs following an outbreak of ASF disease constitutes a barrier for producers to see the wider negative impact of their practices on the entire value chain and eventually the rest of the country. The weak enforcement of laws on pig movement control and the poor quality

of veterinary services probably contributes to the presence of sick animals in the market. This shows the inefficacy of support services as far as pig disease control is concerned.

Value chain actors who made efforts to apply some of the biosecurity measures perceived those as effective in controlling the disease. Such measures were generally limited to the application of total confinement during outbreak period following early reporting. However, these actions were not considered sustainable by them because of the high cost involved.

It was considered that few farmers would adopt the good practices taught to them after a training session over the long-term. The value chain actors think that the low adoption rate of biosecurity practices after training could be due to several factors, such as inadequacy of the methods used for the dissemination of messages and lack of capacities for value chain actors to adopt the suggested measures. The failure to take ownership of roles in the process of controlling the disease, as it is the case for the input suppliers, who feel that they do not play any role in the dissemination of the disease, makes them hesitant to apply biosecurity measures during their routine work. Some actors such as veterinary service providers and drug stockists are limited to advising producers especially on husbandry, yet veterinarians were considered to be relatively high risk actors. In Uganda, pig producers have limited access to good quality veterinary services (Dione et al., 2014a); this leaves them with no room to identify the credible suppliers. They end up accepting any service from any supplier, who usually offer poor quality services.

It came out clearly from the discussions that the prevalence of ASF disease outbreaks makes the financial institutions hesitant to extend credit to pig farmers. Low access to financial services by value chain actors has contributed to the fragile pig business environment in Uganda. Although all actors seem to know about the disease and could identify some clinical signs without ambiguity, a gap in knowledge on transmission mechanisms among value chain actors was identified. Previous studies in Uganda indicated that most farmers and other value chains actors were able to identify animals with ASF disease (Muhangi et al., 2014; Chenais et al., 2014); however the issue resides around implementing control measures.

Most recommendations given by actors and stakeholders were related to on-farm activities, thus primarily targeting farmers. This shows that farmers are expected to take practical steps in their farms to influence other value chain actors, such as traders, butchers and veterinarians, who because of their activities are seen as high risk vectors of transmission of the disease yet they do not seem to see the importance of taking preventive and control measures since they do not keep the pigs for rearing but for immediate resale, implying that a pig's health may not affect their business in the same way it would affect farmers. Although traders are perceived to benefit from pig trading during ASF disease outbreaks, this gain is only short term. In the medium and long term they can also be severely affected by ASF outbreaks since the transaction costs associated with searching for pigs for re-sale may escalate incredibly. Moreover, recommendations were also made to government bodies responsible for regulation and enforcement of livestock policies. Value chain actors are convinced that by-laws would be more effective in enforcing existing policies, especially regarding pig disease control in their communities.

Most recommendations were classified as short term and relevant to disease control. This shows how actors are really willing to quickly come up with appropriate and sustainable solutions to control the disease. However, the implementation of recommendations was constrained by poor access to resources, the lack of a policy framework, and socio-cultural barriers to the application of some biosecurity measures. Better organization of the value chain through collective marketing was accepted as a potential boost to

pig enterprises in both districts. This recommendation was well received as it would minimize the risk of the spread of the disease in the cases where there were centralized collection points for live pigs, by limiting the interaction between trading/input supply and producer nodes. Likewise, community education focused on changing attitudes and behaviour was strongly emphasized. Interventions targeting behavioural change of value chain actors in order to control ASF were emphasized in Uganda by Nantima et al. (2015). Long-term recommendation could be development of a vaccine and pen-side rapid diagnostic tests for the detection of the disease. Regardless of the nature of the intervention, cost-effectiveness is the key attribute.

The strength of this study lies in the fact that it has embraced the entire value chain and gave actors and stakeholder's room to engage in self-evaluation in order to guide the development and introduction of appropriate and realistic disease control measures. Results from this study highlighted the importance of introducing interventions at different nodes of the value chain. Although the approach used in the study was participatory and inclusive, the study did not investigate further the type of incentives and capacities needed by actors to improve the adoption of biosecurity measures and best practices in husbandry.

5. Conclusion

The control of ASF disease relies on the application of biosecurity measures, which need to be strengthened at all value chain nodes. This study highlighted the pressing need of putting more emphasis on post-production nodes especially the trading during interventions that target ASF control through application of biosecurity. Challenges faced in implementing biosecurity measures remain, but there are opportunities in winning the fight against ASF disease given the high level of motivation of all actors of the value chain in the search for better control measures. Results of this study will be used to guide the development of interventions for the control of ASF disease in the smallholder pig value chains in Uganda.

Conflict of interest

The authors declare that there are no conflicts of interest.

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