

Enhancing knowledge and awareness of biosecurity practices for control of African swine fever among smallholder pig farmers in four districts along the Kenya–Uganda border

Noelina Nantima¹ · Jocelyn Davies² · Michel Dione³ · Michael Ocaido⁴ · Edward Okoth⁵ · Anthony Mugisha⁴ · Richard Bishop⁵

Received: 20 June 2015 / Accepted: 10 February 2016 / Published online: 27 February 2016
© Springer Science+Business Media Dordrecht 2016

Abstract A study was undertaken along the Kenya–Uganda border in four districts of Tororo and Busia (Uganda) and Busia and Teso (Kenya) to understand smallholder farmers' knowledge, practices and awareness of biosecurity measures. Information was collected by administering questionnaires to 645 randomly selected pig households in the study area. In addition, focus group discussions were carried out in 12 villages involving 248 people using a standardized list of questions. The outcome suggested that there was a very low level of awareness of biosecurity practices amongst smallholder farmers. We conclude that adoption of specific biosecurity practices by smallholder farmers is feasible but requires institutional support. There is a clear requirement for government authorities to sensitize farmers using approaches that allow active participation of farmers in the design, planning and implementation of biosecurity practices to enable enhanced adoption.

Keywords African swine fever · Biosecurity · Pigs · Smallholder systems · Uganda · Kenya

✉ Noelina Nantima
noelinanantima@yahoo.com

¹ Ministry of Agriculture Animal Industry and Fisheries, Entebbe, Uganda

² The Commonwealth Scientific and Industrial Research Organization, Sydney, Australia

³ International Livestock Research Institute, Kampala, Uganda

⁴ College of Veterinary Medicine, Makerere University, Kampala, Uganda

⁵ International Livestock Research Institute, Nairobi, Kenya

Introduction

Pigs are increasingly contributing to improved nutrition and household incomes in regions of Africa where pork consumption and pig rearing are culturally acceptable. There has been a rapid increase in the production and consumption of pork over the past 5 years in some countries in sub-Saharan Africa (FAO 2011; Muhangi et al. 2015). Pig farming is an attractive venture for smallholder farmers because of the pig's ability to convert agro-industrial by-products and household waste into quality animal protein, combined with the short-production cycle of pigs and their high fecundity. As a result, the importance of pigs as a source of food and income generation is growing fast, as reflected in the dynamics of the pig sector in Africa (Muhangi et al. 2015). On this continent, the sector is currently dominated by small-scale free-range pig production systems, characterized by minimum investment in feed and housing. There are low levels of biosecurity in the smallholder pig production in Uganda (Muhangi et al. 2015) resulting in pigs being exposed to diseases. It is widely believed that the major disease constraint to development of the pig sector in Africa is African swine fever (ASF) the most important transboundary animal disease of pigs globally.

ASF is endemic in at least 26 countries in sub-Saharan Africa where it is associated with very serious impact on the livelihoods of pig farmers (Penrith et al. 2013; Muhangi et al. 2014). There is currently no cure or vaccine for ASF (Gladon and Spickler 2008; Bishop 2010; Atuhairwe et al. 2013). The current strategy to control ASF in the region is by implementation of improved biosecurity measures (FAO 2010). Previous research in Uganda has showed that most smallholder farmers especially the poorest pig producers implement poor biosecurity measures (Dione et al. 2014; Kabuuka et al. 2014). Such farmers are usually constrained by low financial capacity to invest resources in biosecurity practices and by the

nature of the production system which is more extensive system (FAO 2010).

Farmer awareness of biosecurity practices is a prerequisite for adoption. In the study area, farmers' knowledge, practices and awareness of biosecurity practices were unknown. This study was therefore carried out to understand knowledge, practices and awareness of biosecurity measures by the small-holder farmers and implications for improved adoption.

Material and methods

Study area

The study was carried out along Kenya–Uganda border in the districts of Tororo and Busia (Uganda) and Busia and Teso (Kenya), an area extending 75 km north from Lake Victoria as shown in Fig. 1.

Study design

Data were collected through a structured survey conducted between 12 July and 30 November 2012 and focus group discussions held with groups of pig farmers between 14 February to 28 June 2013. The target respondents were households pig keepers who were best informed about the disease. The structured questionnaire collected data on household

demography, pig production systems, socioeconomic indicators, ASF awareness, biosecurity practices, access to advisory services and participation in social networks. The methodology used to collect the data was as described in Nantima et al. (2015a, b).

Focus group discussions

Focus group discussions (FGDs) were conducted after the cross-sectional survey. The discussions were accompanied by information about ASF transmission and biosecurity whereas the survey did not provide any such information to avoid influencing respondents' responses. The villages of which seven were from Kenya and six from Uganda were selected purposively based on people's socioeconomic status (poor and relatively wealthier), use of swill feeding, number of ASF outbreaks identified from initial survey and proximity to major towns and roads. Due to resources available, 24 focus group discussions were carried out in 13 villages. The groups were selected purposively from the list of farmers that participated during the cross-sectional survey. The groups were selected based on socioeconomic indicators. The indicators included poor versus less poor, feeding with swill versus not feeding with swill, proximity to main towns versus remoteness from main towns and affected by ASF outbreaks versus never affected. Households were categorized as poor or less poor using guidelines of the Millennium Development Goals

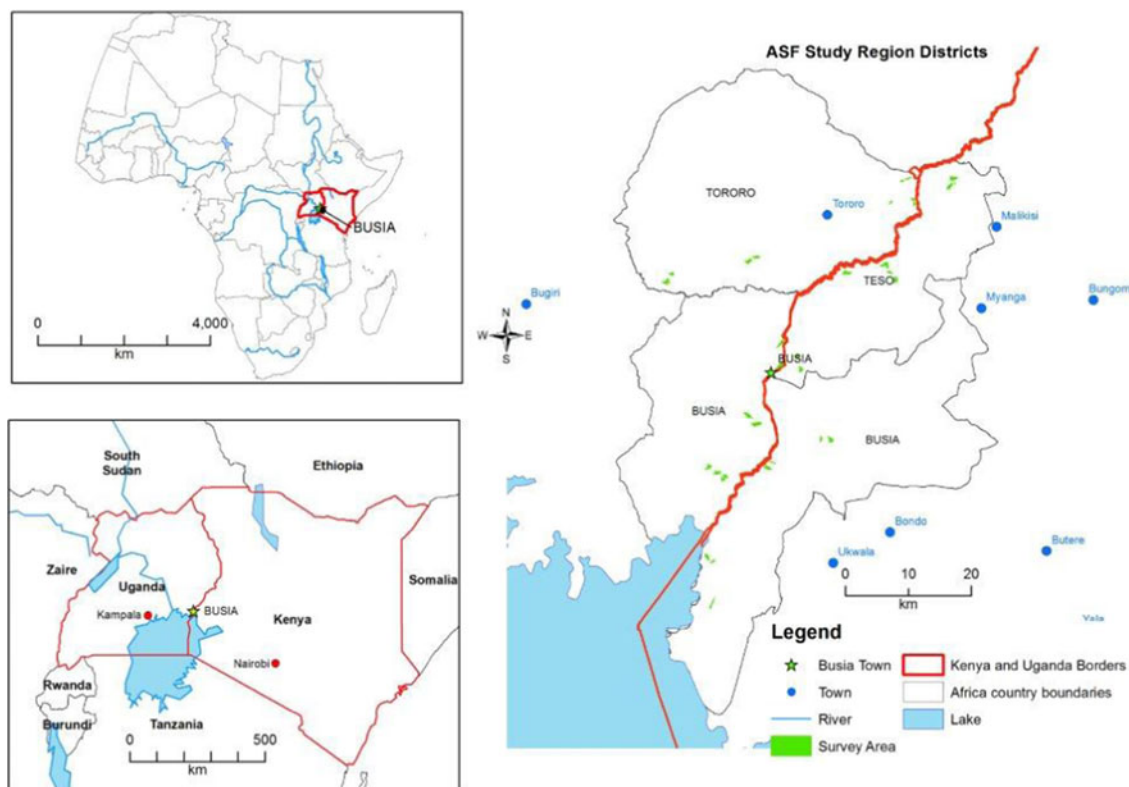


Fig. 1 Map showing location of the cross-section survey countries where the four districts (Busia and Tororo (Uganda) and Busia and Teso (Kenya)) are located

(MDGs). According to the MDGs, a household that earned less than US\$1.25 a day was regarded as poor (UN 2015). The information on household incomes was obtained after analysing cross-sectional survey data that preceded the FGDs.

The categories were derived after analysing the cross-sectional survey data. The groups selected were representing all the categories mentioned above. Before the interview, the researcher administered a consent form (Annex 1) explaining the purpose and benefits of participating in the group discussion. The researcher also requested people to be free to leave the meeting in case they were not interested. The interview was conducted by the researcher assisted by two research assistants. The latter also assisted in translation since the discussions were conducted using local languages.

The FGDs were conducted using a checklist (Annex 2) which was piloted in two villages of which one was from Uganda and the other from Kenya. The checklist consisted of open-ended questions that covered aspects of pig health and biosecurity measures. Biosecurity-related messages included confinement of pigs, swill feeding, importation of new pigs onto the farm, reporting of disease outbreaks, cleaning, disposal of dead pigs and movement of pigs to other districts. The messages were developed from existing literature (Nantima et al. 2015a, b). The messages were translated from English into the main local languages and animated by a graphic handout in calendar format to allow farmers to visualize the recommended practices. The text and the animations were developed into a biosecurity information sheet designed in a form of a calendar (Fig. 2). The calendar was used because it was envisaged that households would benefit from using it and therefore value it more and keep it longer. This format also allowed sharing of the information with visitors more effectively with the wider community.

The participants were mobilized and invited to the focus group discussions by the village leaders and technical personnel. The list of names of people to be invited for the meetings was provided by the research team using the previously collected cross-sectional data. The chiefs were also encouraged to invite to the meetings other interested pig farmers in the village that may not have participated in the cross-sectional survey. The meetings were attended by 8–12 people on average, both men and women, bearing in mind that ownership of pigs is dominated by combined females and males (Nantima et al. 2015a, b). The focus group discussion data was analysed using Microsoft Excel.

Results

Knowledge and awareness of ASF

The majority (84.7 %) of the pig farmers surveyed said that they had heard of ASF and 20 % said they had lost pigs due to the disease (Table 1).

Fate of pigs owned by surveyed households during 2012

It was noted that 15.7 % of the pigs died before sale or disposal by other means (Table 2). The farmers interviewed reported signs indicating ASF in nearly 81.7 % deaths. During the FGDs, a case definition was adopted as in previous studies in Uganda (Muhangi et al. 2014; Nantima et al. 2015a, b; Dione et al. 2015) and farmers were requested to describe clinical signs of ASF. The farmers' perceptions were triangulated with information obtained from the cross-sectional survey results.

Knowledge, perceptions and practices of biosecurity measures to reduce ASF impact

Management types and hygiene

The majority (61.2 %) of the pig farmers surveyed said that they kept their pigs tethered (Table 3). Disinfectant was not used on farms by 95.6 % of farmers because they did not know that they were required to use them or had never heard of disinfectants (Table 4). Separation of new pigs brought into their farms was not commonly practiced as 85.5 % of farmers never did it.

Feeding with swill

The majority of the households (95.2 %) were not aware of the requirement to boil swill and/or add sodium bicarbonate before feeding it to their pigs (Table 5). Some farmers said that sodium bicarbonate was not readily available and feared that it would kill their pigs. However, 94.2 % of farmers who were feeding swill stated that they obtained it from institutions that were not serving pork.

Disposal of dead pigs at home

Burning or burying of dead pigs was not practiced by 64.5 % of farmers. Burying dead pigs was considered taboo by the Iteso tribe. It was also considered as loss of both food and income. Farmers feared that some people would steal the buried pigs for personal gain. Some participants said that they shared the meat of dead pigs amongst relatives and friends or exchanged the meat for grain and other food items. Some children viewed the death of pigs in a positive way because it represented an opportunity to eat meat that was not otherwise available. Some farmers stated that they were jealous of their neighbours when their pigs became sick and would throw the carcass of a dead pig onto neighbouring farms with the intention of spreading disease.

Control of pig movement and reporting of outbreaks

The majority (65.3 %) of the farmers did not know that they were obliged to obtain movement permits before moving pigs.

You can help stop African Swine Fever killing your pigs

**Unaweza kusaidia kuzuia homa ya nguruwe kutowaua nguruwe wako
Ebekin jo akingarakin akitogwo adeka nakimajala narenene ingurei
Inyalo Konyo geng'o tuo mar ASF nego Mbidhi (anguro)
Onyala okhukhonya okwikaliila obulwale bwa embichi okhubira embichi chao**

Confine your pigs

Wazule Nguruwe wako
Kigalik ingurei kon
Geng' ne mbithi kik wuoth alanda
Bikha embichi munyumba yacho

a. No free range
Usiweke nguruwe malishoni
Mam akinyekite kiladete kichar
Kik ilag Mbithi ka chiae mamoko
Embichi/nguruwe chikhadanga danga tawe, muowe name chibe munyumba)

b. Control other pigs and people from having contact with your pigs
Wazule nguruwe wengine na pia watu kukutanana na nguruwe wako
Kirebok ingurei lukokinga kiton itunga komam kwapete kalukon kingurei
Kiki Iwe Mbithi ma ipitho kikre gi Mbithi mamoko kat gi j mamoko
Yakaila embichi chindi nende abantu okhubukanana nende embichi chao



Feeding

Kulisha
Akitano
Pidho mbidhi chiemo
Okhulisia

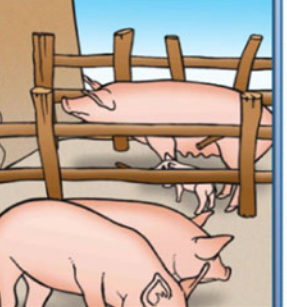
Before feeding your pigs, boil the swill for 20 minutes with 1% Magadi Soda
Kabla ya kulisha nguruwe chakula kutoka hotelini, yachemshe kwa muda (dakika 20) halafu uongezee asili mia moja (1%) ya magadi soda kuuu virusi
Eringa jo kitana inyamen lwechakanaro ingurei kon kotukulao bere idakikan akaishare tomaken ejej abalang adiosit nilesikina
Kapak ipitho mbidhi chiemo hoteli, kuong ichweak chiemo hoteli no kuom nyiriri maromo piro aryo (20) kae imede magadi soda maromo achiel kuom mia (1%) mondo oneg kut tuo anguro, eka lini mbidhi ocham
Nosi okhulisia embichi chao ebikhulia bindonga muhotel, bidekha khu dakika makhumi kabili nende magadi



Bringing new pigs onto your farm

Kuleta nguruwe wapya shambani
Ayaan ingurei iche lukitetiak atamaujo kon
Kelo mbidhi manyien e puothi/dalani
Okhurea embichi chingeni mwidala liayo

Isolate new pigs for 15 days when you bring them onto your farm (no contact with any other pigs)
Watenge nguruwe wapya kwa muda wa siku kumi na tano (15) kuwatenga na nguruwe wako na kuhakikisha hawana ugonjwa
Kogetu ingurei lukitetiak kaparasha katomoru kakany kapaki ni yasunayo jo atamaujo kon (mam kidunyakinao kingurei kiche)
Geng' mbidhi ma walo rweora gi mbidhi magi kuom ndalo apar kod abich (15) mondo ifweng ka gin gi tuo
Nokula embichi chingeni orachanganya nende echa omudala tawe, mbaka enyanga ekhumi na chirano chive mberi (chirabukanana khaba)



Reporting

Kupasha habari juu ya ugonjwa
Akitodiyar
Lando wach tuo
Okhumanyisia bulwaye bwe embichi

Report rumours about sick or dead pigs to the vet office
Pasha uvumi yoyote juu ya ugonjwa ama vifo vya nguruwe kwa ofisa wa mifugo wilyani
Kitodiya alimilit ikamutosi ingurei lwedekasi kiton lukitwakata efisi loka ibaren (vet)
Chiw awingo more amora mar tuo kata tho mbidhi ne jatele mochungne weche chiayo e gweng'u
Manyisia Musirithi we-ebiyao nonyola mbo embichi iluala nomba ifwira,ata niyarali yao




Cleaning

Usafishaji
Alaus
Luoko
Okhuosia

a. Use disinfectant for cleaning pig houses and after slaughter
Tumla dawa ya kuuu vilini kusafisha nyumba ya nguruwe na baada ya kuchinga nguruwe
Kitosoma ekeya lari igasia kijokis akilosia etogo kingurei kiton kedaun akilar
Luok od Mbidhi kod kama iyeng'e gi yath manego kute
Dumikhila olunyasi okhuosia enyumba ye embichi,khandi nowakhamala wera embichi.

b. Dispose of dead pigs
Kutupa mzoga ya nguruwe
Epone lingadanakiner ingurei lukitwakata
Wito anguro ma otho
Embichi chifwira chisunwe ebulal

c. Bury all parts of the carcass and the skin 6 feet deep
Zika mzoga pamoja na ngozi futi sita (6) chini ya mchanga
Konukak iwalinkijokis adwi kwap efutin ikankape
Ik mbidhi ma otho fut auchiel (5) ei loo
Embichi nefwa,oyabira yooi nende esero lioi, efudi sia mwiroma, asi





Moving pigs between districts

Kusafirisha nguruwe kutoka wilaya moja hadi nyingine
Ayaanar ingurei Alomar kodistirikt kepe akitodol namka loche
Ting'o kata wuotho gi anguche e kind gwenge
Okhuhusia embichi okhurea muidistrikti endala, muyindi

Contact the vet office when moving pigs in or out of the district
Wasiliana na afisa mkuu wa mifugo wilyani kabla ya kusafirisha nguruwe
Kitodiya efisi lokibaren ikotoyo ayaar ingurei Alomar kodistirikt kepe akitodol loche
Tudri gi jathieih mar chiayo e distric kapok iting'o anguche ka itero kamachielo
Onale okonye daktari we-ebiyao nodakha okhukesa namwe okhuduma ebiyayo biao erwanyi we-distict yao



bioinocenes     

Republic of Kenya
International Livestock Research Institute
(BioArid) Hub
PO Box 30708 Nairobi 00100 Kenya
Tel: +254 20 422 3805
ksh@ilri.org | info@ilri.org | www.ilri.org
http://hub.africa.bioinocenes.org | www.iri.org

Ministry of Livestock Development
Department of Veterinary Services
Private Bag 00025, Nairobi, Kenya
Tel: +254 20 2718870
DVS@kvc.or.ke

July 2012						
S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

August 2012						
S	M	T	W	T	F	S
		1	2	3	4	
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

September 2012						
S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

October 2012						
S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

November 2012						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

December 2012						
S	M	T	W	T	F	S
30	31					1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

January 2013						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

February 2013						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

March 2013						
S	M	T	W	T	F	S
31						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

April 2013						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May 2013						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

June 2013						
S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

Fig. 2 Calendar poster with biosecurity messages

With regards to reporting suspected ASF outbreaks, the majority of the farmers (63.7 %) never reported to the veterinary authorities and 61.9 % never trusted veterinarians to give them advice when they got problems affecting their pigs (Table 6).

Action taken by farmers during outbreak of ASF

Frequently when outbreaks occurred, farmers would rapidly spread rumours within the village resulting in panic selling of pigs. The majority (60.9 %) of the farmers either self-

Table 1 Responses on awareness about ASF

Have you heard of ASF?	Number of households	Percentage
Yes	580	84.7
No	105	15.3
Total	685	100.0
Have you had pigs that died from ASF?		
Yes	137	20.0
No	548	80.0
Total	685	100.0

medicated using local herbs or sold pigs during suspected ASF outbreaks (Table 6). Farmers in 16 sampled villages reported that they had sold pigs for slaughter during ASF outbreaks which had occurred 12 months prior to the study.

Level of awareness by farmers of biosecurity practices for reduction of ASF impact

The procedure for which farmers had the highest level of awareness was reporting of ASF outbreaks (Fig. 3).

Discussion

The study demonstrated that the majority of the smallholder farmers in the study area had good theoretical knowledge regarding ASF and were familiar with the clinical signs. This was in agreement with results obtained earlier in Uganda (Chenais et al. 2015; Muhangi et al. 2015). However, a caveat was that farmers appeared to assume that any disease that killed pigs was ASF, suggesting that ‘ground truthing’ using validated diagnostic tests was required to validate prevalence estimates based solely on feedback from farmers.

It was noted that there were numerous rumours in the villages during suspected outbreaks, resulting in people

Table 2 Fate of pigs owned by surveyed households during 2012 and not on farm at time of survey, by age/gender of pigs

Category	Fate of pigs		
	Died	Sold	Other disposal
Piglet	32	152	26
Sub adult	52	102	12
Sows	17	121	12
Boars	5	79	8
Castrated boars	3	67	8
Total	109	521	66

Table 3 Percentage of households practicing a certain pig husbandry system in Uganda and Kenya along the border

Characteristics	Number of households	Percentage		
		Overall	Kenya	Uganda
Pig management				
Free range	7	1.1	0.0	2.2
Tethered	392	61.2	61.9	60.5
Housed	3	0.5	0.3	0.6
Tethered/free range	226	35.4	35.6	35.1
Other (includes housed and tethered or free range)	12	1.6	2.3	1.6

selling pigs quickly without substantiating the information to other smallholder farmers usually further away from the outbreak sites or traders. Farmers perceived the strategy of selling sick animals as the best option to realize the financial real value of their pigs rather than to wait for them to die of ASF. The habit of selling sick pigs resulted in rapid spread of outbreaks in other villages that would otherwise have not been affected. This was in agreement with results of other studies carried out in Uganda (Muwonge et al. 2012; Dione et al. 2014; Penrith et al. 2013; Muhangi et al. 2014; Chenais et al. 2015)

Biosecurity was generally not practiced in almost all of the farms surveyed. The low level of awareness of biosecurity practices amongst smallholder farmers was a major weakness in the control of ASF which could have contributed to the persistence of the disease in the area. These findings were in agreement with a study carried out in Indonesia among smallholder farmers where awareness of biosecurity by smallholders, which is equally applicable to other diseases such as classical swine fever occurring in the part of East Asia, was very low (Lestari et al. 2011). In addition, farmers’ limited

Table 4 Do you ever use disinfectant on your farm?

Characteristics	Number of households	Percentage
Do you use disinfectant?		
Yes	30	4.4
No	655	95.6
Total	685	100.0
Reasons for not using disinfectant		
	Number of households	Percentage
Cash constraint	55	8.0
Did not know that I need to use it	318	46.4
Have never heard about it	281	41.0
Do not know how to use it	19	2.8
Do not know what to use	12	1.8
Total	685	100.0

Table 5 Households feeding swill

Characteristics	Number of households	Percentage
Do you feed swill?		
No	500	77.6
Yes	144	22.4
Source of swill for feeding pigs		
Hotel/restaurant	62	36.0
Institutions (schools, hospital)	14	8.0
Neighbour	82	47.0
Other	15	9.0
Do you treat the swill before feeding pigs?		
No	500	77.6
Yes	144	22.4
Does the swill contain pork products?		
No	537	94.2
Yes	2	0.4
Don't know	10	1.8
Sometimes	21	3.7

knowledge of the financial returns that would potentially accrue from implementing low-cost biosecurity practices also limited the use of these measures. It will therefore be necessary to educate the farmers on the benefits of implementing biosecurity. Fasina et al. (2012) in Nigeria found out that it was profitable to implement biosecurity, and such findings could be extrapolated to our study area on the Uganda/Kenya border.

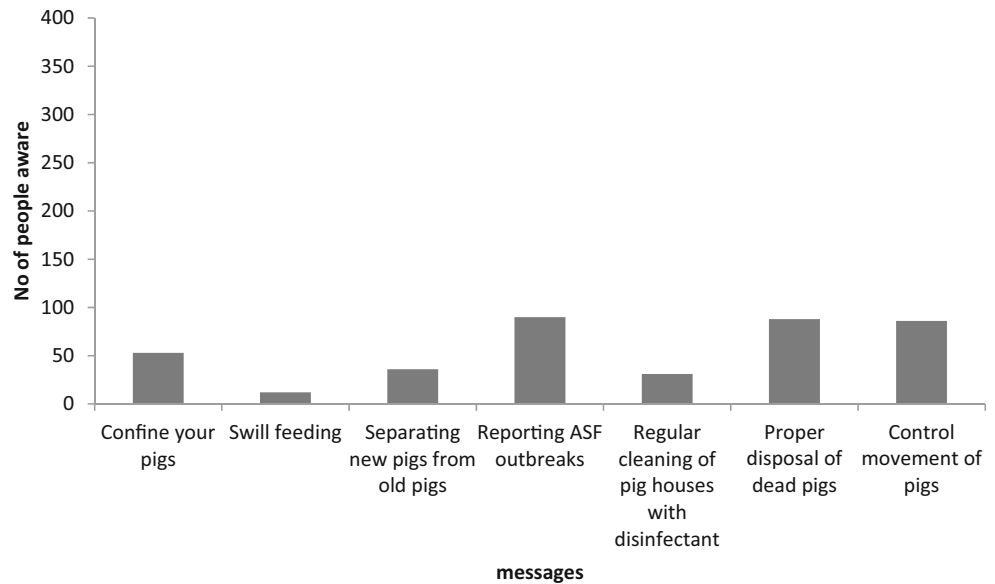
Weaknesses in the implementation of legislative and policy measures severely affected adoption of biosecurity practices by smallholder farmers. Although there is a legal framework for controlling animal diseases including ASF in Kenya and Uganda, enforcing such legislation is in reality impractical due

to lack of financial and human resources. For example, there is no compensation policy which negatively impacts on ASF reporting and control. There was also a very weak farmer extension system resulting from limited availability and accessibility of veterinary practitioners. There was also no formal programme for training farmers on biosecurity practices in either Kenya or Uganda. Farmers exploited these institutional weaknesses and continued selling sick pigs even when quarantines were instituted by government. Similar findings were reported in other studies (Dione et al. 2014; Muwonge et al. 2012; Mutua 2010). This social dilemma greatly compromised control efforts by government officials leading to the rapid spread of the ASF virus in the area.

For biosecurity practices to be adopted by smallholder producers, commitment is required from farmers to change their behaviour and practices, which in turn requires incentivization and demonstration of the benefit of implementing biosecurity to the farmers. However, the key to changing people's behaviours and practices in relation to enhanced biosecurity lies in people's perceptions of risk and resources available at the production level. For meaningful change to take place among smallholder pig farmers, a holistic, multi-sectoral approach is required to identify critical risk points for disease spread and to understand the evolution of the diseases in specific environments. It is also important to understand the impact of disease on people's livelihoods, but little quantitative data currently exists on this. The promotion of biosecurity practices should go hand-in-hand with the use of participatory methodologies as an integral component of the communication strategies for disseminating ASF prevention and control awareness messages. Active participation of farmers and

Table 6 Households reporting ASF outbreaks

Characteristics	Number of households	Percentage
What action do you take during ASF outbreak?		
Reported to veterinary authorities (public and private)	54	39.1
Self-medicated	18	13.0
Slaughtered	8	5.8
Sold	16	11.6
Never sought for help	42	30.4
Whom do you trust to give you advice or help when you have a problem in pig keeping?		
Livestock officer	261	38.1
Friend or relative	69	10.1
Other farmer or trader	62	9.1
Local leader	84	12.3
Neighbour	36	5.3
Household member	78	11.4
No response	95	13.9

Fig. 3 Number of people aware of some biosecurity messages

other value chain actors in designing such messages is key to improving farmers' awareness and capacity to adopt biosecurity practices.

Formation of common interest groups such as pig farmers associations, pig traders and pig butchers associations are important for community mobilization and sensitization. For instance, pig traders/butchers in Busia district, Uganda, formed a pig traders association after being sensitized by the District Veterinary Officer, and this association has helped to improve reporting and control of ASF in the district.

The period of adoption of improved practices could be shortened if the majority of the smallholder farmers could be persuaded to invest in biosecurity practices to a level sufficient to break ASF transmission cycle. This would require sensitization regarding the long-term benefits that would accrue from adopting biosecurity and also creation of opportunities to access credit. It was noted that the majority of the pig farmers in the study area were not keeping pigs at an optimal carrying capacity although their major objective was to obtain cash income. The rate of adoption of biosecurity practices would be enhanced if farmers could change their minds set and target at profit maximization rather than keep pigs solely for cash income. The potential benefits and impact of implementing biosecurity practices then would easily be appreciated by the smallholder farmers. A pilot study on socio-economic benefit of implementing biosecurity practices on smallholder pig farms should be undertaken to provide evidence-based information regarding the potential benefits of adopting biosecurity practices by the smallholder farmers. The promise of increased profits in the future could attract many farmers to invest in biosecurity practices and reduce

the time to adoption. The government therefore needs to develop evidence-based education programs to demonstrate to farmers and other stakeholders along the pig value chain the benefits of implementing simple biosecurity measures and to facilitate the practical constraints to implementation. Innovations such as establishing model farms with improved biosecurity, creating insurance for pig farmers and construction of abattoirs where sick pigs could be slaughtered and processed at higher biosecurity containment levels would motivate farmers and other stakeholders to adopt biosecurity measures.

During the study, the researchers were limited by language of communication during focus group discussions and frequently depended on translators. Second, the presence of chiefs during the discussions could have influenced some people not to speak freely. These issues could have affected the outcome of the study but are not easily overcome.

The study concluded that adoption of straightforward biosecurity practices by the smallholder farmers was feasible and potentially effective at reducing the risk that ASF presents to them. Good husbandry practices such as confinement of pigs, treatment of swill, appropriate disposal of carcasses, early reporting, movement control and establishment of check points should be given high priority and are relatively low cost to implement. However, it is essential that government authorities in collaboration with other groups such as NGOs intensify their efforts to deliver information relating to biosecurity measures to the farmers.

It is anticipated that the results of this study will guide decision making at policy level to design appropriate ASF control strategies in the Eastern African region and other regions with similar production systems.

Acknowledgments The research was performed under the ASF Epidemiology module within the CSIRO-AusAID Africa-Australia Food security Initiative. We are grateful to the Bioscience East and Central Africa (BECA) Hub for project implementation. We also appreciate salary support provided to RB under CGIAR consortium research project CRP 3.7. The researcher acknowledged all the personnel of ILRI ASF project team and the technical personnel in the study districts.

Compliance with ethical standards

Conflict of interest There is no conflict of interest identified.

Ethical standards The manuscript does not contain clinical studies or patient data. Involvement of human participants was in accordance with ethical standards of the CSIRO Social Science Human Research Ethics Committee and ILRI Institutional Research Ethics Committee.

References

- Atuhairwe, K.D., Ochwo, S., Afayoa, M., Mwine, F., M, Kokas, I., Arinaitwe, E., Ademun-Okurut, R.A., Okuni, J.B., Nanteza, A., Ayebazibwe, C., Okedi, L., Olaho-Mukani, W., Ojok, L., 2013. Epidemiological Overview of African Swine Fever in Uganda (2001–2012). *Journal of Veterinary Medicine* 9, 263.
- Bishop, R. (2010). Understanding the epidemiology of African Swine Fever (ASF) to support development of evidence-based control strategies. *Paper presented at the African Swine Fever diagnostics, surveillance, epidemiology and control: identification of researchable issues targeted to the endemic areas within sub-Saharan Africa. Workshop hosted by BECA-ILRI and sponsored by CSIRO-AusAid Africa Food Security Initiative, Fairview Hotel, Nairobi, July 19-22 2011.* <http://biolives.wordpress.com/presentations/bt01/>
- Chenais, E., Boqvist, S., Sternberg-Lewerin, S., Emanuelson, U., Ouma, E., Dione, M., Aliro, T. Crafoord, F., Masembe, C., Stahl, K. 2015. Knowledge, Attitudes and Practices Related to African Swine Fever within Smallholder Pig Production in Northern Uganda. *Transboundary and Emerging Diseases*. doi:10.1111/tbed.12347
- Dione, M.M., Ouma, E., Roesel, K., Kungu, J., 2014. Participatory assessment of animal health and husbandary practices in smallholder pig production systems in three high poverty districts in Uganda. *Preventive Veterinary Medicine* 117, 566-576.
- Dione, M.M., Akoll, J., Roesel, K., Kungu, J., Ouma, E., Wieland, B., Pezo, D., 2015. Risk Factors for African Swine Fever in Smallholder Pig Production Systems in Uganda. *Transboundary and Emerging Diseases*. doi:10.1111/tbed.12452
- FAO (2010). Good Practices for Biosecurity in the Pig Sector. Food and Agriculture Organisation, Rome, Italy.
- FAO (2011). The State of Food and Agriculture. Food and Agriculture Organisation, Rome, Italy.
- Fasina, F.O., Agbaje, M., Ajani, F.L., Talabi, O.A., Lazarus, D.D., Gallardo, C., Thompson, P.N., Bastos, A.D.S., 2012. Risk factors for farm-level African swine fever infection in major pig-producing areas in Nigeria, 1997-2011. *Preventive Veterinary Medicine* 107, 65-75.
- Gladon, J., & Spickler, A. R. (2008). African Swine Fever. *The Centre for Food Security and Public Health*, Iowa State University
- Kabuuka, T., Kasaija, P.D., Mulindwa, H., Shittu, A., Bastos, A.D.S., Fasina, F.O., 2014. Drivers and risk factors for circulating African swine fever virus in Uganda, 2012-2013. *Research in Veterinary Science*.
- Lestari, V.S., Sirajuddin, S.N., Kasim, K., 2011. Adoption of Biosecurity measures by layer smallholders. *J. Indonesian Trop. Anim. Agric* 36 (4).
- Muhangi, D., Masembe, C., Berge, K., Stahl, K., Ocaido, M., 2014. Practices in the pig value chain in Uganda. *Livestock research for rural development*. . 26.
- Muhangi, D., Masembe, C., Emanuelson, U., Boquist, S., Mayega, L., Ademun, R.O., Bishop, R.P., Ocaido, M., Berge, K., Stahl, K., 2015. A longitudinal survey of Africa swine fever in Uganda reveals high apparent disease incidence rates in domestic pigs, but absence of detectable persistent virus infections in blood and serum. *BioMed Central Veterinary Research*. . 11: 106
- Mutua, Florence. (2010). Farmer Perceptions on Indigenous Pig Farming in Kakamega District, Western Kenya. *Nordic Journal of African Studies*, 19(1): 43-57.
- Muwonge, A., Munangandu, H.M., Kankya, C., Biffa D., C, O., E, S., J, O., 2012. African swine fever among slaughter pigs in Mubende district, Uganda. *Tropical Animal Health and Production* 44, 1593-1598.
- Nantima, N., Ocaido, M., Ouma, E., Davies J., Okoth E., 2015a. Risk factors associated with occurrence of African swine fever outbreaks in smallholder pig farms in four districts along the Uganda-Kenya border. *Tropical Animal Health and Production* 47, doi 10.1007/s11250-015-0768-9.
- Nantima, N., Dione, M.M., Brandes-van, D., Kawuma, B., Smith, 2015b. African swine fever: In. Uganda smallholder pig value chain capacity development training manual. ILRI Manual 14. Nairobi, Kenya: ILRI.
- Penrith, M.L., Vosloo, W., Jori, F., Bastos, A.D.S., 2013. African swine fever virus eradication in Africa. *Virus Research* 173, 228-246.
- UN (2015). The Millennium Development Goals Report 2015.