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Research Application Summary

Disentangling the complex epidemiology of African swine fever in Uganda: A product of inter-Higher Education Institutions collaboration

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Abstract

Despite the significant contribution of pig industry to livestock economy and food security in sub Saharan Africa , it is faced with the devastating African swine fever (ASF) disease that kills up to 100% of infected pigs in both commercial and small-scale pig production. There is no vaccine for ASF and it has no cure.Therefore coordinated and concerted efforts that can support its effective control using means other than treatment and vaccination are of high priority. Appropriate diagnostics is extremely important for early detection of ASF and implementation of its preventive measures using enhanced farm biosecurity measures. In the absence of a vaccine, biosecurity is a forefront arsenal in the control of ASF. In this review we highlight the role of High Education Institutions (HEIs) and research organizations in tackling challenges posed by ASF by understanding the factors that can enhance its control using biosecurity measure. The review shows how higher education and research institutions have played a pivotal role towards disease control as a contribution towards attaining Africa's Agenda 2063.

Keywords: African swine fever, epidemiology, genomics, Higher Education Institutions, livestock, pigs

Résumé

Malgré la contribution significative de l'industrie porcine à l'économie de l'élevage et à la sécurité alimentaire en Afrique subsaharienne, elle est confrontée à la maladie dévastatrice de la peste porcine africaine (PPA) qui tue jusqu'à 100% des porcs infectés dans la production porcine commerciale et à petite échelle. Il n'y a pas de vaccin contre la PPA et il n'y a pas de remède. Par conséquent, des efforts coordonnés et concertés qui peuvent soutenir son contrôle efficace par des moyens autres que le traitement et la vaccination sont hautement prioritaires. Des diagnostics appropriés sont extrêmement importants pour la détection précoce de la PPA et la mise en œuvre de ses mesures préventives en utilisant des mesures de biosécurité à la ferme améliorées. En l'absence de vaccin, la biosécurité est un arsenal de premier plan dans le contrôle de la PPA. Dans cette revue, nous soulignons le rôle des établissements d'enseignement supérieur (EES) et des organismes de recherche dans la résolution des défis posés par la PPA en comprenant les facteurs qui peuvent améliorer son contrôle à l'aide de mesures de biosécurité. L'examen montre comment les établissements d'enseignement supérieur

et de recherche ont joué un rôle central dans la lutte contre la maladie en tant que contribution à la réalisation de l'Agenda 2063 de l'Afrique.

Mots clés : peste porcine africaine, épidémiologie, génomique, établissements d'enseignement supérieur, élevage, porcs

History of ASF in Africa

African swine fever (ASF) is a devastating haemorrhagic fever of domestic pigs originally discovered in Kenya (Montgomery, 1921). The disease causes up to 100% mortality (Arias and Sanchez-Vizcaino, 2002; Penrith *et al*., 2004; Costard *et al*., 2013). This disease is caused by a double stranded DNA virus, the African swine fever virus (ASFV) in genus Asfivirus that is classified within the Asfarviridae family (Dixon *et al*., 2005; Takamatsu *et al*., 2011). The disease is contagious and it has no vaccine or cure (Penrith *et al*., 2004). African swine fever (ASF) is one of the most serious diseases of pigs in many sub-Saharan African countries and continues to threaten the pig population and the rural economy of Africa and other continents (Arias and Sanchez-Vizcaino, 2002; Costard *et al*., 2009).

In Uganda, 85% of the population lives in rural areas with majority of the people depending on agriculture (UBOS, 2010). The country has the second largest and most rapidly growing pig production system in Africa (Phiri *et al*., 2003). More than 75% of Ugandan pigs are found in smallholder farms (UBOS, 2010). The sector is however faced with the continuous threat of the most feared African swine fever disease. The disease is endemic in Uganda (Gallardo *et al*., 2011; Aliro *et al*., 2012; Muhangi *et al*., 2012; Muwonge *et al*., 2012; Atuhaire *et al*., 2013) with outbreaks occurring at regular intervals. Indeed about 20 outbreaks were confirmed in 2009 alone (Aliro *et al*., 2012), while several others were subsequently reported annually throughout the country.

In order to elucidate the epidemiology of ASF in Uganda a consortium of higher education institutions (HEI's), National Agricultural Research System (NARS) and international partners was formed to spearhead research aimed at improving the scientific understanding of the disease so that knowledge-based approaches can be adopted for disease control using enhanced biosecurity. For the last 10 years, this consortium has been investigating several aspects of the disease and now, there is a body of knowledge in Uganda that is useful for control of ASF (see http://asf.mak.ac.ug). The consortium comprises Makerere University (MAK), Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and the National Livestock Resources Research Institute -NaLIRRI), Swedish University of Agricultural Sciences (SLU https://www.slu.se/en/), the National Veterinary Institute, Sweden (http://www.sva.se/ en) and the MRC University of Glasgow Centre for Virus Research (https://www.gla.ac.uk/ researchinstitutes/iii/cvr/). The strength of this consortium is that it is spearheaded by HEIs both nationally and internationally. Having mandates for teaching, research and outreach, HEIs are highly motivated. They can generate useful knowledge for disease control as illustrated in the ASF case studies presented here. They can be trusted with research funds by development agencies. Recently, the move to get universities to the communities has started to receive support which will directly benefit grassroots, making education directly and instantly useful.

The objective of this research was to understand the epidemiology of African swine fever for improved pig production and livelihoods in resource-constrained settings in Uganda.

Effects to date

The approach. This study has been carried out in Uganda, spanning 10 years (2008-2018), with support from several development agencies. The research was conducted in several districts of Uganda as detailed in the results section ahead. It focused on generating information related to diagnostics, biosecurity, viral molecular epidemiology, transmission dynamics, host genomics, socio-economic, disease modelling and full genome sequencing. Data collection tools ranged from questionnaires, focus group discussions, blood collection in longitudinal surveys and suspected ASF outbreak responses, to capture of bushpigs and fixing GSM-enabled collars.

ASFV DNA detection. In order to check for the presence of ASFV nucleic acids, the samples were prepared for total genomic DNA extraction using the DNeasy Blood & Tissue kit (Qiagen, Duesseldorf) following the manufacturer's protocol. The extracted DNA was either immediately used in the RT-PCR assay or stored at -20°C until used. For the detection of ASFV DNA, a commercially available ASF RT-PCR Tetracore® assay (Tetracore Inc., Rockville, Maryland) was used according to the instructions of the manufacturer. The assay was optimized for use on a SmartCycler® (Cepheid Inc., Sunnyvale, California.

ASFV antibody detection. For the detection of antibodies against ASFV, commercially available ELISA kits (INGEZIM PPA Compac 11.PPA.K3, INGENASA, Spain), and SVANOVIR® ASFV-Ab (Boehringer Ingelheim Svanova, Uppsala, Sweden) were used in accordance with instructions from the manufacturers. The positive and doubtful samples were re-tested using the same INGENASA ELISA and/or the recently released indirect ELISA. The SVANOVIR® ASFV-Ab ELISA kit was used according to the instructions by the manufacturer.

Capture of bushpigs. Bushpig capture was performed using game capture nets. The captured bushpigs were immobilized and blood samples (whole blood and serum) taken. The bushpigs were then equipped with GPS/GSM tracking collars of harness type (Savannah Tracking Ltd, Kenya) to monitor their movements in real time. A few domestic pigs were sampled and also collared from different farms at the wildlife-livestock interface areas in order to determine their home ranges. The pig movement data was analysed using ArcGIS v10.3.

Results and discussion

A longitudinal survey of African swine fever in the greater Masaka region of Central Uganda (Muhangi *et al*., 2015) revealed high disease incidence rates in domestic pigs, but absence of detectable persistent virus infections in blood and serum. However, half of the respondent farms reported an ASF outbreak on their farms in the previous one to two years and during the study period, respectively. These results indicate that the ASFV is circulating in a wave of epidemics. The virus is so highly lethal that it does not allow the immune system of the pigs to produce detectable antibodies. The implication of this observation is that although the OIE (World Organization for Animal Health) recommends the use of antibody detection diagnostic tools to confirm ASF outbreaks, these tools may not be appropriate in Uganda's situation, where there is a highly lethal type of ASFV that kills in a few days. In a related study in Gulu in Northern Uganda the knowledge, attitudes and practices related to ASF disease in smallholder pig producers was evaluated (Chenais *et al*., 2017). The study showed that participants knew clinical presentations of ASFand how it could be prevented or controlled. They however were not implementing the control actions. This was attributed to the deep-seated poverty in the communities.

Through GSM observations, the study showed that domestic pigs in Gulu are mostly active during night (http://repository.ruforum.org/documents/role-bushpigs-epidemiology-african-swine-fever-wildlife-livestock-interfaces-uganda). At the same time period, the bushpigs were also active wandering between game reserves and domestic farmlands. Two bushpigs samples tested positive for ASFV with Ct values of 35.8 and 43.2. Molecular sequencing efforts of these two samples and their relationship to ASFV in the domestic pigs is on-going.

The collaboration has shown that the ASFV genotype circulating in Uganda is P72 Genotype IX (Kalenzi Atuhaire *et al*., 2013). It has further revealed that molecular characterisation of partial sequences of fragments P72, P54 and CVR show limited variation among the ASF viruses from different outbreaks in Uganda (Atuhaire *et al*., 2013). Through this collaboration in ASF research, five Ugandan ASFV full genomes are now readily available. These genomes have accession numbers of MH025916 - MH0259120 (https:// www.ncbi.nlm.nih.gov/nuccore/MH025916). This research has generated data on ASF in Uganda. Synthesis of the data and its translation into policy will go a long way in deigning control strategies for this devastating disease.

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