Socio-economic impact of African swine fever outbreak of 2011 and its epidemiology in Isoka District of Zambia

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SUMMARY

A study was carried out to evaluate the socio-economic impact of African swine fever (ASF) and associated epidemiological factors following the 2011 outbreak in Isoka district of Zambia. One hundred and twenty small holder farmers were interviewed using a structured questionnaire to collect information on the socio-economic impact of the outbreak. Blood samples were also collected from 190 pigs from 65 households in the areas previously affected by the ASF outbreak. Sera were harvested and subjected to antibody blocking Enzyme Linked Immunosorbent assay (b ELISA). Questionnaire survey revealed that the majority of farmers (51.0%) kept pigs for business. A large proportion of the remaining farmers (37.0%) kept pigs for home consumption. Eighty-four percent of the respondents were aware of ASF and 46.7% were directly affected by the 2011 outbreak which resulted into 50.0% reduction in pig population in the surveyed area. This ASF outbreak caused 99.9% mortality of affected pigs. The socio-economic impacts of the disease were in terms of loss of the pigs due to mortalities, loss of business and the cost of disease control. Serological analysis showed that no pig had circulating antibodies against ASF; suggesting that none of the exposed pigs during the outbreak survived. With our findings we can conclude that ASF is still an important trans-boundary animal disease (TAD) with enormous socio-economic impact that requires concerted efforts of all stakeholders in the enforcement of control and preventive measures.

Key words: African swine fever, socio-economic impact, seroprevalence, Isoka, Zambia

INTRODUCTION

African swine fever (ASF) is a highly contagious haemorrhagic disease of pigs that produces a wide range of clinical signs (Etter *et al*., 2011). It causes major economic losses, threatens food security and limits pig production in affected countries (Costard *et al*., 2009). The ASF has been reported in the Eastern Province of Zambia since 1912 and is now considered to be enzootic there (Wilkinson *et al*., 1988). The disease has now spread within the province to Nyimba, Petauke, Lundazi and Chadiza districts and is common in indigenous breeds of pigs. The disease has resulted into the perpetual ban of trade in pigs, pork and pork products from the eastern part of the country to other regions (Samui *et al*., 1996).

In September 2011, ASF outbreak was reported in Isoka district of the Northern Province in Zambia (DVS, 2011). This outbreak was the first one to be reported in this part of the country and caused high mortality of many indigenous breeds of pigs in the small-scale farming sector. The disease spread fast within the province to Chinsali, Mungwi and Mbala Districts. The widespread occurrence of the disease to areas that were ASF free was of great concern and had serious implications for the growing small-scale farmers in the Northern Province of Zambia and the entire nation's pig industry. It could also pose a serious threat to other countries in the Eastern and Southern African regions, if not brought under urgent control, since the most recently affected province borders with Tanzania to the North and Malawi to the North-east. The only measure employed to contain this outbreak was restriction of movement of pigs, pork, and pork products. Following this outbreak of ASF many socio-economic activities were destabilized by the mortality of the pigs and the veterinary measures instituted to control the disease. Furthermore, there was inadequate information known about the socio-economic loses the small-scale farmers and other stakeholders incurred. There was also no information about the role of survivor pig populations in the epidemiology of the disease and this could have implications for the future of the pig industry in the country and the region as a whole. Understanding the impact the disease outbreak had on the community and the carrier status of the pigs, could have served as a platform towards the development of better disease control strategies in future. The main objective of this study was therefore to determine the socio-economic impact of the 2011 ASF outbreak on the small-scale pig farmers and other stakeholders in Isoka district of Zambia; and to establish the post-epidemic seroprevalence of ASF in the pig population in the district.

MATERIALS AND METHODS

Study area

The study was conducted in Isoka district in the Northern Province of Zambia in November 2012. The respondents for the current survey originated from 24 villages from two veterinary camps which were severely affected by ASF outbreak of 2011; Isoka Central camp (69%) and Kalungu camp (31%). The study area is a rice-producing and processing and rice by-product obtained from processing of rice (rice husks) is a readily available feed for the pigs. The abundance of this by-product makes it possible for most small-scale pig producers in Isoka to rear their pigs under intensive management complementing with maize bran and kitchen leftovers. According to the 2000 Zambian Census, the district had a human population of 99,319 (ZPHC, 2003). The pig population for Isoka as of the 2012 annual report was 3,911 owned by 934 small-scale farmers (District veterinary officer, Isoka, 2012).

Study design and sample size calculation

This study adopted a cross-sectional study design. The sample size for assessing the socio-economic impact of the outbreak was calculated based on the formula by Bartlett *et al*. (2001). Using this formula the survey involved a total of 120 pig keepers. Simple random selection was adopted to obtain 216 pigs using a sampling frame of all pigs in households which were involved in the ASF outbreak of 2011.

Data collection

Assessment of socio-economic impact of ASF outbreak

Data on socio-economic impact of the outbreak were collected using a structured questionnaire administered by face-to-face method to the selected small-scale farmers. The questionnaire was administered preferably to household heads; however in their absence any other family member who could correctly deliver the required information was interviewed. Data that were gathered included: purpose of rearing pigs, the type of feed given, awareness on the ASF, its clinical presentation, the cause and possible sources of infection to pigs, effect of the disease outbreak on trade, disease morbidity and mortality; and the effect of disease control measures on the livelihoods of the small-scale farmers.

Seroprevalence study

Blood samples for sera were collected from pigs in previously ASF affected areas for the assessment of circulating antibodies against the African swine fever virus (ASFV) in order to determine the existence of pigs previously exposed to the ASF infection, either before or during the 2011 outbreak. About 5 millilitres of blood were collected from the external jugular vein or the cranial vena cava into a plain vacutainer tube. The blood was centrifuged at the Isoka Regional Laboratory within 8 hours at 2500 rounds per minute. Sera were decanted from the clots of blood into Eppendorf tubes and kept frozen at -21°C until analysis.

Laboratory analysis

For detection of circulating antibodies against ASFV, serum samples were subjected to a blocking ELISA (b ELISA) (Immunologia Y Genetica Aplicada®, Madrid, Spain) test which was performed at the Central Veterinary Laboratory (CVL) in Lilongwe, Malawi. The test was performed according to the manufacturer's instructions. Briefly the ELISA test was carried out as follows: All reagents (except the conjugate) were allowed to stand at room temperature before use. Then a 50 percent dilution was done directly on the plate by adding 50 micro litres (μl) of diluents and an equal volume of sera into each well. The ELISA plates were sealed with aluminium foil and incubated for one hour at 37°C. The wells were emptied into a container with sodium hydroxide solution and washed four times with 300 μl of washing solution. One hundred micro litres of specific conjugate was added to each well, sealed the plate with aluminium foil and the plate incubated for 30 minutes at 37°C. Washing of plates was carried out five times as previously described. One hundred micro litres of substrate was added to each well and the plate kept at room temperature for 15 minutes. One hundred micro litres of the stop solution was added to each well. The optic density (OD) of each well was read at 450 nm with LEDETECT 96 Microplate Reader (Labgene Scientific). Interpretation of the results was carried out according manufacturer's instructions.

Data analysis

Questionnaire responses were entered in Microsoft Excel and imported into SPSS 16.0 for windows version for analysis. Descriptive statistics and frequencies were computed using the same software. Presumptive losses were assessed based on the direct losses incurred by different stakeholders.

RESULTS

Respondents' characteristics

Characteristics of respondents are summarized in Table 1. The majority of respondents were males who were also household heads. More than 50% of the respondents had less than 36 months experience in pig farming and approximately 41% had experienced ASF outbreak in 2011.

Table 1. Characteristics of respondents involved in a questionnaire survey (n=120)

Variable	Level	Number	Percentage
Sex	Male	98	81.0
	Female	23	19.0
Position in Household (HH)	Head of household	73	60.8
	Family member	39	32.5
	Caretaker	4	3.3
	Others (pig keeping group members)	4	3.3
Experience in pig rearing (months)	12 months and below	17	14.3
	Between 13 and 36 months	47	39.5
	Between 37 and 60 months	22	18.5
	Between 61 and 84 months	10	8.4
	84 months and above	23	19.3
Experience of the 2011 outbreak	Affected	49	40.8
	Not affected	71	59.2
Restocking	Yes	25	20.8
	No	95	79.2

Pig keeping purposes and husbandry practices

Farmers in the study area reared pigs for various purposes as indicated in Figure 1. The majority of them kept pigs as a business activity. The majority of respondents (97.0%) practiced total confinement pig husbandry system. It was also noted that many farmers (99.0%) fed their pigs on rice husks, maize bran and kitchen leftovers. Farmers in the study area sold pigs, preferably at slaughter age, to buyers within the villages (30.0%) and other villages within the district (70.0%). The pigs were sold as either live, carcasses for commercial use or pieces of pork for home consumption. Pig owners reported to had stopped selling animals for six months during the ASF outbreak period.

Awareness and knowledge on ASF disease

The majority (84.2%) of the respondents were aware of the ASF disease regardless of involvement of their pigs in an outbreak. Figure 2 shows means pig farmers used to acquire extension information on ASF. It was observed that most farmers acquired information through media and veterinary assistants. Respondents' perceptions on source of ASF infection are summarized in Figure 3. The farmers believed that ASF is mostly acquired through contact with a sick pig, infected pork as well as contact with wildlife.

ASF outbreak of 2011 and its socio-economic impact

Around 40% of the visited households were affected by the ASF outbreak of 2011. Almost all (99.9%) of the affected pigs (n=758) by the disease in the survey area died of the disease during the outbreak. Table 2 illustrates the pig populations in the research area before and after the outbreak.

Out of 120 respondents interviewed, 7.5% reported to suffer loss of business as a result of both lack of pigs to sell and fall in price as consumers were concerned with whether the sold pork came from slaughtered animal or from a died animal due to disease. Generally the price of a pig dwindled during the outbreak and has been steadily increasing six months after the outbreak up to date (survey time). Figure 3 illustrates the change in price of a pig at different periods relative to the outbreak.

A small proportion (2%) of the interviewed individuals mentioned to incur cost of controlling the disease as they attempted to treat their sick and in-contact pigs using antibiotic and multivitamin injections. On the other hand, the district veterinary offices incurred costs in enforcing trade restrictions and conducting education campaigns to the public on different aspects of the disease including the epidemiology; important for its control.

Out of the 120 respondents interviewed, twenty-five percent reported to had introduced new pigs in their households after the 2011 ASF outbreak as replacement stocks. The sources of introduced pigs were either from the affected village (43.3%), other villages within the district (53.3%) or even from other districts within the country (3.3%).

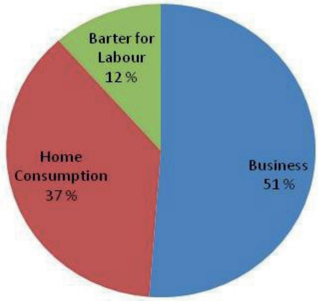

Figure 1. Purpose of rearing pigs as reported by respondents in Isoka district (n=120)

Seroprevalence of ASF

Serological results indicated that out of all 190 serum samples subjected to blocking ELISA, none was positive translating to zero ASF seroprevalence.

Table 2. Dynamics in herd size as a result of ASF outbreak in Isoka district

Item	Number	Mean ± Standard Deviation	Median	Range	Number of households
Pigs before the outbreak	1515	14 ± 15	11	1 – 83	105
Sick pigs from ASF	758	16 ± 14	14	1 – 65	49
Dead pigs from ASF	757	15 ± 14	14	1 – 65	49
Current pig population	552	6 ± 6	3	1 – 32	96

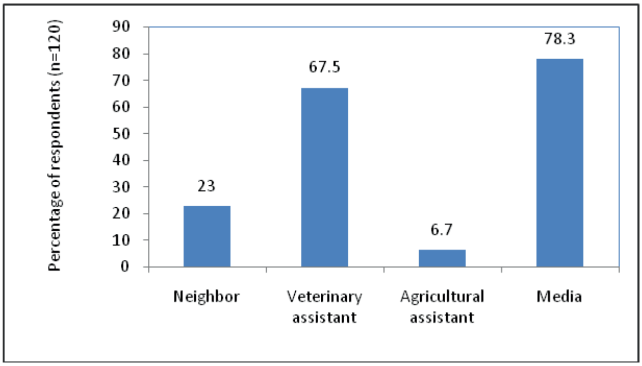

Figure 2. Sources of information on ASF to farmers in Isoka district

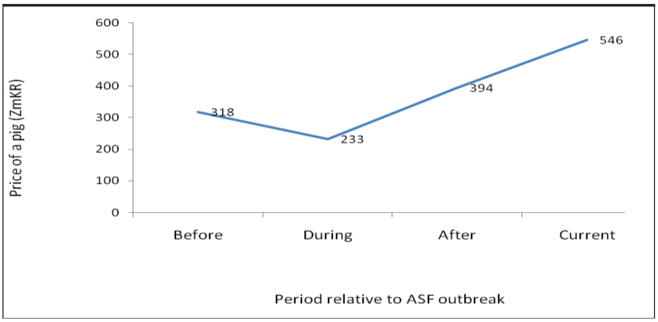

Figure 3. Trend of pig price before, during and after ASF outbreak

DISCUSSION

In Zambia pigs and pig products are the source of approximately 7% of the country's total meat supply and the country has been self-sufficient in the production of pork for many years (Wilkinson *et al*., 1988). Commercial pig production is mainly practiced near the main consumer centres, namely along the line of rail from the capital Lusaka to the Copper belt, in the Southern Province and the north of the Central Province. A large proportion of the remaining pig populations in the country are of indigenous type, kept by small-scale farmers under village conditions (Wilkinson *et al*., 1988).

Apart from problems associated with husbandry and parasitism, featuring more in the traditional pig production, the existence of African swine fever (ASF) is one of the major factors limiting pig production in Zambia (Wilkinson *et al*., 1988); impacting on both the commercial and the traditional husbandry systems. Since its first report in Kenya in 1909 (Montgomery, 1921) epizootics have been reported in many countries in Africa which lie on or south of the Equator (Neitz, 1963; Wilkinson, 1981). The disease can cause mortality approaching 100% in affected domestic pigs (Boinas *et al*., 2011) suggesting high virulence of the ASFV (Costard *et al*., 2009). This was evident in the present study in which 99.9% of the affected domestic pigs in the study area died. Serological testing of a random sample of the current pig population revealed absence of antibodies in all the tested pigs further suggesting absence of survivor pigs found in all previously affected areas surveyed. This indicates that all the pigs which contacted the virus during the outbreak died and all the remaining pigs must have not been exposed to the infection (Costard *et al.,* 2009). The zero percent seroprevalence on the other hand is a good indicator of the absence of the ASF virus in the current pig population of Isoka district, presence of which could have implication in the future epidemiology of the disease.

In many developing (African) countries, ASF outbreaks are of considerable socio-economic importance (Edelsten and Chinombo, 1995); as they result into loss of a source of income for farmers and pig traders, loss of employment for farm workers particularly in the commercial sector and loss of a major source of cheap, quality animal protein for marginal communities. Among others are the consequences for traditional ceremonies for which pigs are often required in some communities (Nana-nukechap *et al*., 1985; El Hicheri *et al*., 1998). In the study area where majority of farmers keep pigs as a business activity the 2011 ASF outbreak impacted severely on socio-economic aspects as there were losses of revenue that was to be obtained from selling pigs due to direct losses of animals and fall of the price of pork (before the trade ban) as the demand for the product decreased due to consumers' concerns that the sold meat was probably from pigs that died of the disease rather than slaughtered healthy pigs. The community also suffered non availability of a cheap source of quality protein attributable to pig losses and trade ban. Effects on socio-economic aspects also involved disease control costs, trade restrictions and non availability of man power to till the land for crops which is in exchange with pork. With a compromised crop production and loss of a valuable protein source, there is a risk of food insecurity and poor livelihoods for the farmers.

Knowledge on the epidemiology of an infectious disease is a prerequisite for its successful prevention and control. Most of the farmers in the study area were aware of ASF disease and knew some transmission routes. They however acquired this knowledge from different sources during the outbreak. Their lack of knowledge on the disease and its epidemiology before the outbreak might have compromised efficiency of some prevention and control strategies aiming at interfering transmission of the disease. Similarly though quarantine was imposed on the entire Isoka district during the outbreak, it was only easy to enforce it on markets and commercial outlets. Village to village movements were difficult to control which created possibilities for disease transmission.

The maintenance of ASFV in eastern and southern African countries has for a long time been in an ancient sylvatic cycle involving soft ticks (*Ornithodorus* spp.) and asymptomatic infected warthogs and bushpigs and red river hogs (*Potamochoerus* spp.) (Haresnape *et al*., 1988; Wilkinson *et al*., 1988; Oura *et al*., 1998; Kleiboeker and Scoles 2001; Bastos *et al.,* 2009). In endemic areas cycles involving domestic pig and tick, and a pig to pig cycle in the absence of other vertebrate or invertebrate hosts (Penrith *et al.,* 2004a; Jori and Bastos, 2009) have been described. Penrith *et al*. (2004b) noted that in some regions of South East Africa there is evidence that the disease can be maintained in populations of domestic pigs that have become resistant to the pathogenic effects of ASF. In the study area the absence of warthogs in the wildlife population (Kanemanema, personal communication, 2013) reduced the chances of maintenance of the sylvatic cycle and thus introduction and eventually transmission of ASF virus (ASFV) could be attributed to other routes including the movement of infected pigs or pig products. This mode of transmission is common in West African countries where virus transmission occurs in the absence of sylvatic host involvement (Gallardo *et al.*, 2010). These different epidemiological transmission patterns could be related to the genetic variability observed in Eastern and Southern African ASFV isolates that comprise 22 distinct p72 genotypes as opposed to the high homogeneity in West African ASFV isolates that are classified in a single p72 genotype I (Lubisi *et al.*, 2005, 2007; Boshoff *et al.*, 2007; Gallardo *et al.*, 2009a).

In conclusion the current study has documented socio-economic impact of ASF outbreak in Zambia in terms of mortality, loss of business opportunities and costs associated with disease control. The study also revealed absence of circulating ASFV antibodies in pig population in Isoka district. We recommend the Government of the Republic of Zambia through the Veterinary department, to apply very stringent pig, pork and pork products movement control measures in cases of ASF epidemics as well as supporting more research activities particularly on those targeting investigation of the role of sylvatic cycle of ASF in maintenance and source of infection to susceptible domestic pig population. As this condition is a trans-boundary, it is recommended to enhance technical cooperation between Zambia and the neighbouring countries with respect to surveillance and adoption of appropriate strategies for its control.

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