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An outbreak of African swine fever in small-scale pigs, Gauteng, South Africa, July 2020

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ABSTRACT

Objectives: Since 2012, outbreaks of African swine fever (ASF) in domestic pigs have increased outside of South Africa's ASF control zone. This study describes the epidemiological investigation and findings of an ASF outbreak in a small-scale pig unit in Gauteng Province and makes recommendations to prevent future outbreaks.

Methods: PCR testing and molecular analysis were performed on pig tissue samples. Veterinary services conducted epidemiological investigations, forward and backward tracing, and surveillance. Farm management and biosecurity practices were assessed. Quarantine, culling, carcass disposal, and disinfection were implemented.

Results: ASF virus genotype I was detected. A concurrent ASF outbreak in neighbouring Mpumalanga Province was identified as a possible source. Inadequate biosecurity measures probably facilitated viral transmission. Potential mechanisms for the introduction of the ASF virus include swill feeding practices, free roaming of pigs, scavenging, illegal slaughter, and trade of pig products within the community.

Conclusions: Molecular typing of the ASF virus linked the outbreak to an ongoing ASF outbreak in Mpumalanga Province. Pig enterprises with poor biosecurity practices may face greater risk of ASF introduction. Small-scale pig keepers should be targeted for ASF awareness and education campaigns. Innovative and cost-effective biosecurity solutions are needed in this resource-poor setting.

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Introduction

African swine fever (ASF) is a highly pathogenic, transboundary disease that affects domestic and wild pigs. ASF typically presents as a haemorrhagic disease, with variable mortality rates that may approach 100% in affected domestic pigs (Magadla et al., 2016). It is caused by a DNA virus in the *Asfarviridae* family (Gallardo et al., 2015; Penrith et al., 2019). ASF virus evolved and is maintained in a sylvatic cycle between warthogs and soft ticks belonging to the *Ornithodoros moubata* complex (Janse van Rensburg et al., 2020b; Penrith et al., 2019). These ticks act as biological vectors and are essential for the transmission of ASF virus from warthogs to domestic pigs (Dixon et al., 2019; Janse van Rensburg et al., 2020a). ASF transmission between warthogs and domestic pigs through direct contact does not occur efficiently (Janse van Rensburg et al., 2020a; Penrith et al., 2019). ASF is endemic to many countries in sub-Saharan Africa (World Organisation for Animal Health (OIE), 2020a), including parts of South Africa where it is a controlled animal disease in terms of the Animal Disease Act, Act No. 35 of 1984 (Janse van Rensburg et al., 2020b). Disease control is hampered by the lack of an effective treatment or vaccine (Dixon et al., 2019; Penrith et al., 2013) and the ability of the virus to remain viable in tissues and the environment for lengthy periods (Penrith et al., 2019).

In the domestic pig cycle, susceptible domestic pigs may become infected through close contact with excretions from infected domestic pigs. Indirect transmission may occur when pigs consume swill containing infected material or have contact with contaminated fomites (e.g. farm equipment or vehicles) (Beltran-Alcrudo et al., 2017; Dixon et al., 2019).

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The ASF-endemic area in South Africa, designated as the ASF control zone in 1935 (Magadla et al., 2016), includes the majority of Limpopo Province, the northern part of North West Province, and the north-eastern parts of Mpumalanga Province and Kwa-Zulu Natal Province. In the ASF-endemic area, pig-proof pens and double-fencing are used to prevent contact between domestic and wild pigs. Movement permits issued by a state veterinarian are required for the movement of domestic or wild pigs and their products within, from, and into the control zone (Fasina et al., 2015).

The first ASF epidemic outside of the control zone, since an isolated event in 1996, occurred in 2012. Investigations of the outbreak events in the provinces of Gauteng and Mpumalanga suggested that they were related to illegal movement of pigs from a Limpopo farm within the control zone to an auctioneer located in the ASF-free area. Most subsequent outbreak events were related to pig trading at auctions and interprovincial transport of pigs (Janse van Rensburg et al., 2020b). A second ASF epidemic occurred in 2016–2017, with 17 outbreak events recorded in the North West, Northern Cape, and Free State provinces. The source of these outbreak events was not confirmed (Janse van Rensburg et al., 2020b). The ASF-free area experienced a resurgence of ASF in 2019 (Figure 1), with half of the outbreak events occurring in Gauteng Province, resulting in approximately 2700 domestic pigs being culled (personal communication with the Deputy Director of Epidemiology, Biosecurity and Laboratory Services at Gauteng Department of Agriculture and Rural Development (GDARD)). In early 2020, ASF outbreak events were reported in the provinces of Free State, Mpumalanga, and Eastern Cape (Department of Agriculture Land Reform and Rural Development, 2020). Since Mpumalanga and Free State provinces border Gauteng, the province faced an increased disease risk. The lively interprovincial trade of pigs and pig products between the provinces of Gauteng, Mpumalanga, Free State, and North West compounds the risk of ASF disease transmission (unpublished observations).

Pork is an affordable source of protein (Janse van Rensburg et al., 2020b). Thus, pig-keeping is considered a means of poverty alleviation in low-income settings (Chenais et al., 2019; Penrith et al., 2013). Informal pig-keeping by inexperienced and ill-equipped individuals is increasing in rapidly expanding peri-urban settlements around Gauteng Province (unpublished observations). This might be because the province is an important economic hub in South Africa, attracting domestic and international economic migrants (Statistics South Africa, 2019).

Peri-urban pig units with under-developed infrastructure run a greater risk of ASF introduction due to their poor biosecurity measures (Chenais et al., 2017; Simulundu et al., 2017). The enforcement of biosecurity practices may be prohibited by their high cost (Janse van Rensburg et al., 2020b; Penrith et al., 2019, 2013). Moreover, pig keepers in low-income settings are likely to prioritize income generation and food supply above disease prevention measures (Penrith et al., 2019). Given the infrequency of ASF outbreaks outside of the control zone (Fasina et al., 2015; Janse van Rensburg et al., 2020b), pig keepers may under-estimate the threat of ASF.

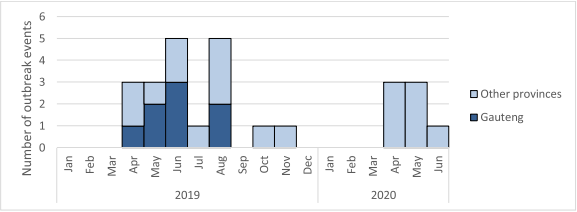


Figure 1. Epidemic curve of African swine fever (ASF) outbreak events outside of South Africa's ASF control zone (2019–2020).

The socioeconomic fallout of an ASF outbreak may be severe. Financial losses occur due to pig fatalities and trade barriers including quarantine of affected farms and restrictions on sales and movements (Arias et al., 2018; Gallardo et al., 2015). There can be knock-on, community-level effects since pig production is a tool for income generation (Chenais et al., 2019). Local food security and access to a protein source may be threatened (Janse van Rensburg et al., 2020b), as many small-scale pig keepers produce for their own consumption or supply pork to the immediate community.

On July 10, 2020, veterinary services in Gauteng Province were alerted to a possible outbreak of ASF in a small-scale communal pig unit in Ratanda informal settlement, Sedibeng district. Ratanda has a low-income community with high rates of unemployment. From July 3 to July 10, 2020, 61 mortalities occurred in a herd of 86 pigs. This paper describes the epidemiological findings of the outbreak investigation and offers recommendations for improved disease control and prevention strategies that target small-scale pig producers.

Methods

Setting

The epidemiological unit investigated was the communal farming area in Ratanda, Extension 2 with 97 live pigs belonging to five small-scale pig keepers. The pig population at risk included an additional 133 pigs belonging to 10 pig keepers in Ratanda, Extension 7, a neighbouring communal farming area within two kilometres. These communal farming areas were epidemiologically linked by proximity and regular movement of people and vehicles between the areas.

Outbreak investigation

A clinical history of symptoms and disease progression in pigs at the index site was obtained. A state veterinarian performed post-mortem examinations of pig carcasses at Ratanda Extension 2 communal farm. Based on the preliminary findings, lung and lymph node samples were submitted to Onderstepoort Veterinary Research Transboundary Animal Diseases Laboratory (OVR-TAD) for PCR testing to detect ASF viral DNA. Molecular analysis of the causative virus was performed using the c-terminal portion of the P72 gene encoding the major capsid protein of ASF (Bastos et al., 2003).

A case was defined as a domestic pig of any age, within a 10-kilometre radius of Ratanda Extension 2, showing any one of the following clinical signs: lethargy, anorexia, dyspnoea, reddening of the skin, or death, or a pig or pig product with a laboratory-confirmed ASF diagnosis from June 14, 2020 until 6 weeks after the last case. Reports from veterinary officials were used to collect information about the pig mortalities and the possible source of the outbreak. Farm management and biosecurity practices were assessed informally after engaging with the pig keepers. Backward and forward tracing of all pig movements into and outside of the epidemiological unit was conducted. Surveillance of all pig units within a 10-kilometre radius was performed telephonically. Due to the concurrent severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic, in-person surveillance was avoided.

Disease control activities

The disease control measures including quarantine, culling, carcass disposal, and disinfection are described based on the

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authors' experience and reports from provincial veterinary services.

Results

Outbreak investigation

Ante-mortem clinical signs included anorexia, lethargy, ataxia, dark coloured urine, and bloody diarrhoea. Post-mortem examination of the pig carcasses revealed marked autolysis, congestion, reddening of the skin of the neck and ears, cutaneous ecchymoses on the legs and abdomen, and haemorrhagic lymph nodes in the neck and precrural regions. Pulmonary congestion, haemorrhagic mesenteric and pulmonary lymph nodes, renal cortical ecchymoses, and enteritis were apparent. On July 10, 2020, PCR testing of tissue specimens detected ASF virus. Further molecular analysis determined that the causative virus belonged to ASF virus genotype I. The virus was designated RSA 10/2020 (TAD 20/1012 Heidelberg GP) (Figure 2). RSA 10/2020 was genetically closely related to, but distinct from, causative viruses associated with ASF outbreaks in the North West, Northern Cape and Free State provinces during the preceding 4 years (genotype Ia and Ic). However, it was found to be genetically identical to the causative viruses of ASF outbreaks in Gauteng, Mpumalanga, and Free State provinces during 2019 and 2020 (genotype Ib).

The pigs were housed in clusters of makeshift pens constructed from scraps of metal sheeting, wire, logs and wooden boards. Food scraps, maize, and swill were the main food sources, but pig keepers in Ratanda allowed their pigs to roam freely to scavenge for additional food. Biosecurity practices in both extensions of Ratanda were lacking. An absence of perimeter fencing allowed pigs to escape. Pig keepers wore their regular clothing inside the pens with no designated footwear, footbaths, or disinfectant available. Movements of vehicles and people between Extension 2 and Extension 7 took place regularly. The pig pens were not pig-proof. Pig keepers did not report the presence of wild suids around

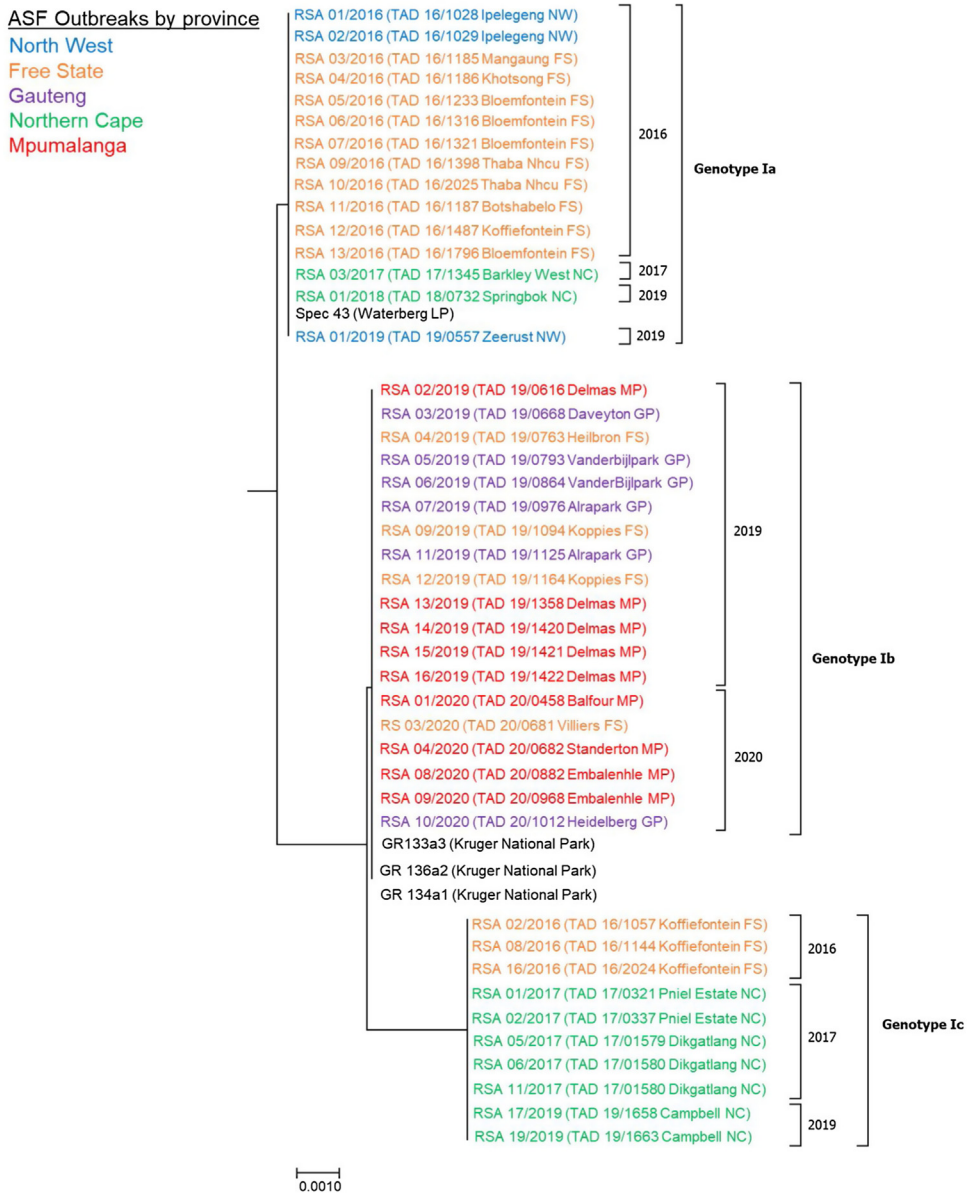


Figure 2. Neighbour-joining tree depicting p72 gene relationships of African swine fever (ASF) viruses from outbreak events in domestic pigs outside of the ASF control zone of South Africa, 2016 to 2020 (in colour). One domestic pig (Spec 43) and three tick specimens (GR 133a3, GR 136a2, GR 134a1) from within the ASF control zone are indicated in black.

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their pens, but community members had recently seen a bushpig near to the informal settlement. The hunting of wild suids by locals and the use of European wild boar for mating with domestic pigs was intimated. Pigs kept at Ratanda Extension 7 were healthy, with no notable increased mortality. However, 1 month prior to the outbreak, five pigs from different pens had died of unknown causes.

Backward tracing determined that no new pigs had been introduced to the index site (Extension 2) in the preceding 5 years. Forward tracing revealed that the index pig keeper had sold 47 weaners to an individual in North West Province on an unknown date. The purchaser reported that the weaners had already been slaughtered, showing no signs of ill-health. A number of autolysed and scavenged pig carcasses were discovered next to Blesbokspruit River, three kilometres away from the outbreak site (Figure 3). Based on the degree of autolysis, it was suspected that they had been disposed of within 2 weeks prior to the outbreak. Samples were not collected, and their origin could not be traced.

Community members alleged that a resident in a neighbouring area, Shalimar Ridge, had recently slaughtered pigs informally at his residence and sold the pork locally within the community. He had reportedly received pigs from the Free State Province a few weeks prior to the outbreak and some had arrived deceased. These claims could not be substantiated. The individual claimed to have slaughtered the pigs at the local abattoir, making use of the abattoir's meat inspection service before selling the pork privately. Inspection of the abattoir by veterinary public health officials found no non-compliances or evidence of processing of ASF-infected carcasses. A meat processing plant in Shalimar Ridge that receives carcasses from the abattoir was investigated by the Department of Health. There was no indication that the plant was linked to the outbreak.

Telephonic surveillance determined that no other pig units within a 10-kilometre radius had clinically ill pigs or unusual mortalities.

Disease control activities

On confirmation of ASF on July 10, 2020, a quarantine was imposed on Ratanda Extension 2 and Ratanda Extension 7 communal pig units. The movement of pigs and pig products into or away from the communal farming areas was prohibited. Provincial veterinary services officials inspected the units regularly to ensure adherence to the quarantine measures. Quarantine was prescribed for at least two incubation periods (38 days) after the last death due to ASF.

On July 16, 2020, 140 ASF-infected or ASF-exposed pigs were culled at both extensions in Ratanda. Humane euthanasia was performed by veterinary services officials and representatives from the National Society for the Prevention of Cruelty to Animals using captive-bolt and jugular bleeding techniques. To minimize the economic losses, an independent pig producer association purchased the pigs at a set market-related rate per live weight. Four pig keepers at Extension 2 declined the recommendation from provincial veterinary services to cull their pigs, leaving 57 live pigs without clinical signs under quarantine at the index site.

At the time of culling, the mortality rate for the index pig keeper was 95% (82/86). Inaccurate record keeping led to discrepancies between the pig census prior to culling and on the day of culling. In Extension 2, after accounting for pigs that had died between the census and culling (21 pigs), those that were culled (14 pigs), those that were quarantined (57 pigs), and those that had died under quarantine (one pig), five pigs were unaccounted for. It was assumed that these pigs were informally slaughtered. Of the 133 pigs enumerated at Extension 7 on July 15, 2020, 126 were culled. Blood pools in the pens indicated that the remaining seven pigs were informally slaughtered (Table 1).

The culled carcasses were disposed of by deep burial at an approved municipal landfill site and covered with hydrated lime (calcium hydroxide). On July 17 and 18, 2020, the pig pens at both sites were disinfected with hydrated lime, but thorough cleaning was difficult due to the earth floor in most pens.

At a quarantine inspection on July 21, 2020, a clinically ill pig was found in a quarantined pen near to the index site. Later that day, the carcass was found at a stream 300 metres away along with two other autolysed carcasses. Two further mortalities were reported on July 25 and August 12, 2020. Since the carcasses were disposed of before post-mortems could be performed, they were presumed to be ASF-related deaths. The quarantine was lifted on September 23, 2020.

Local pig keepers were advised to improve their biosecurity practices and to contact the state veterinarian if any ASF disease

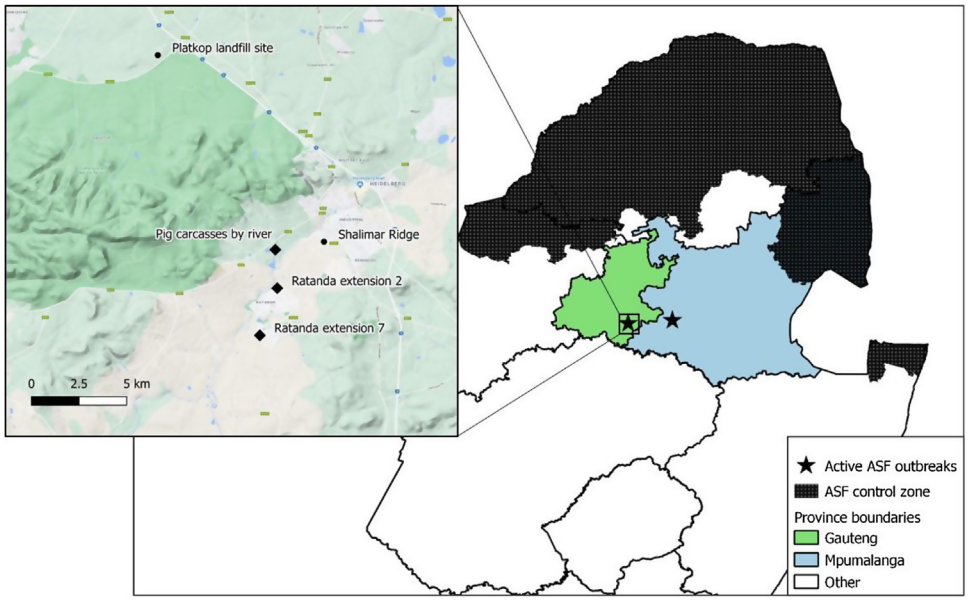


Figure 3. Layout of the African swine fever (ASF) outbreak area in Ratanda, South Africa, June 2020.

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Table 1
Summary of the numbers of pigs and pig keepers at the census and culling stages in Ratanda Extension 2 and Extension 7, Gauteng, 2020.

		Start of quarantine		Quarantine			Discrepancy[a]
		Census on July 11	Census on July 15	Died between July 11 and 16	Culled on July 16	Refused culling	
Ratanda, Extension 2	Number of pig keepers	5			3	4	+2
	Number of pigs	97		21	14	57	−5
Ratanda, Extension 7	Number of pig keepers		Unknown		8		+8
	Number of pigs		133		126		−7

[a] Discrepancy: the difference between the numbers counted under quarantine and those counted at the start of quarantine.

symptoms or unusual mortalities occurred. Multi-language pamphlets about ASF control were distributed to local pig keepers.

Discussion

The provincial veterinary services conducted an ASF outbreak investigation and implemented disease control measures. Based on an incubation period of 4–19 days (<7 days for highly virulent ASF virus) (World Organisation for Animal Health (OIE), 2013), it is estimated that ASF virus was introduced to the unit between June 14 and June 29, 2020. The mortality rate at the index site was high (95%) and quarantine was extended to 74 days.

The causative virus was genetically identical to the ASF genotype I viruses previously isolated from 2020 outbreaks in Mpumalanga and Free State. The outbreak in Govan Mbeki local municipality, Mpumalanga Province that was detected on June 10, 2020 was ongoing at the time of the Ratanda outbreak (World Organisation for Animal Health (OIE), 2020b). Given that the outbreak sites in Gauteng and Mpumalanga provinces were within 90 kilometres, and there were no other concurrent outbreak events in Gauteng, it is suspected that this outbreak was linked to the Mpumalanga outbreak. Forward tracing of the outbreak in Free State Province identified no additional cases. Furthermore, the Free State outbreak was resolved on June 10, 2020 (World Organisation for Animal Health (OIE), 2020b), 1 month before the Ratanda outbreak. Therefore, it is unlikely that the Free State outbreak event was connected. Uncontrolled movements of pigs or pig products or the introduction of contaminated fomites from the outbreak site in Mpumalanga Province were likely the mechanism of ASF virus spread to Ratanda. The poor level of biosecurity measures and husbandry practices at the index site enabled viral transmission. Several hazardous actions that could facilitate entry of ASF into the pig population were recognized. These included informal pig slaughter and trade of pig products within the community, swill feeding, free-roaming and scavenging behaviours, and careless disposal of carcasses. Similarly, the source of the 2016–2017 ASF outbreak in the ASF-free area was not identified; however, the investigations established that risky actions including illegal interprovincial pig movements, swill feeding, and scavenging facilitated transmission of the ASF virus across farms and provinces (Janse van Rensburg et al., 2020b). Inadequate biosecurity practices have also been documented as important risk factors for outbreaks of ASF in Uganda (Chenais et al., 2017), Namibia (Samkange et al., 2019), and Zambia (Simulundu et al., 2017) in commercial and small-scale units.

Although warthogs and bushpigs were sighted near Ratanda, the sylvatic cycle has not been documented in Gauteng Province (Magadla et al., 2016). Furthermore, bushpigs have not been confirmed to act as reservoirs for ASF (Netherton et al., 2019). A low-density population of European wild boar with limited domestic pig interaction would not be sufficient to act as a viral reservoir. Therefore, wild suids are not relevant to this outbreak (Penrith et al., 2019).

ASF outbreaks in the informal pig sector are driven by complex socioeconomic factors. These cannot be addressed solely by provincial veterinary services; rather, multi-sector collaboration is required. Government departments, non-profit and private organizations involved in environmental management, sanitation, agriculture, rural development and land reform, social development, and human settlements must coordinate a strategy to address the dynamic drivers of ASF disease in the South African context. The response should be directed by a joint operations committee with role players from local municipalities and the above stakeholders.

Following the ASF outbreak in 2019, awareness campaigns and engagements with small-scale pig producers, auctioneers, and abattoirs in Gauteng were conducted by provincial veterinary services (personal communication with the Deputy Director of Epidemiology, Biosecurity and Laboratory Services at GDARD). It is possible that small-scale pig keepers were overlooked, since not all informal pig keepers access abattoirs or are known to provincial veterinary officials. This gap is significant, since pig-keeping units in a communal or small-scale setting may have poor biosecurity practices and are more vulnerable to ASF transmission (Chenais et al., 2017; Penrith et al., 2019; Simulundu et al., 2017). Most ASF outbreaks in Gauteng in 2019 occurred in similar small-scale units with 26 pigs per owner on average (range 1–114) (personal communication with Deputy Director of Epidemiology, Biosecurity and Laboratory services at GDARD).

Veterinary services may support pig producers to improve animal husbandry and upgrade biosecurity practices; however, the onus rests on livestock owners to prevent and control animal disease. Provincial veterinary services should develop an ASF education campaign that specifically targets the small-scale pig sector and communal production systems. The aim of the campaign should be to promote responsible animal ownership, and improve animal husbandry and biosecurity practices. Focus groups for pig keepers run by provincial veterinary services should be reinstated. Unstructured pig-keeping in peri-urban areas should be discouraged by local municipalities; rather, formalized cooperative farming systems should be developed on land that is suitable for agriculture. Until then, entry-level biosecurity measures including fencing materials to improve the farming infrastructure and prevent pigs from scavenging possibly contaminated materials may need to be supplied. Disinfectant can be provided and pig keepers trained to use it appropriately to disinfect equipment, vehicles, and footwear (Arias et al., 2018). Single-use plastic bags are easily available and affordable and may be used as shoe covers if separate footwear designated for the pig unit is not available. Responsible use of meat-free and well-cooked swill may be explained.

This outbreak demonstrated that the provincial ASF emergency response plan should be updated. Difficulties with the procurement of equipment and resources such as trucks and hydrated lime, access to the landfill site, preparation of the trench, and availability of personnel delayed the response activities and

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compromised biosecurity at the outbreak site. Prior agreements should be in place with multiple suppliers of emergency supplies such as hydrated lime, sticking knives, and personal protective equipment. Quarantine and culling agreements should be signed promptly to prevent pig-owners from reneging on verbal agreements. Samples from any pig mortality that occurs during the quarantine period must be tested to confirm the cause of death. This information is epidemiologically relevant to the length of the quarantine period and may indicate the extent of ASF virus spread.

Informal slaughter of the pigs that were not accounted for at culling suggests that infected pigs or pig products may have been transported elsewhere, risking further outbreaks. An adequate livestock identification system in South Africa is lacking, therefore it was difficult to accurately enumerate and track the affected pig population and to individually identify mortalities that occurred during quarantine. A national livestock identification system is in development and must be fast-tracked.

In conclusion, this investigation revealed that a lack of biosecurity practices was the most probable cause of an ASF outbreak in a peri-urban area of Gauteng Province. Provincial veterinary services should facilitate improved biosecurity practices in resource-poor farming enterprises that are affordable, practical, and sustainable. The prevailing socioeconomic circumstances result in pig keepers valuing the production of low-cost protein and income generation over disease prevention. Therefore, it is critical for pig producers to financially benefit from improved husbandry and biosecurity practices. We recommend pig keeper education on ASF disease and responsible pig-keeping that is tailored to small-scale producers to promote proper biosecurity practices. Cross-sector cooperation and consultation are essential to address the multi-faceted socioeconomic drivers of ASF disease.

Ethical approval

No ethical approval was required for this study.

Conflict of interest

The authors declare that there are no conflicts of interest.

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