African swine fever: risk assessment, prevention, and disease control

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African swine fever (ASF) is a contagious, fatal, and infectious haemorrhagic viral disease of *suidae* of all ages and sexes, affecting domestic pigs and wild boars. The disease can cause severe economic losses, food safety and trade problems, and disruption to the pig industry in affected countries.

ASF is caused by an enveloped DNA virus belonging to the genus *Asfivirus* of the family *Asfariridae*. The strains of ASFV may differ in virulence. There are two genotypes (genotypes I and II) and 22 serotypes of ASFV. The virus is highly stable in the blood, secretions, carcasses, fresh pork, wild boar meat, and some products of infected pigs or wild boars. ASFV has a very high resistance to environmental stress. Appropriate approved disinfectants must be used to ensure its inactivation in the environment.

The ASF virus (ASFV) is transmitted by direct contact with excreta, secretions and blood. Animals can also be infected with ASF through indirect contact: contaminated equipment, clothing, transport, feed, feed additives, raw materials, contaminated food waste, etc. In some countries, the virus is transmitted by *Ornithodoros* ticks. Ticks of the genus *Ornithodoros*, which have been the main source of ASF infection in African or Southern European countries, have not been found in Lithuania.

The ASFV is resistant to environmental stress. It is inactivated by temperatures of +60°C within 30 minutes, fat solvents, and many commercial biocides (1% formaldehyde within six days, 2% sodium alkali within one day). ASFV remains stable for months frozen or at +4°C. It can also remain stable in highly acidic and alkaline environments (pH range 4–13).

Originating in Georgia in 2007, ASF has spread to many European countries and in 2018 was detected in East Asia, where more than 60% of the world's domestic pigs are reared.

In Eastern and Central Europe, the significant increase in the density of wild boar over the last few decades has become the main environment in which the ASFV could spread geographically. In most of Eurasia, the inadequate management practices of the wild boar population have artificially increased both the abundance of wild boars and their geographical spread, despite the natural capacity of the environment to sustain it.

In the EU, ASF has been detected in Estonia, Latvia, Poland, Germany, Slovakia, Hungary, Romania, and Bulgaria, and only the Czech Republic and Belgium have managed to fully contain and eradicate ASF, which occurred in a small area and was eradicated thanks to significant human and financial resources. The only outbreak of ASF on a pig farm in Greece was been successfully eradicated and the virus has not spread further to the pig or wild boar populations.

In Serbia, a non-EU country, ASF is currently detected in both domestic pig farms and wild boar.

In the second half of 2018, ASF gradually spread to China and in 2019–2020 to Mongolia, Vietnam, Cambodia, Laos, Myanmar, the Philippines, North and South Korea, Indonesia, and Papua New Guinea. ASF has also been detected in India and Malaysia. Similar to the wild boar epidemiological situation in Europe, the risk of endemicity of ASF has increased in East and South-East Asia and the potential for further intensive global spread of the disease with unpredictable consequences is also possible. The control of ASF, with wild boar populations involved in the transmission and maintenance cycle, poses additional challenges for veterinary and wildlife authorities, including the complexity of the epidemiology of the disease, the lack of previous experience, the unprecedented geographical scale of the problem and its causes, and the trans-boundary and multi-sectoral nature of the disease.

An outbreak of ASF in domestic pig holding causes direct and indirect economic losses. Their magnitude and variation depend on the number of infected farms, the number of infected pigs on the farms and factors that are not directly dependent on the infected farms. The spread of the disease in a country can cause significant financial losses to the pig production and meat processing industry. Analysis of data from other countries has shown that the main direct economic losses are due to the mortality of sick pigs, the destruction of infected pigs, the ban on the trade and export of live pigs and products of the porcine species to other countries, and the cleaning and disinfection of pig farms.

Economic calculations carried out in some countries under a possible scenario of an outbreak of ASF show that the prevalence of ASF would reduce pig meat exports by up to 50%. In addition, the costs of monitoring and control of ASF and of laboratory tests would be maximised. Indirect losses include an increase in environmental pollution through the processing of pig carcasses, disinfection of premises, vehicles, slurry, manure, feed, equipment. In the event of an outbreak of ASF, there are also socio-economic consequences, such as loss of employment for pig farmers, the loss of jobs, and the loss of productivity.

Spread of the disease

ASF is endemic in African countries. The first introduction of ASFV into Europe occurred in 1957 in Portugal with food waste. The outbreak of ASF was quickly liquidated. In 1960, a second outbreak of ASF occurred in Portugal and Spain and the disease became endemic until 1995. During this period, outbreaks of ASFV were detected in Andorra (1975), Belgium (1985), France (1964, 1967, 1974), Malta (1978), the Netherlands (1986), and Italy (1967, 1969, 1993). The spread of ASFV was linked to the feeding of food waste to pigs.

Since 2007, ASFV has spread to the countries of the Caucasus region and the Russian Federation. In 2013, outbreaks of ASF were detected in the Republic of Belarus (in the Grodno region the outbreak was recorded about 40 km from the Lithuanian border). In January 2014 ASF was detected in samples taken from wild boars in Lithuania.

The main natural mode of transmission of ASFV in Europe is through direct or indirect contact with infected pigs or wild boars, their carcasses, or through feeding with ASFV contaminated, untreated feed or food waste. The approximate incubation period for individual animals may be 4–19 days or even longer, although the average incubation period is 15 days. Acute, sub-acute and chronic courses of ASF are defined. The course of the disease depends essentially on the virulence of the virus. The virus is detected in the blood on day 3 after infection with high- and intermediate-virulence strains of ASFV. The current course of ASF in pigs is acute and up to 100% of them die on day 5–12 of the disease. No antibodies are produced in the pigs until then. Pigs infected with moderately-virulent ASF can recover. They spread the virus for up to six months. In pigs infected with low-virulence ASF, the virus in the blood is very short-lived. The virus replicates and can be detected in lymphoid tissues. Low-virulent virus infection in pigs is chronic and does not cause clinical symptoms of ASF. Currently, genotype II virus is circulating in both Europe and Asia causing acute course of disease.

The most common route of transmission of ASF in pigs is through the nasal or pharyngeal mucosa. The virus spreads to the submandibular and supraglandular lymph nodes and, once in the bloodstream, spreads throughout the body. Infection affects bronchial, gastric, and hepatic and mesenteric lymph nodes. ASFV can be detected in the blood as early as eight hours after infection. Secondary viremia is possible after 15–24 hours. The ASFV multiplies actively in lymph nodes, liver, and lungs. The viruses can replicate in megakaryocytes, endothelial cells, epithelial cells, liver cells, fibroblasts, smooth muscle cells, neutrophils, and lymphocytes.

Clinical or pathological anatomical tests do not enable distinguishing ASF from classical swine fever (CSF). Samples must be sent to the laboratory for confirmation.

Pigs are not treated for ASF in and there is no effective vaccines against it. Control of ASF is based on biosecurity measures. In the EU, feeding food waste from international transport to pigs is prohibited. Such waste must be disposed of safely. Biosecurity measures in pig farms are a good preventive measure against ASF. However, the risk of transmission of the ASFV is increased by trade or import of live pigs and pork products from countries where ASF is prevalent. The disease may be introduced into the country through the import of live pigs, semen, ASF-infected pig meat and its products, contaminated food waste, pig excreta, faeces or other materials; also, through contaminated means of transport of animals, animal products, feed, or other consignments which were or may have been in contact with infected animals or animal products. Inadequate control, cleaning, and disinfection of transport vehicles may influence the spread of the ASFV.

The virus can be spread by people who were in contact with a source of ASFV contamination. Persons in contact with live potentially infected pigs or boars should not visit a pig farm for at least 48 hours. Uncooked food waste containing pork products contaminated with the ASFV may be a source of virus contamination. The ASFV can spread via animal by-products, hides, manure, and other contaminated materials. Personal hygiene and strict biosecurity measures must be observed by the personnel handling the pigs. Free movement of wild boars or their confinement in pens is also a risk factor in the spread of the virus.

Possibility of the transmission of the African swine fever virus during the movement of wild boars

A herd of wild boar usually consists of a group of interrelated adult wild sows and young wild sows together with their offspring of up to one year of age. This structure of a wild boar herd is usually stable during the summer period. The young males leave the herd as soon as the first adult sow has the piglets, or during the summer. However, they remain in their native area and often have contacts with their former herd, although there are occasions when they move more than 15 km away. Adult male wild boar are solitary and settled in the area in which they live, although they may move longer distances during the mating season. Young boars may remain in their herd for a second annual cycle or may leave the herd when adult females bring their litter or when they have their own litters. However, they may return to their former herd after some time, or form a new herd with other wild boars individuals.

If there is no hunting or hunt is limited in the area inhabited by the wild boar, herds may consist of 30–40 individuals; when there is a hunting pressure, herds may consist of 5–10 individuals, i.e., one or two females with their litters and a number of young boars. In summer, the so-called home area of wild boar herds covers from 500 to 1000 ha. Obviously, the area may vary according to food resources, but movements over long distances are not observed. During the hunting season, this area can increase considerably, with animals moving 5–10 km to seek refuge in areas with no or limited hunting pressure. At the end of the hunting season, the herds are observed returning to their native areas.

The herds are led by adult sows who know the routes to potential refuge sites during the hunting season and can also find their way back. If the lead sow is killed, another adult or young female takes its place. If all the adult or young female boars in the herd are killed or disappear, then the young are left to fend for themselves and some individuals may travel up to 50 km (EC, 1999). It has been observed that the surviving young members of the herds move around together and also settle together in the new area.

There is scientific evidence and opinion that there may exist ecological corridors linking populations of the wild boar from infected third countries (Russia, Belarus) with the EU countries (Poland, Latvia, Lithuania). Corridors are also possible from the infected territories of Russia to Lithuania or Latvia. The available data suggest that there may be a link between the geographical distribution of wild boar habitats extending into the neighbouring countries. Belarusian wild boar populations are linked to Polish and Lithuanian wild boar populations, while Ukrainian wild boar populations are linked to Polish and Romanian wild boar populations, and, to a lesser extent, to Slovak and Hungarian wild boar populations. Wild boar infections can spread between larger regions, but only where there is continuity in the geographical distribution of the wild boar (EFSA, 2009c), and although the movement of wild boars is limited, the spread of viral diseases through them is quite frequent (EFSA, 2010).

Assessment of the consequences of the outbreak of African swine fever

The outbreak of ASF primarily affects the health and welfare of pigs and wild boars. The consequences of an ASF outbreak depend on the extent of the outbreak and the effectiveness of eradication measures in the restricted areas. In an ASF outbreak focus, all pigs shall be liquidated regardless of the number of infected pigs; their carcasses shall be disposed of safely, and trade in pigs and pig meat in the infected area or region shall be restricted. Cleaning and disinfection of pig farms as well as cleaning and disinfection of infected vehicles, equipment, tools, slurry, manure, and feed shall be carried out. This leads to increased environmental pollution. Suspension of exports of pigs and pork and other agricultural products causes huge losses.

Measures to control the spread of African swine fever virus

The success of the eradication and control of ASF depends on the rapid identification of ASF outbreaks and contact pig farms and liquidation of infected pigs. The control of ASF must take into account the prevalence of the disease and the epizootic situation, the prevalence of vectors, the sanitary conditions in which the pigs are kept, and the application of biosecurity measures.

The assessment of the size and geographical distribution of the population of susceptible animals (pigs and wild boar) is of major importance for the control of ASF. The spread of ASF can be slowed down in a susceptible animal population and environment where the number of susceptible animals is kept to a minimum, but in the case of ASF there is no precise number of individuals at which the disease will naturally disappear. Any new infection introduced into a new environment spreads very easily if susceptible species are present in that environment. Once an infection becomes established, its effect may wane, become endemic or, if there is a potential for continued transmission through susceptible animals, spread to other areas. The potential for the spread of infection within a population is strongly related to some epidemiological and demographic parameters of the susceptible populations.

The lethality of the infection, the efficiency of its transmission, the size of the susceptible population, the level and duration of the immune status of the population, and the growth of the susceptible animal population are highly important for the development of the disease. They determine whether the spread of the disease weakens or transforms into endemic development. Information about the geographical distribution and the size of the population of susceptible animals is particularly important for understanding the risk of the spread of infection to different areas and countries. For this reason, the regulation of population size is a very effective tool to stop the spread of ASF.

Natural spread of infection into infection-free areas is prevented if these areas are free of wild boar populations or if physical/artificial barriers are in place to prevent direct contacts between infected and susceptible groups of animals, which usually results in the spontaneous disappearance of infections (Artois et al., 2002). Such a pattern for ASF has been observed in Sardinia (EFSA, 2010). There is also evidence that physical barriers (fences), which are used to separate wild animals from domestic livestock in reserves or parks may help to prevent the spread of diseases or slow down the transmission of diseases between these populations (FAO, 1997).

The situation of African swine fever in Lithuania

In Lithuania, intensive monitoring of the populations wild boars and domestic pigs for ASF has been conducted since 2013. During such intensive wildlife monitoring, on 24 January 2014 the National Food and Veterinary Risk Assessment Institute (National Reference Laboratory for ASF) detected African swine fever after analysing the samples taken from two wild boars in a forest in Alytus-Varėna district and in a forest in Šalčininkai district. The samples were sent to the European Union Reference Laboratory for African Swine Fever in Spain to confirm the results. The obtained results confirmed that two wild boars in Lithuania were found to be infected with ASFV identical to the African swine fever virus circulating in the Transcaucasian region, Russia, and Belarus. In 2014, ASF was detected for the first time in the history of Lithuania and since then various measures have been put in place to prevent the spread of the disease. ASF is a nationwide problem as there is no cure or vaccine for it, and the virus is dangerous for both pigs and wild boars, with a mortality rate as high as 95–99%.

From 2014 to the present day, a slow spread of ASF has been observed in the wild boar population, with seasonal outbreaks (mostly in summer) on pig farms, both commercial and small-scale, where pigs are kept only for domestic use. The peak of ASF was observed in 2017–2018, when ASFV found its way to the most densely populated areas of Lithuania, and more than 5,000 boars were diagnosed with ASF during that years. As the disease wiped out the larger part of the wild boar population, the number of cases started to fall and in 2020 the number of ASF cases in wild boar population decreased by more than six times.

Today, the ASF contamination area, where the infection is found in wild boars, covers 97% of the territory of Lithuania.

ASF restricted zones established by the European Commission

Based on the epidemiological situation of ASF, the European Commission has classified the territories of the EU Member States by the level of risk:

Zone I – Risk area – due to the proximity of infected wild boar populations. In this zone, trade and exports of live pigs are not restricted. Farms must comply with national biosecurity requirements. Continuous state control and monitoring of pig holdings are carried out.

Zone II – Infected area. ASF is detected in wild fauna (wild boars) and the epizootic situation is constantly changing. Restrictions on the movement of pigs from farms (the farm must comply with all biosecurity requirements, and permanent official veterinary surveillance is carried out); trade in live pigs is allowed within the territory of the Republic of Lithuania and the European Union, and exports to third countries are only allowed with the permission of the country concerned, provided that the third country recognises the regionalisation applied by the European Commission. Trade in pork and pig meat products may only be conducted from officially recognised farms with strict biosecurity requirements. The export of the wild boar and wild boar products from the territory of Lithuania to the EU and third countries is prohibited.

Zone III – Infected area. ASF has been detected in the wild boar and domestic pigs and the epizootic situation is constantly changing. The movement of live pigs is allowed only within the territory of Lithuania and only from the farms that have fully implemented biosecurity requirements. Trade in pork and its products is limited to the local market. Products must bear a special health mark. Exports of live pigs, pork and its products to the EU and third countries are prohibited.

Zone IV – Endemic area. The epidemiological situation of ASF has been stabilised and has become endemic. Zone III restrictions apply.

The State Food and Veterinary Office and its subdivisions, the territorial services, are devoting continuous attention to the diagnosis, assessment, prevention, and control of this serious disease.

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