

Rapid Communication  
Infectious Disease



# Surveillance of ASF-infected pig farms from September to October 2019 in South Korea

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## ABSTRACT

Fourteen African swine fever (ASF) outbreaks occurred in the pig farms in the northwestern region of South Korea, near the border with North Korea, from September 16, 2019 to October 9, 2019. Active and passive surveillance on the ASF-infected farms indicated that the infection was limited only to pigsties where the infected pigs were detected on the farm for the first time before further transmission to other pigsties and farms. This early detection could be one of the pivotal factors for the prompt eradication of ASF in domestic pig farms within 1 month in the northwestern region of South Korea.

**Keywords:** African swine fever (ASF); surveillance; epidemic; South Korea

## INTRODUCTION

African swine fever (ASF) is endemic in sub-Saharan countries of Africa and Sardinia in Italy. The virus was introduced into Georgia from East Africa in 2007. Then, ASF spread to the Russian Federation in the same year and swept across the country for more than a decade. The disease continuously expanded westward and eastward, arriving in the European Union member states and Far East. Its epidemiological situation changed drastically when China reported the first ASF case in August 2018. The disease occurred all over China within nine months. Meanwhile, the disease had spread to other Asian countries including Mongolia, Vietnam, North Korea, Laos, Cambodia, Myanmar, Philippines, and Timor-Leste. South Korea also notified its first ASF outbreak in September 2019 [1].

The swine industry is the second largest agricultural sector after rice and has a major portion (approximately 30%) of the livestock industry in South Korea. The country produces more than 1 million metric tons of pork annually, but is also a large buyer of pork due to the high level of pork consumption [2]. It is a very intensive industry with 11,784,312 heads distributed to 5,725 farms as of 2019. The density of domestic pigs is high in the central-western region of South Korea, including the southern area of Gyeonggi province, Chungcheongnam province, and the northern area of Jeollabuk province [3]. The Korean pig industry has been highly vulnerable to epidemics of infectious diseases such as foot-and-mouth disease and classical swine fever. The region with high density has been more damaged by contagious swine diseases. In this context, once introduced, ASF may cause huge socio-economic consequences in the country.

**Conflict of Interest**

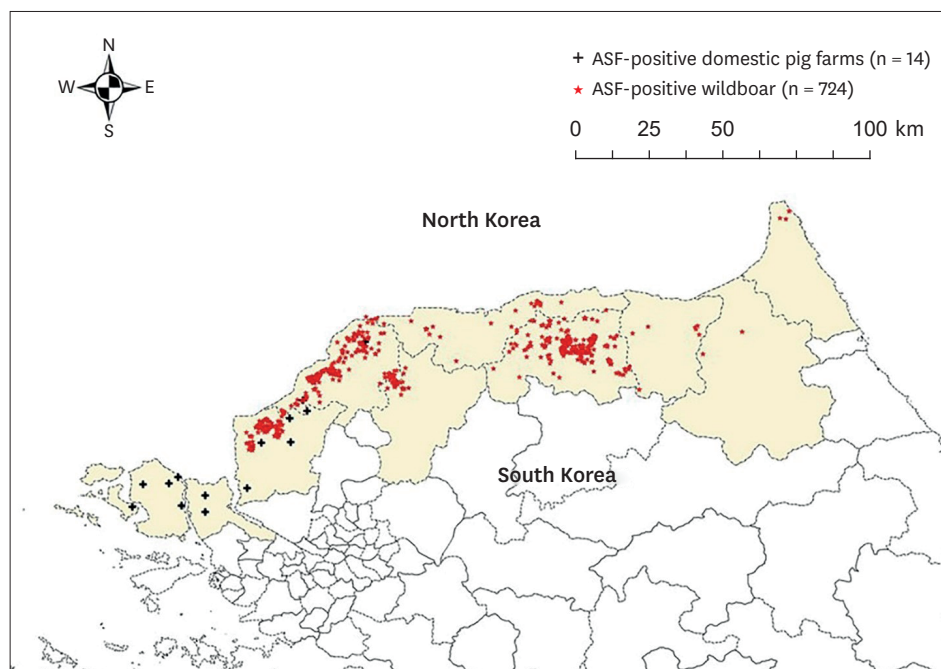
The authors declare no conflicts of interest.

**Author Contributions**

Conceptualization: Kang HE, Kim YJ, Cho KH; Formal analysis: Kim HJ, Yoo D; Funding acquisition: Kim YJ; Investigation: Kim HJ, Kim DY; Methodology: Kim YJ, Nah JJ; Supervision: Kang HE; Visualization: Yoo D; Writing - original draft: Kang HE, Kim YJ, Cho KH; Writing - review & editing: Kang HE, Cho KH.

On September 16, 2019, the first ASF outbreak was reported at one mixed farm in Paju, Gyeonggi province, located approximately 7 km from the border with North Korea. Four sows in the farm had a loss of appetite for 2–3 days and fever (40°C) and died. Distinguishing gross lesions included marked splenomegaly with infarction. Until October 9, 2019, a total of 14 cases in the domestic pig population had been confirmed in four cities/counties in South Korea [4]. All positive farms were located within 20 km of the demilitarized zone (DMZ) between South Korea and North Korea. In the meantime, 724 ASF cases were detected in wild boar carcasses and hunted wild boars in the same infected region and their adjacent regions from October 2, 2019, to August 25, 2020 (**Fig. 1**). According to the genetic analysis, all 14 Korean isolates from domestic pigs in 2019 were genotype II and serotype 8 with an intergenic region (IGR) II variant with 10-bp of tandem repeat sequences between the I73R and I329L genes and central variable region (CVR) 1 of the B602L [5]. Meanwhile, 56 isolates from wild boars also belonged to the same genotype and serotype with various IGR variants (I, II, and III) [6]. This genetic information is not sufficient to trace the origin of the infection; therefore, further studies involving whole genome sequencing and analysis among isolates from domestic pigs and wild boars are necessary. Veterinary authorities established a buffer zone composed of the infected region and its adjacent regions, and domestic pigs were culled preemptively. Control measures on wild boars such as fencing, population control, carcass search, and disposal have been implemented to prevent further transmission to domestic and wild pig populations [7].

In South Korea, active and passive surveillance for ASF has been implemented. Passive surveillance is based on farmers' notifications of ASF-suspected clinical cases. Active surveillance is conducted with sampling for each production period focusing on sows and dead/diseased pigs and pigs with fever. If ASF is confirmed in a farm by passive surveillance, additional sampling through active surveillance plus evaluation of environmental swab



**Fig. 1.** ASF outbreaks among domestic pigs and wild boars in South Korea as of August 25, 2020. Black cross and red dots show ASF outbreaks in pig farms and wild boars, respectively. ASF, African swine fever.

samples collected from the floor, wall, and feedbox of each barn is conducted before slaughtering the infected farm. In addition, other farms owned by the same possessor and its consigned farms that are closely linked by the movement of pigs, staff, and vehicles are also subjected to sampling. In this study, the results of active and passive surveillance of the 14 ASF-infected farms were analyzed to assess how early the infection was recognized and the degree of ASF virus contamination within the farms and other farms with a close epidemiological link.

## MATERIALS AND METHODS

In South Korea, active surveillance is based on sampling for each production period. Considering the clinical signs of ASF and that sows were mostly affected in China and Vietnam, the sampling focused on sows, dead/diseased pigs, and pigs with fever. Passive surveillance is based on farmers' notifications. When ASF is reported on a farm by passive surveillance, more blood and environmental swab samples from the floor, wall, and feedbox of each barn should be obtained from all the pigsties to assess the level of contamination of the farm. Other farms owned by the same possessor of the infected farm and its consigned farms closely linked by the movement of pigs, staff, and vehicles are also subjected to sampling. This additional sampling was conducted based on the sampling of active surveillance.

All samples for both surveillances were transported to a Biosafety Level 3 (BSL-3) laboratory at the Animal and Plant Quarantine Agency (APQA) in Gimcheon, South Korea. The organ samples were homogenized, and environmental samples in the form of five cotton swabs per conical tube were mixed with sterilized phosphate-buffered saline (PBS). Nucleic acids were extracted from all the samples using the Maxwell RSC Instrument (Promega, <http://www.promega.com>). Real-time PCR was conducted according to the Manual of Diagnostic Tests and Vaccines for Terrestrial Animal of OIE [8].

### Ethics Statement

No ethical approval was required for the investigations. Samples were collected and tested under the agreement of the Ministry of Agriculture, Food, and Rural Affairs of the Republic of Korea, local veterinary authorities and farm owners. The suspected samples were inactivated in the BSL-3 Lab and transferred to the BSL-2 Lab for viral DNA extraction and real-time PCR.

## RESULTS

Fourteen ASF cases of pig farms occurred in four cities/counties near the border with North Korea (**Fig. 1**). Of the 14 infected farms, 11 (78.5%) had a mixed production system (breeding and fattening), and 10 farms, with the exception of one farm, showed clinical signs of ASF in sows. The remaining farms included one breeding farm and two fattening farms. In the ASF-positive farm identification, 11 farms (78.5%) out of the 14 affected premises were detected by farmers' notifications to the veterinary authorities, while the remaining three farms were identified through active surveillance. The clinical manifestations of 11 farms detected by farmers' reports varied. The most frequent clinical signs were loss of appetite (9/11, 81.8%), death (8/11, 72.7%), abortion (4/11, 36.4%), fever (3/11, 27.3%), and depression (2/11, 18.2%). Nasal hemorrhage or paralysis was observed only in one farm (**Table 1**).

**Table 1.** Result of the surveillance on the African swine fever-infected farms in South Korea

| Farms            | City/county | Number of pigs and type of production | Classification      | Clinical signs                      | Affected pigsties   |       |       | Other pigsties    | Family owned and consigned farms (swabs) |
|------------------|-------------|---------------------------------------|---------------------|-------------------------------------|---------------------|-------|-------|-------------------|--|
|                  |             |                                       |                     |                                     | Name                | Pigs  | Swabs |                   |  |
| 1 <sup>st</sup>  | Paju        | 2,369 (mixed)                         | Notification        | Inappetence, fever, death           | Parturition pigsty  | 4/20  | +     | 0/34              | 0/90 (-)                                 |
| 2 <sup>nd</sup>  | Yeoncheon   | 2,432 (mixed)                         | Notification        | Inappetence, death                  | Pregnancy pigsty    | 2/5   | -     | 0/10              | 0/20 (-)                                 |
| 3 <sup>rd</sup>  | Gimpo       | 2,119 (mixed)                         | Notification        | Inappetence, abortion               | Pregnancy pigsty    | 9/14  | -     | 0/50              | None                                     |
| 4 <sup>th</sup>  | Paju        | 2,273 (mixed)                         | Notification        | Inappetence, Abortion, death        | Pregnancy pigsty    | 2/12  | -     | 0/40              | None                                     |
| 5 <sup>th</sup>  | Ganghwa     | 388 (breeding)                        | Active surveillance | None                                | Pregnancy pigsty    | 4/18  | -     | 0/10              | None                                     |
| 6 <sup>th</sup>  | Ganghwa     | 869 (mixed)                           | Notification        | Inappetence, fever, abortion, death | Pregnancy pigsty    | 4/4   | -     | 0/10              | None                                     |
| 7 <sup>th</sup>  | Ganghwa     | 2 (fattening, backyard)               | Active surveillance | None                                | Two cages*          | 2/2   | +     | None              | None                                     |
| 8 <sup>th</sup>  | Ganghwa     | 1,014 (mixed)                         | Notification        | Inappetence, death                  | Pregnancy pigsty    | 2/5   | -     | 0/20              | None                                     |
| 9 <sup>th</sup>  | Ganghwa     | 2,123 (fattening)                     | Notification        | Inappetence, death                  | Fattening pigsty #5 | 8/8   | -     | 0/20              | None                                     |
| 10 <sup>th</sup> | Paju        | 2,661 (mixed)                         | Notification        | Depression, nasal hemorrhage, death | Pregnancy pigsty    | 6/6   | -     | 0/41              | None                                     |
| 11 <sup>th</sup> | Paju        | 19 (mixed, backyard)                  | Active surveillance | None                                | One pigsty          | 3/19  | -     | None              | None                                     |
| 12 <sup>th</sup> | Paju        | 2,226 (mixed)                         | Notification        | Inappetence                         | Parturition pigsty  | 16/20 | -     | 0/15              | None                                     |
| 13 <sup>th</sup> | Gimpo       | 2,916 (mixed)                         | Notification        | Depression, paralysis, death        | Fattening pigsty #1 | 22/39 | -     | 0/73 <sup>†</sup> | None                                     |
| 14 <sup>th</sup> | Yeoncheon   | 4,245 (mixed)                         | Notification        | Inappetence, fever, abortion        | Parturition pigsty  | 7/9   | -     | 0/15              | 0/80 (-)                                 |

\*Two pigs were raised in 2 cages. <sup>†</sup>During the epidemiological investigations, more blood samples were collected from all pigsties.

Results of active and passive surveillance of ASF-infected farms in South Korea showed that ASF infection was limited to pigsties where infected pigs were detected on the farm for the first time, mainly in pregnancy or parturition pigpens with frequent access by farm staff. Environmental swab samples from infected pigsties of only two farms were positive, while swab samples from other pigsties were negative. Furthermore, pig blood and swab samples collected from family owned and consigned farms were all negative (Table 1).

## DISCUSSION

Of the 14 ASF cases, 11 were detected by farmers' reports, while the remaining three positive farms were found in active surveillance. At the time of notifications, most farmers in the affected areas were on high alert for the probability of ASF virus introduction into South Korea due to the continuous education by Korean governments, as ASF had occurred in neighboring countries such as China and North Korea. Major clinical signs reported by farmers were loss of appetite, death, abortion, and fever. These signs could be not recognized and lead to its huge spread. ASF causes low morbidity compared to other important swine diseases such as foot-and-mouth disease and classical swine fever [9]. Additionally, the spread of ASF in a commercial pig farm in Latvia was slow [10], where clinical signs suspicious of ASF were detected after more than 1 month, because the mortality caused by the virus did not exceed the usual farm mortality in the first weeks of infection. This tendency was also observed in Estonia [11,12]. Without early detection by active and passive surveillance, the disease can be transmitted to other farms and not easily eradicated. In South Korea, effective active and passive surveillance was conducted to detect the positive cases in the initial phase of infection within the farms and contributed to the prompt containment.

Passive surveillance is highly recommended for the early detection of ASF. When an ASF case occurred in a region of South Korea, active surveillance was conducted for pig farms of the affected region depending on the degree of risk. The active surveillance system is based not on statistics but on risk. This surveillance focused on sampling from sows, dead/diseased pigs, and pigs with fever, which had a high possibility of ASF infection. In addition to passive surveillance, active surveillance contributed to prompt eradication by detecting three ASF cases without clinical signs in South Korea.

Surveillance on the infected farms indicated that the ASF virus was confirmed only in the pigpens with infected pigs in all 14 premises and environmental swabs in the affected pigsties of two farms were positive. Farms owned by the family of infected farms and consigned were negative. It is highly possible that there was no evidence of pen-to-pen infection within and across farms. In addition to the fact that the number of animals with clinical signs was less than four heads at the time of notification and that the number of asymptomatic virus-positive cases did not exceed four heads per farm on average [13], this surveillance also supports the fact that the infection was detected in the initial phase.

Fourteen ASF cases in domestic farms of the infected region near the DMZ from September 16, 2019, to October 9, 2019, were eradicated. However, since the first infected wild boar was detected on October 2, 2019, a total of 724 cases were positive until August 25, 2020. More positive wild boars out of the previously infected region were found (**Fig. 1**). In 2019, ASF infection in domestic pig farms in South Korea was eradicated promptly by early detection through both active and passive surveillance. This can be an example for other countries that are struggling for the containment and preparing for ASF introduction into their countries. In South Korea, the transmission of ASF from infected wild boars to domestic pigs is highly probable, and educating farmers about ASF clinical signs shown during this epidemic and encouraging them to be on high alert for the chance of infection of their farms should be consolidated for the early detection of infection.

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