Common practices and knowledge about African swine fever amongst pig farmers in the Dominican Republic

Ellinor Fuglsang

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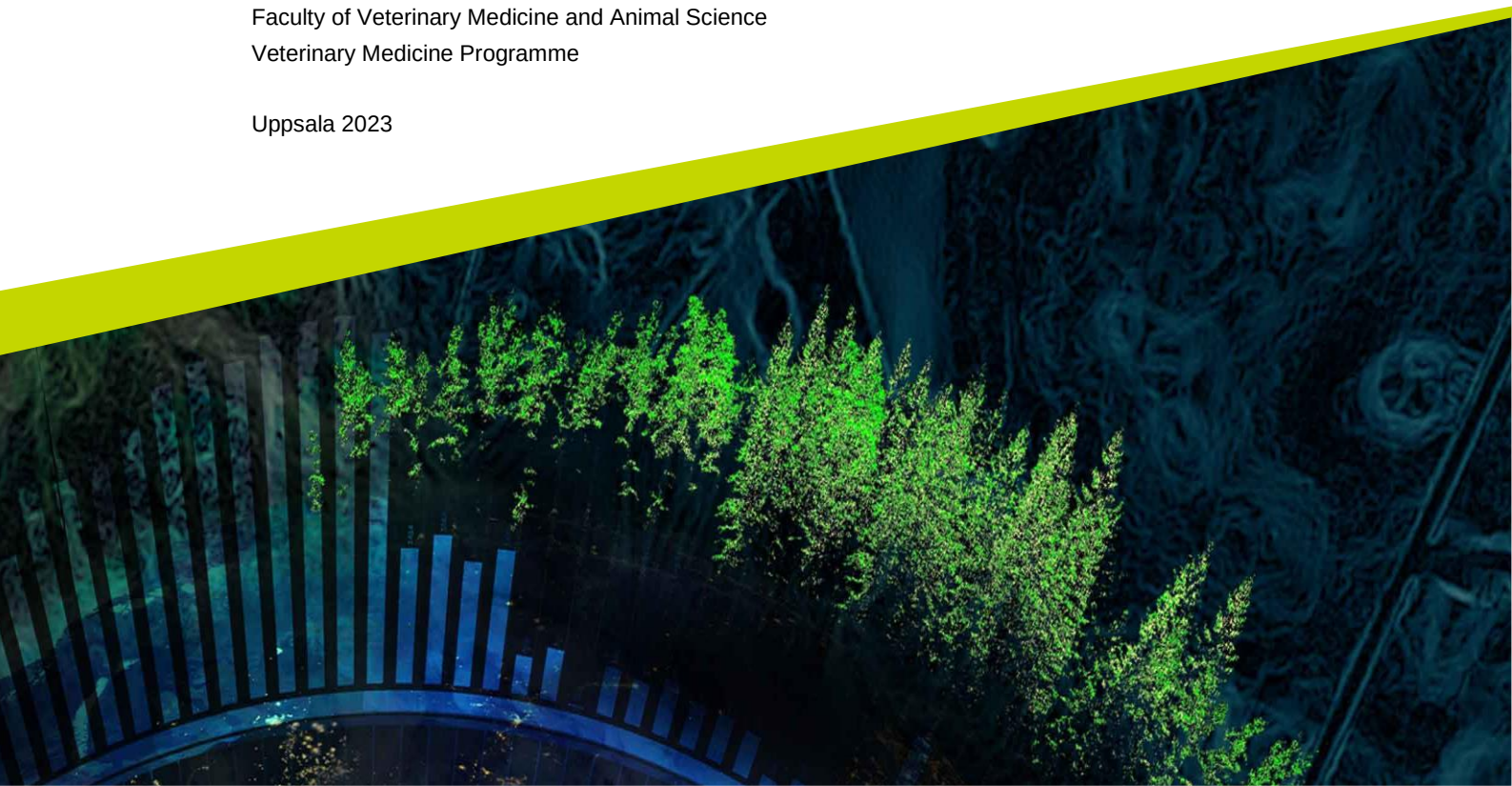

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Supervisor:	**Johanna Lindahl, Swedish University of Agricultural Sciences, Department of Clinical Sciences**
Assistant supervisor:	Erika Chenais, National Veterinary Institute
Assistant supervisor:	Karl Ståhl, National Veterinary Institute
Examiner:	Susanna Sternberg Lewerin, Swedish University of Agricultural Sciences, Department of Biomedical Sciences and Veterinary Public Health

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Swedish University of Agricultural Sciences
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Abstract

In the summer of 2021, African swine fever (ASF) made its reappearance in the Dominican Republic after 40 years of absence. The disease is known for its high mortality amongst pigs and its consequences for human welfare. To be able to provide relevant advice aiming to limit the spread of disease, it is important to understand more about pig farmers' knowledge and practices concerning the disease and its prevention. This is poorly researched in the Dominican Republic. Therefore this study was carried out to investigate it further. The study was performed through interviews in five selected areas of the Dominican Republic. The participants were farmers, some of which also worked as meat sellers or veterinarians. A questionnaire containing questions concerning common practices in their pig holdings, encountered diseases, transmission, and prevention of ASF as well as expectations on authorities and consequences of outbreaks was used in the interviews.

The study showed that, together with diarrhoea, ASF seemed to be the most commonly encountered disease on the farms. If encountering a disease, most farmers treated sick pigs themselves but contacted veterinarians if further help was needed. The majority vaccinated their pigs and the most common vaccines used were against classical swine fever, mycoplasmosis, and circovirus. Many farmers cleaned their farms regularly and used disinfectants effective against ASF. The awareness of ASF, its symptoms, transmission, and prevention was generally high. Economic loss was the biggest consequence of ASF on a farm. In case of an outbreak of ASF authorities euthanised sick animals and compensated for these according to the participants. Some participants, however, questioned whether this actually was implemented. Economic support was the action most wanted from authorities.

These results contribute to a preliminary picture of the practices and level of knowledge of ASF in the Dominican Republic. It can serve to better understand the current situation and guide future research areas.

Keywords: Disease transmission, Caribbean, Biosecurity, Swine, Outbreak, Pig production

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Abbreviations

ASF	African swine fever
ASFV	African swine fever virus
CSF	Classical swine fever
DNA	Deoxyribonucleic acid
ELISA	Enzyme-linked immunosorbent assay
FAT	Fluorescent antibody test
HAD	Hemadsorption
IFA	Indirect fluorescent antibody test
OIRSA	Organismo internacional regional de sanidad agropecuaria
PCR	Polymerase chain reaction
SLU	Swedish University of Agricultural Sciences
SVA	National Veterinary Institute, Sweden
USDA	United States Department of Agriculture

1. Introduction

African swine fever (ASF) is a deadly disease in pigs. Globally, 35% of the meat intake comes from pork, making ASF a threat to the world's food security and hindering the fulfilment of several of the sustainable development goals (UNDP n.d.) ASF further poses a threat to the ecosystem since it also causes disease in the population of wild endangered pig species (IUCN 2021).

ASF is an Asfivirus (Alonso *et al.* 2018). The virus originates from the sub-Saharan region in Africa (Montgomery 1921). It is transmitted between domestic pigs and wild boars through both direct and indirect contact (Dixon *et al.* 2019). Since the virus can survive for long times both in frozen and salted pork meat, food scraps are a possible route of transmission and a historically documented intercontinental transmission route. Infected domestic pigs and wild boars often die within a week after infection after showing signs such as high fever, diarrhoea, and abortions in pregnant sows (Sánchez-Vizcaíno *et al.* 2015). The symptoms are the same in domestic pigs and Eurasian wild boars *(Sus scrofa)* (Dixon *et al.* 2019). Warthogs and bushpigs do not show any clinical signs of disease (Jori *et al.* 2013).

In 1978 ASF entered the Dominican Republic for the first time. Waste from a Spanish flight has been reported to be the cause of the introduction (Alexander 1992). The introduction led to a large disease outbreak, killing 30 000 pigs during one month. An eradication program started and all pigs in the country were euthanised. In 1981 the country was considered free from ASF (Costard *et al.* 2009). After 40 years of disease absence, ASF reappeared in the Dominican Republic in July 2021, and later also in Haiti (Gonzales *et al.* 2021).

There is no cure for ASF (Sánchez-Vizcaíno *et al.* 2015). In addition, although vaccine development has advanced quickly, safe and effective vaccines are still lacking (Gladue & Borca 2022). The impact of ASF is large since pig production can be a household's biggest income in many countries and pig-keeping small-holders will lose both a source of income and food if the pigs die or are euthanised (WOAH n.d). In addition to this, ASF results in trade restrictions and eradication strategies with high financial costs for affected countries (Costard *et al.* 2009).

The disease is poorly researched in the Dominican Republic, including practices and knowledge about symptoms, transmission, and prevention of ASF amongst smallholders and meat sellers. This study, therefore, investigated these issues. A qualitative interview study in five areas of the country was performed.

2. African swine fever

2.1 The virus

ASF virus (ASFV) is a double-stranded DNA virus in the family *Asfiviridae* (Alonso *et al.* 2018). The virus is 200 nm big and possesses an icosahedral structure. ASFV consists of the nucleotide in the centre, the core-shell surrounding the nucleotide, the inner envelope, the capsid, and the outer envelope. The capsid consists mainly of the protein p72 (Revilla *et al.* 2018).

The virus exists in 24 genotypes based on the p72 protein (Qu *et al.* 2022). All 24 genotypes have been found in Africa, the virus's origin. Identifying the genotype is important for understanding the spread of the virus and in the development of vaccines. The virus found in the Dominican Republic is of genotype II and is almost identical to the virus strain that was first found in Georgia in 2007 and that is causing the ongoing outbreak in large parts of Europe and Asia (Ramirez-Medina *et al.* 2022).

ASFV is present in all excretions and secretions of infected pigs (Costard *et al.* 2013). ASFV is very resistant and has been estimated to survive in urine and faeces for about five days at 4°C and three days at 37°C (Davies *et al.* 2017). ASFV can survive in blood stored at 4°C for up to 18 months (Plowright & Parker 1967). In the same study, a spleen from an infected pig was frozen at -70°C for 105 weeks without loss of infectivity. The virus is inactivated at pH levels under 3.9 and over pH 11.5 if not in serum. (WOAH 2022). The virus can also be inactivated by heat, 60°C during 20 minutes is sufficient (Costard *et al.* 2013). In meat processing at lower temperatures, ASFV requires drying for a month or smoking at 32-49°C for 12 hours to get inactivated. Sindryakova (2016) showed that corned meat still contained both infectious virus and its genome after storing it in a refrigerator during 60 days (the duration of the study). In the same study, canned meat was investigated in the same manner but without finding either ASFV or its genome, probably due to the high temperature during the production leading to destruction of the virus. When stored at room temperature virus genome was detected by PCR during 28 days in fat, heart, kidney, and liver.

2.2 Epidemiology

There are four different cycles of transmission described: (1) the sylvatic cycle, (2) the tick-pig cycle, (3) the domestic pig cycle, and (4) the wild boar-habitat cycle (Chenais *et al.* 2018). The sylvatic cycle is a pathway of infection that is seen amongst warthogs in Africa with the *Ornithodoros moubata* soft ticks acting as a biological vector (Jori *et al.* 2013). The ticks live in warthog burrows and feed on their blood causing infection of neonatal warthogs which during a limited time develop an adequate level of viremia for new ticks to get infected by ASFV. Warthogs do not show any clinical signs upon infection. In areas where the sylvatic cycle is present, the virus cannot be eradicated.

Adult warthogs can carry the ticks to pig farms leading to infection of domestic pigs, which starts the tick-pig cycle (Chenais *et al.* 2018). This has been seen in Africa (Costard *et al.* 2013). In the Iberian Peninsula ASF got transmitted to ticks in the pens. The ticks can survive for many years without a blood meal and can carry the virus for several months to years. The virus can in this way be maintained in a pig stable by *Ornithodoros* ticks. In the domestic cycle, the virus is transmitted between domestic pigs by direct and indirect contact such as through equipment, shoes, and clothes contaminated by body secretions and excretions. In the wild boar-habitat cycle the virus is transmitted between wild boar through direct contact or indirect contact with car-casses or the contaminated environment (Chenais *et al.* 2018). The survival of the virus in the carcasses is favored by moist and cold weather. In the following section, some different transmission routes within the domestic pig cycle are discussed.

2.2.1 Transmission by direct and indirect contact

ASFV can be transmitted between domestic pigs by direct contact through the oral-nasal route (Dixon *et al.* 2019). It can also be transmitted by indirect contact such as through blood, faeces, urine, or saliva that contaminate the environment or objects. This means that contaminated vehicles, cribs, water, equipment, and other surfaces can contribute to the spread of infection. In a study by Guinat *et al.* (2014) ASFV DNA was found in blood, nasal secretion saliva, and faeces from domestic pigs from three to five days post infection. In the same study, some pigs were inoculated with ASFV and the rest were either in direct contact with the infected pigs or in a pen next to them. All pigs developed clinical signs of infection, confirming the spread both through direct and indirect contact and through short distances by air.

2.2.2 Transmission by aerosol

As mentioned above, ASFV can be transmitted through air, but only for very short distances. This is further evidenced in a study by Olesen *et al.* (2017), where pigs with no other contact with experimentally infected pigs than by air got infected. The infected pigs and the non-infected pigs were separated by a 1-meter-wide corridor. The non-infected pigs soon showed the same symptoms as the other pigs and tested positive for ASFV with PCR. The symptoms started to show in the air-contact pigs 11 days post inoculation of the other pigs.

2.2.3 Transmission by infected meat

Infected meat is another potential source of transmission (Dixon *et al.* 2019). Since the virus survives in uncooked meat, some processed meat, and after freezing meat, throwing infected food scraps in nature may infect susceptible, free-roaming pigs. Feeding pigs uncooked swill is likewise a risk factor. When new cases of ASF show up in new places with longer distances to previous outbreaks, it is often thought to be caused by pigs getting in contact with infected meat brought from other countries or continents by humans.

2.2.4 Other animals and flies as mechanical vectors

Outbreaks of ASF have been seen in farms with high biosecurity and since flies are abundant in stable environments it is feared that flies might act as mechanical vectors. In a study performed in Lithuania, multiple stable fly species such as *Stomyxus* spp. and *Musca* spp. were collected from stables with ASF outbreaks, and some of the flies carried ASFV DNA when tested by polymerase chain reaction (PCR) (Turčinavičienė *et al.* 2021). Nevertheless, the study could not draw any conclusion regarding transmission. In another study, it was investigated if the bloodsucking fly, *Stomoxys calcitrans*, feeding on infected blood can infect pigs in case of oral intake of the fly (Olesen *et al.* 2018). The pigs fed with the infected flies fell sick and infectious ASFV was detectable in serum. The author concluded that this is a possible route of infection, but primarily within farms. The author further hypothesized that larger flies, feeding on larger volumes of blood, could spread the infection longer distances, leading to transmission between farms.

Whether rodents or birds can transmit ASF between farms is poorly researched but since it is well known that the virus can be transmitted by humans on boots it seems likely that this applies to the surfaces of rodents and birds as well (Nielsen *et al.* 2021). Apart from contaminated animals, there is a possibility that scavengers, both birds and mammals, can carry infected meat between farms (Probst *et al.* 2019). Scavenging birds was discovered as a risk factor by Fasina *et al.* (2012). However,

the epidemiological risk of transmission by scavengers seems to be limited when studied on wild boar in Germany (Probst *et al.* 2019).

2.2.5 Transmission by persistently infected pigs

It has for a long time been suspected that pigs surviving ASF can carry the virus even after recovering from the disease and thereby contribute to the spread. A literature review was carried out to investigate this further (Ståhl *et al.* 2019). From this study, it is concluded that there are two types of ASF survivors: chronically infected pigs and pigs that manage to get rid of the disease. The chronic cases get periodic viremias and during these periods they might show symptoms, and eventually, they will die from the disease. This is often caused by low virulent strains of ASFV. The other type of survivor recovers from ASF and only excretes the virus for up to 40 days. The virus might be persistent in lymphoid tissues from both of these categories of pigs. It is however unclear if this poses an actual risk of transmission through carcasses since the dose for oral infection is about 140 000 times as high as the dose required for infection parentally.

In one of the studies included in the review (Petrov *et al.* 2018), pigs were inoculated with ASFV and the survivors were tested by PCR and hemadsorption test (HAD) to see for how long they would carry the virus. The result showed that HAD was only positive until 63 days post infection but PCR could detect viral genome over 90 days post infection. In addition, 99 days post infection the survivors were put in contact with negative pigs to see if the survivors could infect the healthy pigs, but none of the contact pigs tested positive or showed any symptoms. This finding supports the theory that apparently healthy pigs do not carry the virus long-term or contribute to the spread.

2.3 Clinical signs and pathological findings

The dose and route of infection as well as the virulence of the virus strain affect the clinical presentation as does also the health status of the host (Sánchez-Vizcaíno *et al.* 2015). The incubation period is usually 4-19 days. With a highly virulent strain, clinical signs include inappetence, apathy, nasal discharge, and a body temperature around 40-42°C. Incoordination, vomiting, eye discharge, and diarrhoea are other symptoms that may occur (WOAH 2022). The diarrhoea may become haemorrhagic. Erythema can typically be seen on the abdomen, extremities, ears, chest, tail, and around the anus (Sánchez-Vizcaíno *et al.* 2015). Haematological changes such as lymphopenia leading to leukopenia are common. Abortion in pregnant sows is a common sign of acute ASF. If the course of the disease is more per-acute the pigs die within 1-4 days after the first symptoms and if it is acute, they die within 6-13

days with a mortality rate close to 100% (WAOH 2022b). Death is caused by circulatory shock or the sudden decrease in body temperatures to subnormal levels causing coma followed by death (Iacolina *et al.* 2021). The pigs might develop pulmonary oedema leading to visible foam around nose and mouth commonly found on the dead pigs (Sánchez-Vizcaíno *et al.* 2015).

Moderately virulent strains cause a more subacute course of disease (Sánchez-Vizcaíno *et al.* 2015). The symptoms can be similar to the ones caused by highly virulent strains, but milder. Abortion in pregnant sows is often one of the first clinical signs of this form of the disease. The pigs show signs of sickness for 5-30 days and the mortality rate varies from 30-70% (WAOH 2022b). Survivors might recover after 3-4 weeks (Sánchez-Vizcaíno *et al.* 2015).

Low virulent strains cause a chronic form of the disease (Sánchez-Vizcaíno *et al.* 2015). For 2-15 months they develop symptoms such as pericarditis, arthritis, adhesions in the lungs, necrosis of the skin, intermittent fever peaks, and weight loss (WOAH 2022b). This has mainly been associated with vaccine strains (Sánchez-Vizcaíno *et al.* 2015). The mortality is low.

Pathologically, cyanosis, necrosis, and subcutaneous haematomas can also be seen but in addition to affected skin, other pathological findings can occur (Sánchez-Vizcaíno *et al.* 2015). The spleen can become up to six times its normal size. Haemorrhages caused by imbalanced haemostasis can be seen in lymph nodes, kidneys, pleura, epicardium, pericardium, and urinary bladder (Gómez-Villamandos *et al.* 2013).

An important differential diagnosis to ASF is classical swine fever (CSF) where the presentation of the clinical signs are very similar (Kleiboeker 2002).

There has been one study performed to investigate the clinical signs of the specific ASFV isolate found in the Dominican Republic 2021 (ASFV-DR21) (Ramirez-Medina *et al.* 2022). For this, pigs were inoculated with ASFV-DR21, the first group intramuscularly and the second oro-nasally. The third group was a contact group to the first. The study showed that the isolated strain seemed to only cause an acute and fatal sign of disease in the pigs that got an intramuscular injection. They showed symptoms such as fever over 40°C, anorexia, depression, red-purple skin lesions, and the disease got so severe that all pigs had to be euthanised due to animal welfare reasons. However, the second and third groups generally showed milder symptoms and some of them survived the infection. The second group showed variation in the expression of the clinical signs, one with a similar path as the intramuscularly inoculated pigs and others showing symptoms such as lethargy, discoloration of the skin, decreased appetite, and recovery. Further, one pig got high

fever and died. Meanwhile, one pig did not show any symptoms at all. The results for the contact group were similar to the oro-nasally inoculated pigs.

2.4 Diagnostics

There are several possibilities for diagnosis: detection of the virus, virus genome, antigen, or antibodies (WOAH 2022b). For diagnosis, blood or tissue from spleen, lymph nodes, kidney, bone marrow, lungs or tonsils may be collected. For detection of the virus, inoculation of samples on cell culture can be used. It is also possible to perform a hemadsorption test (HAD), if this gives a positive result it is conclusive, but if negative it should be followed up with PCR. Fluorescent antibody test (FAT) is an option to detect antigens by adding conjugated antibodies against ASFV that will cause fluorescence if bound to the antigen (Kommissionens beslut 2003/422/EG). To detect the virus genome, PCR can be used. In PCR, segments of DNA are amplified by DNA polymerase, primers, and nucleotides until detectable levels are reached (Ryu 2017). Since PCR detects the genome, it can be positive even though no infectious virus can be detected for example in recovered animals (Kommissionens beslut 2003/422/EG). Serological tests to detect antibodies are performed on serum (WOAH 2022b). ELISA, indirect fluorescent antibody test (IFA), and immunoblot are serological tests used for ASF (Kommissionens beslut 2003/422/EG). When an indirect ELISA is performed, the pigs' antibodies (primary antibodies) will bind to the ASF-antigen (Ryu 2017). When added anti-species enzyme-conjugated antibodies bind to the primary antibodies a change in colour will appear, detecting the ASF-antibody's presence. When IFA is performed, the pigs' primary antibodies bind to the infected cells and added secondary antibodies will induce fluorescence once bound to the primary antibodies. Immunoblot is a third serological test that can be used if ELISA is inconclusive (Kommissionens beslut 2003/422/EG).

2.5 History

African swine fever was first described in what is today Kenya in 1921 (Montgomery 1921). In the following years, reports of outbreaks came from several other Sub-Saharan countries (Costard *et al.* 2009). The first time ASF entered Europe was in 1957 when pigs in Portugal got infected. This is thought to be due to feeding the pigs with food waste from an airplane. The outbreak was controlled, but unfortunately, ASF reappeared in 1960. After this introduction, the virus remained in the Iberian Peninsula until the 1990s. Further outbreaks were seen around Europe, first in Malta, then in Italy, followed by France, Belgium, and Netherlands. However, the disease was eradicated in all these European countries

apart from Sardinia where it has remained endemic ever since but now seems to be under control (Laddomada 2020). In the same period of time, the disease spread to the Caribbean, firstly to Cuba (1971), followed by the Dominican Republic (1978) and Haiti (Costard *et al.* 2009). All these Caribbean countries were reported free at the beginning of the 1980s.

In 2007 the ASF was introduced to Europe via Georgia (Rowlands *et al.* 2008). Both domestic pigs and wild boar were infected and the disease spread to countries in proximity to Georgia such as Russia and Armenia. In 2014 the disease entered the EU and in 2018 it was seen in Asia for the first time, starting in China (WOAH n.d). The next victim of the disease was Oceania where it entered 2019 and 2020 on the islands of Timor Leste and Papua Guinea. In 2021 ASF reached the Americas again, first in the Dominican Republic and then in Haiti (Gonzales *et al.* 2021). In 2022 cases of genotype II were also declared in Italy's mainland, Macedonia, and Thailand (WOAH n.d).

2.6 Prevention

2.6.1 Biosecurity

Risk factors

There are several biosecurity risks for introduction of ASF to and within stables. As ASFV is present in meat and in all secretions and excretions, transmission between naïve and infected pigs can occur by direct or indirect contact (Dixon *et al.* 2019). Risks thus include direct contact but also all the different pathways by which naïve pigs might get in contact with infectious materials such as contaminated feed, food, shoes, clothes, or vehicles.

Infected pork is thought to be what introduced ASF to for example the Dominican Republic (Alexander 1992). In a study in the Democratic Republic of Congo, feeding swill was identified as one risk factor amongst others (Bisimwa *et al.* 2021). Having an abattoir in the neighbourhood has been shown to increase the risk of infection of ASFV in Nigeria (Fasina *et al.* 2012). Fasina *et al.* (2012) also found that presence of birds seemed to be a risk factor as well as having infected farms in the neighbourhood. In the study by Bisimwa *et al.* (2021), several other risk factors in smallholder settings were identified, including sharing equipment between pigs, introducing new pigs to the farms, and mixing pigs of different ages. The study also showed that farmers commonly bought pigs with unknown health status from other farms.

When pigs roam freely, they might ingest infected carcasses or contaminated grass. A connection has been shown between free-ranging pigs in Sardinia and increased risk of infection by ASF compared to the pigs kept strictly indoors (Mannelli *et al.* 1997). This is thought to be due to the free-ranging pigs sharing grazing areas with pigs from other farms. In areas where ASF is endemic and can be transmitted by soft ticks and warthogs or bush pigs, keeping pigs free ranging is also a risk (Penrith *et al.* 2021).

Biosecurity to prevent infection of ASF

In a study of the epidemiology of the outbreaks of ASF in Estonia 2015-2017, it was discovered that approximately 62% of the outbreak farms had low or very low biosecurity (Nurmoja *et al.* 2020). Biosecurity was generally higher on commercial farms than on backyard farms. Many biosecurity measures are adapted for bigger producers and might not be implementable for smallholders (Penrith *et al.* 2021).

Biosecurity in pig stables consists of both internal and external biosecurity measures (Alarcón *et al.* 2021). The external consists of preventing disease to get into the farm, and internal aims to stop the spread of infection within the farm. Penrith *et al.* (2021) discuss the effect of good fencing as an important part of external biosecurity amongst smallholders in Uganda. In settings where wild boar are present, domestic pigs should be prevented from getting in contact with wild boar. Confinement is also important to be able to implement most other biosecurity measures. Other measures to avoid transmission of ASF through direct contact between pigs include keeping new pigs in quarantine for 30 days prior to introduction to the other pigs, not sharing boars for breeding between farms, and only purchasing ASF-free pigs (Bremang 2022). However, the strict purchases of ASF-free pigs and quarantine might not be applicable in smallholder settings (Madec *et al.* 2010). Preventive measures to hinder transmission through indirect contact includes storing feed properly due to the risk of contamination by wild boars (Bremang 2022). The same applies to bedding materials. As the ASFV is present in infected meat, the pigs should not be fed food waste, but if necessary, it should be boiled at 60°C for 30 minutes prior to feeding the pigs. For the same reason, the carcasses of sick domestic pigs need to be properly destroyed (Madec *et al.* 2010). This can be done by either burning or burial. This is also an important measure to take when keeping free-ranging pigs (Penrith *et al.* 2021). Slaughters and butchers in informal settings should also make sure that tools do not get in contact with live pigs and dispose the waste unavailable to pigs.

Transports should be disinfected and equipment not be shared between farms (Bremang 2022). If necessary to move equipment between farms, it should be disinfected before use. Cleaning equipment between farms was shown important to prevent spread of ASF when studied in Nigeria (Fasina *et al.* 2012). Visitors to the

farm should be limited and employees trained to implement biosecurity measures (Bremang 2022). When visitors are allowed on the farms, safety measures should be taken such as handwashing, changing of boots and clothes, and registration of the visitors (Alarcón *et al.* 2021). Employees should not get in contact with other pigs outside of the farm (Bremang 2022).

An important part of internal biosecurity is implementing an all-in-all-out system (Bremang 2022). However, this might not be a possibility in a smallholder setting. Cleaning should be performed when the stables are empty and before a new batch of pigs moves in (Madec *et al.* 2010). However, since faeces is infectious this should be removed every day, or the pens should have slatted floors. To obtain a proper cleaning of the stables in between batches, dry mechanical cleaning should first be performed (Iacolina *et al.* 2021). Following dry cleaning, water and detergents should be used. This should then be followed by disinfectants. There are several effective disinfectants against ASFV such as formaldehyde, caustic soda solution, glutaraldehyde, sodium or calcium hydroxide, phenols such as creolin, sodium hypochlorite, and multi-constituent compounds such as potassium peroxymonosulphate, sodium chloride, organic acids, surfactants, etc. However, some of these are limited in use due to their toxicity. This cleaning process might not be possible in a smallholder setting if an all-in-all-out system is not implemented and due to other limitations mentioned in the following section (Madec *et al.* 2010). Further, change of clothes and handwashing between the different sections of the stable is important to limit internal transmission (Alarcón *et al.* 2021).

2.6.2 Biosecurity implementation in low-income countries

There are different possible reasons for smallholders not implementing biosecurity measures. One could be lack of knowledge. For example in a study in Uganda, few participants used disinfectants since they did not know what it was (Nantima *et al.* 2015). Similarly, the majority did not know that food waste needed to be boiled prior to feeding it to the pigs. However, another study also performed in Uganda showed that lack of knowledge did not seem to be the main reason for not implementing biosecurity measures, instead economy and culture might play an important role (Aliro *et al.* 2022). In the study by Aliro *et al.* (2022) buying commercial feed and disinfectants was often mentioned as a constraint amongst the smallholders. Some further mentioned that they sold the dead pigs without telling anyone that they had died from ASF to avoid losing money and that they let potential buyers such as butchers contaminated by blood enter the stables. In accordance with this, in the study by Nantima *et al.* (2015) some farmers admitted that when rumours were spreading of ASF outbreaks, farmers tended to sell their pigs to prevent the loss if they died.

Reasons for not taking proper care of the carcasses were mentioned to be expenses for fuel if the carcass was to be burned and for labour if to be buried (Aliro *et al.* 2022). Culture also played a role since burial of carcasses was considered taboo and to bring bad luck to the rest of the herd. Other reasons for not burying the dead pigs were that it took a lot of work to dig a sufficiently big hole and in poor areas throwing away food was not considered an option and carcasses could still be sold to earn some income.

2.6.3 Vaccine

There are currently no effective vaccines against ASFV on the market, research is however ongoing (Gladue & Borca 2022). Until now inactivated vaccines and virus proteins have not shown satisfying results. Most successful so far are live attenuated vaccines. These protect from disease when vaccinated pigs encounter a genetically similar strain to the vaccine strain. Naturally attenuated strains might however still be somewhat virulent. Another option to create live attenuated vaccines is by replication of the virus in cell cultures. In this way, the virulence is often lost. A disadvantage with this method is however partial loss of the virus genome, making the vaccine less efficient since genes encoding for antigens might disappear. A third approach in creating an attenuated vaccine is genetic manipulation where genes are removed to gain attenuation, the problem here is that even though the same gene is deleted from the different strains, the success of vaccination differs.

2.6.4 Genetic resistance

In the long run, a possible prevention method could be to breed pigs with a profitable trait such as genetic resistance to the virus, this is however still at research level (Penrith *et al.* 2021). Gene editing is another researched approach, but without any success so far.

2.7 Impact of ASF

ASF is not a zoonosis, yet it has large consequences on human livelihood and society (Blome *et al.* 2020). Disease impact is seen both amongst the farmers and other actors along the value chain, on a national and global level. Globally, 35% of the meat intake originates from pork (WOAH n.d). Therefore, ASF poses a threat to food security. For example, Haiti is one of the top ten countries in the world concerning the risk for food insecurity and a large portion of national protein intake originates from pork (Rozstalnyy *et al.* 2022). The disease also has a very negative impact on the affected countries' economies, since trade becomes restricted and costly eradication programs need to be implemented (Berthe 2020). The market price for pork might increase or decrease during outbreaks (Hui-shang *et al.* 2021).

Half of the world's consumption of pork was covered by Chinese pig production prior to the ASF introduction (Berthe 2020). In 2019, the country's production decreased to half the previous size due to ASF. The impact of ASF has also been studied in Tanzanian villages in 2019, where the mortality was 89.1% and what corresponds to 41,065 USD was lost because of ASF (Kivumbi *et al.* 2021).

For many farmers, pig production is important for both food and income. In addition, pigs can act as savings for use in difficult times (Berthe 2020). Outbreaks in Uganda resulted in the farmers not being able to pay for farm labour, their kid's education, and medical costs (Chenais *et al.* 2017). Kivumbi *et al.* (2021) also showed that financial loss can affect the possibility to pay for school fees and medical supplies. Other consequences in the study by Chenais *et al.* (2017) included less meat consumption in the household, emotions of fear and lost hope, disputes with neighbours, loss of pig breeds, and delayed weddings. Some farmers chose not to restart their business after an outbreak for reasons such as lack of pigs available for purchase, concern about new outbreaks, or lack of funding.

2.8 Situation in the Dominican Republic

In 1493 Christopher Columbus made his second journey to the Hispaniola island (Majo 2022). This time he brought eight pigs. These pigs were domesticated, but still similar to wild boar and thrived on the island, lacking predators. With time pigs started to become more feral moving to the highlands. It is said that the feral population still existing all originates from these eight animals brought by Columbus and still roam freely in the mountains in the Dominican Republic (Raysa Reyes, professor and researcher at La Universidad Autónoma de Santo Domingo, personal communication 2022).

The Dominican Republic is one part of the island Hispaniola located in the Caribbean Ocean (Plan International n.d.). The other half of the island is Haiti. The country has about 10 million inhabitants. The Dominican Republic has been embossed by dictatorship for many decades but is today a democracy with an improving economy (Globalis 2021). Today the country is ranked as an upper-middle-income country (Worldbank n.d.). However, the Dominican Republic is still amongst the poorest of the Caribbean countries with corruption and scepticism against authorities (Globalis 2021). During 2020, before the reappearance of ASF, the country produced 88 400 tons of pork meat which covered 70% of the domestic consumption (Azevedo 2022). 70% of the pig production comes from 400 modern farms in the Dominican Republic (Beek 2021). The remaining 30% equals 20 000 smaller producers. In total, about 50 800 jobs are generated in the pig industry in the Dominican Republic.

ASF was first introduced to the Dominican Republic in 1978 with a successful eradication being completed in 1981 (Alexander 1992; Costard *et al.* 2009). Following this, the disease was reintroduced in the summer of 2021 (Gonzales *et al.* 2021). However, others claim it was confirmed already in April 2021(Morillo Poche 2022). According to Gonzales *et al.* (2021), 98% of the outbreaks in the Dominican Republic from July 28 to September 10th 2021 occurred in backyard farms. Correlations have been made that smallholder farmers feed the pigs with waste and have lower biosecurity than commercial farmers in the Dominican Republic. There is no confirmed source of introduction of the disease, but different theories have been discussed, including introduction of illegal, infected pork. Even though ASF was first reported from and confirmed in the Dominican Republic it cannot be excluded that Haiti was infected first.

In August 2021 FAO published recommended safety measures for the Dominican Republic including preventing movement of pigs, strengthening border control, increasing biosecurity in pig farms, and increasing the control of luggage of travellers leaving the Dominican Republic. The recommendations further include isolation of suspected outbreak farms, not using food waste for pig feed, testing of sick pigs and finally, efforts to increase the awareness of the disease and the risks amongst producers, veterinarians, slaughters, and hunters.

On the 28th of April 2022, a digital meeting was held including several organisations. The representative from Ministerio de Agricultura, Ángela Morillo Poche, decribed how rumours of increased mortality were spreading in the Dominican Republic already in February 2021 (Morillo Poche 2022). Following the confirmation of ASF, a committee was founded to eradicate the disease. The diagnosing capacity was improved in the country to be able to diagnose ASF. An incident command centre was also initiated. Groups were put in charge of quarantine and mobilisation control where pork products should be inspected and pigs entering and leaving different zones, controlled. Positive pigs should be euthanised by electrocution and the carcasses are buried and covered with lime. The farmers get compensated, and the stables are disinfected.

Multiple organisations have supported the Dominican Republic since the first confirmed cases, for instance, United States Department of Agriculture (USDA) which assisted with sampling, implementation of an eradication plan, and funding (Shere 2022). Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA) which among other things has been working on training dogs to detect pork in passenger luggage leaving the Dominican Republic to other member countries, with help from funding from USDA (De Garcia 2022). A proposal about a buffer zone between Haiti and the Dominican Republic was also being discussed at the time of this meeting as was scanners able to detect meat, improved control of

movement of pork products through the country and traceability, as well as informational campaigns for the public and medias.

3. Materials and methods

This is a qualitative interview study, aiming to learn more about the knowledge and practices among pig farmers in five different villages in the Dominican Republic.

3.1 The team

The fieldwork was conducted in collaboration with another Swedish veterinary student, Andrea Hentz, also writing her thesis on ASF in the Dominican Republic. María Victoria Ogando and Tomás Mendez, two Dominican veterinary students from La Universidad Autónoma de Santo Domingo (UASD) also participated in the fieldwork. A translator assisted with the translation from Spanish to Swedish.

3.2 Study area

The Dominican Republic consists of 31 provinces which in turn are divided into municipalities (González 2022). The study took place in the areas around San Fransisco de Macoris, Moca, La Noria in La Romana, San Pedro de Macoris, and El Puerto San Geronimo. The cities were purposively selected based on being located in areas that had suffered from outbreaks of ASF and for reasons such as previous contacts with key people in the areas, participants assumed willing to participate, and logistical considerations such as road access.

Different amounts of time were spent in the different areas depending on the number of farmers available for interviews. The interviews also took place in different locations, some on a feed factory, some on farms, and others in animal pharmacies. This was due to practical circumstances such as the availability of a driver.

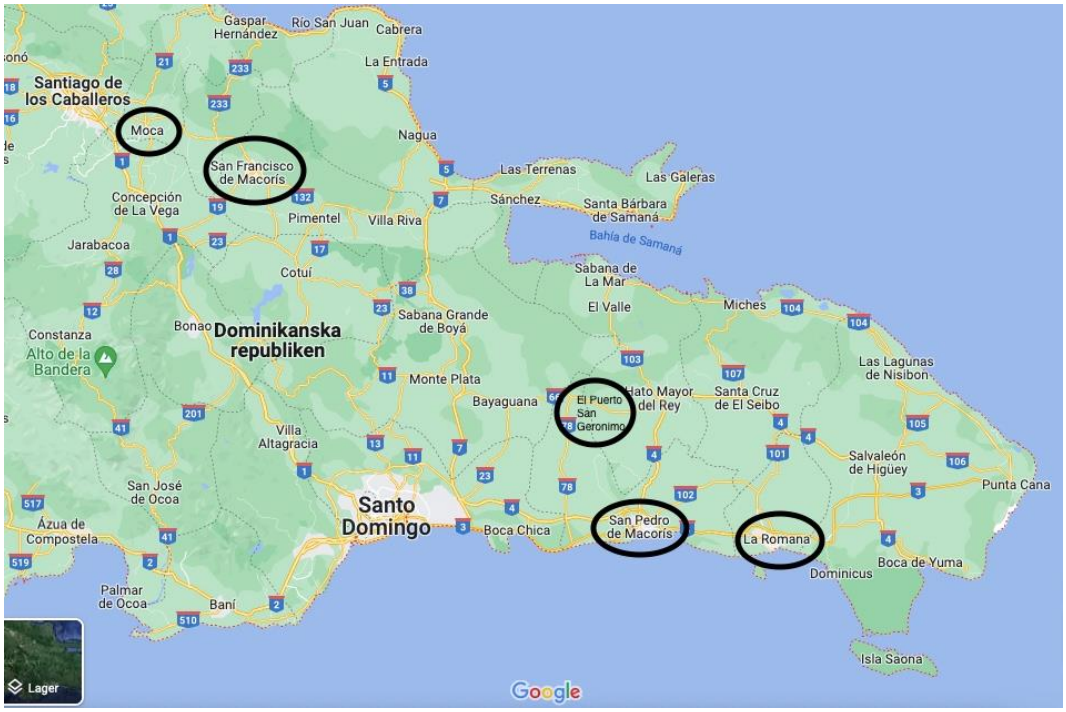

Figure 1. A picture from google maps, modified to mark the study locations in an interview study on ASF performed in the Dominican Republic in 2022.
https://www.google.se/maps/place/Dominikanska+republiken/@18.6665716,-71.2514305,8z/data=!3m1!4b1!4m5!3m4!1s0x8eaf8838def1b6f5:0xa6020f24060df7e0!8m2!3d18.735693!4d-70.162651

The first week of interviews took place in San Francisco de Macorís. San Francisco de Macorís is a city located in the north, in the Duarte province (Britannica n.d.-c). San Fransisco de Macorís is known for its production of cacao, coffee, and fruits (Britannica n.d.-c). The first three days were spent on a feed factory interviewing the farmers who came to buy feed for their pigs. Since the majority of these farmers had a larger number of pigs, the last two days of interviews were performed by visiting smaller farms and meat sellers in the area. Because this was the first week working with the survey, some questions were edited to make them clearer based on the experiences throughout the week of interviews.

The second week the interviews were performed during five days in Moca. Moca is a city in the north of the Dominican Republic belonging to the Espaillat province (Citypopulation 2019). The city's economy is based on the production of sugar, cacao, coffee, and tobacco (Britannica n.d.-b). In this village, interviews were conducted both on an animal pharmacy, connected to a company that also produces feed and on-site on farms.

The third interview location was in an area called La Noria in the city and province of La Romana (Citypopulation 2019). La Romana is located next to the coast of the Caribbean sea in the southeast of the country (Britannica n.d.-a). The city is large

in sugar production but also coffee and tobacco. These interviews were held during two days in a small community of pig farmers in smaller villages in La Noria called Batey el Gato and Las Tumbas.

In San Pedro de Macoris two farmers were interviewed, and two group interviews and one individual interview were held in El Puerto san Geronimo about 60 kilometers north of San Pedro de Macoris. San Pedro de Macorís is a city next to the coast in the southeast. The production of the city is based on sugar (Britannica n.d.-d).

3.3 Participant selection

Participants included in the survey were purposively selected. The inclusion criteria were adult pig farmers, with preference given to farmers with fewer pigs and farmers who had lost their animals due to ASF. In addition, some meat sellers participated. There were no age limitations for the participants and both men and women were included. The goal was to reach saturation within the different villages. In the feed factories and animal pharmacies, the idea was to get a higher quantity of participants since many farmers pass by during the day. The aim was to focus on the smallholders and have as equal gender representation as possible. Therefore, smallholders and women were actively searched for and interviews were conducted on their farms. Meat sellers were interviewed in the centre of San Fransisco de Macorís but were not included in interviews in any of the remaining villages due to limited availability.

3.4 The questionnaire

The questionnaire (see Annex 1) was prepared in English, containing open questions concerning common practices and knowledge of ASF among the farmers such as symptoms of ASF, routes of transmission, prevention, current health problems on the farms, and actions from the authorities during an outbreak. Before commencing, the questionnaire was translated into Spanish by Tomás Mendez. The questionnaire was adjusted between some of the interviews as it was noticed that some questions needed clarification.

3.5 The interviews

The interviews were facilitated by Maria Victoría Ogando or Tomás Mendez. The translator translated simultaneously to Swedish and the two Swedish students both

took turns taking detailed notes either in the questionnaire in a Word document on a computer or in a notepad, depending on the practical situation in the field. A second person, the other of the two Swedish students, followed along with the questionnaire during the interview. The notetaker or the second person interrupted the interviewer if any follow-up questions were necessary, or clarification was needed. All questions were not answered by all participants. Most of the interviews were recorded by a dictaphone (Olympus VN-541 PC) after obtaining consent for this from participants.

Within 24 hours from the interview notes written on paper were transferred to a Word document and digital notes were controlled for accuracy. Ambiguities of the notes were cleared in the best possible manner by listening to the audio recordings.

3.6 Ethical considerations

No ethical permit was necessary for this study according to the national regulations. All participants were informed before starting the interviews that their participation was voluntary and anonymous and that no names or exact locations of their farms would be shared in this thesis. Furthermore, the participants were informed that the research team was students and not from the authorities and that the aim of the study was only to acquire local information on the practices and knowledge about ASF.

3.7 Data analysis

In the first step interview data was organized in one document per question containing answers from all interviews for that question. Following, the data were sorted into tables with the answers in one column and the interview number in the other to be able to trace answers back to the respective interview. In the next step, data was read repeatedly and analyzed inductively searching for similarities and themes. For example, answers on transmission such as by saliva, nasal discharge, or sperm were all categorized as “secretions”. The themes were colour-coded, the different colours were then counted and the result was put into tables. The method has been previously described by for example Moskalenko *et al.* (2022). All answers to the questions from the group interviews were collected in one separate document and analyzed separately from the individual interviews.

Answers from participants who suffered from ASF and participants who had not, were compared regarding symptoms, transmission and prevention of ASF. This was done by counting answers from the tables of the individual interviews that had at least one correct symptom/transmission route/preventative measure. Classified as

“wrong” were the participants who either could not answer the question or did not give any correct suggestions.

4. Results

4.1 Definition of ASF

Answers mentioning ASF (PPA in Spanish), the fever, the pest, or the pandemic were interpreted as African swine fever. However, what name the participants used to describe the disease was noted.

4.2 Participants

In total 80 interviews were held. Thirty-eight interviews in San Fransisco de Macoris, 21 interviews in Moca, 10 in Batey el Gato (La Romana), six in La Tumba, two in San Pedro de Macorís, and three in El Puerto San Geronimo. Four of these interviews were group interviews, and the rest were individual. A total of 93 people were interviewed. Amongst these, 10 people worked within meat selling and most of these were also farmers. Of the interviewed farmers five were also veterinarians. One of these veterinarians also worked within the stuffing sector, producing sausages. Eleven of the total 93 participants were women. The ages ranged from 22 to 77 years. Time working with pigs varied between 1.5 years to over 50 years. The number of pigs per farmer ranged from zero to 6,500 pigs. The four group interviews are categorized into A, B, C, and D. In group A in Moca two male farmers participated. Group B consisted of two male farmers from Moca. Group C took place in El Puerto San Geronimo with 10 participants, of which one was a woman. Group interview D also took place in El Puerto san Geronimo and consisted of two male farmers and one female farmer.

4.3 Diseases observed in own pigs

4.3.1 Individual interviews

The participants were asked what diseases or symptoms they had seen in their own pigs over the past two years. In total 74 participants answered this question. The

results are presented in Table 1. Of the ones who answered ASF, one only experienced ASF in the 1970s and is therefore not included. Symptoms from the gastrointestinal tract mainly included diarrhoea. Under affected skin, petechiae and purple ears were mentioned. Counted as pneumonia were the participants who only mentioned pneumonia but also the one veterinarian who mentioned *Actinobacillus pleuropneumoniae* and one farmer and two veterinarians who mentioned mycoplasmosis. Other respiratory symptoms were either not specified or included answers such as coughing. In the second and third last columns, answers who were only mentioned once are collected. The majority answered that they did not see any symptoms or diseases. However, one of these had a sow who was visibly lame.

Table 1. Symptoms or diseases observed in own pigs the past two years. Answers from an interview study performed in the Dominican Republic in 2022 (n=74).

Answers	Farmers and meat sellers	Veterinarians
No diseases or symptoms observed	26	0
ASF/”the pest”	21	1
Symptoms from the gastrointestinal tract	18	1
Pneumonia	9	3
Other respiratory symptoms	6	2
Fever	2	0
Affected skin	2	1
Classical swine fever	2	1
Porcine respiratory and reproductive syndrome	2	2
Influenzas	1	1
Post weaning multisystemic wasting syndrome	1	3
Enterococcus, shivers, green skin on chest, inappetence, allergies, do not know.	1	0
Toxoplasma	0	1
Total	69	5

4.3.2 Group interviews

During the group interviews pneumonia, PRRS, diarrhoea, and vomiting amongst piglets, ASF, and CSF were brought up. One participant in group C and all three farmers in group D had suffered from ASF the past year. One participant in group D showed a film on his phone of one of his pigs not being able to stand up with tachypnoea followed by death. He believed his pig got infected with Covid-19. Another farmer from group D had seen piloerection and red eyes prior to the ASF outbreaks but she managed to treat it with antibiotics.

4.4 Feared diseases

4.4.1 Individual interviews

What disease the participants fear the most and why was a question which was missed in the first interviews until the questionnaire was clarified. Out of respect for participants suffering from ASF, this question was not asked in areas where many farmers had experienced ASF on their farms. In the interviews in which the question was asked (n=40) the most commonly mentioned disease was ASF (see Table 2). One of the four persons who were not afraid of any diseases stated that it is normal for pigs to die. Another answered that he is not afraid of ASF since he does not believe it is a fatal disease. One farmer said that all diseases are equally as bad to be exposed to. Reasons for having the most respect for ASF were because it is a fatal disease where pigs die fast, it affects businesses since the pigs get euthanised, the difficulties of prevention without a vaccine, and lack of treatments.

Table 2.The most feared diseases amongst the participants. Answers from an interview study performed in the Dominican Republic in 2022 (n=40).

Answers	Farmers and meat sellers	Veterinarians
Most afraid of ASF/PPA	24	3
Most afraid of "the fever" or "the pest"	7	0
Not afraid of any diseases	4	0
Afraid of all diseases	1	0
Most afraid of other disease than ASF.	1	0
Total	37	3

4.4.2 Group interviews

During the group interviews, everybody agreed that ASF is the most feared disease because of its high mortality. Group D was not asked this question since they all had suffered from the disease.

4.5 Vaccination of own pigs

4.5.1 Individual interviews

In total 74 participants answered if they vaccinate their pigs or not (see Table 3). Fifty-three participants were currently vaccinating, and 21 participants were either not vaccinating (2 participants), no longer had pigs (9 participants), or no longer vaccinated (9 participants) or did not know if he vaccinated (1). In the following

tables (tables 3 and 4) these 21 participants are therefore not included even though some of them described how they used to vaccinate.

Table 3. How many of the participants vaccinated their pigs at the time of the interview. Answers from an interview study performed in the Dominican Republic in 2022 (n=74).

Answers	Farmers and meat sellers	Veterinarians
Vaccinated at the moment	48	5
Did not vaccinate at the moment	21	0
Total	69	5

Table 4 shows how many vaccinated by themselves and the amount getting help from a veterinarian. In total 53 participants answered this question. Some of them mentioned that some of their vaccinations were performed by themselves and others by the veterinarian.

Table 4. Who perform the vaccinations of the farmers' pigs? Answers from an interview study performed in the Dominican Republic in 2022 (n=53).

Answers	Farmers and meat sellers currently vaccinating	Veterinarians currently vaccinating
Vaccinate by themselves or employees	28	5
Veterinarians perform vaccination	22	0
Did not specify	4	0
Total	48	5

Fifty-three of the participants that were currently vaccinating their pigs informed about what kind of diseases they vaccinated against, see Table 5. Fourteen people answered that they do not know what they vaccinate against, and a majority of these had a veterinarian who took care of the vaccination. Two persons believed that they vaccinated against some kind of fever, pest, or pig epidemic. In addition, five people who no longer vaccinated said that they had vaccinated against ASF at some point. Two participants answered that they gave some sort of antibiotics and did not mention any vaccine. However, multiple other farmers also added what kind of supplements they give their pigs when asked about vaccination.

Table 5. What diseases the participants vaccinate their pigs. Answers from an interview study performed in the Dominican Republic in 2022 (n=53).

Answers	Farmers and meat sellers currently vaccinating	Veterinarians currently vaccinating.
Mycoplasma	15	3
Classical swine fever	15	4
Do not know what vaccine the pigs get	13	0
Circovirus	14	3
Pneumonia	3	0
"The fever"/"pest"/"pig epidemic"	2	0
Toxoplasma	2	1
Porcine respiratory and reproductive syndrome	2	0
Diarrhoea	2	1
Confuses vaccine and medicine	2	0
Do not specify	2	0
Escherichia coli	1	2
Parvovirus	1	2
IPE, tuberculosis, influenza	1	0
Actinobacillus pleuropneumoniae, swine erysipelas, clostridiosis	0	1
Leptospirosis	0	2
Total	48	5

To get an idea of the vaccination status in the neighbourhood the participants were asked if they thought their neighbours vaccinate. Twenty-seven participants out of 33 (including both people vaccinating and not vaccinating) that were asked this question, believed that their neighbours vaccinated their pigs. One veterinarian stated that economic limitations may influence the possibility to afford vaccines. A farmer that no longer had any pigs informed about a vaccination program that offered free vaccinations. Another farmer shared that before 2020 there was a vaccination programme where authorities vaccinated the pigs regularly, but with the new government, this has not been working.

4.5.2 Group interviews

Groups A, B, and D stated that they vaccinated currently, and A and B performed the vaccination by themselves while all participants in group D had help from a veterinarian. Vaccines against CSF, mycoplasmosis, and circovirus were men-

tioned. In group D they initially answered ASF but then remembered that there is no vaccine against ASF. Group C did not vaccinate at the moment since the vaccine against CSF was not available. It used to be a veterinarian sent out from the government who vaccinated the pigs in group D. In group A they answered that they did not know if neighbours vaccinate since it is a matter of costs. One from group B thought the majority of farmers vaccinate and the other ones did not know. The vet vaccinated all pigs in the area at the same time according to group D. Group C did not answer this question

4.6 Measures taken by the farmers if their pigs get sick

4.6.1 Individual interviews

The participants were asked what they do if their pigs get sick, see Table 6. Most of the participants who shared that they treat their animals by themselves often answered that if it does not work, they contact the veterinarians. Others said that they cannot afford to call the veterinarian. Euthanasia was mostly used as a last option if the pigs cannot be treated. One of the four who asked acquaintances for help had a son who worked as a veterinarian, he was however not included in the "contact the veterinarian" option.

Table 6. Measures taken by farmers when their pigs get sick. Answers from an interview study performed in the Dominican Republic 2022 (n=62).

Answers	Farmers and meat sellers	Veterinarians
Treats animals by themselves	31	3
Contact the veterinarian	32	0
Separate the animals	19	1
Euthanise	8	0
Ask acquaintances for help	4	0
Testing to see what disease it is	1	0
Total	59	3

4.6.2 Group interviews

Most groups discussed treating pigs by themselves and contacting the veterinarians if help was needed. One of the farmers in group A mentioned autopsy of dead pigs. Most participants in group C agreed that general diseases were treated by themselves with antibiotics for three days.

4.7 Cleaning routines

4.7.1 Individual interviews

The participants were asked about their cleaning routines such as how often they clean and with what formulas. Sixty farmers or meat sellers answered how often they clean, 43 of these cleaned at least once a day and 15 cleaned a couple of times per week. Two persons kept their pigs tied to trees and hence only moved them to other trees when the ground was getting "bad". One farmer answered that she does not clean since the pigs were kept on such a large amount of land. Two out of five veterinarians shared that they cleaned every day, two a couple of times per week, and one of them answered that he cleans regularly.

Methods and disinfectants for cleaning brought up are listed in Table 7. Some farmers used more than one method. Mechanical cleaning was mentioned by nine farmers and included mucking out stables. Two of these only used this method for cleaning whilst the rest combined it with at least using water. Seven only used water and six participants mentioned that they use detergents for cleaning without specifying what kind. The majority of participants asked about what formulas they use for cleaning (n= 61) answered some kind of disinfectant and some of them used multiple disinfectants.

Table 7. Methods and disinfectants used to clean pig stables (n=65). Answers from an interview study performed in the Dominican Republic 2022.

Answers	Farmers and meat sellers	Veterinarians
Mechanical cleaning	9	0
Only used water	7	0
Detergents	5	1
Unspecified disinfection	5	1
Creolin	23	0
Chlorine	11	0
Despadac [1]	7	2
Virkon [2]	4	1
Iodine	4	2
Glutaraldehyde	2	0
Virocid [3]	2	1
Total	61	4

1. *Glutaraldehyde, formaldehyde, glyoxal, didecyldimethylammonium chloride.*
2. *Potassium peroxymonosulfate.*
3. *Quaternary ammonium, glutaraldehyde, isopropanol.*

4.7.2 Group interviews

Cleaning routines within the groups varied. In group A both farmers cleaned with water every day and then with disinfectants a couple of times per week. Both farmers in group B used disinfectants such as Viroflex, chlorine, iodine, or creolin every day. In group C all participants cleaned at least once a day and the disinfectants used were mainly chlorine and creolin. Some only used water. One farmer in group C did not clean since his pigs were tied to trees and therefore moved them in similarity to the two farmers from the individual interviews. Both farmers from group D cleaned their stables every day with water and creolin.

4.8 Awareness of ASF

4.8.1 Individual interviews

The vast majority of farmers, meat sellers, and veterinarians were familiar with ASF. See Table 8. In total 70 persons answered this question. Of the 23 participants who suffered outbreaks of ASF, one person had only experienced an outbreak in the 1970s. Another farmer claimed that he was exposed to an outbreak of ASF in 2015 and then another outbreak in 2021 where 400 pigs died. Nevertheless, he did not believe the second outbreak to be ASF since more pigs died this time than in 2015. Other participants referred to “the fever” or “the pest” and did not seem to know ASF by the Spanish name “Peste porcina Africana” (PPA).

Table 8. Farmers familiar with ASF. Answers from an interview study performed in the Dominican Republic 2022 (n=70).

Awareness	Farmers and meat sellers	Veterinarian
Have heard of ASF, but not experienced it	34	4
Have had pigs with ASF	22	1
Have heard of ASF by another name	6	0
Have not heard of ASF	3	0
Total	65	5

4.8.2 Group interviews

All participants in the group interviews had heard of ASF.

4.9 Clinical signs of ASF

4.9.1 Individual interviews

To explore the participant's knowledge of ASF the participants were asked to mention all symptoms they could think of in connection to ASF, see Table 9. The farmers who had experienced ASF mentioned the symptoms they had seen during their outbreaks. Not being able to stand up, spasms, wobbliness, and dizziness were categorized into "neurologic symptoms". Impaired general condition includes answers describing fatigue and inappetence. Redness of the skin was the most common suggestion included in the syndrome "affected skin". Other signs included in this syndrome were purple spots on the skin. One participant said that red skin is the main symptom of ASF. Classified as respiratory symptoms were clinical signs such as nasal discharge, dyspnoea, sneezing, "signs of influenzas", cough and bronchitis. Shivering could be interpreted as both freezing and neurological signs and therefore placed in its own category. Multiple participants brought up affected eyes, and most of them mentioned red eyes and one said that they can get swollen eyes. When asked this question some mentioned high mortality, others had mentioned that ASF is a fatal disease at some point during the interview, in total this included 35 of the individual interviews. Some of the ones who answered that they did not know the symptoms expressed that the disease is fatal at some point during the interviews.

Out of all 23 participants who had suffered ASF, only one expressed that he did not know the symptoms since his pigs died before he noticed any signs. This means that 22 out of 23 participants (95.7%) who had suffered from ASF and answered the question were able to correctly mention clinical signs other than death. Fifteen out of 52 of the participants who had not experienced ASF could not answer, while the remaining 37 correctly mentioned clinical signs associated with ASF corresponding to 71.2%.

Table 9. Symptoms of ASF according to the participants. Answers from an interview study performed in the Dominican Republic in 2022 (n=75).

Answers	Farmers and meat sellers	Veterinarians
Impaired general condition	28	2
Fever	25	5
Shivering	17	0
Do not know	16	0
Affected skin	11	4
Neurologic symptoms	10	0
Diarrhoea/vomiting	9	3
Affected eyes	9	0
Respiratory symptoms	9	3
Freezing	4	0
Oedema	3	1
Abortion	2	2
Total	70	5

4.9.2 Group interviews

In group A inappetence, itch and lethargy were brought up as signs of ASF. One said that it is more common in sows with piglets than other pigs. In group B purple to black spots on the skin and fever were suggested. One farmer in group C who suffered from ASF described the symptoms he had observed as inappetence, ataxia, diarrhoea, red and protruding eyes, salivation, and deviating from the other pigs. The rest of the participants in group C did not know the symptoms. All farmers in group D had experienced that their pigs fell sick fast and unexpectedly, having trouble breathing followed by sudden deaths.

4.10 Differences between ASF and CSF

4.10.1 Individual interviews

The participants were asked what the differences were between ASF and CSF, see Table 10. Sixty-seven participants answered the questions and the majority said that they did not know what the difference was. Nine participants came up with descriptions of differences. Seven of these expressed that ASF is worse than CSF. One said that ASF causes a higher fever and red eyes. Another said that if infected with CSF pigs do not get oedemas and red skin. One person stated that ASF has a more aggressive course and is more fatal than CSF but, some said that they die more suddenly if infected by CSF than ASF. One participant answered that there is a

vaccine available against CSF and that CSF causes shivers and white faeces while ASF causes high fever and apathy. Another participant suggested that CSF causes respiratory symptoms and ASF does not. Two veterinarians address that they know the difference but did not want to share what it was. Another veterinarian stated that there is a vaccine against CSF but not ASF and that ASF is more fatal than CSF.

Table 10. Differences between ASF and CSF according to the participants. Answers from an interview study performed in the Dominican Republic in 2022 (n=67).

Answers	Farmers and meat sellers	Veterinarians
Do not know what the difference is or if there is a difference	49	1
Described a difference	9	3
There is no difference	4	1
Total	62	5

4.10.2 Group interviews

Both farmers in group A agreed that there are no differences, they both cause the same symptoms. In group B none of the farmers knew the difference. Only one farmer from group C thought he knew and answered that CSF can be successfully treated. In group D all farmers answered that they did not know but one compared it to the classic and haemorrhagic form of dengue fever.

4.11 Transmission between farms

4.11.1 Individual interviews

The participants were asked about transmission routes between farms. Not all participants answered this question because it was originally a more open question leading to some farmers only bringing up transmission between pigs. The results are summarized in Table 11. Out of 53 farmers and meat sellers, 31 thought that visitors could introduce the infection to the herd through their shoes, clothes, and vehicles such as transports. However, one of these farmers questioned if we really believed that ASF exists and stated that he thought it is a conspiracy from the authorities. Thirteen suggested that the disease is spread by the wind to the farms while none of the four veterinarians thought this was a pathway of transmission. Eleven farmers or meat sellers believed that insects or other animals such as rats, birds, and dogs carry the virus as mechanical vectors between the farms. This was supported by two out of four participating veterinarians. One farmer specified that scavenger birds might transmit the disease. Eight of the farmers or meat sellers addressed moving pigs between farms as an issue. Bringing new pigs to the herd, pigs running away, and borrowing boars for breeding were brought up as examples.

One farmer had experienced that his piglets escaped to another farm and when they came back home all pigs on the farm fell sick with ASF and died. Two participants mentioned the risk of contaminated feed or water as a source of transmission. Seven of the participants did not know about the transmission and therefore did not answer, however, multiple of the other participants initially also answered that they did not know but then came up with some possible suggestions. One out of these seven farmers expressed confusion on how it is transmitted since he had been taking safety precautions such as disinfection of transports but still got his herd infected. One farmer answered that ASF is transmitted like Covid-19, but did not elaborate further.

In total 21 participants who had suffered from ASF answered this question. Twelve gave at least one correct answer, corresponding to 57.1%. The remaining nine participants either could not answer or answered incorrectly. Eight out of 21 mentioned that ASF can be transmitted by air between the farms. Of the participants who had not experienced ASF on their farms and answered the question, 30 out of 36 gave at least one correct answer, corresponding to 83.3%. The remaining 6 participants could not answer or did not mention any correct transmission routes. Five of the ones who had not experienced ASF mentioned transmission by air.

Table 11. Transmission routes between farms. Answers from an interview study performed in the Dominican Republic 2022 (n=57).

Answers	Farmers and meat sellers	Veterinarians
Humans and equipment	31	4
Airborne	13	0
Insects and animals	11	2
Movement of pigs	8	1
Do not know	7	0
Feed and water	2	0
Like covid-19	1	0
Total	53	4

4.11.2 Group interviews

In the group interviews, the same transmission routes were brought up, mostly discussing birds as mechanical vectors, moving pigs between farms, unauthorized people on the farm as well as contaminated transports and equipment. In group C only one out of ten participants suggested a transmission route, the rest answered that they did not know. In interview group D, one participant mentioned that he thought that ASF is a zoonosis.

4.12 Transmission between pigs

4.12.1 Individual interviews

The participants were asked to suggest possible transmission routes between pigs, see Table 12. Twenty-seven participants mentioned close contact but the majority of these were not able to specify how. One farmer mentioned that high animal density was a risk and was included in this category of answers. Seventeen of the 62 farmers or meat sellers answering this question believed that ASF was transmitted by air between the pigs. Twenty-two participants answered that secretions or excretions can transmit disease, of these urine/faeces were mentioned by seven participants, and secretions such as sperm, nasal secretions, and saliva by 15 participants. Three farmers or meat sellers mentioned mechanical vectors such as animals and insects contributing to spread of infection. Feed and water were mentioned as a source of infection by 11 farmers or meat sellers. Three participants believed that the sow gets sick first and then transmits the disease to her piglets. Two of the participants thought that ASF is transmitted through skin contact. One farmer or meat seller mentioned contaminated equipment such as shoes spreading ASF when the staff walk in between the sections of the stable. Further, five persons mentioned routes in which they believed the disease does not transmit. These included two participants that thought it does not transmit with feed or water, two who believed that it could not transmit by urine and faeces, and one who did not believe it was transmitted between stalls. Four of these participants had experienced ASF.

Twenty-two participants who suffered from ASF on their farms, answered this question. Out of these, 18 mentioned at least one correct route of transmission, corresponding to 81.8%. The remaining four could not answer the question. Thirty-six participants who had not experienced ASF gave at least one correct suggestion on transmission out of the 43 who answered the question, corresponding to 83.7%. Seven could not answer the question.

Table 12. Transmission routes between pigs. Answers from an interview study performed in the Dominican Republic in 2022 (n=65).

Answers	Farmers and meat sellers	Veterinarians
Close contact between pigs	26	1
Airborne	17	0
Secretions	13	2
Feed and water	11	0
Do not know	11	0
Urine and faeces	5	2
Animals and insects	3	0
Sow to piglet	3	0
Skin contact	2	0
Humans, and equipment	1	0
Total	62	3

4.12.2 Group interviews

Group A mentioned nasal secretion and close contact. One of the farmers also explained that the sow transmits the disease to her piglets. Close contact and airborne transmission were suggested in group B. In Group C, only two farmers had suggestions on transmission routes. One suggested flies, and another one close contact and clarified that it is a lie that ASF can be transmitted by air. In group D, one farmer answered close contact and breeding. The rest did not know.

4.13 Transmission by meat

4.13.1 Individual interviews

When asked about the transmission of ASF, some participants brought up infected meat as a source of infection, while others were directly asked if they thought ASF could spread through this pathway, see Table 13. The majority agreed that meat from a pig infected by ASF can be contagious to other pigs. This result was supported by the three participating veterinarians. Some participants who believed meat to be infectious specified that only uncooked meat is contagious. One participant thought that humans also can get sick if they eat the infected meat. The ones who did not believe meat to be infectious motivated it by “if humans do not get infected by eating the meat, why should the pigs?” Another said it would be illogical if it was transmitted by meat since the scavenger birds do not get sick. Two of the seven who answered that meat is not infectious had experienced ASF on their farms.

On this question, 13 out of 16 participants who had suffered from ASF answered that meat can be infectious, corresponding to 81.2%, while three either did not know or thought it was not infectious. Compared to the participants who had not experienced ASF, 21 out of 29 (72.4%) knew meat can be infectious, and 8 did not know.

Table 13. Infected meat as a route of ASF transmission. Answers from an interview study performed in the Dominican Republic in 2022 (n=45).

Answers	Farmers and meat sellers	Veterinarians
Meat can be infectious	31	3
Meat is not infectious	7	0
Do not know	4	0
Total	42	3

4.13.2 Group interviews

The two participants in group A agreed that meat cannot infect the pigs. In group B one participant believed that meat is contagious if not cooked, and the other participant did not answer the question. The majority in group C did not believe meat to be infectious. In group D, one farmer shared that his piglets died, and he did not have time to remove them from the sow, the sow ate from her dead piglets and after five days she fell sick.

4.14 Prevention

4.14.1 Individual interviews

The participants were asked how ASF can be prevented, see Table 14. In total 72 participants answered this question and gave analysable answers. Twenty-three participants expressed that good hygiene or high biosecurity is important in preventing the disease, most of them did however not specify how this should be achieved. One suggested washing hands between the pigs. Twenty-three participants mentioned that unauthorized visitors on the farms should be limited to avoid transmission by shoes, clothes, or vehicles. One farmer shared that under the outbreak ash was used as a disinfectant on their shoes when visiting other farmers. Disinfection, for instance of shoes, vehicles, and surfaces, was raised as an important factor in preventing spread of ASF by 20 of the 72 participants. Two out of the 20 were veterinarians.

Nine participants answered that vaccine is used or is a solution for future prevention. Six farmers or meat sellers suggested some sort of separation either of sick pigs from the other pigs or generally keeping pigs apart and well confined. Three

participants suggested medical treatment of sick pigs such as antibiotics, this was not supported by any of the five veterinarians. The importance of preventing rats and birds to get in contact with the pigs was raised by two participants. One of these, a bigger producer also working as a veterinarian claimed that backyard farmers are a large problem and that birds can get contaminated on these smaller farms and then fly to the bigger farms and introduce ASF. Two participants claimed it important not to move pigs between farms. Thirteen participants answered that they did not know how to prevent ASF or that it is impossible. One of the meat sellers explained that since the disease flies in the wind no measures taken can prevent it.

Twenty-two participants who had experienced ASF on their farms answered this question. Of these, 15 participants knew at least one way to prevent transmission, which equals 68.1%. Seven did not know or suggested incorrect ways of prevention such as by vaccines or other medical treatments. Out of 50 participants who had not suffered from ASF, 35 were able to suggest at least one possible way of prevention, which equals 70%. The remaining 15 participants did not know or answered incorrectly.

Table 14. Prevention of ASF. Answers from an interview study performed in the Dominican Republic in 2022 (n=72).

Answers	Farmers and meat sellers	Veterinarians
Good hygiene, high biosecurity	20	3
Limit visitors/isolation	20	3
Disinfection	18	2
Do not know/not possible	13	0
Vaccine	9	0
Separation of pigs	6	0
Medical treatment	3	0
Prevent access for other animals	1	1
Not moving pigs	1	1
Total	67	5

4.14.2 Group interviews

In the group interviews similar preventative measures were raised, such as preventing unauthorised people and transports to enter the farms, good hygiene, disinfection, and separation of the pigs. In interview C most people suggested vaccination for prevention. One farmer in group D said that if the pigs have a good immune defence, they will not get infected by the virus.

4.15 Information

4.15.1 Individual interviews

During the study, an additional question was added concerning where the participants can obtain information about ASF from. Due to this, only 36 answered this question in the individual interviews, see Table 15. Thirteen farmers or meat sellers consulted their veterinarian for information. Seven farmers or meat sellers sought advice from acquaintances such as family, friends, or neighbours. Amongst the ones who answered the internet, Google and YouTube were brought up as examples. Four farmers or meat sellers and two veterinarians stated that they consulted ministries or institutions for information such as Ganaderia and Ministerio de Agricultura. Three farmers or meat sellers turn to feed cooperatives for help. Two persons stated news as an information source and one of them shared that they were notified about the "pest" on the news. Three of the 34 farmers or meat sellers did not know where to obtain information from.

Table 15. From where can the participants obtain information? Answers from an interview study performed in the Dominican Republic 2022 (n=36).

Answers	Farmers and meat sellers	Veterinarians
Veterinarians	13	0
Friends and acquaintances	7	0
Internet	6	0
Ministry/institution	4	2
Feed cooperatives	3	0
Do not know	3	0
News	2	0
Total	34	2

4.15.2 Group interviews

In group A both participants said that the feed cooperative and the agricultural ministry arranged information meetings. In group B they contacted their veterinarian for information. Veterinarians, social media, TV, and rumours were suggested as information sources in group C. In group D none of the participants knew where from they could obtain information.

4.16 Consequences of ASF

4.16.1 Individual interviews

The farmers were asked what they thought the biggest consequences would be in case of an outbreak or what the consequences were if they had an outbreak, see Table 16. This question was answered by 66 participants. Forty-five addressed economic losses as an outcome of ASF. Out of these, seven said that the economic impact would not be completely devastating since they had other sources of income than the pig business, one of these was a veterinarian. Amongst the remaining 38, some specified that an outbreak would mean that they cannot pay debts or send their kids to university. Twelve participants shared that they would have to close their business or put it on pause. One of these, a female farmer had switched to chicken production when she realised the potential economic impact if she would suffer an outbreak of ASF.

Seven farmers or meat sellers mentioned that they would get difficulties selling their pigs. Reasons for this were described as people getting afraid to buy pigs or their meat during outbreaks. Other participants said that they would need to fire employees and thus contribute to increased unemployment. Four of the participants expressed that they would lose or had already lost everything due to an outbreak of ASF. Two persons mentioned that the value of the pigs increased due to ASF. The biggest consequence would be that the pigs die according to two participants, without specifying how that would affect them. One veterinarian shared that the importation has increased from countries such as the US, Belgium, England, and Brazil. According to the veterinarian, this has led to the Dominican Republic only covering 50% of its previous national production of meat. Another veterinarian expressed concerns regarding increased smuggling of pigs since the reappearance of ASF.

Table 16. Consequences of ASF outbreaks. Answers from an interview study performed in the Dominican Republic in 2022 (n= 66).

Answers	Farmers and meat sellers	Veterinarians
Economic losses	43	2
Permanent or temporary closure of business	12	0
Problem selling pigs	7	0
Loss of employment	5	0
Loses everything	3	1
Increased value of pigs	2	0
The pigs die	2	0
Increased importation	0	1
Increased smuggling	0	1
Total	62	4

4.16.2 Group interviews

The economic impact was brought up by all participants in the group interviews. In group C multiple farmers said that many sold their pigs as a precaution and that this affected the sales negatively. All three participants in group D expressed concern since they normally sell a lot of pigs around Christmas but will not be able to do so this year since they all suffered from outbreaks of ASF.

4.17 Presumed actions from the authorities

4.17.1 Individual interviews

The participants were asked what they think authorities do in case of an outbreak. Both participants who had and had not suffered from an outbreak answered the question, see Table 17. In total 40 farmers or meat sellers and three veterinarians participated in this question. Seventeen participants had received compensation, and one of them had also received compensation from an outbreak in the 1970s. Six participants had experienced ignorance from authorities and described that the authorities did not do anything when they were suffering from ASF outbreaks. However, some of these also admit that they did not report the outbreak to the authorities. Seven participants came up with other suggestions and were hence categorized as "other". This category includes answers such as authorities came to the farm but by the time they got there it was too late, authorities giving recommendations for high biosecurity and the agricultural ministry confiscating the farm and no pigs being allowed in the area.

Table 17. Actions from the authorities. Answers from an interview study performed in the Dominican Republic in 2022 (n=43).

Answers	Farmers and meat sellers	Veterinarians
Compensate	16	1
Euthanise	14	2
Other	7	1
Perform testing	6	1
Experience ignorance from authorities	6	0
Do not know what authorities do	4	0
Total	40	3

In total 31 of the individual participants answered a question concerning if they had received compensation from the authorities when suffering an ASF outbreak, see Table 18. Some participants also answered if they knew someone who had or had not received compensation.

Table 18. Compensation from authorities. Answers from an interview study performed in the Dominican Republic in 2022 (n=31).

Answers	Farmers and meat sellers	Veterinarians
Have not or know people who have not received compensation	14	1
Know people who have received compensation	8	0
Have received compensation themselves	7	0
Do not know if authorities give compensation	5	0
Total	30	1

4.17.2 Group interviews

In group A both farmers mentioned that the authorities performed randomized testing on the farms. Group B stated that the government has decided that the agricultural ministry is allowed to euthanise positive pigs. In group C one farmer shared that when he suffered an outbreak, he tried to call the authorities, but no one answered and he, therefore, left his pigs to die. In group D, one farmer claimed that the authorities did not do anything even though they were informed about his ongoing outbreak.

Groups A and B did not discuss the question about compensation. One farmer in group C mentioned that the government offers 5000 pesos per pig. None of the farmers in group D received any compensation.

4.18 Opinions on actions from the authorities

4.18.1 Individual interviews

The participants answered a question about what actions they wished to see from the authorities, see Table 19. Sixteen responded that they want economic support such as compensation. Some specified that they wish to receive compensation faster and even for the already dead animals. Another participant stated that he thought it is absurd that authorities use money to buy chickens from Brazil instead of focusing on national production. Two of the 16 responders wished to see microloans to be able to restart their business after an outbreak and one of them, a male farmer from La Romana, motivated it by *"I do not like to receive offerings"*. Multiple participants thought that the authorities should help but did not specify how. Ten participants thought it was important that the authorities make sure that the animals are euthanised. Five of these argued that all pigs in the country should be euthanised to be able to eradicate ASF from the Dominican Republic. One veterinarian stated the issue of only euthanising pigs on certain farms that might lead to desperation to

restart, therefore it is better to eliminate all pigs in the country. Two persons on the contrary thought the euthanasia should be abolished or be limited to the pigs with symptoms and the rest sent to slaughter. Five persons thought that the authorities are obliged to offer vaccination against ASF. Five people suggested that the authorities should do testing such as randomised samples on farms to detect ASF or take tests to assure that the farm is free from ASF and can restart the production.

Five participants thought the authorities need to monitor and follow up more. Three persons stated that authorities need to contribute with knowledge on prevention and one suggested education programmes for the farmers. Two persons could not come up with suggestions or did not want to answer this question. Answers from seven participants were categorized as "other" since they all contributed with each one answer that did not fit any other category. This included one person thinking that it is necessary to get rid of backyard farmers since they do not have as good biosecurity as bigger producers. One participant suggested that the authorities should help start a business with other animals and shared that she now had egg production instead.

Table 19. Which actions should the authorities take? Answers from an interview study performed in the Dominican Republic in 2022 (n=57).

Answers	Farmers and meat sellers	Veterinarians
Economic support	16	0
Help (unspecified)	15	0
Euthanasia	9	1
Other	6	1
Vaccine	5	0
Testing	4	1
Monitoring and follow up	4	1
Contribute with knowledge	3	0
Questions euthanasia	2	0
Help increase biosecurity	2	0
Cannot or do not want to answer	2	0
Total	54	3

4.18.2 Group interviews

Group A did not discuss this question. Group B suggested economic compensation for the euthanised pigs and help from the authorities with proper disinfection after an outbreak. In group C, breeding for genetic resistance and searching for treatments were suggested. A female farmer in group C from El Puerto San Geronimo said, *"ASF will disappear when God wants it to"*. In group D suggestions such as

euthanising all pigs in the country, testing sick animals, and forbidding the consumption or sale of sick pigs were discussed.

4.19 Field observations

When working in the field stray dogs were regularly observed, some searching through waste for food and others being directly fed by humans.

On the farm interviews, none of the participants hesitated to let the field team enter the stables without protective clothing or washing hands and shoes. However, only a few stables were entered. Some pens were very simple and consisted of wooden poles where the pigs could get in direct contact through the walls of the pens.

5. Discussion

Many were aware of ASF and the mentioned symptoms were almost always correct. However, about 21% could not answer at all, which indicates that there are knowledge gaps. In a study performed in Estonia, amongst farmers with at least 10 pigs per farm, fever and high mortality were also the top most mentioned clinical signs (Moskalenko *et al.* 2022), similarly to the results of this study. Neurologic symptoms and skin affection was also regularly suggested by farmers in this thesis, which is similar to a study performed amongst smallholders keeping free ranging pigs in Uganda (Chenais *et al.* 2017).

It was important to find out what the farmers and meat sellers knew about transmission since this is what they can base their prevention on. Factors related to human activities such as contaminated equipment, clothes, and transports were by far the most common answer, supported by four of the five veterinarians. All these transmission routes are possible ways to transmit disease to other farms by indirect contact (Chenais *et al.* 2018). These transmission routes were also mentioned in a similar study where farm machinery was the most common answer (Moskalenko *et al.* 2022). The second most suggested path of transmission was airborne. However, ASF is only transmitted by aerosol for short distances (Olesen *et al.* 2017). In previous studies, it also seemed to be a common misunderstanding that ASF is airborne (Aliro *et al.* 2022; Chenais *et al.* 2017). One meat seller said that prevention is not possible since the disease flies in the wind, expressing a feeling of hopelessness towards prevention and other preventive measures could therefore be ignored (Aliro *et al.* 2022). In the study by Aliro *et al.* (2022) no limitations on amounts of pigs were set in similarity to this thesis, however, most of the farms in Uganda had not more than 39 pigs. In addition, many different actors along the value chain were interviewed in Uganda in comparison to this thesis.

Other animals and insects as mechanical vectors could be a possible transmission route and were also regularly mentioned in the study by Moskalenko *et al.* (2022). Research about indirect transmission by animals is lacking, but it seems like a possible route of transmission. Even though the epidemiological risk of transmission by scavengers was discovered to be limited amongst wild boar (Probst *et al.* 2019) the regularly observed stray dogs might play a part in transmission. The stray dogs could potentially spread infected meat or be contaminated themselves.

How likely this is to contribute to transmission remains unclear. However, interestingly more people mentioned transmission by mechanical vectors than direct contact by moving pigs between farms as a transmission route. One reason for this could be lack of knowledge about incubation periods and the possibility of transmitting disease before showing clinical signs.

None of the participants brought up transmission by feral domestic pigs roaming freely in the mountains that possibly could contribute to transmission (Raysa Reyes, professor and researcher at La Universidad Autónoma de Santo Domingo, personal communication 2022). This could be because of lack of knowledge concerning spread of disease by feral pigs or simply because wild boar are rarely seen near the farms and hence not considered as a great risk of transmission.

When asked about transmission between pigs many correct suggestions were mentioned. Interestingly, humans and equipment were only mentioned by one farmer in this question compared to 31 farmers/meat sellers when asked about transmission between farms. This could indicate that sharing equipment between pigs and movement of humans within the farm is not considered as high a risk as between farms. However, this result could also be due to practical reasons such as the design of stables. If the farm only has a few pens and the pigs can get in direct contact through the wall of the pen built by for example wooden poles, using separate equipment might seem pointless. This theory could further be supported by a study performed in Estonia on larger commercial farms where changing clothes and shoes was considered as an important preventative measure when walking between different sections of the farm (Moskalenko *et al.* 2022).

The vast majority knew that infected meat is a risk if fed to other pigs. Despite this food waste was fed to the pigs on 19 of 65 farms, five of them claiming that it did not contain meat (Hentz 2023). This could be due to economic limitations for buying commercial feed (Aliro *et al.* 2022). Furthermore, avoiding to feed the pigs food waste was never mentioned as an option for prevention.

Close to 32% of the participants suggested good hygiene and high biosecurity for prevention. Equally as many suggested limiting unauthorized visitors on the farm. However, on contrary to personal experiences when visiting some Dominican farms, no farmer demanded disinfecting shoes, washing hands, or putting on protective clothing before entering stables, instead, this was an initiative taken by the field team. This is suggesting that it might not be fully practiced in the reality. On the other hand, it was a very limited amount of stables visited by the field team because of the risk of transmission. In previous studies, several reasons for not implementing preventative measures were discovered. These included economic limitations, cultural traditions, and lack of knowledge about implementation

(Chenais *et al.* 2017). For prevention, some also suggested vaccine which was also commonly mentioned as a preventive measure in Uganda (Chenais *et al.* 2017). In both studies, some participants mentioned vaccines for prevention and some of them believed that they vaccinate against ASF. Farmers incorrectly thinking that they vaccinate their pigs against ASF might not prioritize necessary preventative measures.

When the farmers who had suffered from ASF were compared to the ones who had not they were more aware of the symptoms which is not unexpected. The portion of participants correctly mentioning at least one possible way of transmission or prevention of ASF was slightly higher amongst the farmers who had not suffered an outbreak, especially when asked between farms. This could indicate that knowledge about transmission and prevention is a protective factor. However, more participants who suffered from ASF seemed to be aware of the transmission through meat. In addition, one should keep in mind that the population of affected farms was relatively small and not all of them answered these questions.

The reported consequences of outbreaks underline the width of impact ASF can have on the individual level as well as the national level. The possibility to pay for their kids' education was mentioned in similarity to other studies (Chenais *et al.* 2017). Further people explained how they lose everything and how they put their whole soul into their business that then gets destroyed, also in accordance with previous results from Uganda (Chenais *et al.* 2017). Many participants in this thesis mentioned that they had to fire employees. At the same time the increased importation and loss of interest in investing in the national production mentioned by some, might result in further unemployment in the country with negative livelihood impact

Information about current legislation and recommendations was difficult to find. Based on the results of the interviews and the IICA meeting it seems like authorities euthanise all pigs on the affected farms and that farmers can receive compensation for pigs euthanised, but not for the pigs who died from ASF. How well this is implemented remains unclear since almost equally as many participants reported having received compensation as did not and in addition, all outbreaks were not officially reported. Different reasons for not reporting disease outbreaks to authorities have been discovered when reporting of CSF was studied (Elbers *et al.* 2010). Not wanting to cause potential false alarms, scepticism against authorities, lack of ability to recognise the clinical signs, and fear of consequences such as time restrictions before restarting their production. Shame was discovered as another reason for not reporting, expressing fear of being viewed as someone who has mismanaged their own farms leading to infection (Elbers *et al.* 2010). However,

some of the participants in this study who suffered an outbreak of ASF and reported it still did not receive help from authorities.

Generally, compensation was highly requested from the farmers. Many participants were also positive towards euthanasia and some even wished to see euthanasia of all pigs in the country. However, one veterinarian underlined that the reintroduction of the disease might originate from Haiti in similarity to what has been hypothesized previously (Gonzales *et al.* 2021). If this is true, combating ASF is more complicated than euthanasia on a national level.

The study has some limitations that need to be considered while interpreting the results. The total length of the interviews and the fact that some participants were stressed might have reduced the depth of the answers. There was also a risk of recall bias since some questions referred to a two-year historical period. Since a large part of the participants suffering from ASF, never reported their outbreaks to the authorities, it adds an insecurity to the study when calculating the amount of farmers who have experienced ASF.

In addition, some information seemed to get lost in the translation process. Even though all participants spoke Spanish, the translator was not a native Dominican, and different accents and slang used sometimes made it difficult for the interpreter to understand everything that was being said. The researcher of this thesis who was often also the notetaker did not speak the native language and hence missed information that could have been picked up between the lines (Fischer *et al.* 2020). The interviews were never practiced by the whole team before starting the interviews, another possible source of error (Borchgrevink 2003). However, the questionnaire was talked through with the facilitators, but due to language limitations, misinterpretations were sometimes discovered later during the actual interviews. Since we used both a facilitator and a translator the waiting time for the participants was limited which otherwise can cause the participants to lose interest (Bujra 2006). Unfortunately, some information might have gotten lost since it sometimes was difficult for the translator to follow the discussion between facilitator and participants while translating at the same time. Having a Dominican facilitator was probably an advantage in building trust towards the participants who were encountered by researchers from a foreign country (Borchgrevink 2003).

It is also possible that there were misinterpretations from the participant's side. For example, when asked about symptoms seen over the past two years, the participants might have thought the question was only concerning ASF since it seems unlikely that many participants had not seen any signs of disease at all during this period of time. The same might apply to the question about what measures they take when the pigs are sick since what they do probably depends on what disease they picture

that they are encountering. For example, the participants answering euthanisation might have interpreted the questions as concerning ASF, since it seems a bit extreme to euthanise for milder diseases not related to ASF. Another insecurity connected to interpretation was that some farmers mentioned “the fever” or “the pest” which was interpreted as ASF, but they could also have meant CSF or other diseases. To get an idea of if the participants were aware of the risk of transmission by infected meat, this was specifically asked for, and therefore the question might have been leading.

The study was originally supposed to focus on smallholders, but to obtain a larger number of participants, even owners of bigger farms were included. The included participants of meat sellers were smaller than expected and only located in San Francisco de Macoris making the study population of meat sellers unrepresentative for other parts of the Dominican Republic. Likewise, only very few veterinarians participated. This subgroup of participants was not purposively selected but included since they also had farms and not initially because of their veterinarian profession. The participant selection in especially Moca for the on-farm interviews was connected to the feed factory and an employee attended the interviews and sometimes interfered which might have affected the farmers’ answers. This employee together with other mobilisers in the other areas might also contribute to mobiliser bias since they decided which farms to drive us to (Fischer *et al.* 2020). The gender balance was unequal since it was a lot harder to localise women causing us to be able to draw more conclusions concerning the male farmers. However, this unequal balance might perhaps reflect a reality where more men work in the pig business.

Further, the interview situation was not always ideal. Some interviews were performed in the feed factory with very loud machines making it harder to communicate. Others took place standing in the meat sellers’ stores with much noise at the same time as they helped customers. This probably split their focus and stressed the field team who felt like we disturbed their work. The interviews in which we obtained the most useful information often seemed to be when we visited the farms and the farmers welcomed us to sit down and took their time to answer the questions.

In conclusion, this study taught us that the vast majority of participants were aware of ASF and it was also the most feared disease on their farms with severe economic consequences. A high portion vaccinated their pigs and had implemented cleaning routines. The perceptions on the symptoms, transmission, and prevention were mostly very accurate to the literature, however with some knowledge gaps. Authorities compensate in case of an outbreak but how well it is implemented remains unclear and the farmers wish to see better economic support from the

authorities in the future. Even though some biases exist in this study, the result still gives a good overall impression of common practices and knowledge about symptoms, transmission, and prevention of ASF among pig farmers in the Dominican Republic. These results contribute to a preliminary picture of practices and level of knowledge of ASF in the Dominican Republic. Hopefully, it can serve to better understand the current situation and future research areas.

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Popular science summary

African swine fever (ASF) is a devastating pig disease caused by a virus. The disease lacks both treatment and vaccine and is therefore a great danger to pig production worldwide. The virus was first discovered in Kenya in 1921. Since then, the virus has been endemic in Africa. The virus has four different cycles in which transmission is possible. The two first cycles include transmission by soft ticks in Africa. The third cycle is the domestic pig cycle where the pigs can get infected by direct contact with another pig but also by indirect contact such as a contaminated surfaces by any of the following body fluids: saliva, nasal discharge, blood, urine, faeces, and sperm. In addition, uncooked meat is another pathway of transmission. This means that other pork products such as some types of ham if originating from a pig infected by ASF, can infect other pigs by oral intake. The fourth cycle is the wild boar-habitat cycle where domestic pigs and wild boars can transmit disease between each other through direct contact or indirect contact with carcasses from an infected pig.

Pigs infected by ASF can show many different symptoms. The severity depends on how virulent the virus strain is. Acute disease caused by highly virulent strains is the most common form of the disease. The pigs show clinical signs such as high fever, loss of appetite, apathy, vomiting, diarrhoea, neurologic symptoms, red skin, haemorrhages, and abortion in pregnant sows. The mortality is very high and they usually die within 6-13 days.

The virus cannot infect humans but still causes devastating effects on human livelihood as it poses a risk to food security and restrict trade between countries, leading to a major economic impact. In addition, for many farmers, the pig production act both as a source of food and income and for some people this means that they cannot pay debts or send their kids to school.

The Dominican Republic is a country in the Caribbean located on the same island as Haiti, Hispaniola. The Dominican Republic is one of the poorest countries in the Caribbean, but with an improving economy. In 2020, 88 400 tons of pork meat was produced in the country. ASF was first observed in the Dominican Republic in 1978 followed by successful elimination in 1981. Unfortunately, the virus got

reintroduced in the summer of 2021, after approximately 40 years of absence. The source was thought to be pork meat from a flight.

This project aimed to investigate the practices and knowledge of ASF amongst pig farmers in the Dominican Republic since it has not been done previously and knowledge was lacking within the area. This was done by 80 interview studies in five different areas of the country. The majority of participants were farmers, five also working as veterinarians, and ten as meat sellers. Four interviews were carried out in groups, resulting in a total of 93 participants in the study.

Many farmers expressed that they had not seen any diseases in their own pigs in the past 2 years. Out of the participants, 28.4% had experienced ASF in their farms, or what some referred to as the "pest" or "the fever". Just as many had experienced symptoms from the gastrointestinal tract such as diarrhoea. Of the farmers, 69.6% were currently vaccinating their pigs at the time of the interviews. Some had vaccinated previously but stopped when the authorities no longer offered a vaccination programme. It was close to equal parts vaccinating their pigs by themselves or having veterinarians vaccinate the pigs for them. Vaccines against classical swine fever, mycoplasmosis, and circovirus were the most commonly used vaccines. However, 24.5% of the participants did not know what they vaccinated against. Some incorrectly believed that they vaccinated against ASF. When the participants encounter sick pigs they often initially try to treat them but if the treatment is unsuccessful they contact their veterinarian.

Since good hygiene is essential for limiting the spread of disease all participants were asked how often and with what formulas they clean their stables. Of the farmers and meat sellers, 61.7% cleaned their stables every day and 25% a couple of times per week. Some did not clean at all since their pigs were tied to tries and moved when the ground was getting dirty. Disinfectants were commonly used, and multiple disinfectants were mentioned, all effective against ASF.

The participants were asked questions to explore their knowledge about ASF. The result showed an overall good knowledge of symptoms, transmission, and prevention. Of the farmers and meat sellers, 95.4% were familiar with ASF and this was also the most feared disease by many farmers. Most mentioned symptoms were correct, impaired general condition being the most commonly mentioned symptom. However, 22.9 % of the farmers and meat sellers could not mention any symptoms. The general knowledge on transmission was interesting since this is important for knowing how to prevent disease. For transmission between stables humans, clothes, shoes, equipment, and transports were the most mentioned route. The majority of all mentioned transmission routes were correct. However, 13 of 53 farmers and meat sellers answering this question suggested transmission by air which is only

possible for very short distances. In total, 13.2% could not answer how ASF transmits from one farm to another. Between pigs close contact was the most commonly mentioned route. About 15% did not know the transmission routes from one pig to another. The vast majority of participants were aware that ASF can be transmitted by meat.

Many correct examples of prevention were brought up, the most popular among the participants were good hygiene and biosecurity. Out of 67 farmers and meat sellers, 13 could not answer how to prevent or thought it impossible. To obtain more information about ASF, veterinarians were the most mentioned information source.

The participants were asked what the biggest consequence of an ASF outbreak would be and 68.2% answered economic losses. Some explained that they are not able to pay debts or send their kids to university. They were further asked what the authorities do in case of an outbreak. The most common answer was that they give economic compensation and many also said that they euthanise the pigs. A few expressed that they experienced ignorance from the authorities during outbreaks. Almost equally as many had not received compensation during outbreaks or knew someone who had not. However, many also informed that they did not report their outbreaks to the authorities. Many interesting suggestions were brought up on what the authorities should do such as better compensation routines, elimination of all pigs in the country, developing vaccines, testing etcetera.

In conclusion, this study helped obtain more information about common practices amongst Dominican farmers as well as an overall picture of the knowledge about ASF symptoms, transmission, and prevention. It also contributes with an insight into the consequences and expectations of the authorities. Hopefully, this study helped build a base for further research on ASF in the Dominican Republic.

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Appendix 1

- **Interview code:**
- **Date:**
- **GPS coordinates/village:**
- **Starting and finish time:**
- **Note taker:**

Introduction

The purpose of this part is to welcome the participants, get to know them a bit and map the background of the participants to be able to make a fair assessment.

- Presentation of us and the project (specify that we are only here to learn from them and not to judge them. We are not from the authorities).
- Presentation of the participant (fill in the tabel)
    - No names will be present in the final presentation

Name/number	**Age**	**Sex**	**Main activity with pigs**	**Number of years in business/ with pigs**	**For farmers: Number of pigs (specify*)**

*= specify how they count their pigs, does the piglets count or only the sows?

B. Knowledge about diseases.

The purpose is to evaluate the participants' knowledge of the various symptoms of ASF and how it is spread.

1. What diseases/symptoms have you seen in your pigs or pork you buy/sell during the last two years and what are the symptoms? For example: lameness, coughing, diarrea, nasal discharge etc.
2. Which disease do you fear the most? Why?
3. Vaccination
    a. Do you/your clients vaccinate your pigs?
    b. Against what?
    c. Who vaccinates the pigs?
    d. Do everyone in the village vaccinate?
4. What do you do if your pigs are sick? For example: lameness, coughing, diarrea, nasal discharge etc. Does the treatment vary depending on the disease? Do you call the vet?
5. Have you heard of African Swine fever? (if not mentioned) .
6. List all the symptoms of ASF you know?
7. What are the differences between Classical swine fever and African swine fever?
8. How is ASF spread between farms?
9. How is ASF spread between pigs? Ask them to specify what they mean (direct contact is not enough)!
10. Can ASF be transmitted through meat?
11. Do you know how ASF can be prevented?
12. Transporter: How/when do you clean your transports? (for example: every day, every week, between every transport)
13. Farmer: How/when do you clean your stables? What kind of formula is used?
14. Do you know where you can get information about ASF?

C. Reflection about what happens during and after an outbreak. (If a village has had an outbreak we ask them more about how it was spread between villages and farms, how it started and the consequences. If possible we draw a map of how the disease progressed. If no one has any experience of ASF, ask some of the same questions about CSF to rule out how they act during an outbreak of CSF)

The purpose is to find out what happens during an outbreak according to the participants and if they know how to act, but also their motivation to prevent the spread of ASF.

1. What is the actions from the authorities during an outbreak?
2. What do you think the authorities should do during an outbreak?
3. If you had an outbreak: Did you get any compensation from the authorities? (if they did something for example killed some pigs or closed your business)
4. What were the biggest consequence of the outbreak for you and your pigs/business? If no outbreak: what would the biggest problem be if your pigs got infected?

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