Food and Agriculture Organization of the United Nations

A risk assessment for the introduction of African swine fever into the Federated States of Micronesia

MASSEY UNIVERSITY
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A risk assessment for the introduction of African swine fever

into the Federated States of Micronesia

by

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Abbreviations and acronyms

ASF	African swine fever
DECEM	Department of Environment, Climate Change & Emergency Management, the Federated States of Micronesia
DOA	Division of Agriculture
DRD	Department of Resources and Development, the Federated States of Micronesia
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
OIE	World Organisation for Animal Health
PCR	polymerase chain reaction
PICs	Pacific Island Countries
FAO RAP	FAO Regional Office for Asia and the Pacific
FAO SAP	FAO Subregional Office for the Pacific Islands
SEA	Southeast Asia
TAD	transboundary animal disease
WAHIS	World Animal Health Information System

Executive summary

This report describes a risk assessment mission in the Federated States of Micronesia, undertaken by the EpiCentre, School of Veterinary Sciences, Massey University, and the Food and Agriculture Organization of the United Nations (FAO) under FAO Technical Cooperation Programme (TCP/SAP/3802). The overall aim was to evaluate the risk of introducing the African swine fever virus into the Federated States of Micronesia and use the findings to propose recommendations that enable professionals, communities and key stakeholders to implement prevention and mitigation measures to reduce the impacts of African swine fever (ASF) incursion.

ASF is a highly contagious viral disease of domestic and wild pigs. It has emerged from Africa, spreading to eastern Europe, China and Southeast Asia. Due to ASF outbreaks in Asia and Papua New Guinea, Pacific Islands countries now prioritize preventing the introduction of ASF. A risk assessment of ASF virus introduction is necessary for deciding which preventive actions would be most effective. The assessment of risk was conducted using the OIE import risk analysis framework. The most likely pathway for introducing ASF virus into the Federated States of Micronesia was importing unauthorized pork products that international arrival passengers may bring in via airport or seaport. Should infected products enter the Federated States of Micronesia, there is a distinct pathway for exposure because pigs are routinely fed food scraps (swill) from households. The likelihood of transmission of ASF virus to other susceptible pigs was considered extremely high due to the lack of farm biosecurity and the presence of feral pigs.

The assessment method was a systematic, qualitative import risk analysis of ASF virus introduction to the Federated States of Micronesia. Results provide information about high-risk areas for ASF introduction, exposure and spread in the Federated States of Micronesia. They also identify gaps in control and prevention measures. The following steps are being proposed to minimize the likelihood of entry and exposure and the consequence of ASF virus introduction.

Key recommendations are to:

1. Increase awareness of incoming passengers about meat products and fomites that can carry ASF virus and instruct passengers to declare such materials or indicate whether they have visited any farms recently (30 days) to the quarantine officer. Passengers can dispose of their food items in designated bins. Non-compliance shall be penalized.
2. Strengthen quarantine procedures and infrastructure at the border to ensure that all baggages are manually searched thoroughly upon arrival. Installation and application of X-ray baggage scanner are recommended.
3. Ensure appropriate disposal of confiscated products through the incinerator.
4. Encourage households and restaurants to separate meat from vegetable waste and ban the supply of meat leftovers to pig owners.
5. Ensure sufficient cooking of swill (core temperature of 70°C for 30 minutes).

6. Increase awareness of pig owners and villagers about the ban on meat waste feeding, especially pork meat.
7. Educate stakeholders on ASF clinical signs and prompt reporting by pig owners/animal workers/general public of signs of disease to the Livestock unit of Division of Agriculture.
8. Promote and strengthen farm biosecurity practices i.e. proper fencing of pigs, apply appropriate hygiene and sanitation measures.
9. Prepare an emergency response plan for ASF with implementation and financial plan.
10. Strengthen biosecurity legislations/regulations to include ASF and other TADs preventive and response measures, including the ability to fine companies/people who break these regulations where they exist.
11. Encourage a multi-sectoral and multidisciplinary approach (One health) to address biosecurity threats of ASF and other TADs.

1. Introduction

1.1.1 BACKGROUND

African swine fever (ASF) is a highly infectious transboundary animals disease of pigs (Costard *et al*., 2013). ASF virus infected pigs develop severe lethargy, diarrhoea, or acute haemorrhagic fever, which typically results in death (Gabriel *et al*., 2011; Gallardo *et al.*, 2017). After introducing ASF to Georgia in 2007, the disease has spread to nearly every Eastern European country (Rowlands *et al*., 2008). The situation has been worse in 2018 as ASF was reported in China and rapidly spread to other adjacent Asian countries, causing the loss of more than 6.7 million pigs, mostly as pre-emptive culling (OIE, 2020). The movement of the ASF virus into the Asia Pacific region poses a risk of ASF introduction to Pacific Island countries (PICs) such as the Federated States of Micronesia. An outbreak of ASF in the Federated States of Micronesia would result in high levels of pig mortality which would significantly affect food security in the country as most pigs are kept for subsistence. In addition, the costs associated with safely disposing of animals that die because of the disease and the slaughter and disposal of healthy animals to control the outbreak would be significant.

Recently, a pilot project was initiated by the FAO Subregional Office for the Pacific Islands (FAO SAP) based in Apia, Samoa, in close collaboration with FAO Regional Office for Asia and the Pacific (FAO RAP) to assess the risk of ASF introduction to Samoa. The mission was completed by EpiCentre, Massey University, New Zealand. Two consultants visited the country to interview government agencies, farmers, and stakeholders and delivered a risk assessment report. Given the lack of import risk assessment of ASF in other Pacific countries, the project's scope was recently expanded to cover the risk for the Federated States of Micronesia.

1.1.2 MISSION ACTIVITIES

Due to the travel restriction caused by the COVID-19 pandemic, EpiCentre consultants couldn't visit the Federated States of Micronesia. Therefore, instead of face-to-face interviews administered by EpiCentre consultants, questionnaires were developed (attached in Annex) and administered by the College of Micronesia coordinator (Mr Engly Ioanis) and the national project coordinator (Mr John Wichep). The questionnaires were used to collect information from the following agencies:

- Division of Agriculture (DOA), Department of Resources and Development (DRD),
- Quarantine office,
- Custom office,
- Seaport authority office (Kosrae),
- Airport authority office (Kosrae).

The information collected aimed to aid our understanding of the roles and responsibilities of various government agencies and gather information on factors influencing the occurrence and spread of ASF for import risk analysis. For data relating to the introduction pathway, the focus was on what happened before the travel restrictions imposed due to the COVID-19 pandemic.

The survey also included pig farmers to understand the farming practices and biosecurity measures in commercial/subsistence pig farms and local pork supply. Visits were made to nine representative pig farmers in the Federated States of Micronesia. The national coordinator also conducted spot checks for imported and local pork products in the supermarket.

2. African swine fever

2.1.1 AFRICAN SWINE FEVER

African swine fever virus is a double-stranded DNA arbovirus of the family of *Asfarviridae*. ASF virus isolates could be classified into eight serogroups, and recent genetic research has demonstrated that the virus can be categorized into 23 geographically related genotypes with numerous subgroups (Beltran-Alcrudo *et al.*, 2017). The genotype is classified by the variability of a segment in the VP-72 gene, which is used for phylogenetic analysis to identify the source of outbreaks. No distinctive differences in the virulence between different genotypes have been reported.

ASF virus can be isolated from the blood, faeces, urine, and nasal/ocular/vaginal excretions of infected pigs up to at least 70 days of infection (de Carvalho Ferreira *et al.*, 2012). Depending on the environmental conditions, the virus can also be isolated from the carcasses of infected pigs and/or the soil of the deathbed for up to several months (Fischer *et al.*, 2020; Zani *et al.*, 2020). In addition, the virus can survive in fresh, salted, dried, and frozen meat for months to years (Table 1).

Table 1. Expected survival time of African swine fever virus in various conditions

Product	Survival time (days)
Meat (boned, de-boned, ground)	105
Salted meat	182
Cooked or canned meat	0
Dried meat	300
Smoked meat	30
Chilled meat	110
Frozen meat	10 00
Fat or skin	300
Offal	105
Urine	15
Faeces	11
Meat (boned, de-boned, ground)	105
Salted meat	182

Source: adapted from **Adkin, A., Coburn, H., England, T., Hall, S., Hartnett, E., Marooney, C., Wooldridge, M**., 2004. *Risk assessment for the illegal import of contaminated meat and meat products into Great Britain and the subsequent exposure of GB livestock (IIRA): foot and mouth disease (FMD), classical swine fever (CSF), African swine fever (ASF), swine vesicular disease (SVD). New Haw*: Veterinary Laboratories Agency. and ***Davies, K., Goatley, L.C., Guinat, C., Netherton, C.L., Gubbins, S., Dixon, L.K., Reis, A.L.,*** *2017. Survival of African Swine Fever Virus in Excretions from Pigs Experimentally Infected with the Georgia 2007/1 Isolate. Transboundary and Emerging Diseases 64, 425–431. https://doi.org/10.1111/tbed.12381*

Transmission of ASF virus could occur via direct contact with infected animals, consumption of contaminated pork or material, fomites (e.g. cloths, trucks, feeds), and soft tick vectors of *Ornithodoros spp.* (Dixon *et al.*, 2020). In ASF virus free countries, the virus could be introduced through the movement of infected wild boars or contaminated pork products carried by passengers (Kim *et al.*, 2019; Sauter-Louis *et al.*, 2021).

Currently, there is no available treatment or vaccine to prevent the spread of ASF. Therefore, the best control option for ASF is the immediate culling of pigs on infected farms and those near or in contact with infected farms (OIE, 2020). Thus, rapid and reliable detection is required for the timely implementation of the control measures. Early detection relies on immediate reporting when pigs are observed to have clinical signs

consistent with ASF (i.e. dermal haemorrhages, fever, diarrhoea, bleeding from orifices, high mortality) and rapid testing dead pigs. A PCR based on the VP-72 gene is the test of choice for early detection in peracute, acute or subacute ASF cases. However, PCR cannot confirm infectivity but can confirm the presence and quantitative information (Beltran-Alcrudo *et al.*, 2017).

2.1.2 AFRICAN SWINE FEVER SITUATION

ASF had been an endemic disease only in Africa until 1957 when the first transcontinental case occurred in Portugal (Boinas *et al.*, 2011). Although ASF had spread to some European and American countries, the disease was declared to be eliminated in 1995 (except in Sardinia in Italy) (Dixon *et al.*, 2020). Almost two decades later, another introduction of ASF virus to Europe was reported from Georgia in June 2007 (Rowlands *et al.*, 2008). ASF quickly spread to the Caucasus region (Beltrán-Alcrudo *et al.*, 2009) and persisted in the continent mainly via the "wild boar–habitat cycle" that the transmission of ASF occurs directly between wild boars and indirectly through carcasses in the habitats (Chenais *et al.*, 2018). Since its re-introduction in 2007, ASF has transmitted to other European countries, including Belarus, Bulgaria, Belgium, the Czech Republic, Estonia, Germany, Greece, Hungary, Italy, Latvia, Lithuania, the Republic of Moldova, Poland, Romania, Serbia, the Slovak Republic and Ukraine (OIE, 2020; Sauter-Louis *et al.*, 2021; Schulz *et al.*, 2019).

In 2019 ASF virus was reported in China and has rapidly spread to other Asian countries, most likely via illegal importation of pig meat from affected countries (Schulz *et al.*, 2019). Since ASF virus was reported in China, outbreaks have been reported in 15 other countries in the Asian Pacific (see Figure 1 [FAO, 2022]). Affected countries implemented control measures, such as pre-emptive culling and movement restriction. Between 2018 and 2020, nearly 7 million Asian domestic pigs had been culled to prevent the spread of ASF. The Ministry of Agriculture and Fisheries of Timor-Leste announced the culling of 100 000 pigs after the confirmation of ASF in September 2019. In January 2022, an outbreak of ASF was reported in Thailand, and the government allocated USD 17.3 million to control the disease spread. Due to the geographical proximity to Thailand, the Cambodian government restricted any importation of pigs from its neighbouring countries. ASF outbreaks and followed control measures have severely affected national food security and livelihood, especially poor rural families in many Asian countries. However, ASF control was largely ineffective due to a lack of technical or financial resources.

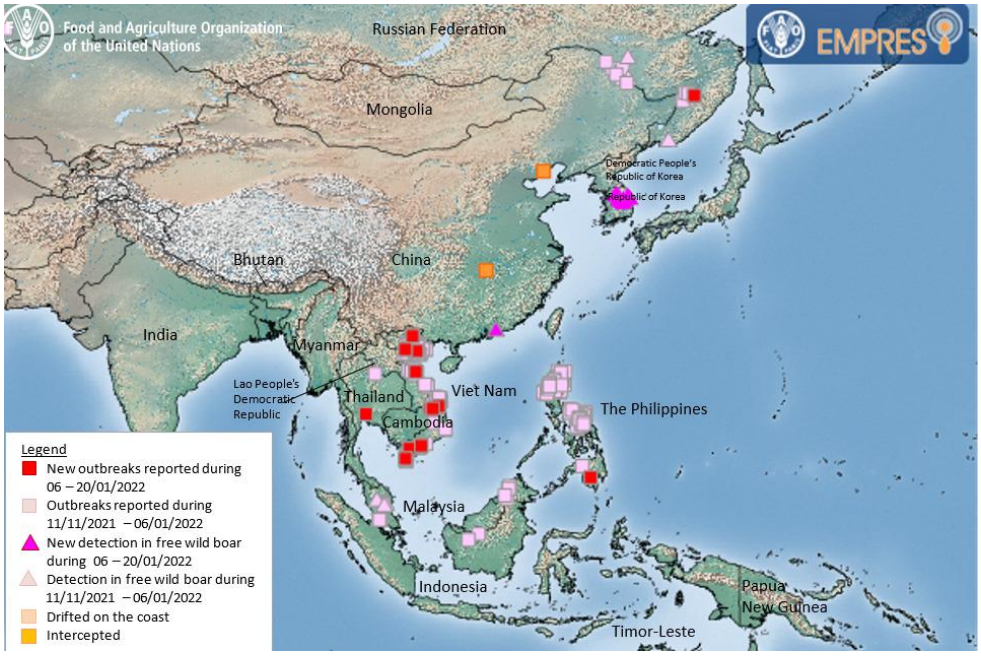

Figure 1. Current situation of ASF in Asia as of January 2022; Source: **FAO**. 2022. ASF situation in Asia update. http://www.fao.org/ag/againfo/programmes/en/empres/ASF/situation_update.html#

3. Federated States of Micronesia

3.1 GENERAL PROFILE

The Federated States of Micronesia is an island country in Oceania comprised of four states, namely Yap, Chuuk, Pohnpei and Kosrae, situated across the western Pacific Ocean (Figure 2). The states comprise over 600 islands and atolls with a combined land size of approximately 700 square kilometres. The islands and atolls are scattered between the latitude of 0° and 10° north, and between the longitude of 135° and 165°. The islands are approximately 2 000 kilometres northeast of Papua New Guinea and 5 000 kilometres northwest of New Zealand.

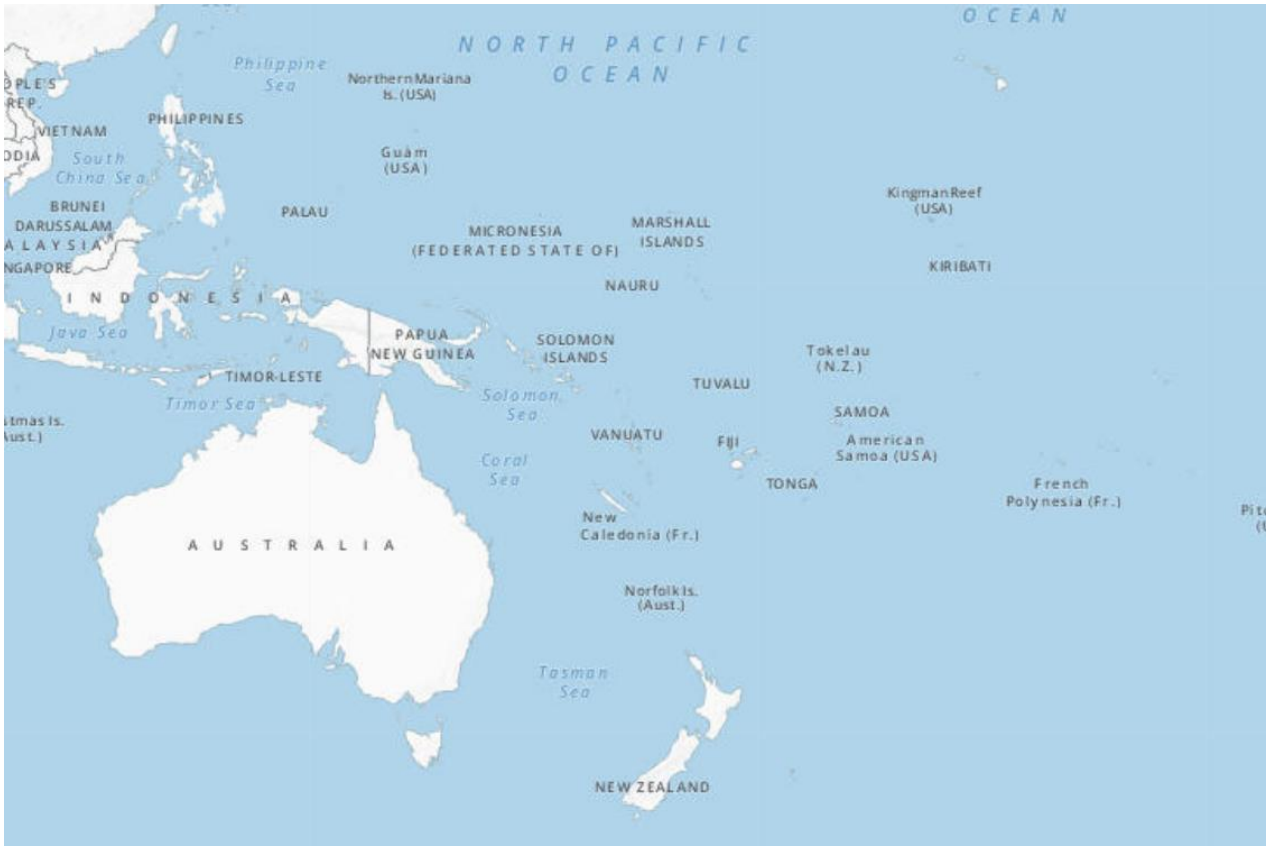

Figure 2. Location of the Federated States of Micronesia; Source: **United Nations**. 2022. *Geospatial map*. New York. Cited 20 July 2022. www.un.org/geospatial/content/map-world

The total population of the Federated States of Micronesia is approximately 105 000 people (FSM Statistics Division, 2022), with a gross domestic product (GDP) being estimated at around USD 410 million (The World Bank, 2020). There are 15 545 households in the Federated States of Micronesia, and the vast majority of the households (14 029 out of 15 545 households) have access to and are using lands for agricultural purposes (FSM Statistics Division, 2019). The agricultural sector is an important part of households' livelihoods across the Federated States of Micronesia, contributing approximately 16 percent of national GDP. Among the households engaging in agricultural activities, 67.2 percent raise livestock, and the most commonly raised animal was pigs, followed by poultry (Table 2).

Table 2. Proportion of households raising livestock in the Federated States of Micronesia.

Livestock	State				Total
	Yap	Chuuk	Pohnpei	Kosrae	
Pigs					
Adults (> 6 months old)	47.7%	44.0%	45.9%	41.0%	45.1%
Piglets (< 6 months old)	18.2%	12.3%	22.1%	14.5%	17.0%
Chicken					
Adult broiler	2.1%	0.9%	1.9%	0.3%	1.4%
Adult layer	2.3%	0.4%	1.3%	0.4%	1.0%
Adult broiler + layer	1.1%	0.5%	0.9%	0.1%	0.7%
Adult local	37.7%	28.5%	35.9%	17.6%	32.0%
Chicks	15.0%	6.2%	11.4%	1.7%	9.2%
Ducks	0.6%	0.3%	1.6%	0.4%	0.8%
Other	3.4%	1.1%	0.8%	0.1%	1.3%

Source: **Federated States of Micronesia Statistics Division. 2019.** *Federated States of Micronesia Integrated Agriculture Census 2016*. https://fsm-data.sprep.org/resource/federated-states-micronesia-integrated-agriculture-census-2016

3.1.1 PIG SECTOR

Pigs in the Federated States of Micronesia are generally raised for self-consumption or customary obligation. In addition, pigs have an important ceremonial value, especially funerals (DECEM, 2004). According to the 2016 census, approximately 30 000 pigs were being farmed across the Federated States of Micronesia, of which approximately two-thirds were adult pigs. The majority of the animals are located in Pohnpei (55.4 percent), followed by Chuuk (28.5 percent), Yap (9.5 percent) and Kosrae (6.6 percent). The number of households raising adult pigs is 6 322, corresponding to 41 percent of the total households. This figure represents the importance of subsistence pig farming in the Federated States of Micronesia (FSM Statistics Division, 2019). The average number of pigs per household is two to four heads, depending on the state (Table 3).

Table 3. Number of households (HHs) raising livestock and pigs and number of pigs in each state of the Federated States of Micronesia.

Pig type and states	HHs with livestock	HHs raising pigs	Number of pigs	Average pigs per HH
Adult pigs (> 6 months old)				
Yap	2 138	1 019	2 068	2.0
Chuuk	5 742	2 524	6 184	2.5
Pohnpei	5 259	2 415	9 338	3.9
Kosrae	890	364	1 237	3.4
Piglets (< 6 months old)				
Yap	2 138	390	781	2.0
Chuuk	5 742	709	2 355	3.3
Pohnpei	5 259	1 163	7 228	6.2
Kosrae	890	129	725	5.6
Total				
Adult pigs	14 029	6 322	18 827	3.0
Piglets	14 029	2 391	11 089	4.6

Source: **Federated States of Micronesia Statistics Division. 2019.** *Federated States of Micronesia Integrated Agriculture Census 2016*. https://fsm-data.sprep.org/resource/federated-states-micronesia-integrated-agriculture-census-2016

Approximately 65 percent of households raising pigs keep their animals in a fenced enclosure or building/ cages (Table 4; Figure 3). In the other households, pigs were allowed to roam freely; this practice was most common in Chuuk state, where more than 60 percent of the households lacked any pig pens or cages. Given the presence of free-ranging pig farms being relatively common, it is believed that some of the animals could escape the premises and become feral pigs. However, the number and distribution of feral pigs in the Federated States of Micronesia are unknown.

Table 4. Number (proportion) of households with different housing types for raising pigs in the Federated States of Micronesia.

States and pig type	Housing type		
	Free-ranging	Fenced closure	Building/cages
Yap			
Adult pig	228 (22.4%)	669 (65.7%)	122 (12.0%)
Piglets	113 (29.0%)	242 (62.1%)	35 (9.0%)
Chuuk			
Adult pig	1 580 (62.6%)	824 (32.6%)	120 (4.8%)
Piglets	497 (70.1%)	188 (26.5%)	24 (3.4%)
Pohnpei			
Adult pig	408 (16.9%)	1 634 (67.7%)	373 (15.4%)
Piglets	222 (19.1%)	762 (65.5%)	179 (15.4%)
Kosrae			
Adult pig	21 (5.8%)	204 (55.9%)	140 (38.4%)
Piglets	3 (2.3%)	84 (65.1%)	42 (32.6%)
Total			
Adult pig	2 237 (35.4%)	3 331 (52.7%)	755 (11.9%)
Piglets	835 (34.9%)	1 276 (53.4%)	280 (11.7%)

Source: **Federated States of Micronesia Statistics Division. 2019.** *Federated States of Micronesia Integrated Agriculture Census 2016*. https://fsm-data.sprep.org/resource/federated-states-micronesia-integrated-agriculture-census-2016

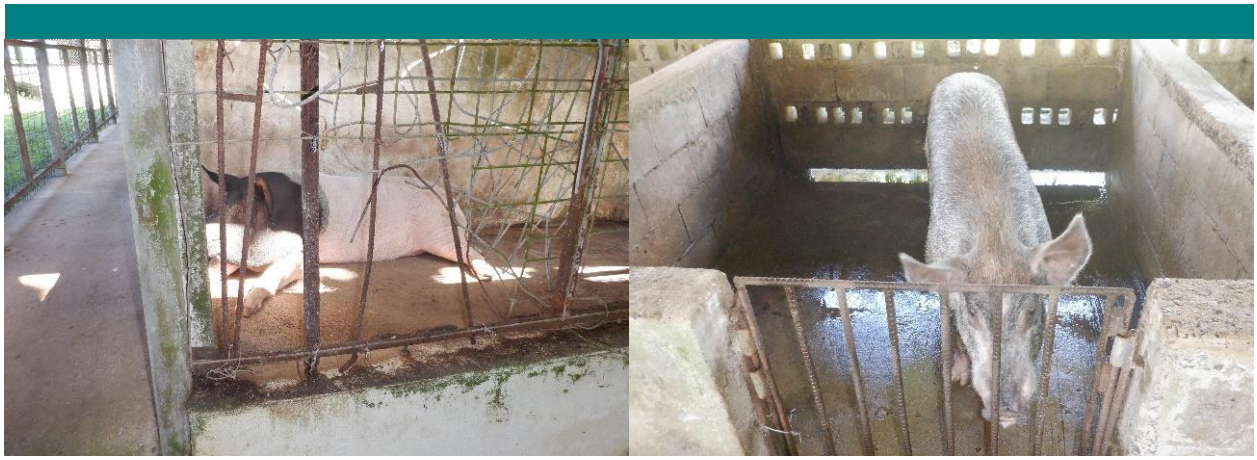

Figure 3. Pigs in building/cage of subsistence farms in the Federated States of Micronesia; ©FAO

Approximately 60 percent and 40 percent of households raising pigs purchase commercial feed for the animals in Pohnpei and Kosrae, respectively, whereas less than 5 percent of the households in Yap and Chuuk states purchase the feed (FSM Statistics Division, 2019). According to pig farmers surveyed for this mission, the cost of commercial feeding for pigs in the Federated States of Micronesia varied from USD 170 per year to USD 200 per week. The variation in the cost is most likely differences in the number of pigs kept and the type or frequency of commercial feeding.

Approximately 14 500 adult pigs are killed each year in the Federated States of Micronesia (Federated States of Micronesia Statistics Division, 2019). Majority of pigs are killed for self-consumption (42 percent) or customary/social obligation (38 percent) such as a wedding, funeral, or commemorating a fatal event. Pigs are commonly slaughtered at the live weight of between 25 and 75 kg, but a small number of pigs will be killed at 90 kg. Pigs not killed for self-consumption or customary/social obligation are sold to neighbours or pig traders. Pig trade is more active and frequent in the state of Yap, with more than 55 percent of produced pigs being sold to different households. The overall value of pig sales in the Federated States of Micronesia was over USD 0.8 million in 2016.

Inbreeding within a farm or cross-breeding with pigs from neighbouring farms are believed to be a common practice to reproduce animals, as only 1.5 percent of households keeping pigs report using artificial insemination of frozen semen (FSM Statistics Division, 2019). Including artificial insemination, the use of any type of animal health services is quite limited for pig farmers in the Federated States of Micronesia. According to a census in 2016, more than 80 percent of households raising pigs reported not using any animal health services.

Pork products, such as retail cuts (e.g. loin, belly, shoulder, hock, spareribs), ham, sausage, and cured or canned pork, are imported to the Federated States of Micronesia mainly from the USA (Figure 4). The overall value of imported pork products in 2018 was USD 1.6 million (Federated States of Micronesia Statistics Division, 2020). Most of the imported pork products are thought to be consumed by households; however, few of them might be distributed to restaurants (Figure 5).

Figure 4. Imported pork product examples; ©FAO

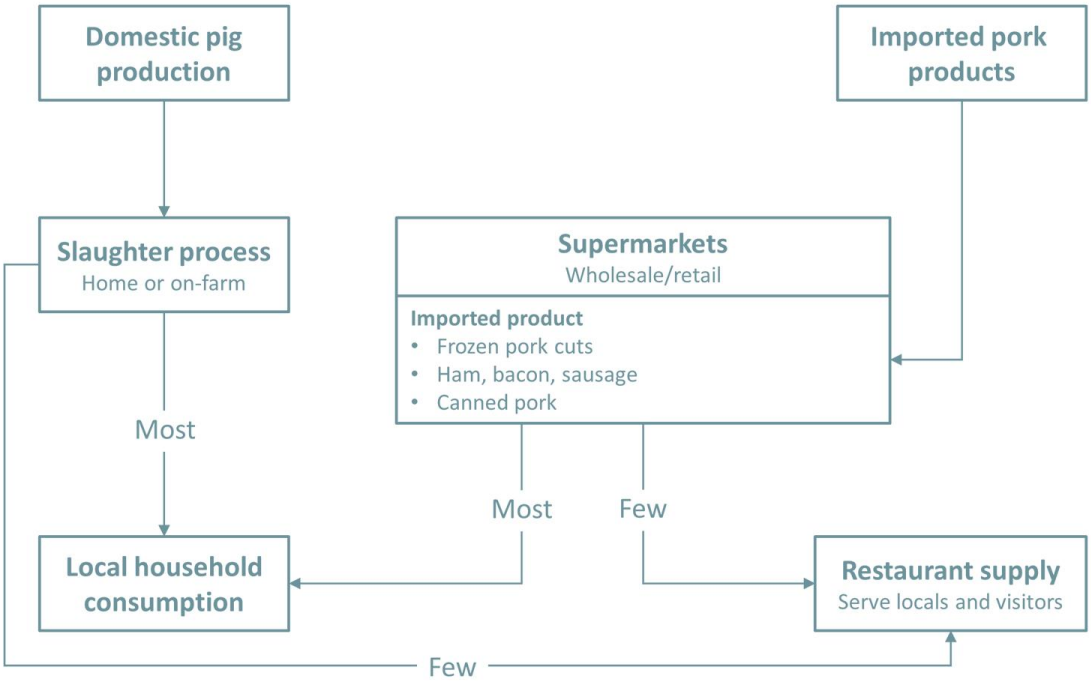

Figure 5. The value chain of pork products in the Federated States of Micronesia; Source: elaborated by the authors.

3.1.2 ROLES OF AGENCIES FOR PREVENTING AND RESPONDING TO AN ASF OUTBREAK

A joint task of the Quarantine offices of federal and state governments is responsible for securing the Federated States of Micronesia border and the borders between states against invasive pathogens. The Quarantine offices liaise with Custom, Aviation and Marine offices. They are responsible for preventing the introduction of all harmful insects, pests, and diseases through passenger arrival, cargo, and post. The importation of live animals or unsterilized meat products to the Federated States of Micronesia requires a Plant and Animal Quarantine Entry Permit. After confirming an international animal health certificate, the federal government issues the permit, proving the animal is in good health. The permit cannot be issued to live animals or unsterilized meat products from countries where OIE – List A diseases are present. When found, illegally imported animal or animal products, including those without the permit, are confiscated for incineration and burial. However, during interviews, Quarantine officers reported that they manually conduct the screening of baggage/cargo to detect prohibited items without any aid of X-rays or detection dogs.

No qualified veterinarian is operating in the Federated States of Micronesia. Currently, simple treatment of sick animals and castration services are routinely done by extension officers from the College of Micronesia and/or DOA of each state government. It was narrated that several extension officers had completed the requirements for the qualification of para-veterinarians; however, their services are no longer available due to either demise or migration.

In the event of an animal disease emergency, such as ASF, the DOA for each state sanctions provisional measures to verify the outbreak and control its spread. The legal basis for declaring a biosecurity emergency is the Biosecurity Act 2017. Should an ASF outbreak occur, the DOA for each state government have the legal powers to coordinate the response involving several government agencies. The Biosecurity Act allows other

parties, such as Police, to exercise reasonable force to ensure compliance. However, there is no standard of procedure prepared against an outbreak of ASF in the Federated States of Micronesia.

During an ASF response, the Biosecurity officers will be designated by the Secretary of the Department of Resources and Development of the Federated States of Micronesia under the Biosecurity Act 2017. The Biosecurity officers will be responsible for:

- surveillance of animal populations for ASF outbreaks;
- responding to public enquiries about sick animals, investigation and organization of property access for sample submission and submission of samples for laboratory testing;
- raising awareness amongst communities on the impacts of ASF outbreaks on livelihoods;
- risk reduction and management of outbreaks;
- prohibition of animal movements;
- prohibition of the distribution, sale or use of any animals, animal products or animal-related items;
- slaughter of animals for disease control purposes to prevent the spread of ASF, instructions for the disposal of animal carcasses;
- implementation of official control programmes, including disinfection and eradication measures.

4. Import risk analysis

The methodology used in this mission follows the OIE import risk analysis framework (OIE, 2010) and the New Zealand Biosecurity Risk Analysis guidelines (Biosecurity New Zealand, 2006). The terminology used for risk attributes and descriptors is provided in Table 5. The import risk analysis process is shown in Figure 6.

Table 5. Terminology for risk attributes and descriptors

Risk attributes	
- Negligible	Not worth considering; insignificant
- Non-negligible	Worth considering; significant
Risk sescriptors	
- Very Low	Close to insignificant
- Low	Less than normal level
- Medium	Around normal level
- High	Extending above normal level
- Very high	Well above normal level

Source: **Biosecurity New Zealand.** 2006. *Risk Analysis Procedures, Version 1*. Retrieved from https://www.mpi.govt.nz/dmsdocument/2031/direct

4.1.1 HAZARD IDENTIFICATION

ASF virus is known to be exotic to the Federated States of Micronesia and identified as a potential hazard. Thus, the main goal for this step is to identify risk products/items from ASF affected countries that could be contaminated with ASF virus and enter any state of the Federated States of Micronesia. According to the latest OIE World Animal Health Information System (WAHIS), ASF was reported in Africa, the Eastern part of Europe, Russia and 16 countries in Asia, including China, Mongolia, Viet Nam, Cambodia, North and South Korea, Lao PDR, Myanmar, The Philippines, Timor-Leste, Indonesia, Papua New Guinea, India, Malaysia, Bhutan and Thailand (FAO, 2022; OIE, 2020). ASF virus can be transmitted directly or indirectly via pig-to-pig, feed-to-pig and fomites-to-pig (Guinat *et al.*, 2016). It was assumed that pork meat products, pig feed, and contaminated fomites from these regions would pose a non-negligible risk of ASF introduction into the Federated States of Micronesia.

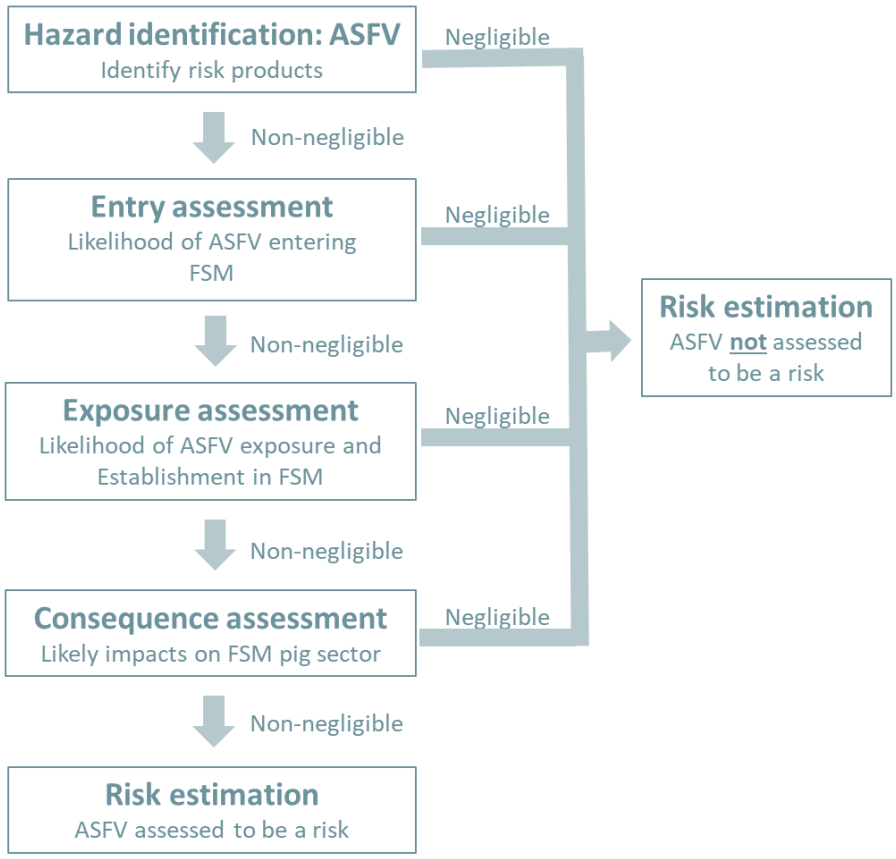

Figure 6. Import risk analysis process; Source: elaborated by the authors.

4.1.2 ENTRY ASSESSMENT

The Federated States of Micronesia is an island country located some distance from its nearest neighbour. Therefore, ASF virus entry into the Federated States of Micronesia would be limited to the international air and seaports located in the four states. The ASF virus could enter the country through contaminated pork meat products and fomites from the passenger. Figure 7 summarises the pathway by which ASF virus might enter the Federated States of Micronesia and infect local pigs.

According to information from government agencies, importation of live pigs or pork products into the Federated States of Micronesia from ASF present countries is restricted. Interview responses indicate that groups of five to seven live pigs are occasionally imported from Australia, which is currently free from ASF. Pork meat and meat products (i.e. pork cuts, ham, shoulder and pork luncheon meat) are imported mainly from the USA (equivalent to USD 0.8 million), and to date, there has been no ASF outbreak reported from the country. Therefore, it is less likely for ASF virus to be introduced to the Federated States of Micronesia via live pigs or pork products importation through the legal channel.

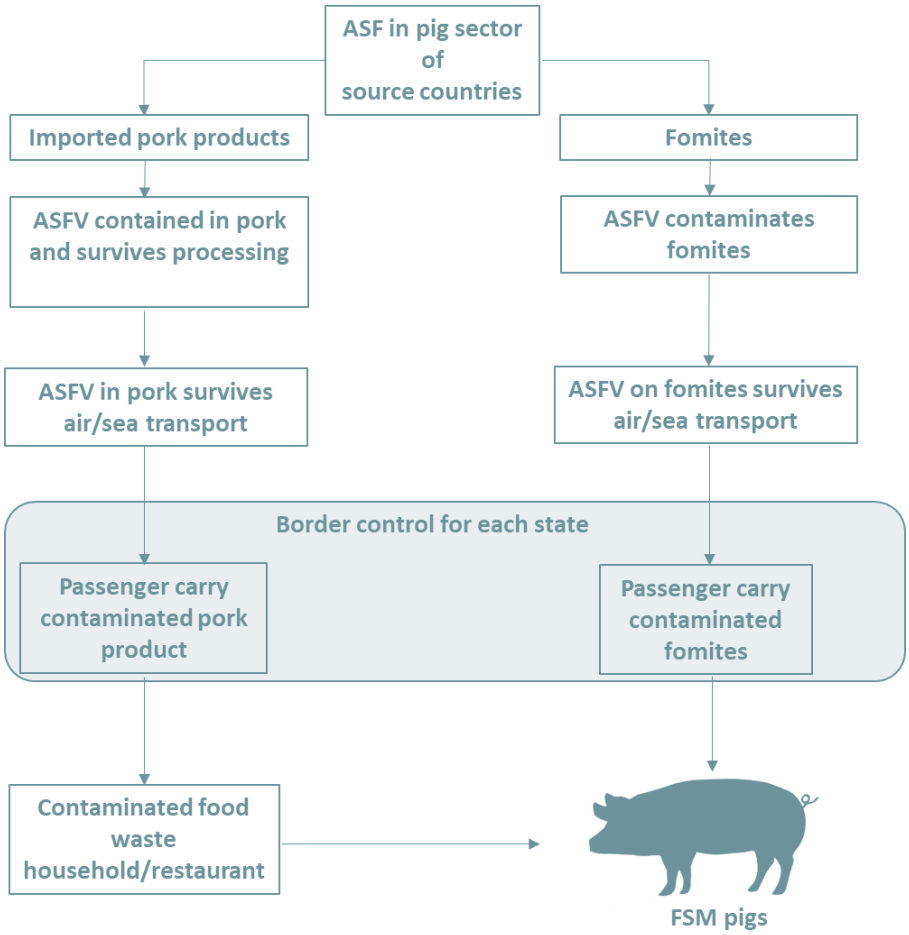

Figure 7. The risk pathway of African swine fever virus into the Federated States of Micronesia; Source: elaborated by the authors

As there is no importation of pork or pork products directly from ASF infected countries, ASF virus could be introduced into the Federated States of Micronesia via passengers carrying infected pork products at international arrival. All passengers must fill in arrival cards and declare whether they carry food items. While manually searching arriving passengers' luggage is prescribed, the process could miss pork products. Before the COVID-19 travel restriction, a quarantine officer narrated that they allowed passengers to bring in processed pork products of up to 10kg, which may pose a risk of ASF introduction. Unconstrained imports of pork products, either accidentally by tourists from affected countries or intentionally by smuggling the products for personal or commercial use, presents a continuous threat for ASF introduction (Wooldridge *et al.*, 2006).

The ASF virus can also be carried on clothing or footwear that could have contact pigs in the source country. Such risky fomites are not being cleaned and disinfected at arrival. In addition, the virus can persist for several days on fomites, particularly if protected by organic matter (Bellini *et al.*, 2016). Therefore, anyone who had contact with an infected area, such as walkers, hunters or farmworkers visiting/returning to the Federated

States of Micronesia, could bring contaminated fomites into the country. According to the Quarantine office, before the COVID-19 pandemic, more than 31 000 passengers arrived in the Federated States of Micronesia each year. Most passengers were returning residents or travellers, mostly from the USA, including Hawaii and Guam. It is uncertain how many passengers are from Asia or Europe, where ASF is currently endemic in some parts. Given the possibility that passengers arriving from ASF endemic regions cannot be ruled out, international travellers could carry infected pork products or contaminated fomites into the Federated States of Micronesia.

International waste originating from aeroplanes and ships arriving from endemic countries is another important pathway of ASF introduction (Costard *et al.*, 2009). Different maritime transport vessels arrive in the Federated States of Micronesia, such as commercial ships with cargo and fishing vessels. For example, a Marine officer from Kosrae state narrated that, before COVID-19, approximately 20 crew members of vessels originating from China arrived at the port per year. Crews and passengers may carry and not declare pork products; containers may be contaminated with viruses, and catering waste may contain contaminated pig meat. However, disposal of catering waste to the Federated States of Micronesia for any foreign aircraft and vessel is strictly forbidden by the Plant and Animal Quarantine Regulations, and the implementation of such regulation was confirmed from the narration of the Quarantine and Custom officers.

In conclusion, the likelihood of ASF virus entry through arrival passengers is non-negligible. It was impossible to quantify the risk because quantitative data about pork meat and products (i.e. type of products, volume) from arriving passengers were unavailable. However, all the surveyed government officials (e.g. Quarantine officer, Customs officer, Aviation and Marine officer) narrated that they had detected pork products a couple of times per year from arrival passengers before the COVID-19 restriction. In addition, there was no awareness of biosecurity guidelines for the prevention of ASF introduction into the Federated States of Micronesia.

4.1.3 EXPOSURE ASSESSMENT

Pigs could be exposed to ASF virus via feeding of leftover pork meat products or through contact with contaminated fomites from ASF affected countries. Although feeding of commercial diet for pigs is somewhat common in some parts of the country, it was narrated that some farmers with commercial feeding mix the diet with food waste. As a result, household scraps or food wastes could be contaminated with infected pork meat. Although some pig farmers may cook waste materials before feeding them to pigs, it is difficult to ensure that the traditional cooking over an open fire is sufficient to inactivate the virus. Thermal inactivation at a core temperature of 70 °C for a minimum of 30 minutes is required to destroy ASF virus (Beltran-Alcrudo *et al.*, 2017).

Feral pigs may play a key role in ASF virus exposure. Feral pigs could be exposed to food waste by scavenging food waste with contaminated pork meat products or fomites contaminated by villagers.

Accordingly, the likelihood of ASF virus exposure is non-negligible.

4.1.4 CONSEQUENCE ASSESSMENT

The spread of ASF virus in the pig population depends on the speed of transmission and its economic impact. Once established, ASF virus spreads rapidly among pig populations. Pig farms in the Federated States of Micronesia generally have no or low levels of biosecurity, a lack of which is recognized as a risk factor for ASF transmission (Sanchez-Vizcaino *et al.*, 2015). Given the trade of pigs as well as cross-breeding with

neighbouring farms is common practice in the Federated States of Micronesia, the lack of basic biosecurity would enhance the horizontal and local spreading of ASF via pig-to-pig contact opportunities. Local traders could also spread ASF virus by travelling between villages and collecting live or slaughtered pigs contaminated with ASF virus.

Inadequate home slaughter facilities sewage and waste disposal could be potential infection sources. The guts and trim wastes were normally buried or composted. They could be directly accessible by feral pigs. Due to ASF being absent from the Federated States of Micronesia, farmers are entirely unaware of the disease and its transmission mechanisms. Lack of awareness could increase the time from introduction to detection, which would increase the size of the epidemic. It is unlikely that a disease outbreak will be promptly reported to DOA if farmers are unaware of it. Moreover, vehicles for the transport of pigs, pig feed, and equipment may be shared.

Due to the absence of vaccination, rapid detection and timely implementation of control measures, such as pre-emptive culling or fencing, could be one of the most effective ways to prevent the spread of ASF (OIE, 2019; Han *et al.*, 2021). In the Federated States of Micronesia, in the case of an ASF outbreak, it was speculated that a timely response to prevent the spread of ASF is unfeasible. A survey from DOA narrated that an overall process of the outbreak investigation, sample collection and logistics of collected samples, and laboratory diagnosis for an ASF outbreak would take up to two weeks. In that time, ASF virus could spread within and between the states. In addition, feral pigs are known to be a risk factor for ASF sustainability (Mur *et al.*, 2016) as these animals are at high risk of contact with household food waste and wild pigs. Therefore, feral pigs could also pose a risk of ASF spread in the Federated States of Micronesia.

The domestic pig population of the Federated States of Micronesia consists of approximately 30 000 animals reared on more than 6 000 properties, mostly backyard piggeries (FSM Statistics Division, 2019). Pigs are an integral component of the agriculture of the Federated States of Micronesia. They have cultural values and provide food security, high-protein nutrition, and financial assets. The socioeconomic consequences of introducing and establishing ASF for the Federated States of Micronesia pig sector must be regarded as extreme. In the event of an ASF outbreak, the rapid slaughter of pigs and proper disposal of pig carcasses are required to control the disease (OIE, 2019). The mortality and mass culling could substantially reduce pig numbers and limit pig meat supply to the local restaurant. Destruction of large numbers of pigs would cause significant socioeconomic losses to threaten food security, culture and livelihood in the Federated States of Micronesia.

In conclusion, the socioeconomic consequences of an ASF virus introduction were assessed to be very high, thus non-negligible.

4.1.5 OVERALL RISK ESTIMATION

The likelihood of an ASF virus introduction and its exposure were both regarded to be non-negligible. The consequences of ASF virus spread and its economic impact are considered very high and non-negligible. Therefore, ASF is considered to pose a risk to the Federated States of Micronesia.

5. Recommendations

5.1.1 REDUCING THE LIKELIHOOD OF ASF ENTRY

The main pathways for entry of ASF virus into the Federated States of Micronesia are pork products. The less likely but non-negligible pathway was through contaminated fomites (boots, gears). These could enter via cargo, package and passenger's luggage. To reduce the likelihood of entry, we recommend:

- Passengers should be instructed to declare food products or contaminated fomites that can carry ASF virus or whether they have visited any farms recently (30 days) to the quarantine officer. Passengers can dispose of their food items in designated bins. Non-compliance shall be penalized.
- Promotional material should be placed in highly visible locations in arrival halls and at baggage carousels of airports to increase awareness of incoming passengers about pork products that can carry ASF and the importance of ASF to the Federated States of Micronesia.
- Ensure the practice of disposing of confiscated products in high-temperature incinerators.
- Increase awareness and provide training on ASF prevention including the importance of biosecurity measures and penalties for non-compliance to relevant stakeholders (Farmers, businesses, the general public, Quarantine, Custom, Port Authority and Marine).
- Strengthen quarantine procedures and infrastructure to ensure that all baggages are manually searched thoroughly upon arrival. Installation and application of X-ray baggage scanner are recommended.

5.1.2 REDUCING THE LIKELIHOOD OF ASF EXPOSURE

From risk analysis, pigs raised in the Federated States of Micronesia would primarily be exposed to ASF virus via waste feeding of meat scraps with ASF virus present. The consultants recommend a public awareness campaign to encourage households to separate meat from vegetable waste and ban the supply of meat waste especially pork meat to pigs. Before feeding, the food waste should be thoroughly cooked to reach the core temperature of 70°C for 30 minutes.

5.1.3 REDUCING THE SIZE OF AN OUTBREAK

In the event of an ASF outbreak, the key to preventing further spread is early detection. Effective prevention requires a monitoring and surveillance system, facilitating early detection and timely intervention. Sufficient budget and personnel resources need to be allocated to motivate early reporting, implement active disease investigation and control, and organize access to laboratories capable of diagnosing ASF. DOA should provide information for veterinary paraprofessionals and livestock owners to recognize ASF and report promptly. Pig farmers and villagers should be aware of the dangers and negative impact of ASF to report unusual sick or dead pigs to DOA as soon as possible. DOA may also want to raise awareness about ASF through social media, TV, radio, printed materials, posters and organize meetings with farmers, animal traders and the general public.

Once infected with ASF, all animals on the infected property, whether affected or unaffected, must be destroyed and disposed of correctly to prevent further spread. The state governments and the national

government of the Federated States of Micronesia need to train and equip sufficient personnel for rapid culling and carcass disposal and cleaning and disinfection in the event of an outbreak. Such an action plan to mitigate the impact of ASF infection should be delineated to maximize the cooperation between DOAs of the federal and state governments. Furthermore, to motivate compliance by pig owners, DOA should develop a compensation strategy and allocate financial resources to ensure adequate compensation for the removal and disposal of affected pig herds as part of disease control measures.

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Annex 1. Questionnaires and data items

Following data items are submitted in electronic format

1. ASF Import Risk Assessment Questionnaires;
2. GEMP questionnaire completed by DRD;
3. ESRI shapefile of the Federated States of Micronesia administrative division (GADM);
4. ESRI shapefile of the Federated States of Micronesia OpenStreetMap (OSM) data.

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