Oniris - National Veterinary School of Nantes, Food and Agri-food industry

YEAR 2023 - Thesis no.

SURVEY OF THE KNOWLEDGE, ATTITUDES AND PRACTICES OF SMALL PIG FARMERS IN LAOS AND CAMBODIA CONCERNING THE AFRICAN SWINE FEVER

THESIS

obtain the state in

VETERINARY DOCTOR

Presented and publicly defended

In front of University of Nantes Medical School **20**

October 2023

by

Ariane MASSON

Born on

04/10/1998 Under

the direction of

Véronique RENAULT and François MEURENS

Chair of the jury: Ms BELLOC Catherine, Professor at Oniris

Members of the jury: Ms RUVOEN-CLOUET Nathalie, Professor at Oniris Mr MEURENS François, Professor at the University of Montreal

Guest members: Véronique RENAULT, Veterinarian charge of Agronomes et Vétérinaires sans Frontières missions in Laos and Cambodia

ONIRIS - NATIONAL VETERINARY, AGRI-FOOD AND FOOD SCHOOL
Veterinary campus
101 route de Gachet
44307 Nantes Cedex 3

Oniris - National Veterinary School of Nantes, Food and Agri-food industry

YEAR 2023 - Thesis no.

SURVEY OF THE KNOWLEDGE, ATTITUDES AND PRACTICES OF SMALL PIG FARMERS IN LAOS AND CAMBODIA CONCERNING THE AFRICAN SWINE FEVER

THESIS

obtain the state in

VETERINARY DOCTOR

Presented and publicly defended

In front of University of Nantes Medical School **20**

October 2023

by

Ariane MASSON

Born on 04/10/1998

Under the direction of

Véronique RENAULT and François MEURENS

Chair of the jury: Ms BELLOC Catherine, Professor at Oniris

Members of the jury: Ms RUVOEN-CLOUET Nathalie, Professor at Oniris Mr MEURENS François, Professor at the University of Montreal

Guest members: Véronique RENAULT, Veterinarian in charge of Agronomes et Vétérinaires sans Frontières missions in Laos and Cambodia

ONIRIS - NATIONAL VETERINARY, AGRI-FOOD AND FOOD SCHOOL
Veterinary campus
101 route de Gachet
44307 Nantes Cedex 3

Teaching staff at Oniris - École Nationale Vétérinaire de Nantes, Agroalimentaire et de l'Alimentation

BPSA Biology, Pathology and Food Science Department

Manager: **Emmanuel JAFFRES** - Deputy: **Frédérique NGUYEN**

Pharmacology and Toxicology	Jean-Claude DESFONTIS (Pr) Yassine MALLEM (Pr) Hervé POULIQUEN (Pr)	Antoine ROSTANG (MC) Meg-Anne MORICEAU (CERC) Martine KAMMERER (Emeritus Professor)
Functional, cellular and molecular physiology	Jean-Marie BACH (Pr) Lionel MARTIGNAT (Pr) Julie HERVE (MC HDR) Grégoire MIGNOT (MC)	Solenn GAVAUD (CERC)
Histology and pathological anatomy	Marie-Anne COLLE (Pr) Jérôme ABADIE (MC)	Laetitia JAILLARDON (MC) Frédérique NGUYEN (MC)
Industrial food biochemistry	Carole PROST (Pr) Joëlle GRUA (MC)	Clément CATANEO (MC) Alix KHALIL (MC) Laurent LE THUAUT (MC)
Microbiotech	Hervé PREVOST (Pr) Géraldine BOUE (MC) Nabila HADDAD (MC) Emmanuel JAFFRES (MC)	Mathilde MOSSER (MC) Boris MISERY (MC) Raouf TAREB (MC) Quentin PRUVOST (CEC)
PACENV= VET1	Eléonore BOUGUYON (PRAG) Nicolas BROSSAUD (PRAG)	Charlotte MOCQUARD (PRAG) Aurore CALVEL (PRAG)

SAESP Livestock and Public Health Department

Manager: **Raphaël GUATTEO** - Deputy: **Jean-Michel CAPPELIER**

Breeding, nutrition and health of domestic animals	Nathalie BAREILLE (Pr) François BEAUDEAU (Pr) Christine FOURICHON (Pr)	Juan Manuel ARIZA CHACON (MC) Ségolène CALVEZ (MC HDR) Aurélien MADOUASSE (MC) Nora NAVARRO-GONZALES (MC)
Infectiology	Alain CHAUVIN (Pr) François MEURENS (Pr) Emmanuelle MOREAU (Pr) Nathalie RUVOEN-CLOUET (Pr) Pauline MAISONNASSE (CERC)	Albert AGOULON (MC) Suzanne BASTIAN (MC) Léa LOISEL (AERC) Kenny OBERLE (MC) Nadine RAVINET (MC)
Farm animal medicine	Catherine BELLOC (Professor) Christophe CHARTIER (Professor Emeritus) Raphaël GUATTEO (Pr) Anne RELUN (MC)	Sébastien ASSIE (MC) Isabelle BREYTON (MC) Mily LEBLANC MARIDOR (MC) Maud ROUAULT (AERC)
Food hygiene and quality	Jean-Michel CAPPELIER (Pr) Louis DELAUNAY (CERC) Bruno LE BIZEC (Pr) Marie-France PILET (Pr)	Sofia STRUBBIA (MC)

DSC Clinical Sciences Department

Manager: **Catherine IBISCH** - Deputy: **Marion FUSELLIER**

Comparative anatomy	Eric BETTI (MC) Claude GUINTARD (MC) Margarida RIBEIRO DA SILVA NEUNLIST (MC)	
Surgical pathology and anaesthesiology	Eric AGUADO (Pr) Olivier GAUTHIER (Pr) Eric GOYENVALLE (MC HDR)	Pierre MAITRE (MC) Caroline TESSIER (MC) Gwénola TOUZOT-JOURDE (MC) Claire DEFOURMSTRAUX (MC)
Dermatology, parasitology of carnivores and equines, mycology	Jacques GUILLOT (Pr) Emmanuel BENSIGNOR (Pr Ass)	Sabrina VIEU (AERC) Maria Dolores SANCHEZ (AERC)
Internal medicine, medical imaging and veterinary professional legislation	Anne COUROUCE (Pr) Jack-Yves DESCHAMPS (Pr) Françoise ROUX (Pr) Juan HERNANDEZ-RODRIGUEZ (Pr Ass) Nora BOUHSINA (MC)	Nicolas CHOUIN (MC) Amandine DRUT (MC) Marion FUSELLIER-TESSON (Pr) Catherine IBISCH (MC) Aurélia LEROUX (MC) Odile SENECAT (MC)
Biotechnology and reproductive pathology	Jean-François BRUYAS (Pr) Françis FIENI (Pr)	Djemil BENCHARIF (Pr) Lamia BRIAND (Pr)

GPA Food Process Engineering Department

Manager: **Sébastien CURET-PLOQUIN** - Assistant: **Vanessa JURY**

Lionel BOILLEREAUX (Pr) Sébastien CURET-PLOQUIN (Pr) Marie DE LAMBALLERIE (Pr) Francine FAYOLLE (Pr) Michel HAVET (Pr)	Alain LEBAIL (Pr) Olivier ROUAUD (Pr) Kévin CROUVISIER-URION (MC) Vanessa JURY (Pr) Emilie KORBEL (MC)	Jean-Yves MONTEAU (MC HDR) Eve-Anne NORWOOD (MC) Raphaël PORYLES (MC) Laurence POTTIER (MC) Cyril TOUBLANC (MC)
PAC-ING	Cyril Gaillard (PCEA)	

MSC Management, Statistics and Communication Department

Manager: **Samira ROUSSELIERE** - Assistant: **Véronique CARIOU**

Mathematics, statistics, computing	El Mostafa QANNARI (Professor Emeritus) Chantal THORIN (Professor Ag) Evelyne VIGNEAU (Pr) Jean-Michel GALHARRET (MC)	Véronique CARIOU (Pr) Benjamin MAHIEU (MC) Michel SEMENOU (MC)
Economics, management, legislation	Jean-Marc FERRANDI (Pr) Pascal BARILLOT (MC) Ibrahima BARRY (MC) Florence BEAUGRAND (MC)	Sibylle DUCHAINE (MC) Sonia MAHJOUB (MC) Samira ROUSSELIERE (MC) Christophe PAPINEAU (Ens. Cont.)
Languages and communication	Marc BRIDOU (PLPA) David GUYLER (Ens. Cont.) Nathalie GOODENOUGH (PCEA) Patricia JOSSE (Ens. Cont.)	Shaun MEEHAN (Ens. Cont.) Linda MORRIS (PCEA) Ian NICHOLSON (ENS. Cont.)

Pr Ag: Professeur Agrégé, Pr: Professeur, MC: Maître de Conférence, MCC: MC contractuel, PLPA: Professeur lycée Professionnel Agricole, PCEA: Professeur Certifié Enseignement Agricole, HDR: Habilité à Diriger des Recherches, CERC, Chargé d'Enseignement et de Recherche Contractuel, Ens.Cont : Contract Teacher

This work was carried out under the supervision of Véronique RENAULT, veterinarian in charge of missions in Laos and Cambodia for the non-governmental organisation Agronomes et Vétérinaires sans Frontières.

Acknowledgements

To Mrs Catherine Belloc, Professor at Oniris.

For having done me the honour of chairing this thesis jury. Yours respectfully

To Mrs Nathalie RUVOEN-CLOUET, Professor at Oniris. For

accepting the role of assessor on this thesis jury.
Many thanks.

To Mr François MEURENS, Professor at the University of Montreal.

For agreeing to co-supervise this thesis. Your careful proofreading, your pertinent comments and your kind advice enabled me to complete this work.
Many thanks.

Véronique RENAULT, Veterinarian in charge of AVSF missions in Laos and Cambodia.

For having suggested this subject to me and for having helped me to carry it out in the field, for having introduced me to this fascinating country of Laos. I am deeply grateful to you. Thank you for your availability, your kindness and your sound advice.

To my parents,

For your love and unfailing support. You have encouraged me from the very beginning in my vocation as a vet, through the joys and the difficult times. I don't know where my next adventures will take me, but I know I can count on you and that gives me wings.

To my grandparents,

For all those happy moments with you, on Belle-Ile or in Ti-Racoon. You are my reference points. Whether at sea or in the mountains, you have taught me to marvel at nature and passed on my desire to understand and explore .

To my brothers and sister,

For our complicity, our past adventures and especially those to come.

To my friends school, at prep school, at lycée and elsewhere,

For your unique personalities, for our laughs and endless discussions. Your opinions and values mean a lot to me and help me to grow.

To all the vets I've met along the way,

For giving me the desire practise this profession with ethics, passion and high standards.

To entire AVSF Laos team,

For your warm welcome to Vientiane and Toomlarn. ຂອບໃຈ !

Table of contents

List of figures

Appendix

List of tables

List of abbreviations

ADIS	*Animal Disease Information System*
DNA	Deoxyribonucleic acid
ANSES	Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (French National Agency for Food, Environmental and Occupational Health and Safety)
AVSF	Agronomists and Veterinarians without Borders
BIG	*Biosecurity in pIG production*
CAP	Knowledge, Attitudes and Practices
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (Centre for International Cooperation in Agricultural Research for Development)
DAFO	*District Agriculture and Forestry Office*
DV	*District Veterinary*
EDTA	Ethylene-diamine-tetra-acetic
EFSA	*European Food Safety Authority*
ELISA	*Enzyme-Linked Immunosorbent Assay*
ENSV - FVI	Ecole Nationale des Services Vétérinaires - France Vétérinaire International
FAO	*Food and Agriculture Organization of the United Nations*
HAD50/mL	*50% HemAdsorbing Doses per mL*
95% CI	*95% confidence interval*
IPT	*Indirect Immunoperoxidase Test*
MAF	*Ministery of Agriculture and Forestry* (Laos)
MAFF	*Ministery of Agriculture, Forestry and Fisheries* (Cambodia)
NIS	*National Institute of Statistics*
OIE	International Epizootics Organisation*, which became WHO in 2003*
WHO	World Organisation for Animal Health, *founded as the OIE*
NGO	Non-Governmental Organisation
OR	*Odds ratios*
PAFO	*Province Agriculture and Forestry Office*
PCR	*Polymerase Chain Reaction*
PCRq	Quantitative PCR
PDAFF	*Provincial Department of Agriculture, Forestry and Fishery*
GDP	Gross Domestic Product
PPA	African swine fever
SDTF	*Standard and Trade Development Facility*
USD	*United States Dollar*
VAHW	*Village Animal Health Worker*
VVW	*Village Veterinary Worker*
WAHIS	*World Animal Health Information System*

Introduction

African swine fever (ASF) is a highly contagious viral disease domestic pigs and wild boar. With mortality rate close to 100%, it decimates entire herds and causes heavy economic losses for farmers. ASF has been reported in Africa, America, Europe and Asia (WHO 2023). In Cambodia and Laos, the first cases of ASF were recorded in 2019 (FAO 2023a).

Small pig farmers are major players in the pig industry in many countries, particularly in Southeast Asia. In Cambodia and Laos, 80% of pigs are reared by small-scale producers (Deka et al. 2014). They manage areas of a few hectares, practise traditional extensive livestock farming often combined with land cultivation and employ family labour (FAO 2013). These farming systems generally have a low level of biosecurity, so they are hit hard by ASF.

Analysing the behaviour of a population in relation to a disease is fundamental to understanding what drives the spread of the disease and identifying potential levers for action. The Knowledge, Attitudes and Practices (KAP) survey used in epidemiology meets this objective by documenting the degree of understanding of the disease, the perception of importance of the risk and the actions taken (WHO 2008).

This study is part of the BIG (*Biosecurity in pIG production*) project, an international cooperation programme aimed at improving biosecurity in pig farms in South-East Asia as part of the fight against African swine fever. The consortium implementing the project is managed by the École Nationale des Services Vétérinaires - France Vétérinaire International (ENSV-FVI). The project is funded by the Ministry Europe and Foreign Affairs and the *Standard and Trade Development Facility* (SDTF). The non-governmental organisation Agronomes et Vétérinaires sans Frontières (AVSF) is one of the partners. Operating in Laos and Cambodia, AVSF supports peasant agriculture and small-scale family farming in rural areas to help these communities fight poverty and make a living from their work.

Four years after the introduction of ASF in Cambodia and Laos, this CAP survey of small pig is the first to be carried out on ASF in these two countries.

PART 1. BIBLIOGRAPHICAL STUDY

African swine fever and its impact on pig farming in Laos and Cambodia

I. General information on African swine fever

I.1. Etiology

African swine fever (ASF) is caused by a DNA virus belonging to the *Asfaviridae* family (genus *Asfivirus*), of which it is the only representative. ASF virus is a double-stranded, enveloped, icosahedral DNA virus 200 nm in diameter (WHO 2022; Salas, Andrés 2013).

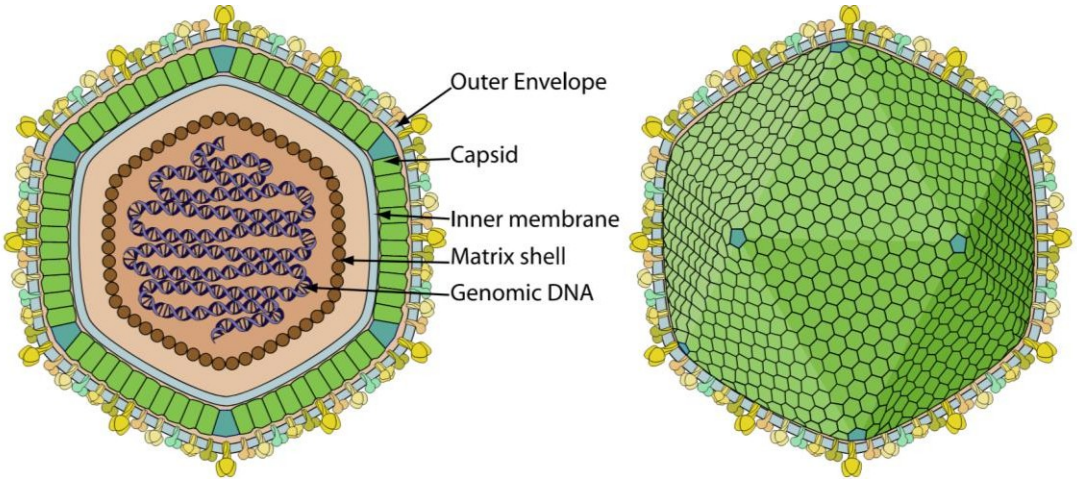

Figure 1: **Structure of the African swine fever virus**
(ViralZone*, Swiss Institute of Bioinformatics* 2023)

The genetic structure of the virus is complex, and it exhibits considerable genetic variability. Twenty-four genotypes have been identified on the basis of sequencing of the gene coding for the p72 capsid protein. The genome has five multigene families whose variations are responsible for the strain's degree of virulence and escape from the host immune response (Sánchez-Vizcaíno et al. 2019).

I.2. Species affected

ASF is a contagious disease affecting wild and domestic swine. The domestic pig (*Sus scrofa domesticus*) and wild boar (*Sus scrofa*) are the most susceptible species and develop a variety of clinical signs with a high mortality rate. On the other hand, the African suidae, warthog (*Phacochoerus* spp.), bushpig (*Potamochoerus* spp.) and hylochoer (*Hylochoerus meinertzhageni*) are infected asymptomatically and constitute a reservoir for the virus. Peccaries *(Tayasu pecari, Catagonus wagneri and Dicotyles tajacu),* which belong to the family Tayasuidae, are considered resistant to the virus (Brown et al. 2018). Soft ticks of the genus *Ornithodoros* also harbour the virus and act as a biological vector in Africa (WHO 2022). ASF does not affect humans (WHO 2022).

I.3 Pathogenesis

Viral replication and necrosis

Depending on the virulence of the strain, clinical manifestations vary in severity. After infection, the virus multiplies in the monocytes and macrophages of the mandibular lymph nodes (Gómez-Villamandos et al. 2013). It then spreads to numerous organs *via* the blood and lymph, in particular lymphoid organs such as lymph nodes and the spleen, followed by the liver, kidney and lungs. Viral replication induces necrosis of the infected macrophage (Sánchez- Cordón et al. 2021). In the final phase of the disease, other cell populations become the site of viral replication, but these events appear to have a minor effect on the pathogenesis of the disease (Gómez-Villamandos et al. 2013).

Phagocytic activation and cytokine storms

Phagocytic activation of both infected and uninfected macrophages is characterised by cell hypertrophy, lysosome proliferation and the presence of phagocytosed cellular debris (Gómez-Villamandos et al. 2013). Despite the necrosis induced by viral replication, macrophage numbers increase and secretory activity intensifies. Pro-inflammatory cytokines (mainly TNFα and IL-1) are produced in large quantities, causing a significant febrile syndrome.

Haemorrhage and disseminated intravascular coagulation

Haemorrhage is a recurrent clinical sign of ASF, regardless of the virulence of the strain. It is not due to virus replication in capillary endothelial cells but to their phagocytic activation, as in macrophages (Gómez-Villamandos et al. 2013). The resulting endothelial hypertrophy obstructs the capillary lumen, leading to an increase in intravascular pressure and disorganisation of intercellular junctions. This leads to haemorrhage and oedema. The endothelial lesions activate the coagulation cascade, rapidly leading to a state of disseminated intravascular coagulation characteristic of acute APP. In the kidneys in particular, severe vasodilatation is observed, with increased vascular permeability leading to oedema and diapedesis of red blood cells (Gómez-Villamandos et al. 1995).

Thrombocytopenia

As a result of the haemorrhage, abundant compensatory platelet production begins three days post-infection (Gómez-Villamandos et al. 2013). The constant strain on megakaryocytes results in platelet production running out of steam: thrombocytopenia is observed six days post-infection (Gómez-Villamandos et al. 2013).

Lymphopenia

Lymphoid depletion affects lymph nodes, the spleen and lymphoid tissues associated with mucous membranes. Massive apoptosis of lymphocytes is observed in these organs. Viral replication is not observed in the

B and T lymphocytes and has therefore been ruled out as a cause of apoptosis. Apoptosis appears to be induced by the action of cytokines released by infected monocytes and macrophages (Salguero et al. 2005).

Splenomegaly and congestion of the spleen

In the red pulp of the spleen, macrophages surround the smooth muscle cells. Macrophage necrosis following viral replication leads to exposure of the basal lamina, activating the coagulation cascade and the deposition fibrin (Gómez-Villamandos et al. 1996). The accumulation erythrocytes and vascular changes lead to spleen hypoxia and lymphoid depletion in the later stages of the disease (Carrasco et al. 1995). The spleen then becomes hyperhaemic and enlarged.

Pulmonary oedema

In the lungs, phagocytic activation of intravascular macrophages causes alveolar oedema, which is the cause of death both acute and sub-acute forms (Gómez-Villamandos et al. 2013).

I.4. Epidemiology

I.4.a. Virus survival in infectious substances

The ASF virus is highly resistant in the external environment, particularly when bound to a protein carrier (blood, serum, even putrefied tissues) (ANSES 2019). Table 1 below summarises the survival times of the virus in different environments.

Table 1. Virus survival in different matrices
(based on ANSES 2019 and EFSA *Panel on Animal Health and Welfare* 2014)

Matrix	Virus survival time
Air	Half-life of 19 minutes Half-life of 5 minutes at >30% humidity
Water	2 months at room temperature
Fabrics - Dried meat - Chilled meat - Bone marrow - Rate	 4 months at room temperature 5 months at 4°C 6 months at room temperature 9 months at room temperature
Blood and serum	18 months at room temperature
Corpses (putrefied blood)	3 months after burial 6 months on the surface
Faeces	8.5 days at 4°C 3.7 days at 37°C
Urine	15.3 days at 4°C 2.9 days at 37°C
Slurry	126 days minimum, at 4°C and 17°C
Inert substrates	70 days in blood on a wooden surface

I.4.b. Resistance to physical treatment

The ASF virus is tolerant to a wide range of temperatures and pH levels.

- **Heat**

The virus is inactivated by heating to 60°C for 30 minutes and 56°C for 70 minutes (ANSES 2019). However, it is resistant to freezing and can survive for several months or even years in frozen meat (ANSES 2019). It has also been shown to survive in refrigerated blood for six years (FAO 2001).

- **The pH**

In serum, the virus is stable for seven days in a pH range of 4 to 13 (ANSES 2019). A study on the supernatant of viral cultures showed that the virus takes longer to be inactivated at basic pH (50 hours at pH=12.6) than at acidic pH (4 hours at pH=2.7) (ANSES 2019). Heat and pH inactivation times seem to depend on the matrix used, and are higher on an organic support (ANSES 2019).

- **Irradiation with ultraviolet radiation**

Ultraviolet irradiation appears to be effective on cell cultures with the aim of inactivating the virus (ANSES 2019). However, this physical treatment method has not been studied on other media.

I.4.c. Transmission

Direct transmission

Transmission by **direct contact between swine** occurs via secretions and excretions (saliva, nasal and genital secretions, urine, faeces). An infected pig excretes the virus 24 to 48 hours before showing the first clinical signs (FAO 2001). During the acute phase, large quantities of virus are present in excretions, secretions and particularly in the blood. In fact, viral titres ranging from 10^6 to 10^8 $_{HAD50/mL}$ have been detected in blood and 10^2 to 10^4 $_{HAD50/mL}$ in rectal and nasal swabs (Guinat et al. 2014). The duration of viremia varies according to the virulence of the strain, averaging 10 days. If the pig survives, the presence of the virus in excretions can last for another 30 days (Sánchez-Vizcaíno et al. 2012).

Indirect transmission

Several media are implicated in the indirect transmission of the virus:

- **Oily water**

Low-cost swill is often used by small pig producers to feed their animals. This type of feed includes kitchen scraps and food waste and, as a result, sometimes contains pigmeat, which may be contaminated (Penrith 2020). Swill is frequently implicated in epidemic outbreaks (see I.5 Worldwide distribution).

- **Pigmeat waste or swine carcasses**

Free-ranging pigs and wild boar, which may forage for food in rubbish dumps, are particularly at risk and likely to spread the disease (EFSA *Panel on Animal Health and Welfare* 2014). Infected carcasses left in the environment can contaminate soil and watercourses.

- **Vehicles, clothing, footwear and equipment**

Because the virus is so resistantit can survive for several days or even weeks on inert surfaces (ANSES 2019). The human factor is thus greatly involved in the spread of the disease.

- **Aerosols**

Transmission is possible via aerosols, but only over short distances and within the same farm (Main et al. 2022).

- **Iatrogenic transmission**

Iatrogenic transmission of the virus via contaminated needles can occur in a context where it is tempting to vaccinate against classical swine fever, which is caused by another virus, or to administer antibiotic treatment against swine mullet (FAO 2001).

Transmission by vector

- **Ticks of the genus *Ornithodoros***

While their role in the transmission of ASF has been proven in Africa and southern Europe, it has not yet been demonstrated in Asia (Gaudreault et al. 2020). Ticks become infected by taking a blood meal from pigs or warthogs, which harbour the virus asymptomatically. They turn transmit the virus during the next blood meal (Mulumba-Mfumu et al. 2019).

- **Biting insects**

Studies seem to suggest a role for flies of the genus *Stomoxys* in the transmission of the disease (Mellor et al. 1987; Stelder et al. 2023), particularly through the ingestion of flies that have fed on the blood of a sick pig (Olesen et al. 2018).

I.5. Worldwide distribution

African emergence

ASF was first described in Kenya in 1921 (Montgomery 1921). Other outbreaks were reported in South Africa and Angola. The disease spread across the continent, reaching West Africa in the 1950s (Penrith et al. 2013). Since then, ASF has been endemic in sub-Saharan Africa. The epidemiological cycle in Africa is complex and involves *Ornithodoros moubata* ticks and wild suids, which act as reservoirs for the virus (Mulumba- Mfumu et al. 2019).

First introduction in Europe

In 1957, ASF was introduced into Portugal through the distribution to pigs of swill carried on an airliner from Angola (Dixon et al. 2019). The virus then spread the Iberian Peninsula and then to several European countries. Outbreaks were observed in France (1964, 1967, 1974), Italy (1967, 1968, 1969), Malta (1975), Belgium (1985) and the Netherlands (1986) (Cwynar et al. 2019). The Caribbean and Brazil (1978) were also affected (Dixon et al. 2019). Strict culling of infected herds, hunting of wild boar and increased biosecurity on pig farms eradicated the disease from these territories. Sardinia is a notable exception: ASF has been endemic there since 1978 despite the measures put in place to eradicate it (Cwynar et al. 2019).

The European epizootic (since 2007)

In 2007, a ship from southern Africa carrying contaminated pork products landed in Georgia. Stored in a landfill site on the shores of the Black Sea, this waste was consumed by wild boar and pigs in semi-liberty, rapidly leading to a resurgence of the disease in domestic swine (Rowlands et al. 2008). The virus (genotype II) spread rapidly in the Caucasus region, reaching Armenia, Azerbaijan and then Russia, where it circulates widely in wild boar populations (Dixon et al. 2019). Ukraine recorded its first cases in 2012, followed by Belarus in 2013. The disease spread to neighbouring countries, Poland and the Baltic States (2014), the Czech Republic and Romania (2017), Hungary and Bulgaria (2018). In September 2018, cases were detected in wild boar populations in Belgium, several thousand kilometres from the nearest European outbreaks. The Belgian epizootic was brought under control in October 2020. New cases were reported in Greece in February 2020 and in Germany in September 2020. Italy (excluding Sardinia) was the last European country to record new cases (January 2022) (ADIS 2022; WHO 2022).

On 1 January 2023, the virus was actively circulating in Eastern Europe, Germany and Italy, both wild and domestic fauna. France has been free of the virus since 1994, but biosecurity measures have been stepped up at the German and Italian borders. All the strains identified are of genotype II, derived from the virus isolated in Georgia in 2007.

The Asian epizootic (since 2018)

In 2018, the virus was introduced into Asia for the first time in Liaoning province in north-eastern China, in domestic pigs (Zhou et al. 2018). Genotypic studies revealed complete similarity with strains isolated in Georgia in 2007 (Zhou et al. 2018), suggesting importation from Russia or Europe. Despite control measures put in place by the Chinese authorities, the disease is spreading rapidly due to the distribution of swill to pigs, illegal local trade in infected pigs and the movement of vehicles and people (Zhou et al. 2018). In January 2019, Mongolia recorded its first cases. The disease then spread to South Asia where it hit Vietnam and Cambodia hard. In June 2019, Laos reports its first outbreaks. Over the course of 2019, Hong Kong, North Korea, the Philippines, Indonesia, Laos and South Korea all reported outbreaks.

Burma, South Korea and Timor-Leste also detected the presence of ASF on their territory. India (2020), Bhutan (2021) and recently Thailand (January 2022) and Nepal (March 2022) have also declared themselves affected (FAO 2023a).

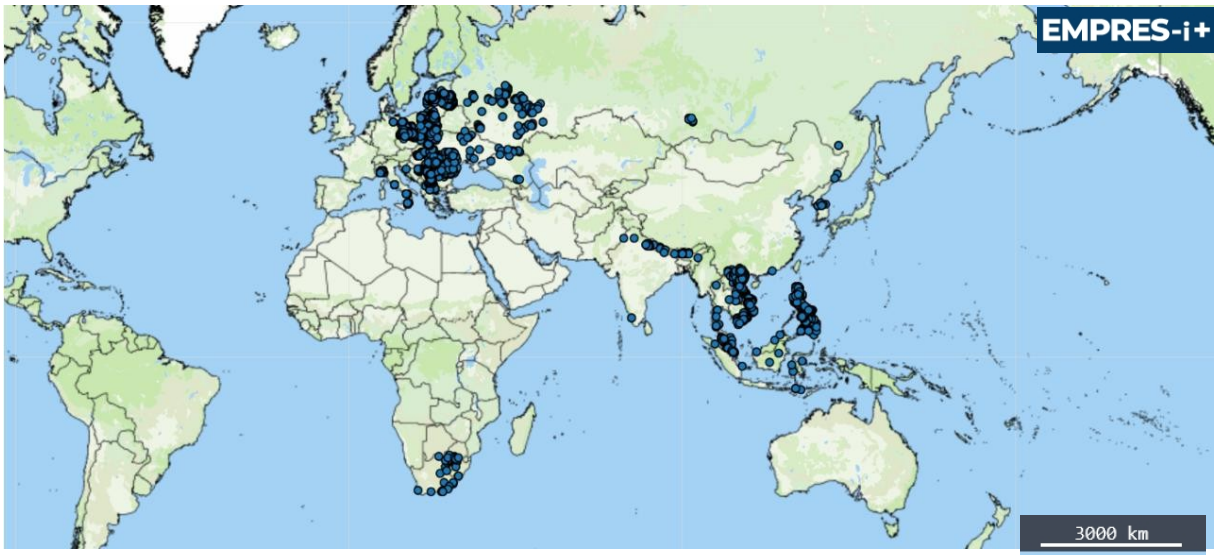

Figure 2: **Worldwide distribution of confirmed outbreaks of African swine fever in domestic and wild swine between August 2022 and August 2023.**
(FAO 2023b)

I.6 Clinic

The incubation period varies from 4 to 19 days, 3 to 4 days for the acute form (WHO 2022). Clinical presentation depends on the virulence of the strain (Hui et al. 2023).

High-acuity form

Pigs are most often found dead without prodromal signs.

Acute form

The mortality rate is close to 100% in 6 to 13 days (up to 20 days) (WHO 2022). Pigs present with fevers of up to 42°C and a deterioration in their general condition, with depression and anorexia. The skin turns red, and haemorrhagic and cyanotic areas are visible, particularly on the ears, tail, distal extremities of the limbs and ventral abdomen (Beltrán- Alcrudo et al. 2017) (Figure 3). Digestive clinical signs such as vomiting, sometimes haemorrhagic diarrhoea, constipation and abdominal pain may occur. Epiphora and mucopurulent discharge are also observed. Dyspnoea, accompanied in the final stages by bloody foam from the mouth and nasal passages, is a sign of pulmonary oedema, a frequent cause of death (Sánchez-Cordón et al. 2021). Nervous signs such as convulsions may develop a few hours before death. A pregnant sow can abort at any stage of gestation (Beltrán- Alcrudo et al. 2017).

Subacute form

Clinical signs are milder than in the acute form and last for up to 30 days. The mortality rate varies, ranging from 30 to 70% (WHO 2022).

Chronic form

It develops over 2 to 15 months and is manifested by irregular peaks of fever, weight loss, respiratory signs of pneumonia, skin signs necrosis and ulcers, arthritis and pericarditis. (WHO 2022).

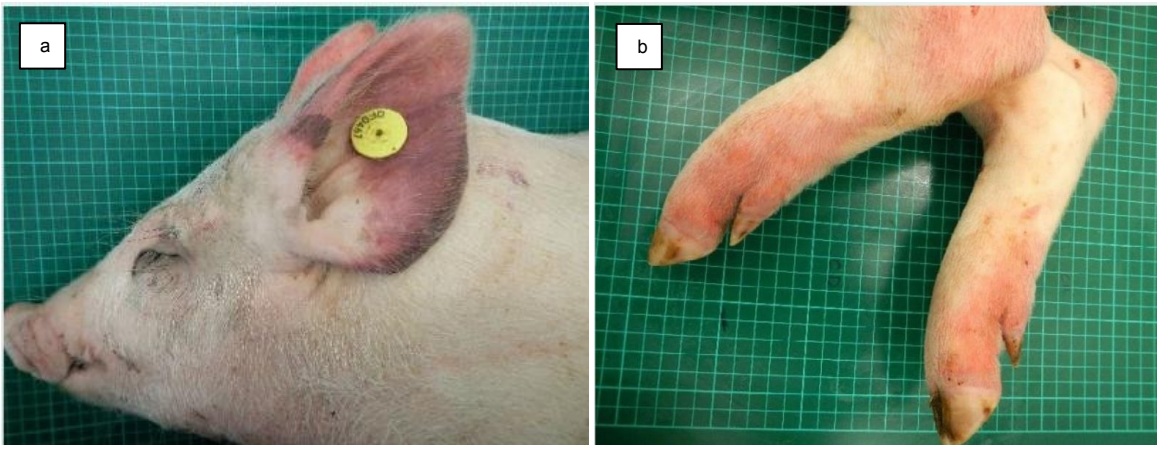

Figure 3: **Clinical signs in a domestic pig with acute African swine fever.** *Erythema and cyanosis of the ears (a) and distal extremities of the limbs (b).*

Photos: Sánchez-Cordón et al. 2021

I.7 Lesions

Acute form

Marked haemorrhagic lesions are seen in the renal, mesenteric and gastrohepatic lymph nodes (Beltrán-Alcrudo et al. 2017; Sánchez-Cordón et al. 2021) (Figure 4). The organs are congested and haemorrhages are visible on the surface of the serosa. Petechiae line the kidneys as well as larynx and bladder (Beltrán-Alcrudo et al. 2017). Splenomegaly is often present. Pleural, pericardial and peritoneal effusions are common (Beltrán-Alcrudo et al. 2017) . More specifically, oedema of the gallbladder and colonic mesentery may be observed (OMSA 2022).

Chronic form

Reported lesions include interstitial pneumonia, fibrinous pericarditis and adenomegaly (Beltrán-Alcrudo et al. 2017).

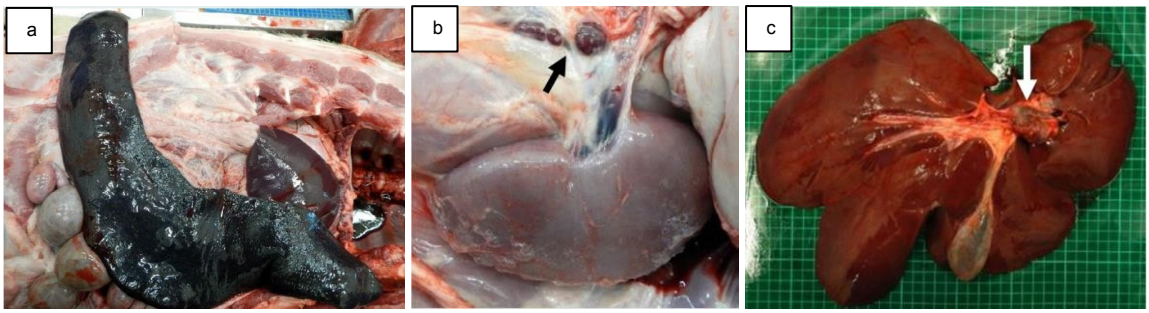

Figure 4. **Lesions in the acute form of African swine fever**
(a) Splenomegaly and congestion of the spleen (b) Adenomegaly of the renal lymph nodes (c) Adenomegaly of the gastrohepatic lymph nodes

Photo**:** Sánchez-Cordón et al. 2021

I.8. Immunity and vaccine research

Humoral and cellular immunity

Antibodies are detectable in the blood 7 to 12 days after the first clinical signs (FAO 2001) and can persist for several years. Seropositive sows can transmit antibodies to piglets via colostrum (Zhu 2022). The neutralising effect of antibodies remains controversial in the literature (Escribano et al. 2013; Montoya et al. 2021; Zhu 2022). Their protective effect appears to be mediated by *Complement Dependent Cytotoxicity* (CDC) and *Antibody Dependent Cell-mediated Cy*totoxicity (ADCC), as demonstrated in vitro (Montoya et al. 2021; Zhu 2022). T cells, particularly CD8+ T cells, also play an important role in protective immunity against ASF virus (Oura et al. 2005).

Vaccine research

The development of a vaccine is one of the priorities of ASF research, but is encountering a number of difficulties due to the complexity of the virus and the immune mechanisms involved. The virus has a number of unusual characteristics, such as extreme glycosylation and low surface density of envelope proteins (Zhu 2022). It is also capable of modulating the host immune response and implements complex evasion strategies (Blome et al. 2020). However, Vietnam has recently developed two inactivated vaccines which are the first be marketed: "NAVET ASFVAC" since June 2022 and "AVAC" since January 2023 (Tran et al. 2022; FAO 2023a). After conclusive trials (FAO 2023a), these vaccines are currently awaiting authorisation for worldwide export (FAO 2023a).

I.8 Diagnosis

I.9.a. Differential

It necessarily involves classical swine fever, which presents identical clinical signs and lesions. A sample must be sent to the laboratory to differentiate between the two. Other diseases that share part of the clinical picture must also be taken into account, such as porcine dysgenic and respiratory syndrome, porcine rouget, salmonellosis, Aujeszky's disease in young pigs, pasteurellosis or any other cause of septicaemia (Beltrán-Alcrudo et al. 2017; WHO 2022).

I.9.b. Laboratory

Viral identification

For identification of the virus, the samples to be collected are blood taken on ethylene-diamine-tetra-acetic acid (EDTA) at the start of the febrile syndrome, or from dead animals - lymph nodes, spleen, kidney, lungs and spinal cord, refrigerated at 4°C.

The laboratory tests recommended by WHOA are *polymerase chain reaction* (PCR) or quantitative PCR (PCRq) and virus culture on pig leukocytes with identification by haemadsorption or immunofluorescence (WHOA 2021).

Serological tests

Given the absence of vaccines, the presence of antibodies is indicative of infection with the ASF virus. The most commonly used test is the *enzyme-linked immunosorbent assay* (ELISA). Confirmation by other serological methods, indirect tests using immunofluorescence, *indirect immunoperoxidase test (IPT)* or *Western Blot* (OMSA 2021), is recommended.

I.9. Prophylaxis

Prevention

Countries that are still free of ASF are encouraged to set up surveillance programmes to detect the disease early on their territory. Imports of pigs and pig products must be subject to increased vigilance, as must the management of waste from aircraft or cargo ships from countries that are not free of the disease. Training programmes for farmers and veterinarians can help raise awareness of ASF. Finally, biosecurity measures tailored to the needs of livestock farms are the most effective bulwark against the disease.

Offensive measures

These measures are recommended by the FAO and are subject to national regulations. In the event of an outbreak, a zoning system is set up concentrically around the outbreak, with an infected zone and a protected zone.

surveillance. In the infected area, the aim is to eliminate the source of infection and prevent it spreading. The pigs are slaughtered by the veterinary services, and the corpses are burnt or buried deep underground. The farm is placed in quarantine, with a ban on the export of pig products or equipment. The premises, equipment and vehicles were cleaned and disinfected. An epidemiological investigation is carried out to identify the source of the infection and its potential spread to other farms. The surveillance zone is subject to special vigilance and biosecurity measures are being stepped up. Pig movements are monitored and permits are issued by the health authorities.

I.10 Biosafety

Biosecurity is the cornerstone of the fight against African swine fever. In anticipation of the following section, we will deal here with the measures recommended for small-scale pig farms, which are mainly found in South-East Asia. These farms have limited financial resources and are unlikely to be able to implement costly measures.

According to the FAO, biosecurity refers to all management and physical measures aimed at reducing the risk of introducing, maintaining and spreading animal diseases, infections or infestations to, from and within animal populations (Bremang et al. 2022). Several key biosecurity points can be implemented by small-scale producers, depending on their needs and motivation.

Housing

Free-ranging pigs are the farming system most at risk from the introduction and transmission of ASF (FAO, OIE *and World Bank* 2010). Pigs must be confined to pens or buildings, taking into account economic constraints.

Visitors

Visitors must not be allowed to enter piggeries. If they are, they must be provided with special clothing and footwear, or the opportunity to disinfect their footwear (Bremang et al. 2022). Vehicles must be cleaned and disinfected frequently. The veterinary surgeon and the intermediaries who buy the pigs from the farm are also affected by this measure. If possible, a parking area should be provided outside the farm.

Introducing animals

In order to control the risk of virus introduction, the number of incoming animals must be limited and come from disease-free sources. New arrivals should be isolated for a minimum period of 14 days being integrated into the herd (Bremang et al. 2022). In order to limit the movement of boars between farms for breeding, artificial insemination is recommended. A

One possible alternative is to keep a boar in common for each village, thus avoiding multiple movements between villages (FAO, OIE *and World Bank* 2010).

Animal health

It is advisable to run the animals in bands, separating them according to their immune status: piglets, sows and boars. Not only does this provide better animal health management, it is also more cost-effective (FAO, OIE *and World Bank* 2010). Furthermore, a sick animal must be isolated immediately. Vaccinating pigs against classical swine fever helps to limit its circulation on farms. Vaccination campaigns can be organised by local authorities or non-governmental organisations in the field.

Power supply

Swill and table scraps fed to pigs should be avoided wherever possible. The use of agricultural co-products is encouraged, with commercial feed remaining the best but most expensive option (FAO, OIE *and World Bank* 2010). If swill cannot be avoided, it should be boiled for a minimum of 30 minutes to inactivate the virus (Bremang et al. 2022). Food and water should be stored away from possible contamination by wildlife.

Farm hygiene

Specific clothing and footwear should be used when handling pigs. A dedicated changing area should be provided, with a clear demarcation between clean and dirty areas. Hand washing and disinfection are also recommended. Tools must be specific to pig care and to each band, and equipment must be cleaned and disinfected regularly. Cleaning is an essential step prior to disinfection in order to eliminate all traces of organic matter (Bremang et al. 2022). Effective disinfectants include quaternary ammoniums at 0.003%, iodine from 0.015% to 0.0075%, and bleach (sodium hypochlorite) from 0.03% to 0.0075% (ANSES 2019; Bremang et al. 2022). Foot baths filled with disinfectants must be placed at the entrance to piggeries (Bremang et al. 2022). To ensure effectiveness, boots must cleaned before entering the foot bath and a minimum of one minute in the disinfectant solution is recommended (Bremang et al. 2022).

Other animals and wildlife

Although the role of ticks in ASF has not yet been demonstrated in Asia, farmers are advised to treat their livestock against ticks. In addition, free-ranging animals such as cows and poultry can carry the virus and should, as far as possible, avoid contact with pigs. Similarly, wild boar should be prevented from coming into contact with pigs.

Manure management

Manure must not be stored or spread outside the farm. If it is not spread on crops, it must be poured into a septic tank. Vehicles

transporting it must be cleaned and disinfected after each use (Bremang et al. 2022).

Body management

These must be burnt or buried deep, in a dedicated location at a distance from the farm (Bremang et al. 2022). Their sale, consumption or abandonment in the environment are high-risk practices.

Restocking after an outbreak

A sanitary vacuum of at least 40 days is recommended before repopulating the farm (Bremang et al. 2022). All premises and equipment must be cleaned and disinfected using suitable products. Sentinel pigs (10% of the usual number) are introduced and monitored for a minimum of six weeks before the go-ahead is given for full repopulation (Bremang et al. 2022).

II. Pig farming in Laos and Cambodia

II.1. Context

II.1.a. Geography and demography

Laos is a country in South-East Asia with a surface area of 236,800 km². Its capital is Vientiane. Around 7.6 million people (2023) live in the country's 18 provinces. The population density, 32 inhabitants per km², is among the lowest in Asia. The climate is tropical, with a rainy season from May to September and a dry season from November to February. Mountains (with the highest peaks over 2,000 metres) and plateaux dominate 80% of the topography. The Mekong flows west along the border with Thailand and into Cambodia. Laos has 49 officially recognised ethnic groups, making it the most ethnically diverse country in Southeast Asia (FAO, *European Union and* CIRAD*,* 2022). Despite a recent increase in the rate of urbanisation, 63% of the population lives in rural areas (FAOSTAT 2023).

To the south of Laos, Cambodia is more populous, with 16 million inhabitants (2023). It covers an area of 181,000 km², with a population density of 93 inhabitants per km². The capital is Phnom Penh. The country is divided into 25 provinces. The geography is dominated by the Tonle Sap lake basin and the Mekong lowlands, where most of the country's farmland is found. As in Laos, the climate is tropical, with monsoon rains from May to October. 75% of the population lives in rural areas (FAOSTAT 2023).

Malnutrition is a major issue in Laos and Cambodia: in 2021, 33% of children under 5 in Laos will suffer from chronic malnutrition, 25% in Cambodia (*World Bank* 2023). Undernutrition affects 4.7% and 4.8% of the population in Laos and Cambodia respectively (FAOSTAT 2023).

II.1.b. Agricultural economy

In 2021, agriculture will account for 16% of GDP in Laos and 23% in Cambodia (*World Bank* 2023). The sector employs 58% and 39% of the working population in Laos and Cambodia respectively (*World Bank* 2023). Rice is the dominant crop in both countries, covering more than 60% of arable land (FAO 2023a). Buffalo, cattle, poultry and pigs are the main livestock species, most of which are kept in free-range systems.

In Laos and Cambodia, the vast majority of the rural population are small-scale farmers (*FAO, European Union and* CIRAD, 2022; NIS, MAFF 2023). These farmers rely heavily on rice cultivation, livestock rearing and foraging for wild foods forests and rivers (FAO, *European Union and* CIRAD, 2022).

II.2. Pig industry in Laos and Cambodia

II.2.a. Pig population

The pig population of Laos totalled 4.3 million head in 2021 *(Lao Statistics Bureau* 2021). Around 90% of pigs are local breeds (Figure 6) in traditional extensive systems, while 10% are so-called "exotic" breeds, i.e. imported from Europe and kept on more intensive farms (703 in Laos in 2022) (MAF 2022; Xayalath et al. 2022). In 2020, pork consumption represented 13.4 kg per capita per year, and demand is rising steadily (FAOSTAT 2023).

In Cambodia, per capita pork consumption is half that of Laos, at 6 kg per capita per year in 2020. There will be 2 million pigs in 2021 (FAOSTAT 2023).

Figure 5**: Local race in Cambodia**

Photo: Boris Sear

Figure 6. **Pig breeds in Laos**
(a) Moo Chid (b) Moo Lat (c) Moo Hmong (d) Moo Deng

Photos: Keonouchanh et al. 2017

II.2.b. Farm structure

In both Cambodia and Laos, the majority of pig farmers are small-scale family farmers who keep between one and five pigs (Chea et al. 2020; Keonouchanh et al. 2017). According to the FAO classification, the farming systems of smallholder pig farmers in Laos and Cambodia are so-called mixed production systems (integrating both crop and livestock production), located in humid to sub-humid areas, extensive to semi-extensive, and with a degree of commercialisation varying from subsistence to commercial purpose only (FAO 2015).

In this context, three different types of rearing are found in Laos and Cambodia: free-ranging, semi-free-range where pigs are enclosed or tethered at certain times, particularly at night or during growth, and the permanent pen or building system (Keonouchanh et al. 2017).

II.2.c. Players in the value chain

Pig farmers have a wide range of stakeholders, as shown in Figure 7 below. Value chain actors refer to anyone involved in the trade of live pigs. They include intermediaries who buy pigs from the farm and sell them on markets, to farmers or to slaughterhouses, slaughterhouse staff, butchers and veterinary officers.

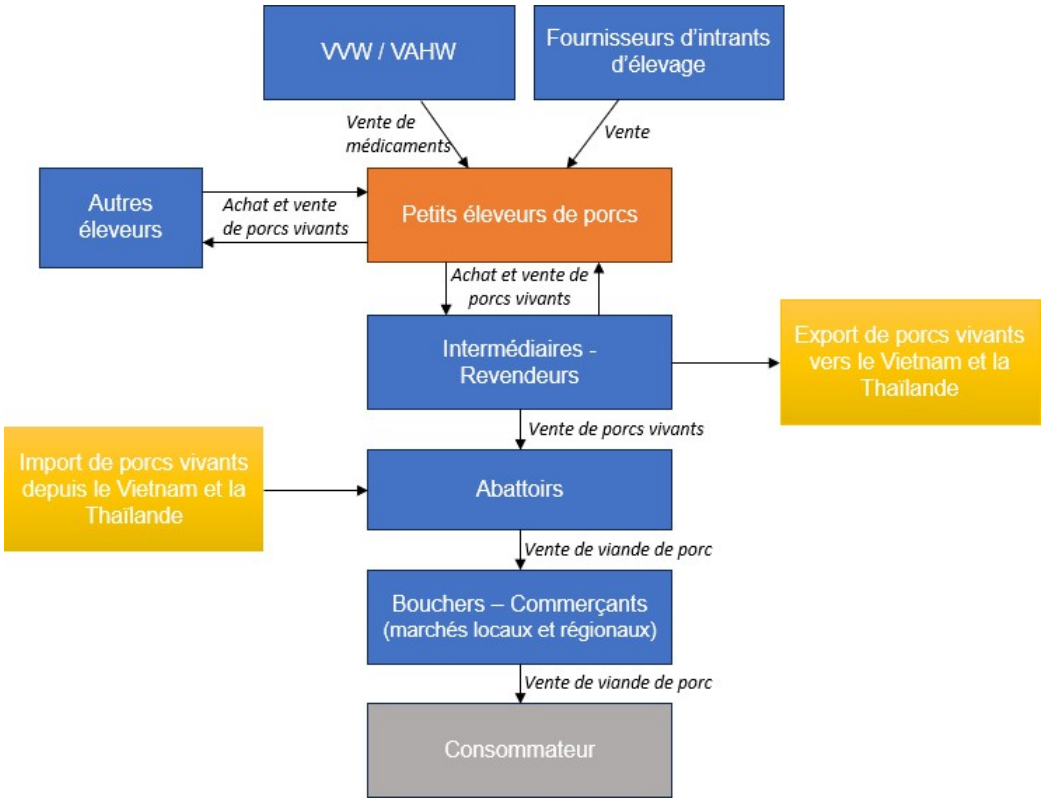

Figure 7**. Pig production value chain in Laos and Cambodia**
VVW: Village Veterinary Worker / VAHW: Village Animal Health Worker

(based on focus groups conducted in May 2023 in Saravan province, Laos)

Veterinary services begin at village level, with the *Village Veterinary Worker* (VVW) in Laos or the *Village Animal Health Worker* (VAHW), a technician trained in animal health and authorised to dispense medicines and vaccinate, in both Cambodia and Laos (Matsumoto et al. 2021; Chea et al. 2020). In Cambodia, farmers can also contact the District *Veterinary* DV. VVW and VAHW communicate with the authorities at district and provincial level: in Laos, these are the *District Agriculture and Forestry Office* (DAFO) and the *Province Agriculture and Forestry Office* (PAFO). In Cambodia, it is the *Provincial Department of Agriculture, Forestry and Fishery* (PDAFF). The latter then inform the country's competent authorities at the level of the Ministry of Agriculture. Figure 7 below illustrates this organisation.

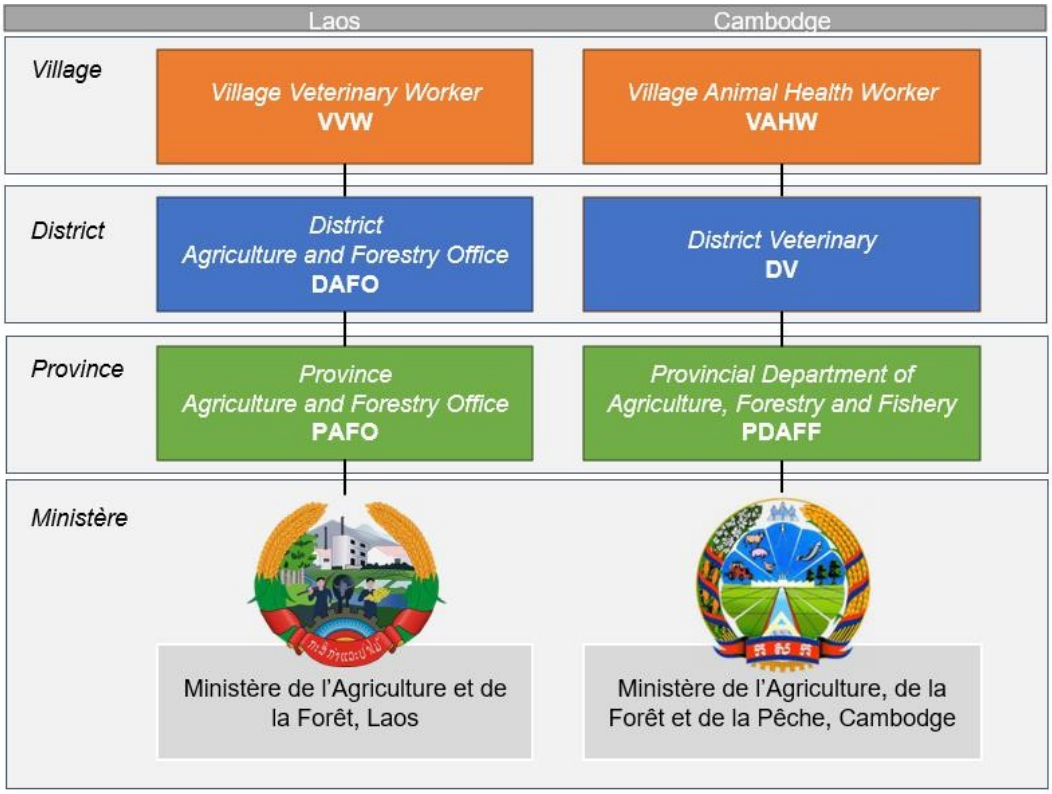

Figure 8. **Organisation of veterinary and livestock services in Laos and Cambodia**

II.4. Importance of small pig farms

Food safety

In Laos and Cambodia, pork is the second most important source of animal protein after fish (Xayalath et al. 2022) (Figure 9). Pork complements a diet made up of 60% cereals, mainly rice, thus contributing nutritional balance (FAO, *European Union and CIRAD*, 2022). However, Laos and Cambodia are still heavily affected by malnutrition in rural areas. Keeping pig farming alive in rural households is a way of combating food insecurity.

Source of income

With less than one hectare of rice on average and one harvest per year, families cannot ensure self-sufficiency in food and generate income. Pigs are an important source of financial security, providing cash for the purchase of food and seeds, as well as access to basic services as schooling and healthcare (Xayalath, 2020). Faced with the vagaries of the weather and fluctuations in market prices for crops, pig farming gives farmers greater economic resilience by diversifying their sources of income.

Socio-cultural importance

Pork is not only a source of financial income and food security, it also occupies a central place in ceremonies

such as weddings, funerals and religious ceremonies (Xayalath, 2020).

Ecological importance

Pigs in traditional extensive mixed farming systems make good use of crop waste and agricultural by-products (Matsumoto et al. 2021). Pig manure is then used as fertiliser for crops (Bremang et al. 2022).

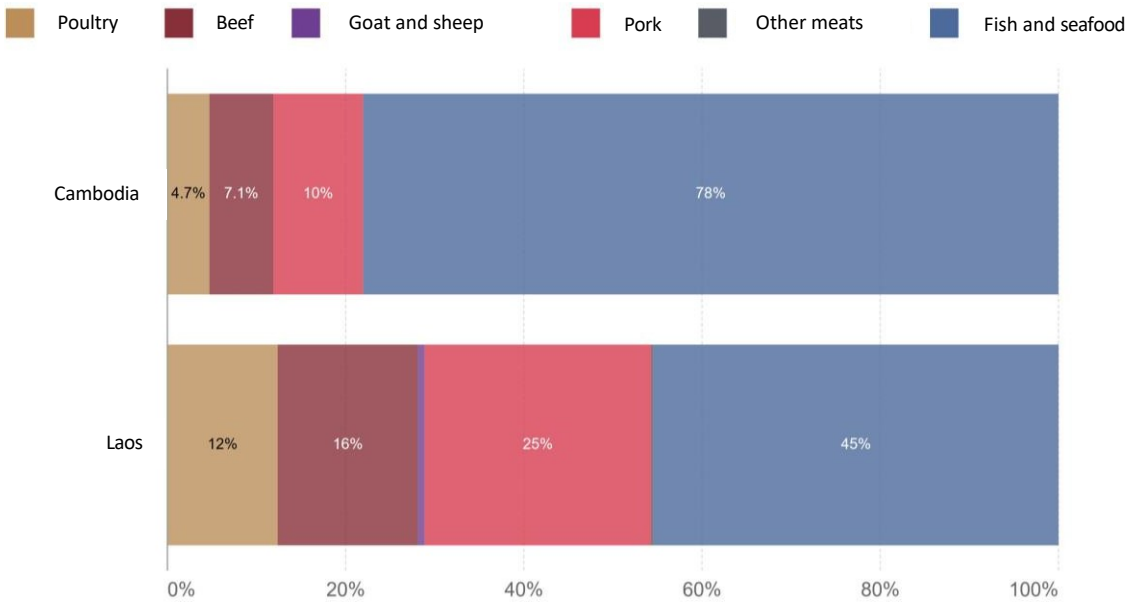

Figure 9. **Meat consumption in 2020 in Laos and Cambodia**
(adapted from FAO, *Our World In Data*, Ritchie et al. 2023)

III. African swine fever in Laos and Cambodia

III.1. History

In Cambodia, the first case is recorded in April 2019 in the province of Ratanakiri (FAO 2023a; OMSA-WAHIS, 2023). Outbreaks are detected in 5 provinces between April and June 2019. The last official case dates from June 2019.

The first outbreak in Laos occurred in June 2019 in Toomlan district, Salavan province (FAO 2023a). It is likely that the virus introduced into Laos through the importation contaminated pigs and pig products Vietnam, as the first outbreaks occurred close to trade routes linking Vietnam, Laos and Thailand (Hui et al. 2023). The disease spread from the south-east to the north-east between June and December 2019 (Hui et al. 2023). Since June 2019, outbreaks have been confirmed in 18 provinces across the country, with the latest officially in September 2023 in Phonehone district, Xianghouang province (FAO 2023a; WHOA-WAHIS, 2023).

The presence of ASF has also been detected in wild boar in Laos (Denstedt et al. 2021).

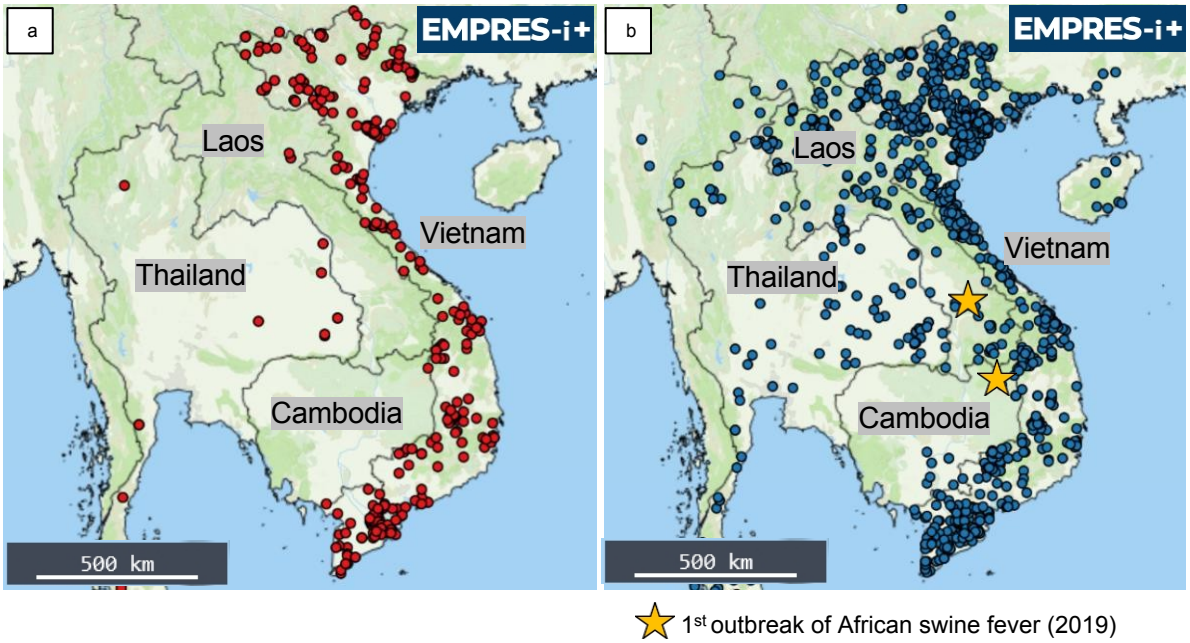

Figure 10. **Confirmed outbreaks in domestic and wild suidae in Laos, Cambodia, Thailand and Vietnam** *(a) Situation at 1 August 2023 (b) Between 2019 and 2022*
(adapted from FAO 2023b)

III.2. Measures put in place by governments

Border control

Laos and Cambodia have temporarily suspended pig imports from Vietnam and Thailand (MAF, 2023) (FAO 2023a) (Vongphachanh 2023). However, borders are porous and illegal imports continue (Kimmarita 2021).

Reporting outbreaks

Farmers, or village chiefs where applicable, must report cases to the DAFO, either directly or, if a VVW or VAHW is in place in the village, via the latter. The vets and district then alert the provincial and national authorities, who decide on the response (Matsumoto et al. 2021).

Isolation and slaughter

When an outbreak of ASF is confirmed, the Ministry designates a red zone around the outbreak to control pig movements and ban the consumption of pork, and a yellow zone (within a three-kilometre radius of the red zones) as a surveillance zone. The pigs in the outbreak were slaughtered (FAO 2023a). In 2019 in Laos, 20,000 pigs died of ASF and 6,000 were slaughtered (FAO 2022).

Training and prevention

In Laos, the Ministry of Agriculture and Forestry is working with international organisations such as the FAO, WHO and non-governmental organisations such as AVSF to train PAFOs and DAFOs in the detection and prevention of ASF (FAO 2023c). Guidelines are distributed to all livestock agents in the districts, along with a reminder of biosecurity measures (WHO-WAHIS 2023) (Bremang et al. 2022).

However, despite the measures taken by the government, the disease continues to spread. NGOs on the ground are reporting a much worse situation than official information would suggest (Lury 2020).

III.3. Consequences of the epizootic for small pig producers

ASF has serious consequences for small pig producers. mortality rate is 90 to 100% and the disease often decimates all the pigs in the village.

Food and nutrition crisis

As detailed above, pork is an important source of animal protein and the ASF epidemic is seriously threatening family food security.

Financial losses

Pig mortality leads to a loss of income for farmers, who are not compensated by the government. They also lose a source of capital that can easily be mobilised in the event of unforeseen circumstances. In Laos, for example, in Thapangtong district, affected by the disease in July 2019, average losses were estimated at 9 pigs per household, or USD 215 per household (USD 23.9 per pig) (Matsumoto et al. 2021). This poses a serious threat in a district where 40.6% of the population lives below poverty line (Matsumoto et al. 2021). Added to this is the general inflation in food prices, which is making the poorest households even more vulnerable (FAO 2023d).

Ecological and health risks

This crisis runs the risk of replacing organic fertilisers with chemical inputs that have little respect for soil and crops. In addition, sick pigs are very often treated with antibiotics, which are unnecessary and increase the risk of antibiotic resistance (Lury 2020). Finally, in the villages affected, pigs are frequently replaced by poultry, which does little to compensate for the losses (high mortality rate caused by disease, poor consumption index, lower profitability) and carries the risk of the re-emergence of zoonotic diseases such as avian flu (Lury 2020).

Risk of disappearance of local breeds

ASF mainly decimates local breeds, and the herd is rarely renewed. These breeds are the best adapted to climatic conditions (Lury 2020). Given the cultural importance of pig farming in Cambodia and Laos, its disappearance could have far-reaching social repercussions.

PART 2. EXPERIMENTAL STUDY

Survey of the knowledge, attitudes and practices of small pig farmers in Laos and Cambodia concerning African swine fever.

I. Aim of the study

The overall objective is to determine the current state of Knowledge, Attitudes and Practices (KAP) concerning African swine fever on family pig farms in Laos and Cambodia.

The results of this study will contribute to the training and capacity-building of small-scale producers in the field of biosecurity in the fight against ASF.

In this study, we will also try to answer three questions:
1) Is there a difference between Laos and Cambodia terms of knowledge, attitudes and practices regarding ASF?
2) Can knowledge, attitudes and practices be explained by socio-demographic factors?
3) Are knowledge, attitudes and practices correlated?

II. Materials and methods

II.1 Study population

The survey is being conducted between February 2023 and June 2023 in Laos and Cambodia.

For the sake of representativeness, the pig farmers belong to different ethnic groups, have different types of farms and rear pigs in different geographical contexts (mountains, wetlands).

In Laos, two districts were selected for the study: **Toomlarn** and **Viengkham** (Figure 11). Toomlarn is where the first outbreaks occurred in Laos and Viengkham is a mountainous area bordering a protected forest with potentially different farming systems. These districts are also areas where AVSF is already active, with teams and projects in place, which facilitates the organisation of the study and access to the farmers. A random sampling of villages was carried out on the basis of the list of villages in each district. A sample of 200 people was then drawn from 14 villages in each district, 97 in Viengkham and 103 in Toomlarn.

In Cambodia, six districts are represented: **Ba Phnum**, **Orang av**, **Svay Chrum**, **Tram Kak**, **Angkor Borey** and **Saang** (Figure 12). These districts in south-east Cambodia are areas of plains and farmland that have been affected by outbreaks. District veterinarians were asked to select villages with a sufficient number of pig farmers. A sample of 199 farmers was selected from 15 villages in each district: 33 in Ba Phnum, 51 in Orang av, 46 in Svay Chrum, 37 in Tram Kak, 12 in Angkor Borey and 20 in Saang.

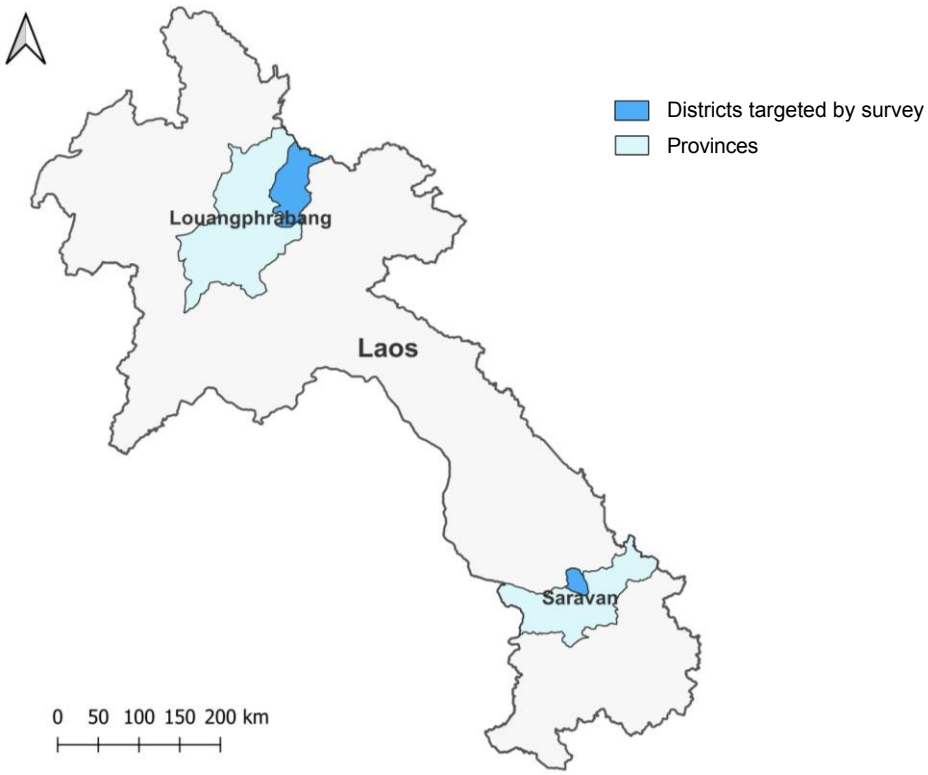

Figure 11. **Administrative map of Laos showing the provinces and districts targeted by the survey** (Véronique Renault)

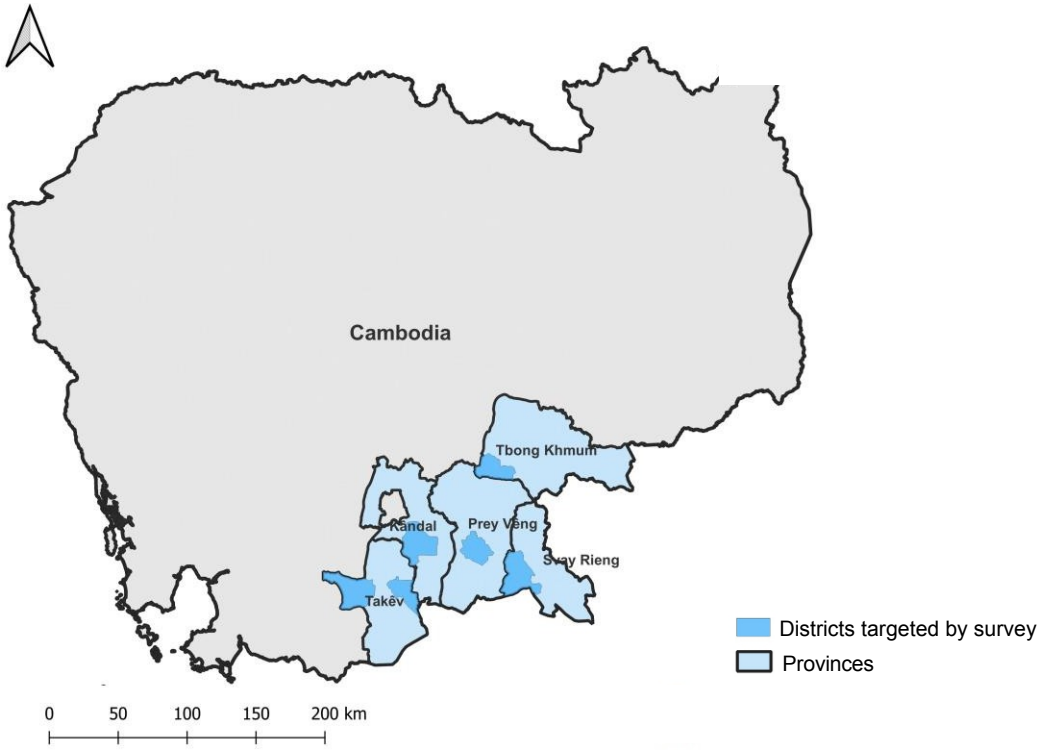

Figure 12. **Administrative map of Cambodia showing the provinces and districts targeted by the survey** (Véronique Renault)

II.2 Drawing up the questionnaire

A questionnaire was designed to collect data from small pig farmers (Appendix). It consisted of five parts: demographic data, characteristics of the activity, knowledge, attitudes and practices with regard to ASF. The questionnaire was first drafted in English and then translated into Lao and Cambodian by AVSF technical assistants Outhen PHOMMASACK in Laos and Boris SEAR and Samnang VEN in Cambodia. It is then tested internally by DAFO staff and the resulting feedback is incorporated into the final version.

II.3 Ethical considerations

Before starting the study, approval is sought from the relevant authorities in the target area. Before each interview, the participants' agreement is sought to record photos and videos, and a confidentiality statement is presented by the interviewers informing them that the personal data obtained as part of the study will remain confidential.

II.4. Data collection

Interviews with pig farmers are carried out by interviewers (university students and DAFO volunteers) trained for one or two days to use the questionnaire and forms on tablets to be filled in using the KoBo application (*KoBo Toolbox*, Cambridge, USA). Each interview lasted around 45 to 60 minutes. Observations at a distance and close to the farms are carried out to assess general hygiene, the environment and pig rearing methods.

Figure 13. **Interview with women farmers in a village in Laos, May 2023**

Photo: Ariane Masson

II.5 Data processing

The data collected on KoBo were extracted into Microsoft Excel 2016 (*Microsoft Corporation*, Redmond, USA) and then transferred to R version 4.3.1 (R Core team, Vienna, Austria) for statistical analysis. Responses from non-active farmers (who had ceased their activity and had not answered the CAP questions) were eliminated: this concerned 1 farmer from Tram Kak district and 11 from Saang district in Cambodia, as well as 5 farmers from Toomlarn district in Laos. **This brings the total number of responses from farmers to 382:** 187 in Cambodia (49%) and 195 in Laos (51%).

Cleaning up the database

A cross sort was carried out in R. Several inconsistencies were corrected in a logical way, taking care not to betray the meaning of the breeder's response.

- The two separate statements "breeder only" and "fattener only" in response to the question on activity were grouped together as "breeder fattener".
- Similarly, when separate, the responses "swill/table scraps" and "table scraps" are the same.
  "Local ingredients" are combined with "local ingredients combined with swill and table scraps". The same approach is applied to
  "commercial food".
- When it is mentioned that pork is not a source of income, but then the answer is given that the purpose of the breeding activity is commercial, the first answer is changed to "additional source of income".
- In the question on food, the mention of "Rice bran" appeared several times in the "Other category, which led to the creation of a new "Rice bran" category.
- 21 farmers did not answer the question "Do you ever feed swill to your pigs? Of these 21, the 8 who mentioned "swill" in their answer the question on feeding in the "Do you ever feed swill to pigs?
  The "Farm characteristics" are considered as "Yes". The remaining 13 are considered to be "Yes" out of an abundance of caution, so that they can be included in the score.

The socio-demographic and contextual variables retained as explanatory variables in the analysis are: country, gender, age, herd size, education level, experience of a CAP outbreak on one's farm, number of years of farming experience and whether pigs are a main source of income. Socio-demographic variables are important explanatory factors for understanding CAP variables, as shown in several studies (Tiongco et al. 2012; Tornimbene et al. 2014; Chenais et al. 2017; Rinchen et al. 2019). Similarly, several studies have linked the experience of a disease to the level of knowledge (Tiongco et al. 2012; Rinchen et al. 2019).

Building the score Knowledge Attitudes Practices

The *Knowledge* score is based on the answers to two questions, for a total of 21 points, concerning :

- Clinical signs (13 points) (Table 12 and Figure 15)
- Transmission routes (9 points) (Table 13 and Figure 16)

One point is awarded if the participant is able to identify a clinical sign or route of transmission, otherwise zero. Participants are then classified into two categories, sufficient or insufficient knowledge. A sufficient level of knowledge is obtained for a score of 50% or more correct answers.

The *Attitudes* score is based on answers to 24 questions divided into categories, for a total of 24 points:

- General perception of PPP (4 points) (Table 16): this question is based on a four-point Likert scale (Bertram 2007). Strongly Agree" and "Agree" are awarded one point, while "Disagree" and "Strongly Disagree" receive no points.
- Perception of effectiveness of biosecurity measures (Table 18) concerning :
    - Visitors (5 points)
    - Food (2 points)
    - Animal health (3 points)
    - Introducing animals (4 points)
    - Farm hygiene (6 points)

One point is awarded if the measure is considered effective. Participants are then classified into two categories, favourable attitude (understood the importance of the disease and the effectiveness of biosafety measures) or unfavourable attitude. A favourable attitude is obtained for a score of 50% or more correct answers.

The *Practical* score is based on answers to 24 questions divided into categories, for a total of 27 points:

- Reporting an outbreak (6 points) (Table 19)
- Accommodation (1 point)
- Implementation of biosafety measures (Table 20) concerning :
    - Visitors (5 points)
    - Food (2 points)
    - Animal health (3 points)
    - Introducing animals (4 points)
    - Farm hygiene (6 points)

Each good practice applied is awarded one point. Participants are then classified into two categories: poor practice and correct practice. A correct practice is obtained for a score 50% or more correct answers.

Descriptive statistics

A descriptive analysis was carried out using R on the entire database, with calculations of frequencies and percentages. Graphs were produced in Excel. A vertical bar chart was used for single-choice questions and a horizontal bar chart for multiple-choice questions.

Explanatory statistics

Socio-demographic, breeding and CAP variables were compared by country using a Chi-square test. A Fisher exact test was used when the expected frequencies were less than or equal to five.

The normal distribution of continuous variables, including CAP scores, was tested using a Kolmogorov-Smirnov test. A Student's t-test was used to compare Laos and Cambodia on the basis of age, which is normally distributed. For household size, herd size and CAP score, which do not have normal distributions, a non-parametric test the Wilcoxon test, was used. As the CAP variables were not normally distributed, they were tested using a Spearman rank correlation test. To compare the Spearman coefficients between Laos and Cambodia, a Fisher transformation was used.

To assess the relationship between the socio-demographic and contextual variables (explanatory variables) and the variables C (sufficient/inadequate), A (favourable/unfavourable) and P (poor/correct), a series of univariate logistic regressions were performed. For the analysis, the 'age variable was divided into three categories based on quartiles 16 - 37, 38 - 53 and 54 - 79. The herd size was divided into two categories based on median, <5 pigs and
≥5 pigs. Variables with a *p-value ≤0.*25 were selected for multivariate logistic regression. They are added in ascending order of their *p- value* obtained in the univariate analyses, according to the method described by Rinchen (Rinchen et al. 2019). Variables with p-values ≤0.05 are then retained in the multivariate logistic regression model. *Odds ratios* and confidence intervals were calculated. The adequacy of the final model was tested using a Hosmer-Lemeshow test. The multicollinearity of the explanatory variables was assessed using a *Variable Infl*ation *Factor* (VIF) test. All the explanatory variables had a VIF very close to 1, allowing us to conclude that there was no multicollinearity with a significant impact on the interpretations. Finally, confounding factors were sought by adding the variables not retained in the final model. If the adjusted *Odds Ratios* vary by more than 25%, the added variable is considered to be a confounding factor (Rinchen et al. 2019). No confounding factors were identified in the analysis.

III. Results

III.1. Socio-demographic characteristics

Table 2 shows the socio-demographic characteristics of the farmers surveyed. Women were in the majority in the survey, accounting for 57%. The average age was 44.7, higher in Cambodia (47.5) than in Laos (41.9). The youngest breeder is 16, the oldest 79. All the farmers in Cambodia belong to the Khmer ethnic group, while ethnic diversity is much more marked in Laos, with eight ethnic groups listed. The overall level of literacy was low, being lowest in Laos with 23% of farmers illiterate compared with 10% in Cambodia ($p<0.001$). Households have a median of five people per household. They are more numerous in Laos, with extremes of up to 25 people under the same roof. All socio-demographic variables showed significant differences between Laos and Cambodia ($p<0.001$).

Table 2. **Socio-demographic characteristics**

	Cambodia n=187	**Laos** n=195	**Total** n=382	***p-value***
Type				<0,001
Men	60 (32%)	106 (54%)	166 (43%)	
Woman	127 (68%)	89 (46%)	216 (57%)	
Age (years)				<0,001
Mean± Standard deviation	47.5± 10.5	41.9± 12.6	44.7± 12.1	
Ethnic group				
Khmer	187 (100%)			
Katang		78 (40%)		
Hmong		36 (18%)		
Khmou		61 (31%)		
Ta-Oy		9 (5%)		
Lao		7 (4%)		
Lue		2 (1%)		
Other		2 (1%)		
Level of education				<0,001
Illiterate	19 (10%)	44 (23%)	63 (16%)	
Primary	92 (49%)	102 (52%)	194 (51%)	
College	55 (29%)	41 (21%)	96 (25%)	
Lycée	18 (10%)	8 (4%)	26 (7%)	
Higher education	3 (2%)	0 (0%)	3 (1%)	
Household size (pers./household) *Median (Q1 - Q3)*				<0,001
Children< 16 years	2 (1 - 2)	3 (2 - 4)	2 (1 - 3)	
Adults >16 years	3 (2 - 4)	4 (2 - 5)	3 (2 - 5)	
Total	5 (4 - 6)	6 (5 - 8,5)	5 (4 - 7)	

III.2. Farm characteristics

Source of income (Table 3)

Pork is the main source of income for 20% of farmers. In Laos, pork is mainly an additional source of income. In Cambodia, it was the second most important source of income after rice (p<0.001). In Cambodia, rice was a source of income for 96% of the farmers surveyed, but only 75% of farmers in Laos earned any income from it.

Table 3. **Source of income**

	Cambodia n=187	**Laos** n=195	**Total** n=382	***p-value***
Pork's share revenue sources 1st revenue source 2st revenue source 3st revenue source Additional source Not a source of income	42 (23%) 94 (50%) 40 (21%) 11 (6%) 0 (0%)	35 (18%) 45 (23%) 40 (20%) 70 (36%) 5 (3%)	77 (20%) 139 (37%) 80 (21%) 81 (21%) 5 (1%)	<0,001
Share of rice in sources of income 1st source of income 2th source of income 3th source of income Additional source of income Not a source of income	92 (49%) 40 (21%) 22 (12%) 26 (14%) 7 (4%)	55 (28%) 12 (6%) 14 (7%) 65 (34%) 49 (25%)	147 (38%) 52 (14%) 36 (9%) 91 (24%) 56 (15%)	<0,001

Pig farming (Table 4)

On the whole, the farmers were experienced, with the majority having farmed for more than 10 years. In Laos, 64% were breeder-feeders, whereas in Cambodia there was an equal distribution of breeders and breeder-feeders (43% each) (p<0.001). In Laos, rearing for personal consumption was found among 92% of farmers, and was associated with a commercial aim in 73% of cases. In Cambodia, the objective was commercial in 88% of cases, with very little for personal consumption (p<0.001).

Housing (Table 5 and Figure 14)

Pig housing differed by country (p<0.001). In Cambodia, 92% of farmers kept their pigs permanently in pens or buildings. In Laos, half the farmers kept their pigs in a pigsty at night and let them run free during the day, and only 30% kept them permanently. Most pigs are kept close to their homes. 19% of farmers let their pigs roam permanently in Laos, and only 5% in Cambodia. In Laos, 97% of farmers use housing consisting of wooden fences, while in Cambodia the majority use concrete buildings or wooden fences with concrete floors.

Table 4. **Livestock activity**

	Cambodia n=187	**Laos** n=195	**Total** n=382	***p-value***
Experience in pig farming				<0,001
< 1 year	2 (1%)	21 (11%)	23 (6%)	
1-2 years	9 (5%)	22 (11%)	31 (8%)	
>2-5 years	32 (17%)	37 (19%)	69 (18%)	
>5-10 years	31 (17%)	21 (11%)	52 (14%)	
> 10 years	113 (60%)	94 (48%)	207 (54%)	
Purpose of rearing *Several options available* Personal consumption Mobile capital	2 (1%)	179 (92%)	181 (47%)	<0,001
Commercial purpose	39 (21%)	37 (19%)	76 (20%)	
Other	164 (88%)	146 (75%)	310 (80%)	
	0 (0%)	4 (2%)	4 (1%)	
Activity				<0,001
Farmer	80 (43%)	25 (13%)	105 (27%)	
Farmer-fattener	26 (14%)	44 (22%)	70 (18%)	
Other	81 (43%)	124 (64%)	205 (54%)	
	0 (0%)	2 (1%)	2 (1%)	

Table 5. **Pig housing**

	Cambodia n=187	**Laos** n=195	**Total** n=382	***p-value***
Type accommodation				<0,001
On the move	9 (5%)	37 (19%)	46 (12%)	
Full-time piggery	172 (92%)	59 (30%)	231 (60%)	
Part-time piggery Other	2 (1%)	99 (51%)	101 (27%)	
	4 (2%)	0 (0%)	4 (1%)	
Distance between the barn and the house	n=174	n= 158	n=332	<0,001
< 100m	173 (99%)	79 (50%)	252 (76%)	
< 2 km	1 (1%)	38 (24%)	39 (12%)	
> 2 km	0 (0%)	41 (26%)	41 (12%)	
Material	n=174	n=158	n=332	<0,001
Wooden barrier / non-concreted	4 (2%)	150 (95%)	154 (46%)	
floor Wooden barrier / concreted	56 (32%)	3 (2%)	59 (17%)	
floor Steel barrier / concreted floor	39 (22%)	0 (0%)	39 (12%)	
Raised wooden floor	0 (0%)	1 (1%)	1 (1%)	
Concrete building	70 (41%)	0 (0%)	70 (21%)	
Other	5 (3%)	4 (2%)	9 (3%)	

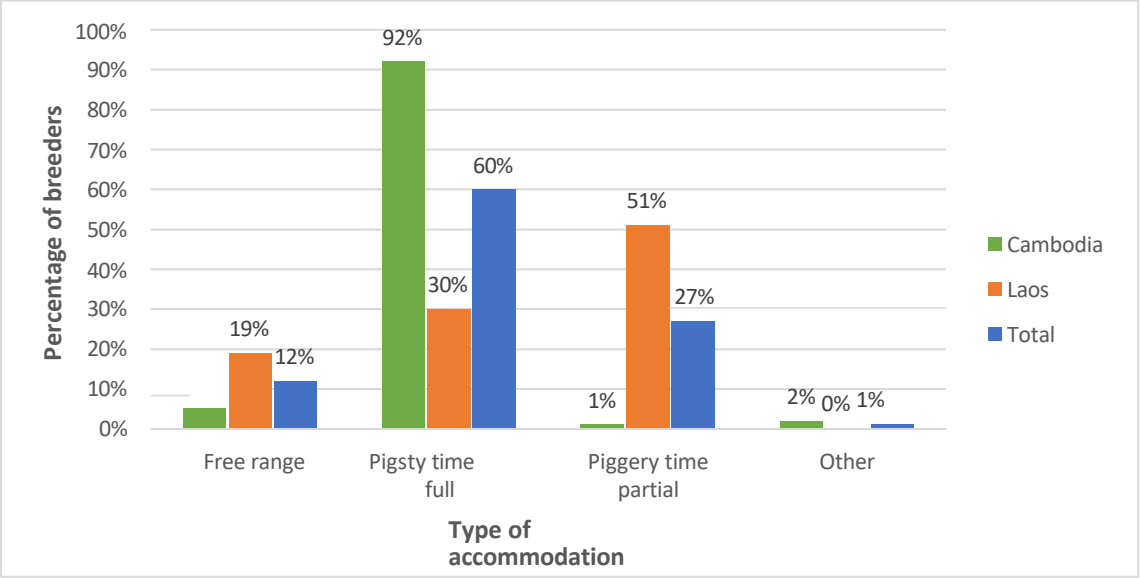

Figure 14. **Pig housing**

Power supply (Table 6)

In both countries, a large proportion of the feed is made up of local ingredients (74% in Laos and 61% in Cambodia). In Laos, due to a higher proportion of roaming animals, free-range foraging is a common feeding method (45%). Commercial feeding is very widespread in Cambodia (66%), unlike its neighbour (3%). Swill and table scraps are rarely fed on their own and are often combined with local ingredients or commercial feed.

Table 6. **Pig feed**

Several possible choices	**Cambodia** n=187	**Laos** n=195	**Total** n=382	***p-value***
- Free roaming	1 (1%)	87 (45%)	88 (23%)	<0,001
- Local ingredients	114 (61%)	144 (74%)	258 (68%)	
- Swill / table scraps	0 (0%)	1 (1%)	2 (1%)	
- Commercial food	124 (66%)	2 (3%)	126 (33%)	
- Local ingredients associated swill / table scraps	25 (13%)	44 (23%)	66 (17%)	
- Commercial food associated with swill / table	19 (10%)	10 (5%)	29 (8%)	
- Rice bran	30 (16%)	0 (0%)	30 (8%)	
- Other	22 (12%)	2 (1%)	24 (6%)	

Pig herd (Table 7)

Farmers have median of five pigs per household, with extremes of up to 110 pigs in Cambodia. Cambodian herds are more numerous, with a median of seven, compared with four in Laos (p<0.001).

Table 7. **Number of pigs per household**

	Cambodia n=187	**Laos** n=195	**Total** n=382	***p-value***
Adults	**2 (1 - 4)**	**2 (0 - 3)**	**2 (1 - 4)**	0,04
Males	0 (0 - 0)	0 (0 - 1)	0 (0 - 1)	
Females	2 (1 - 3,5)	0 (2 - 1)	1 (1 - 3)	
Young people (<6 months)	**4 (0 - 10)**	**2 (0 - 6)**	**2 (0 - 8)**	0,03
Males	1 (0 - 5)	1 (0 - 3)	1 (0 - 4)	
Females	2 (0 - 5)	1 (0 - 3)	1 (0 - 4)	
Total livestock	**7 (2,5 - 12,5)**	**4 (1 - 9)**	**5 (2 - 11)**	<0,001

Pig breeds (Table 8)

In Laos, local breeds are found on all small farms, unlike in Cambodia, where only 17% of farmers breed pure local breeds and the majority are crossbred (p<0.001).

Table 8. **Pig breeds**

Several possible choices	**Cambodia** n=187	**Laos** n=195	**Total** n=382	***p-value***
Local breeds	**32 (17%)** Kandol 1 (3%) Kampot 3 (9%) Hainam 5 (16%) Damrey 4 (12%) Other 1 (3%) DK 21 (66%)	**195 (100%)** Moo Lat 192 (98%) Moo Kang 4 (2%) Moo Cheed 42 (22%) Moo Hmong 17 (9%) Other 0 (0%) DK 1 (1%)	227 (59%)	<0,001
Exotic breeds	33 (18%)	4 (2%)	37 (10%)	<0,001
Cross-breeds	156 (83%)	21 (10%)	177 (46%)	<0,001
Hybrid breeds	0 (0%)	1 (1%)	1 (0%)	
Other	1 (1%)	0 (0%)	1 (0%)	

DK: Don't know

* cross between domestic pig and wild boar (sanglochon)

Other animals (Table 9)

Poultry farming is widespread, as is pig farming, followed by cow farming.

Table 9. **Other animals owned by pork producers**

Several possible choices	**Cambodia** n=187	**Laos** n=195	**Total** n=382	***p-value***
Cow	123 (66%)	83 (43%)	206 (54%)	<0,05
Buffalo	8 (4%)	61 (31%)	69 (18%)	
Goat	2 (1%)	39 (20%)	41 (11%)	
Poultry	159 (85%)	143 (73%)	302 (79 %)	
Other	3 (2%)	7 (4%)	10 (3%)	
None	14 (8%)	36 (18%)	50 (13%)	

Wild boar

93% of farmers say they never see wild boar around their farm. 5% see wild boar a few times a year.

Table 10. **Frequency wild boar sightings around the farm**

	Laos n=195	**Cambodia** n=187	**Total** n=382	***p-value***
Never	172 (88%)	183 (98%)	355 (93%)	<0,001
A few times a year	18 (9%)	1 (1%)	19 (5%)	
1 to 4 times a month	1 (1%)	0 (0%)	1 (0%)	
DK	4 (2%)	3 (1%)	7 (2%)	

DK: Don't know

III.3. Knowledge

Only 77% of farmers surveyed said they had heard of ASF, with a significantly higher number in Cambodia (92%) than in Laos (72%) ($p<0.001$). The main sources of information, in order of importance, were discussions with other farmers, veterinary and livestock professionals, the media (television, radio, Internet and social networks) and training courses. In Laos, 69% of farmers who had heard about ASF had received information from veterinary and livestock professionals (VAHW, DV, DAFO and PDAFF), compared with only 33% in Cambodia ($p<0.001$). However, fewer people in Laos had received training (3% compared with 11%) ($p<0.001$), although this source of information was still in the minority.

There were no significant differences between the two populations in terms of their respective experience of ASF, meaning that the same proportion (60%) had been affected by the disease. This parameter therefore does not represent a bias in the interpretation of the differences between Laos and Cambodia.

Farmers in Cambodia were significantly more confident in their ability to recognise clinical signs (75%) and felt better informed about transmission routes (67%) than Laotian farmers (56% and 53% respectively) ($p<0.001$).

Table 11. **Knowledge: general questions**

	Cambodia n=195	**Laos** n=187	**Total** n=382	***p-value***
Have you heard of ASF?				<0,001
Yes	172 (92%)	121 (62%)	293 (77%)	
No	15 (8%)	74 (33%)	89 (23%)	
If so, how?				<0,001
Discussion other breeders	103 (60%)	91 (75%)	194 (66%)	
Information for DAFOs / PDAFFs / DVs / VAHWs	56 (33%)	84 (69%)	140 (48%)	
Has received training	19 (11%)	4 (3%)	23 (8%)	
Other	50 (29%)	12 (10%)	62 (21%)	
Have you experienced an outbreak of ASF in your farm?				0,62
Yes	114 (61%)	114 (59%)	228 (60%)	
No	73 (39%)	81 (42%)	154 (40%)	
Do you know anyone who has been affected by PPA?				<0,001
Yes	150 (80%)	115 (59%)	265 (69%)	
No	37 (20%)	80 (41%)	117 (31%)	
Do you feel able to recognise the clinical signs of ASF?				<0,001
Yes	140 (75%)	109 (56%)	249 (65%)	
No	47 (25%)	86 (44%)	133 (35%)	
Do you feel well informed about How is ASF transmitted?				0,004
Yes	126 (67%)	103 (53%)	229 (60%)	
No	61 (33%)	92 (47%)	153 (40%)	

** **Other media cited:** television, radio, social networks (Facebook) (35).*

Clinical signs (Table 12 and Figure 15)

In Laos, fever, anorexia and sudden death were cited most often, while in Cambodia, skin redness, sudden death and anorexia were cited most often**.** The differences are significant ($p<0.05$) except for vomiting and abortion.

Transmission routes (Table 13 and Figure 16)

In Laos, direct contact with infected pigs comes first, followed by contact with pork products and contaminated carcasses. In Cambodia, contact with pork products and contaminated carcasses came next, followed by air and wind. The differences are significant ($p<0.05$) except air and wind, and insects.

Significant differences between Laos and Cambodia are indicated with a *p-value* in bold ($p<0.05$).

Table 12. **Which of the following clinical signs do you associate ASF?**

	Cambodia n=187	**Laos** n=195	**Total** n=382	***p-value***
Fever	66 (35%)	130 (67%)	196 (51%)	**<0,001**
Diarrhoea	27 (14%)	59 (30%)	86 (23%)	**<0,001**
Increased mortality	52 (28%)	90 (46%)	142 (37%)	**<0,001**
Joint oedema	17 (20%)	7 (4%)	24 (6%)	**0,03**
Cough	10 (5%)	38 (19%)	48 (13%)	**<0,001**
Vomiting	23 (12%)	26 (13%)	49 (13%)	0,8
Sudden death	77 (41%)	116 (59%)	193 (50%)	**<0,001**
Anorexia	17 (36%)	117 (60%)	184 (48%)	**<0,001**
Reddening of the skin on the abdomen ventral, ears, tail, ears, tail distal extremities	76 (41%)	43 (22%)	119 (31%)	**<0,001**
Dyspnoea	33 (18%)	79 (41%)	112 (29%)	**<0,001**
Abortion	8 (4%)	13 (7%)	21 (5%)	0,3
Polydipsia / mud baths	4 (2%)	29 (15%)	33 (9%)	**<0,001**
Redness of the ears	64 (34%)	22 (11%)	86 (23%)	**<0,001**
DK	24 (13%)	25 (13%)	49 (13%)	1
No	1 (1%)	2 (1%)	3 (1%)	0,6
Other	47 (25%)	34 (17%)	81 (21%)	0,07

DK: don't know

* ***Other clinical signs cited****: convulsions, neurological signs (13), facial oedema (4).*

Table 13. **How can your pigs become infected with the ASF virus?**

	Cambodia n=187	**Laos** n=195	**Total** n=382	***p-value***
Direct contact with an infected pig	54 (29%)	165 (85%)	219 (57%)	**<0,001**
Contact with pork products / contaminated carcasses	94 (50%)	136 (70%)	230 (60%)	**<0,001**
Ingestion of pork / water contaminated fat / offal	50 (27%)	72 (37%)	122 (32%)	**0,03**
Contact with infected wild boar	2 (1%)	31 (16%)	33 (9%)	**<0,001**
By visitors	84 (45%)	26 (13%)	110 (29%)	**<0,001**
By vehicles or equipment	62 (33%)	37 (19%)	99 (26%)	**0,002**
air / wind	90 (48%)	76 (39%)	166 (43%)	0,07
By insects (ticks, flies)	26 (14%)	27 (14%)	53 (14%)	0,99
No	16 (10%)	12 (6%)	28 (8%)	0,37
Other	20 (11%)	31 (16%)	51 (13%)	0,14

* ***Other routes of transmission cited:*** *other animals (dogs, cats, chickens, free-ranging cows) (9), trade with Thailand and Vietnam (2), VAHW (3).*

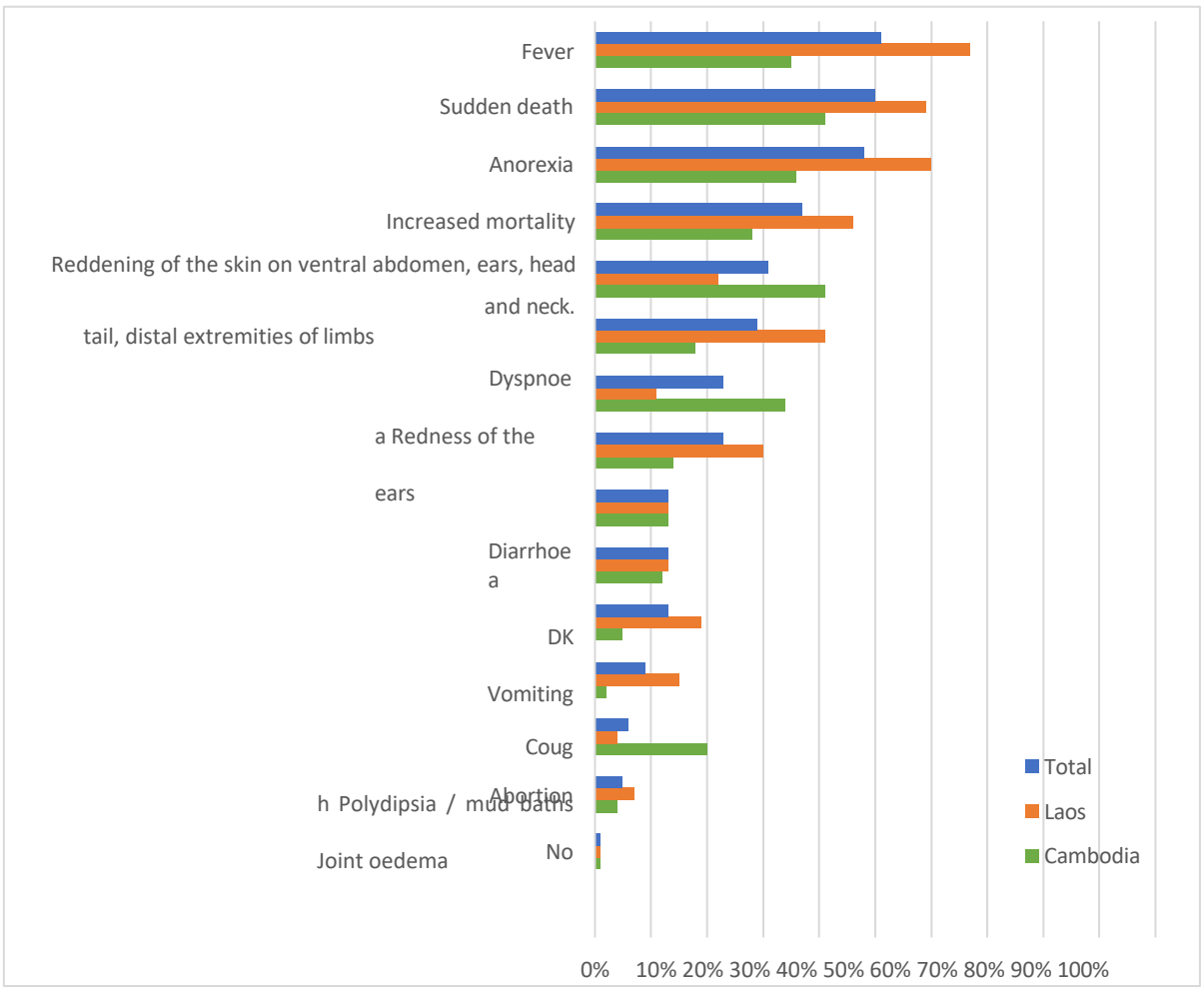

Figure 15. **Which of the following clinical signs do you associate with ASF?**

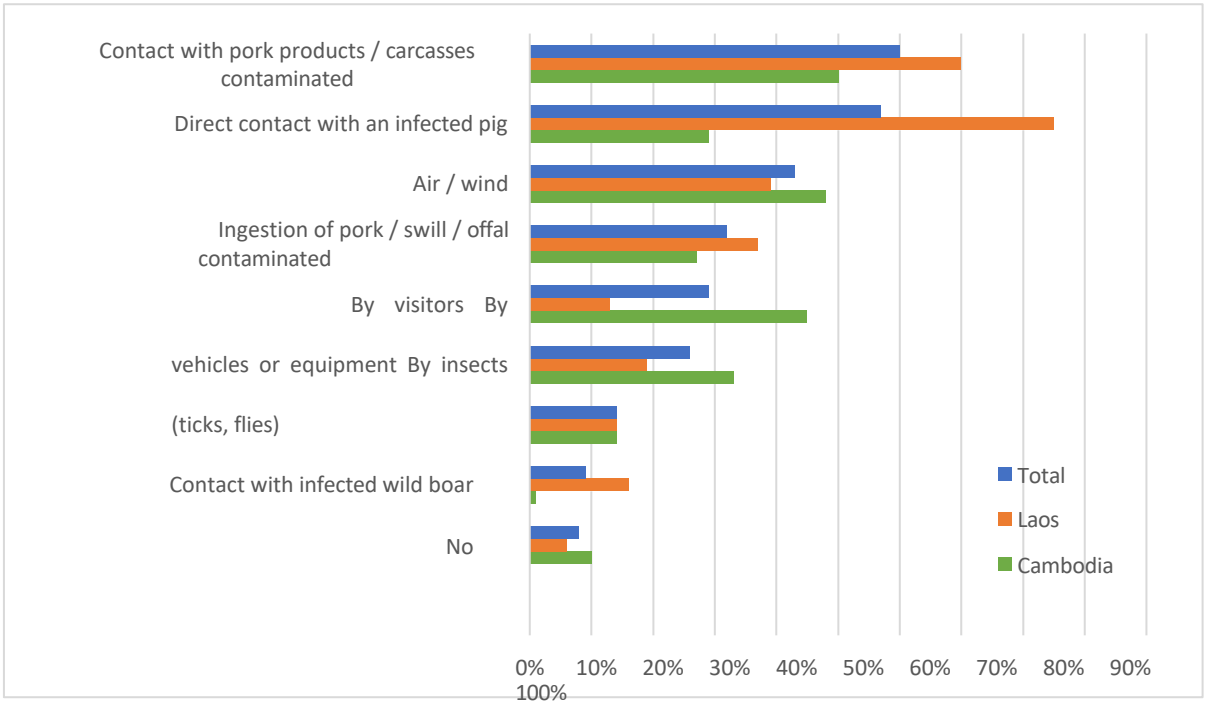

Figure 16. **How can your pigs become infected with the ASF virus?**

Knowledge score

The results of the Knowledge score are detailed in table 14 below. Two histograms can be constructed, showing the distribution of scores (Figure 17a.) and the distribution of the insufficient/sufficient classification (Figure 17b.). Knowledge of the disease was low overall, with only 9% of farmers obtaining half the correct answers. It was higher in Laos than in Cambodia (p<0.001).

Table 14. **Knowledge score results**

	Cambodia	Laos	Total	*p-value*
Clinical signs /13	2.8± 1.9	3.9± 2.3	3.5± 2.6	<0,001
Transmission routes /8	2.5± 1.4	2.9± 1.6	2.7± 1.5	0,011
Total /21	**5.3± 2.7**	**6.9± 3.3**	**6.1± 3.1**	**<0,001**

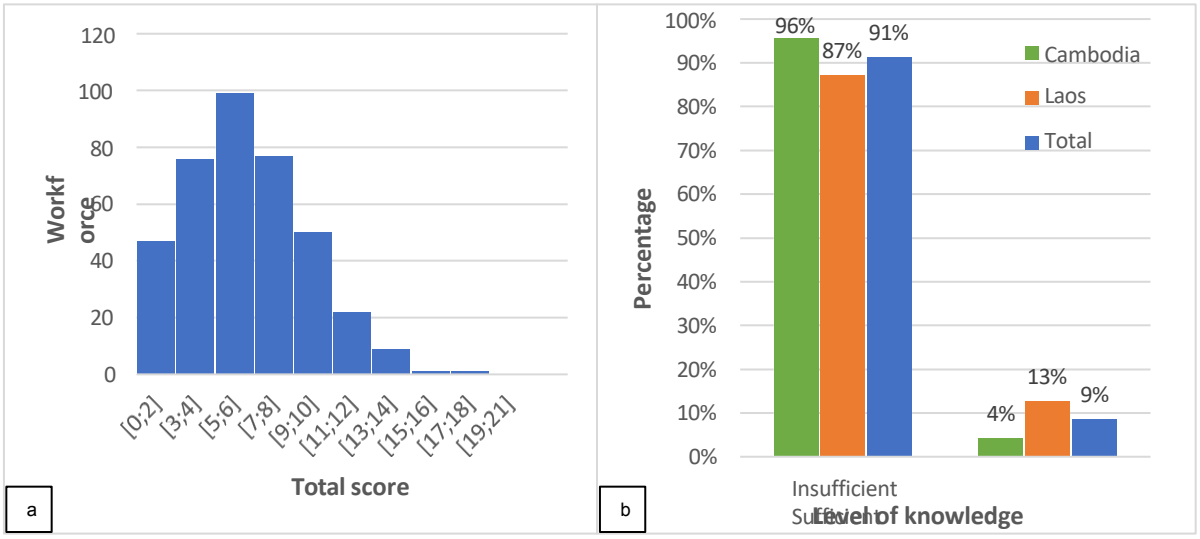

Figure 17. **Knowledge score results**
(a) Distribution of total scores /21 (b) Classification of level of knowledge Insufficient / Sufficient

It appears that Cambodian farmers tend to overestimate themselves in comparison with farmers in Laos. Although 95% of Cambodian farmers felt able to recognise the clinical signs of ASF, they could only name an average of 2.8. On the contrary, although feeling less confident in their ability to recognise the clinical signs of ASF, farmers in Laos cited more than those in Cambodia, 3.9 on average (p<0.001). The same phenomenon was observed for transmission routes (p<0.05).

By cross-referencing the farmers' answers with the scores obtained (clinical signs, transmission routes and total knowledge), several questions emerge:

- Do farmers who have heard of ASF have a significantly higher knowledge score?
- Are farmers who feel confident about recognising clinical signs of ASF actually able to recognise more of them?

- Similarly, are breeders who feel well-informed about the routes of transmission actually able to recognise more of them?

In order to answer these questions, a comparison of the means of the total scores, clinical signs and transmission routes was carried out according to the binary variables (Yes or No) "having heard of ASF", "feeling able to recognise the clinical signs" and "feeling well informed about the transmission routes" (Table 15). As the scores were not normally distributed, a Wilcoxon test was used to compare the means.

Table 15. **Match between feelings and actual level of knowledge**

	Cambodia		**Laos**		**Total**	
Has heard of ASF						
	Average total score (/21)	*p-value*	Average total score (/21)	*p-value*	Average total score (/21)	*p-value*
Yes	5,5	<0,001	7,4	0,004	6,3	0,035
No	2,7		6,0		5,5	
Feels able to recognise clinical signs						
	Average SC score (/13)	*p-value*	Average S score (/13)	*p-value*	Average S score (/13)	*p-value*
Yes	3,4	<0,001	4,5	<0,001	3,9	<0,001
No	1,1		3,2		2,5	
Feels well informed about transmission routes						
	Average VT score (/8)	*p-value*	Average VT score (/8)	*p-value*	Average VT score (/8)	*p-value*
Yes	2,7	0,003	3,2	0,018	2,9	<0,001
No	2,0		2,6		2,4	

SC: clinical signs / VT: transmission routes

This analysis shows that :
- Farmers who had heard of ASF had a significantly higher average total knowledge score than those who had not ($p<0.05$).
- Farmers who felt able to recognise the clinical signs of ASF had a significantly higher average score than those who did ($p<0.001$).
- Farmers who felt well informed about transmission routes had a significantly higher average score than those who did not feel well informed ($p<0.001$).

Surprisingly, farmers in Laos who have not heard of ASF have a relatively high mean score, which seems contradictory. As the questions did not contain any incorrect answers, this observation can be explained by random answers, which constitutes a bias. However, this observation was not found for farmers in Cambodia.

Summary of part III.3 Knowledge

- **Overall level of knowledge:** low
- **Clinical signs:** on average, breeders cite 3.5 clinical signs out of 13. The main clinical signs cited are fever, sudden death, anorexia, increased mortality and reddening of the skin.
- **Transmission routes:** on average, farmers cited 2.7 transmission routes out of 8. The main transmission routes cited were contact with contaminated pig carcasses or products, contact with an infected pig, air and wind.
- Laos performed better than Cambodia.

III.4. Attitudes

Table 16 shows the results of the Likert risk perception scale. It shows that the perceived risk of the disease occurring is relatively high. Most farmers recognised its importance and the threat to their farm. However, 19% of farmers strongly agreed with the statement that ASF is not an important disease, 9% strongly disagreed with the statement that ASF is common in the country and 11% strongly agreed with the statement that there no ASF in the country. Opinions were divided on the question of vaccination and deworming. 42% of farmers consider that regularly vaccinating or deworming their herd protects it from ASF, which needs to be contradicted so as not to create a false impression of security. The differences in perception between Laos and Cambodia were significant ($p<0.05$), except for the statement concerning vaccination and deworming of livestock.

Table 16. **Attitudes: to what extent do you agree with the following statements?**

	Cambodia n=187	**Laos** n=195	**Total** n=382	***p-value***
1. ASF is not a major disease				
- Strongly agree	36 (19%)	35 (18%)	71 (19%)	0,034
- Agreed	15 (8%)	9 (5%)	24 (6%)	
- In disagreement	33 (18%)	19 (10%)	52 (14%)	
- Strongly disagree	103 (55%)	132 (68%)	235 (61%)	
2. ASF is common in the country, if I don't take action I'll have an outbreak on my farm.				
- Strongly agree	113 (60%)	61 (31%)	174 (46%)	<0,001
- Agreed	59 (32%)	65 (33%)	124 (32%)	
- In disagreement	8 (4%)	43 (22%)	51 (13%)	
- Strongly disagree	7 (4%)	26 (13%)	33 (9%)	
3. My herd is protected because my pigs are vaccinated and wormed. regularly				
- Strongly agree	25 (14%)	28 (14%)	53 (14%)	0,449
- Agreed	60 (32%)	48 (25%)	108 (28%)	
- In disagreement	56 (30%)	66 (34%)	122 (32%)	
- Strongly disagree	46 (24%)	53 (27%)	99 (26%)	
4. There is no ASF in the country, only in neighbouring countries				
- Strongly agree	10 (5%)	32 (16%)	42 (11%)	<0,001
- Agreed	19 (10%)	50 (26%)	69 (18%)	
- In disagreement	41 (22%)	58 (30%)	99 (26%)	
- Strongly disagree	117 (63%)	55 (28%)	172 (45%)	

In order to test the reliability of the responses, the correlation is tested between questions 2 and 4 of table 16, which are two almost identical propositions, one affirmative, the other negative. A Spearman correlation test was used. The analysis revealed a significant negative correlation ($r_{s=-0}$.43; $p<0.001$), which is consistent with the wording of the two statements. This correlation is of medium strength ($-0.5 < rs < -0.3$). This suggests that the answers to the questions are fairly reliable.

The proposed biosecurity measures were considered ineffective overall (Table 18). Significant differences between Laos and Cambodia are indicated with a *p-value* in bold ($p<0.05$). The most unpopular measures were changes of clothing and footwear and disinfection of footwear for visitors (92%, 96% and 95% of farmers considered them to be ineffective, respectively).

The results of the Attitudes score are detailed in table 17 below. Two histograms can be constructed from them, showing the distribution of scores (Figure 18a.) and the distribution of the Favourable / Unfavourable ranking (Figure 18b.). Although they perceive the importance of the disease, farmers are generally unfavourable to the introduction of biosecurity measures, which they do not consider to be effective. Only 15% of farmers obtain half of the

correct answers. Cambodia had a more favourable attitude than Laos (p<0.001). On average, Cambodian farmers slightly more importance to the disease, with an average of 2.5 correct answers out of 5, compared with 2.2 in Laos (p<0.001). On average, Cambodian farmers considered 5.6 of the 20 proposed measures to be effective, compared with 4.3 in Laos (p<0.001).

Table 17. **Results of the Attitudes score**

	Cambodia	Laos	Total	*p-value*
Importance of APP /4	2.5± 0.7	2.2± 1.0	2.3± 0.9	<0,001
Effectiveness of measures /20	5.6± 3.9	4.3± 3.0	5.0± 3.5	0,001
Total /24	**8.1± 4.0**	**6.5± 3.5**	**7.3± 3.8**	**<0,001**

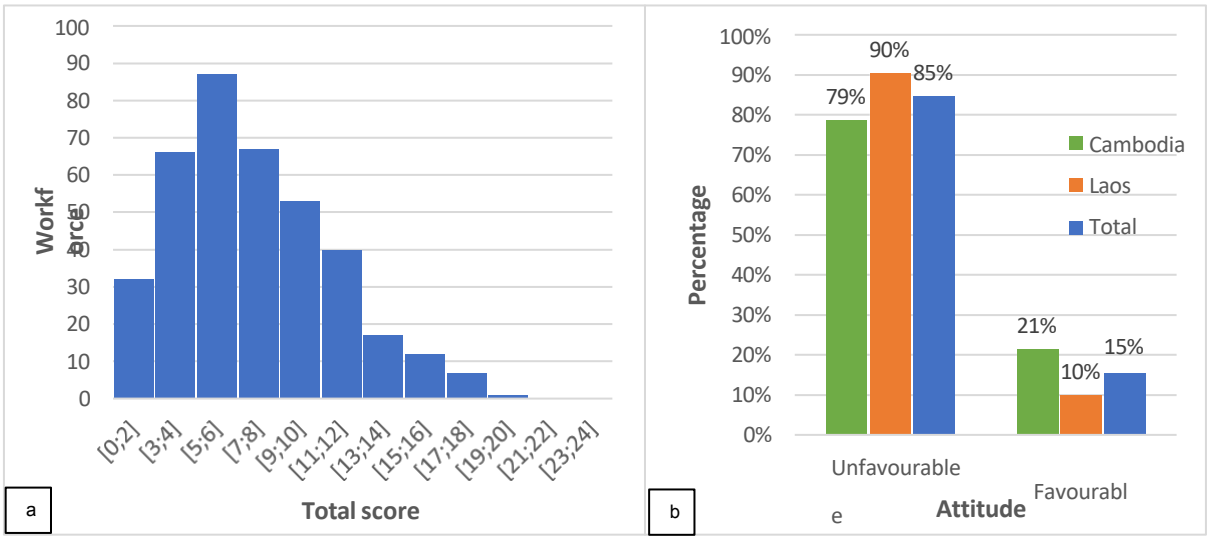

Figure 18. **Results of the Attitudes score**
(a) Breakdown of total scores /24 (b) Unfavourable / Favourable ranking

Summary of part III.4. Attitudes

- **Risk perception:** ASF is generally perceived as a serious disease.
- **Perception of the effectiveness of biosafety measures:** on average, only a quarter of biosafety measures are considered to be effective.
- Cambodia has a better overall attitude than Laos.

Table 18. **Farmers who consider biosecurity measures to be effective**

	Cambodia n=187	**Laos** n=195	**Total** n=382	***p-value***
Visitors				
Do not allow visitors (e.g. the butcher, intermediaries, relatives) to enter the pigsty	109 (59%)	46 (24%)	113 (30%)	**<0,001**
Ask visitors entering the farm/piggery to change their footwear	23 (12%)	8 (4%)	31 (8%)	**0,003**
Ask visitors entering the farm/piggery to change their clothes	9 (5%)	8 (4%)	17 (4%)	0,736
Ask visitors entering the farm/piggery to disinfect their shoes	11 (6%)	8 (4%)	19 (5%)	0,424
Not to other pig farms frequently (more than once a week)	85 (45%)	28 (14%)	113 (30%)	**<0,001**
Power supply				
Protecting pig feed from possible contamination by wildlife	50 (27%)	75 (39%)	125 (32%)	**0,015**
Do not feed swill to pigs	84 (45%)	71 (36%)	155 (41%)	0,090
Animal health				
Isolating sick animals from others	92 (49%)	131 (67%)	223 (59%)	**<0,001**
Vaccinate pigs every six months	65 (35%)	69 (35%)	134 (35%)	0,898
Keep piglets, sows and boars in separate pens	48 (26%)	17 (9%)	65 (17%)	**<0,001**
Introducing animals				
When you buy a new pig, keep it in quarantine for a minimum of two weeks before mixing with the other ingredients.	29 (16%)	98 (50%)	127 (33%)	**<0,001**
buying pigs, ask if there an outbreak in the community or on the farm of origin.	37 (20%)	36 (18%)	73 (19%)	0,742
Do not share boars between farms (loan or borrow)	38 (20%)	19 (10%)	57 (15%)	**0,004**
Use all replacement stock that was born and raised on the farm / do not buy pigs from other producers. outside	41 (22%)	33 (17%)	74 (19%)	0,216
Farm hygiene				
A foot bath at entrance	41 (22%)	89 (46%)	130 (34%)	**<0,001**
Keep the pigsty clean and dry at all times	135 (72%)	88 (45%)	223 (58%)	**<0,001**
Have a drainage system	54 (29%)	10 (5%)	64 (17%)	**<0,001**
Use specific tools to look after pigs (not used for other animals)	49 (26%)	3 (2%)	52 (14%)	**<0,001**
Use specific tools for each pigsty	34 (18%)	4 (2%)	38 (10%)	**<0,001**
Use specific clothing and footwear to look after pigs	21 (11%)	6 (3%)	27 (7%)	**0,002**

III.5. Practices

Practices for reporting an outbreak are detailed in table 19. When clinical signs compatible with ASF are observed, the most common practice is to treat the pigs with antibiotics (51%). 20% of farmers would wait a few days to see if the pigs improved spontaneously, while 19% would sell them immediately. Farmers who report a potential outbreak, even after a certain lapse of time, are still in the minority. More farmers in Cambodia report to the VVW or VAWH than in Laos (28% versus 9%). On the other hand, Cambodian farmers are more likely to sell their pigs as quickly as possible to avoid losses (30% compared with 8% in Laos). A veterinary professional is called in only 17% of cases when clinical signs of ASF are observed. However, 43% of farmers said they called the vet when several pigs lost their appetite or appeared ill, which seems contradictory. 27% of farmers admitted that they never called the vet. The differences between Laos and Cambodia were significant ($p<0.001$).

Table 19. **Reporting an outbreak**

	Cambodia n=187	**Laos** n=195	**Total** n=195	***p-value***
If you observe clinical signs of ASF in your herd, what do you do?				
- I'm waiting a few days to see if the pigs improve or not	20 (11%)	56 (29%)	76 (20%)	<0,001
- I treat pigs with antibiotics	74 (40%)	121 (62%)	195 (51%)	
- I sell the pigs as quickly as possible to avoid excessive losses	57 (30%)	15 (8%)	72 (19%)	
- I call the VVW or a professional vet	53 (28%)	11 (6%)	64 (17%)	
- I report it to the DAFO / DV	8 (4%)	10 (5%)	18 (4%)	
- I'm reporting this to the VVW / VAWH	52 (28%)	17 (9%)	69 (18%)	
- Other	42 (22%)	51 (26%)	93 (24%)	
If you suspect an outbreak of ASF on your farm / village, that what do you do?				
- I'll wait a few days before reporting it to avoid a false alarm	33 (18%)	56 (29%)	89 (23%)	<0,001
- I'll wait a few days before reporting it to have time to sell the pigs in good health and avoid excessive losses	42 (22%)	27 (14%)	69 (18%)	
- I report it as soon as possible, even though it might be a false alarm	52 (28%)	15 (8%)	67 (18%)	
- Other	70 (37%)	101 (52%)	171 (45%)	
When would you call a veterinary professional to your pigs?				
- A pig that loses its appetite / looks ill	96 (51%)	57 (29%)	153 (40%)	<0,001
- Several pigs losing their appetite / appear to be patients	72 (38%)	94 (48%)	166 (43%)	
- Increased mortality	21 (11%)	93 (48%)	114 (30%)	
- Sows without piglets	23 (12%)	1 (1%)	24 (6%)	
- Reproduction	9 (5%)	0 (0%)	9 (2%)	
- Technical advice on nutrition and health	13 (7%)	3 (2%)	16 (4%)	
- Preventive treatment such as vaccination and worming	32 (17%)	22 (11%)	54 (14%)	
- Other	52 (28%)	72 (37%)	124 (32%)	

**** Other.*** *The following were mentioned several : nothing, waiting improvement, self-medication (paracetamol, antibiotics).*

***** Other.*** *The following were mentioned several : selling the pigs as quickly as , prophylactic treatment with antibiotics, nothing.*

****** Other.*** *Mentioned several : other illness/clinical sign, I never call the vet (104).*

The results of the biosecurity measures implemented are presented in Table 20. Measures relating to housing and manure management have been treated separately. Significant differences between Laos and Cambodia are indicated by *p-values* in bold ($p<0.005$).

Visitors

The movement of people between pig farms appears to be relatively limited, with 61% of farmers not allowing visitors and 81% stating that they do not visit other pig farms more than once a week. However, when there are visitors, the majority do not change their clothes or shoes, or disinfect their shoes on entering.

Power supply

On the whole, farmers (58%) are careful to protect the feed given to their pigs from possible contamination by wildlife. However, more than a third give swill. This practice is more widespread in Laos (53%) than in Cambodia (23%) ($p<0.001$).

Animal health

Isolation of a sick animal is practised by 60% of farmers. Preventive measures aimed at limiting the circulation of pathogens on the farm, such as vaccination or separation of pig populations, were implemented less frequently in Laos (20% and 17%, respectively), unlike in Cambodia where they were more common (51% and 63%) ($p<0.001$).

Introducing animals

Few precautions are taken when introducing animals: quarantine is practised by only 28% of farmers, and 55% say they share a boar with other farms. The latter practice is particularly widespread in Laos (81%). 51% of farmers do not inquire about the disease-free status of the farm from which they are buying a pig. Almost half of farmers need to introduce pigs on a regular basis in order to renew their herd.

Farm hygiene

On the whole, the barns are kept clean and dry, but the tools, clothing and footwear are not specific to the care of the pigs or to each barn. The foot bath at the entrance to the pigsty is only installed by

5% of farmers. Cambodian farmers were more rigorous on hygiene than their Laotian counterparts on several key points: cleanliness of the pigsty (95% versus 56%) ($p<0.001$), drainage system (60% versus 7%) ($p<0.001$), tools dedicated solely to pigs (67% versus 3%) ($p<0.001$).

Housing

There is a significant difference between Laos and Cambodia in terms of free-ranging pigs: in Cambodia, only 6% of pigs are allowed to roam, compared with 70% in Laos ($p<0.001$).

Manure management

Pig manure is used by 59% of farmers to fertilise crops (four did not answer this question and were not counted). Manure replaces chemical fertilisers but contributes to the spread of the disease if it is contaminated by the faeces of sick pigs. This practice varies from country to country: it is very widespread in Cambodia (87%) and less so in Laos (31%) ($p<0.001$).

Table 21 shows the biosecurity measures applied in the event of mortality on the farm.

Body management

55% of Cambodian livestock farmers and 73% of Laotian livestock farmers do not have a carcass storage area ($p<0.001$). Where such storage facilities do exist, they are generally well away from dwellings (more than 30 metres for 60% of farmers). The best practices, incineration or burial, were used by 17% and 79% of farmers respectively. Laos is a better pupil than Cambodia in this respect. Among bad practices, 35% of farmers in Cambodia sell dead pigs, compared with none in Laos. Finally, 6% of farmers dispose of them in the bush and 4% throw them into a stream.

Repopulating the farm after an outbreak

18% of farmers who had to repopulate after death from disease or culling had a fallow period of one month or less. In Cambodia, a third of farmers purchased several pigs directly, without first introducing one or two sentinel pigs, compared with only 2% in Laos ($p<0.001$). In Laos, on the other hand, 80% of farmers introduced one or two pigs first. A significant proportion of farmers (36%) used surviving pigs. Finally, 60% of farmers clean the pigsty, but only 27% disinfect it. The difference is even greater in Laos: while 63% of farmers clean their pigsties, only 4% disinfect them. 28% of Laotian farmers admit to doing nothing special. The differences between Laos and Cambodia were significant ($p<0.005$), except for the use of survivors.

Table 20. **Farmers applying biosecurity measures**

	Cambodia n=187	**Laos** n=195	**Total** n=382	***p-value***
Visitors				
Do not allow visitors (e.g. the butcher, intermediaries, relatives) to enter the pigsty	105 (56%)	129 (66%)	234 (61%)	**0,045**
Ask visitors entering the farm/piggery to change their footwear	19 (10%)	9 (5%)	28 (7%)	**0,038**
Ask visitors entering the farm/piggery to change their clothes	10 (5%)	3 (1%)	13 (3%)	**0,040**
Ask visitors entering the farm/piggery to disinfect their shoes	14 (7%)	3 (1%)	17 (4%)	**0,005**
Do not other pig farms frequently (more than once a week)	151 (81%)	159 (82%)	310 (81%)	0,844
Power supply				
Protecting pig feed from possible contamination by wildlife	107 (57%)	116 (59%)	223 (58%)	0,653
Do not feed swill to pigs	143 (77%)	92 (47%)	235 (62%)	**<0,001**
Animal health				
Isolating sick animals from others	122 (65%)	105 (54%)	227 (60%)	**0,023**
Vaccinate pigs every six months	96 (51%)	40 (20%)	136 (36%)	**<0,001**
Keep piglets, sows and boars in separate pens	118 (63%)	33 (17%)	151 (40%)	**<0,001**
Introducing animals				
When you buy a new pig, keep it in quarantine for a minimum of two weeks before mixing with the other ingredients.	29 (16%)	78 (40%)	107 (28%)	**<0,001**
buying pigs, ask if there an outbreak in the community or on the farm of origin.	89 (48%)	87 (45%)	176 (46%)	0,559
Do not share boars between farms (loan or borrow)	134 (72%)	37 (19%)	171 (45%)	**<0,001**
Use all the replacement stocks that have been born and were reared on the farm / do not buy pigs from outside	92 (49%)	95 (49%)	187 (49%)	0,925
Farm hygiene				
A foot bath at entrance	14 (7%)	5 (3%)	19 (5%)	**0,027**
Keep the pigsty clean and dry at all times	177 (95%)	109 (56%)	286 (75%)	**<0,001**
Have a drainage system	112 (60%)	7 (4%)	119 (31%)	**<0,001**
Use specific tools to look after pigs (not used for other animals)	126 (67%)	5 (3%)	131 (34%)	**<0,001**
Use specific tools for each pigsty	44 (24%)	4 (2%)	48 (12%)	**<0,001**
Use specific clothing and footwear to look after pigs	31 (17%)	2 (1%)	33 (8%)	**<0,001**

Table 21. **Farmers applying biosecurity measures in the event of mortality**

	Cambodia n=187	Laos n=195	Total n=382	*p-value*
Management of carcasses (pigs that have died and not been eaten)				
Do you have a storage area for corpses?				**<0,001**
- Yes	84 (45%)	52 (27%)	136 (36%)	
- No	103 (55%)	143 (73%)	246 (64%)	
If so, how far from your farm?				**0,038**
- <10 metres	9 (11%)	1 (2%)	10 (8%)	
- 10 to 20 metres	8 (10%)	12 (23%)	20 (14%)	
- 21 to 30 metres	13 (15%)	5 (10%)	18 (13%)	
- >30 metres	54 (64%)	27 (52%)	81 (60%)	
- NR	0 (0%)	7 (13%)	7 (5%)	
What do you do with the corpses?				**<0,001**
Several possible choices				
- I burn them	20 (11%)	44 (23%)	64 (17%)	
- I bury them	120 (64%)	183 (94%)	303 (79%)	
- I use chemicals	0 (0%)	0 (0%)	0 (0%)	
- I throw them in the bush	8 (4%)	5 (3%)	13 (3%)	
- I sell them	65 (35%)	0 (0%)	65 (17%)	
- Other	40 (21%)	16 (8%)	56 (15%)	
Repopulating the farm after an outbreak				
Did your pigs die of ASF (after having been sick or slaughtered by the local authorities)?				**0,041**
- Yes	94 (50%)	76 (39%)	170 (44%)	
- No	93 (50%)	115 (59%)	208 (55%)	
- NR	0 (0%)	4 (2%)	4 (1%)	
How long after the home did you repopulated?				**0,030**
- Less a week	10 (11%)	5 (7%)	15 (9%)	
- After 2 weeks	4 (4%)	1 (1%)	5 (3%)	
- After 2 to 4 weeks	1 (1%)	9 (12%)	10 (6%)	
- After 2 to 3 months	2 (2%)	6 (8%)	8 (5%)	
- After 4 to 6 months	8 (8%)	6 (8%)	14 (8%)	
- After 7 to 12 months	9 (10%)	12 (16%)	21 (12%)	
- More than a year later	26 (28%)	27 (35%)	53 (31%)	
- I don't remember	1 (1%)	6 (8%)	7 (4%)	
- NR	33 (35%)	4 (5%)	37 (22%)	
Before repopulating, what did you do?				**<0,001**
Several possible choices				
- Cleaning of pigsties	55 (58%)	48 (63%)	103 (60%)	
- Disinfection of pig pens	43 (46%)	3 (4%)	46 (27%)	
- Cleaning of materials and equipment	17 (18%)	1 (1%)	18 (11%)	
- Disinfection of materials and equipment	10 (11%)	12 (16%)	22 (13%)	
- Nothing special	6 (6%)	21 (28%)	27 (16%)	
When you repopulated, how did you process?				**<0,001**
- Introduction one or two pigs first before a full restocking	23 (24%)	61 (80%)	84 (49%)	
- Direct purchase of several pigs	31 (33%)	2 (2%)	33 (19%)	
- Other	7 (7%)	9 (12%)	16 (9%)	
- NR	33 (35%)	4 (5%)	34 (20%)	
Did you use survivors?				0,065
- Yes	28 (30%)	33 (43%)	61 (36%)	
- No	66 (70%)	43 (57%)	109 (64%)	

NR: no answer

***Other: the** following were cited: consumed by family and neighbours (24), thrown into a pond or stream (6), no pigs died on the farm (sold before or start of activity) (19).*

A discrepancy was observed between the number of farmers who had had an outbreak of ASF on their farm (60%) (question in the "Knowledgesection) and the number of farmers who had had pigs die of the disease or be slaughtered by the authorities (44%). A contingency table (Table 22) was drawn up to investigate this difference.

Table 22. **Cross-tabulated matrix between the "experience of PPP" and "experience of PPP" variables**
"Pigs dead from ASF or slaughtered". No replies: 4

	Experience of the PPA		*p-value*
Pigs dead from ASF or slaughtered	**Yes**	**No**	
Yes	159 (42%)	11 (3%)	<0,001
No	67 (18%)	141 (37%)	

The difference between variables was significant (p<0.001). A surprising 18% of farmers who had experienced ASF had no pigs that died or were slaughtered. This may be due to farmers not reporting dead pigs, a less virulent form of ASF (not very credible in this context) or, more probably, an overestimation of the number of farmers who had had ASF, in the absence of a definitive diagnosis and confusion with other diseases such as classical swine fever or porcine reproductive and respiratory syndrome.

The results of the Practices score are detailed in table 23 below. Two histograms can be constructed from them, showing the distribution of scores (Figure 19a.) and the distribution of the Low / Correct classification (Figure 19b.). Farmers unlikely to report a suspicion of ASF, and the biosecurity score is low overall. Only 10% of farmers obtained half of the correct answers. Farmers in Cambodia applied an average of 8.8 biosecurity measures out of the 20 proposed, compared with 6.4 in Laos (p<0.001). Comparing the average Attitude and Practice scores for biosecurity measures, it is interesting to note that a greater number of measures are applied than are considered effective.

Table 23. **Results of the Practices score**

	Cambodia	**Laos**	**Total**	***p-value***
Reporting an outbreak /6	1.9± 1.3	1.5± 1.2	1.7± 1.3	0,003
Accommodation /1	0.9± 0.2	0.3± 0.5	0.6± 0.5	<0,001
Biosafety measures /20	8.8± 3.1	6.4± 2.3	7.6± 2.3	<0,001
Total /27	**10.8**± 3.4	**7.9**± 2.6	**9.3**± 3.3	**<0,001**

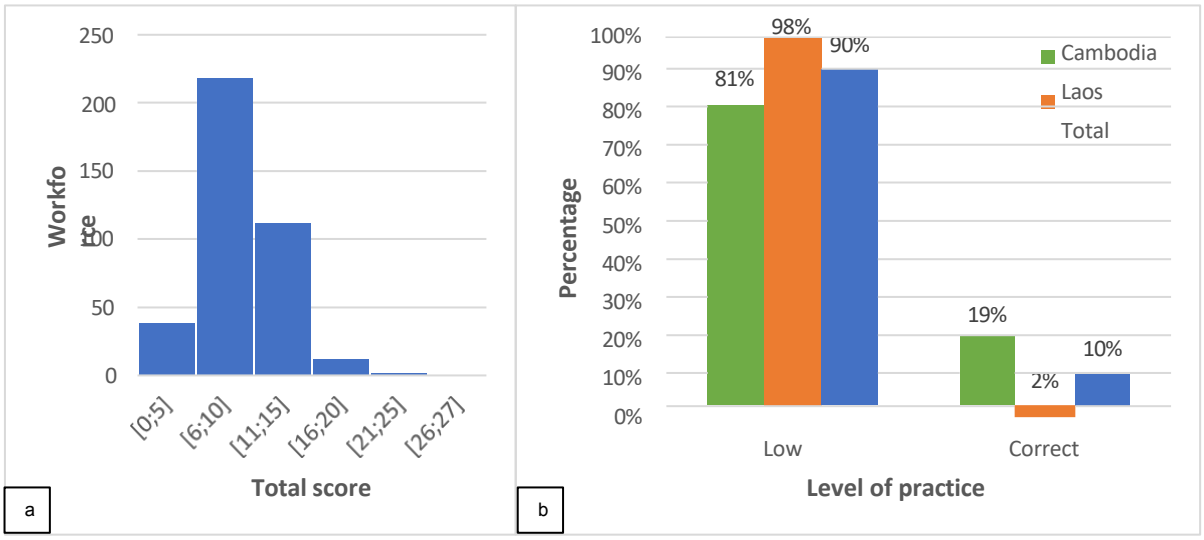

Figure 19. **Results of the Practices score**
(a) Breakdown of total scores /27 (b) Classification of the level of practices Weak / Correct

Summary of part III.5. Practices

- **Overall level of practice:** low
- **Reporting an outbreak:** farmers are unlikely to report suspected ASF. The most common practices are antibiotic treatment of pigs, waiting for spontaneous improvement and selling pigs.
- **Housing:** 70% of farmers in Laos allow their pigs to roam free, compared with just 6% in Cambodia.
- **Biosecurity measures:** on average, around 40% of biosecurity measures are applied.
- Cambodia has a better level of practices than Laos.

III.6. Correlation between knowledge, attitudes and practices

In the absence of a normal distribution of scores, the correlation between the CAP variables was assessed using a Spearman correlation test (Table 24).

Table 24. **Spearman correlation test between CAP variables**

	r_s Cambodia (*p-value*)	r_s Laos (*p-value*)	r_s Total (*p-value*)	*p-value*
C - A	0,33 (p<0,001)	0,39 (p<0,001)	0,30 (p<0,001)	0,497
C - P	0,22 (p=0,002)	0,19 (p=0,009)	0,06 (p=0,270)	0,698
A - P	0,44 (p<0,001)	0,42 (p<0,001)	0,47 (p<0,001)	0,847

The analysis reveals a significant positive correlation between knowledge and attitudes ($_{rs=0}$.30; p<0.001) and between attitudes and practices ($_{rs=0}$.47; p<0.001). This correlation is of moderate strength (0.3 ≤ $_{rs}$ <0.5), and is more marked between attitudes and practices. There was only a weak correlation between knowledge and practices ($_{rs<0}$.3). The differences between Laos and Cambodia were not significant.

To test the correlation between attitudes and practices regarding biosecurity measures, a Spearman correlation test was again carried out (Table 25).

Table 25. **Spearman's correlation test between *Attitudes* scores and Biosecurity *practices* (correlation between effectiveness and application)**

	$_{rs}$ Cambodia (*p-value*)	$_{rs}$ Laos (*p-value*)	$_{rs}$ Total (*p-value*)	*p-value*
Total	0,53 (p<0,001)	0,37 (p<0,001)	0,46 (p<0,001)	0,053

Generally speaking, the analysis reveals a significant positive correlation between "considering a measure to be effective" and "applying this measure" ($_{rs=0}$.46; p<0.001). There was a stronger correlation between these two propositions for Cambodia ($_{rs=0}$.53; p<0.001) than for Laos ($_{rs=0}$.37; p<0.001), significant at the 5% threshold.

Summary of part III.6. Correlations between knowledge, attitudes and practices

- Knowledge is positively correlated with attitudes, which in turn are positively correlated with practices.
- The fact that a measure is considered effective is positively correlated with its application.

III.7. The effect of socio-demographic and contextual factors on knowledge, attitudes and practices

Univariate logistic analyses for the "Knowledgevariables,
The "Attitudes" and "Practices" factors are presented in tables 26, 27 and 28 respectively. During these analyses, several significant factors (p<0.25) were identified and included in a multivariate logistic regression model (Table 29).

In the model of regression logistic multivariate for the variable For the "Knowledge variable, the variables "level primary education", level of secondary education" and "gender" did not significantly influence the model (p>0.05) and were therefore not retained. Similarly, for the 'Attitudes variable, the explanatory variables 'level of education', experience in livestock farming' and 'gender' did not significantly influence the model.

"The variables 'experience of ASF' did not significantly influence the multivariate model. Finally, for the 'Practicesvariable, the variables 'herd size', age' and 'experience of ASF' *did not significantly* influence *the* multivariate model.
The "level of education" criteria were not used.

analysis shows that country, experience of ASF and level of education are explanatory factors for knowledge of the disease:

- Farmers in Laos are four times more likely to have a good level of knowledge than farmers in Cambodia, all other things being equal.
- Having experienced an outbreak of ASF on your farm multiplies the probability of having a good level of knowledge by three, all other things being equal.
- Being illiterate divides the probability of having a good level of knowledge by 10 compared with having received a secondary or higher education, all other things being equal.

For the "Attitudes" and "Practices" variables, country is the only significant explanatory variable in the multivariate model:

- Farmers in Laos are half as likely to have a favourable attitude as farmers in Cambodia, all other things being equal.
- Farmers in Laos are 10 times less likely to have a good level of practices than farmers in Cambodia, all other things being equal.

Summary of Part III.7. Effect of socio-demographic and contextual factors on knowledge, attitudes and practices

- Differences in knowledge can be explained by country, literacy rate, and previous experience of an APP household on the farm.
- For attitudes and practices, country is the only significant explanatory variable in the model.
- Age, gender, herd size, years of farming experience and whether pork was the main source of income did not influence the model significantly.

Table 26. **Logistic logistic univariate : variables associated with the "Knowledge" variable**

Explanatory variable	Knowledge		OR na	95% CI	*p-value*
	Insufficient N=349	Sufficient N=33			
Country					
Cambodia	179	8	1		
Laos	170	25	3,3	1,5 - 8,0	**0,005**
Type					
Female	201	15	1		
Male	148	18	1,6	0,8 - 3,4	**0,182**
Age					
16 - 37	98	7	1		
38 - 52	156	18	1,6	0,7 - 4,3	0,301
53 - 79	95	8	1,2	0,4 - 3,5	0,759
Level education					
High school and	25	4	1		
above Middle school	89	7	0,5	0.1 - 2,0	0,287
Primary	174	20	0,7	0.2 - 2,6	0,574
Illiterate	61	2	0,2	0,0 - 1,1	**0,077**
Herd size					
<5 pigs	161	12	1		
≥5 pigs	188	21	1,5	0,7 - 3,2	0,284
Experience of the PPA					
No	147	7	1		
Yes	202	26	2,7	1,2 - 6,9	**0,024**
Experience in breeding					
<10 years	186	21	1		
>10 years	163	12	1,5	0,7 - 3,3	0,257
Main source of income					
No	72	5	1	1	
Yes	277	28	0,7	0,2 - 1,7	0,456

OR na: Unadjusted *Odds Ratios*
95% CI: 95% confidence interval

Table 27. **Logistic logistic univariate : variables associated with the "Attitudes" variable**

Explanatory variable	Attitudes		OR na	95% CI	*p-value*
	Unfavourable N=323	Favourable N=59			
Country					
Cambodia	147	40	1		
Laos	176	19	0,4	0,2 - 0,7	**0,002**
Type					
Female	186	30	1		
Male	137	29	1,3	0,8 - 2,3	0,338
Age					
16 - 37	90	15	1		
38 - 52	147	27	1,1	0,6 - 2,2	0,781
53 - 79	86	17	1,2	0,6 - 2,5	0,658
Level education					
High school and	22	7	1		
above Middle school	80	16	0,6	0,1 - 0,9	0,366
Primary	163	31	0,6	0,2 - 1,6	0,280
Illiterate	58	5	0,3	0,1 - 0,7	**0,040**
Herd size					
<5 pigs	154	19	1		
≥5 pigs	169	40	1,9	1,1 - 3,5	**0,030**
Experience of the PPA					
No	136	18	1		
Yes	187	41	1,7	0,9 - 3,1	**0,097**
Experience in livestock farming					
<10 years	154	21	1		
>10 years	169	38	1,6	0,9 - 3,0	**0,089**
Main source of income					
No	65	47	1		
Yes	258	12	1,0	0,5 - 2,0	0,970

OR na: Unadjusted *Odds Ratios*
95% CI: 95% confidence interval

Table 28. **Logistic logistic univariate : variables associated with the "Practices" variable**

Explanatory variable	Practices		OR na	95% CI	*p-value*
	Low N=343	Correct N=39			
Country					
Cambodia	152	35	1		
Laos	191	4	0,1	0,0 - 0,2	**<0,001**
Type					
Female	191	25	1		
Male	152	14	0,7	0,3 - 1,4	0,317
Age					
16 - 37	99	6	1		
38 - 52	154	20	2,1	0,9 - 6,0	**0,115**
53 - 79	90	13	2,4	0,9 - 7,0	**0,091**
Level education					
High school and	24	5	1		
above Middle school	86	10	0,6	0,2 - 1,9	0,115
Primary	174	20	0,6	0,2 - 1,8	0,276
Illiterate	59	4	0,3	0,1 - 1,3	**0,115**
Herd size					
<5 pigs	162	11	1		
≥5 pigs	181	28	2,3	1,1 - 4,9	**0,027**
Experience of the PPA					
No	141	13	1		
Yes	202	26	1,4	0,7 - 2,9	0,350
Experience in breeding					
<10 years	154	21	1		
>10 years	189	18	0,7	0,4 - 1,4	0,290
Main source of income					
No	276	29	1		
Yes	67	10	1,4	0,6 - 3,0	0,370

OR na: Unadjusted *Odds Ratios*
95% CI: 95% confidence interval

Table 29. **Multivariate logistic regression. Explanatory variables associated with CAP variables**

	Knowledge			Attitudes			Practices		
Variables	**ORa**	**95% CI**	***p-value***	**ORa**	**95% CI**	***p-value***	**ORa**	**95% CI**	***p-value***
Country									
Cambodia	1			1			1		
Laos	4,1	1,7 - 10,9	**0,001**	0,5	0,3 - 0,9	**0,023**	0,1	0,0 - 0,3	**<0,001**
Type									
Female	1								
Male	1,0	0,4 - 2,2	0,980						
Age									
16 - 37							1		
38 - 52							1,7	0,6 - 4,9	0,320
53 - 79							1,5	0,5 - 4,8	0,451
Level education									
High school and	1			1			1		
above Middle school	0,3	0,1 - 1,5	0,126	0,7	0,3 - 2,1	0,499	0,7	0,2 - 2,7	0,633
Primary	0,4	0,1 - 1,7	0,174	0,7	0,3 - 2,1	0,535	0,8	0,3 - 2,9	0,763
Illiterate	0,1	0,0 - 0,7	**0,020**	0,4	0,1 - 1,6	0,220	0,8	0,2 - 3,5	0,713
Herd size									
<5 pigs				1			1		
≥5 pigs				1,7	0,9 - 3,2	0,091	1,8	0,8 - 4,0	0,149
Experience of the PPA									
No	1			1					
Yes	2,7	1,2 - 7,1	**0,026**	1,7	0,9 - 3,2	0,100			
Experience in breeding									
<10 years				1					
>10 years				1,4	0,8 - 2,6	0,281			

ORa: Adjusted Odds Ratios
95% CI: 95% confidence interval

IV. Discussion

IV.1. Sources of bias

Representativeness

No statistical method was used to assess the sample size. However, the provinces and districts targeted took into account the different ecological and socio-economic contexts so that each was represented. In addition, all the areas selected had been affected by outbreaks of ASF. For Laos, the ethnic representativeness differs from that of the overall population of Laos (40% Katang in our study, compared with 2% in the overall population, $p<0.001$) *(Lao Statistics Bureau* 2016), so care should be taken when generalising the results to the country. For Cambodia, all participants are Khmer, which is the majority ethnicity in Cambodia.

Data recruitment

Data recruitment did not follow an identical methodology in Laos and Cambodia. In Cambodia, the villages selected were those with a majority of pig farmers, whereas the choice of villages was random in Laos. This explains, for example, why pork is a major source of income in Cambodia, whereas it is often only an additional source in Laos. It may also explain the better attitudes and practices.

Information through the media

In the "Knowledge section, the question on the source of information did not include "radio, television or social networks", which is nevertheless an important source information (Rinchen et al. 2019). Several participants specified it in the "Other" category, but this source of information is probably underestimated in our study.

Clinical signs and transmission routes

There were no incorrect answers to the questions clinical signs and routes. A farmer who was presented with lists of clinical signs and transmission routes could therefore answer at random and score points. For future questionnaires, it may be worth not sending the list to the farmers or inserting wrong answers in order to assess the level of knowledge more accurately.

Oily water

In the "Practicessection, a possible bias, albeit limited, is the overestimation of farmers who give swill. In fact, 21 farmers, or 5%, did not answer this question. In order to include them in the score, their response to the more general question on feed in the "activity characteristics" section was taken into account. Finally, 13 breeders, or 3%, were considered to give swill by default.

Pigs that died and were eaten

Also in the 'Practices' section, the question on carcass management excluded pigs consumed after death. Some farmers did report that they consumed their deceased pigs in the "Other category, but the number is probably underestimated. A question aimed at quantifying the number of households consuming their pigs after death would have been interesting, as this practice is widespread among small producers. They often invite family and neighbours to share the meat or offer them some of it, which helps to spread the disease.

IV.2. Knowledge

The level of knowledge focuses on the clinical signs and routes of transmission of the disease. While remaining low overall, it is significantly higher in Laos than in Cambodia. Compared with CAP studies on ASF conducted in other countries, surveys of small pig producers in Uganda and Kenya showed that participants had a good knowledge of the clinical signs and routes of transmission (Nantima et al. 2016; Chenais et al. 2017). This difference can be explained by the fact that the disease has been endemic in Africa for a long time and that farmers are familiar with it, unlike in Laos and Cambodia where the disease is relatively recent. This also explains why age is not an explanatory factor in the multivariate logistic regression model.

Interestingly, despite a high level of confidence and a feeling of being well informed, Cambodian farmers had a low knowledge score. This same phenomenon was observed in a study on ASF in Ukraine (Muñoz-Gómez et al. 2021). The author links it to the Dunning-Kruger effect, still being studied in psychology, which consists of people with limited knowledge of a subject overestimating their abilities (Muñoz-Gómez et al. 2021). This effect needs to be taken into account when setting up training programmes.

One reason for interpreting the low overall level of knowledge is the low literacy rate. In our study, being illiterate is an explanatory variable significantly associated with a low level of knowledge. This link between education and level of knowledge is a frequent observation in CAP surveys (Rahman et al. 2021; Tornimbene et al. 2014).

On the contrary, the experience of an outbreak of ASF on one's farm is associated with a better level of knowledge. This result is similar to that obtained by Na et al. in a study conducted between 2019 and 2022 in Vietnam (Na et al. 2023). It should be noted, however, that diagnosis of ASF is not always possible and that ASF may be confused with other diseases circulating in Laos and Cambodia, such as classical swine fever or porcine reproductive and respiratory syndrome (Holt et al. 2019; Chea et al. 2020).

In the 2017 study by Chenais et al, the clinical signs cited most frequently were anorexia and a change in skin colour. In Cambodia, the same clinical signs were cited first, the addition of sudden death. In Laos, the clinical signs mentioned most frequently were fever, anorexia and sudden death. Reddening of the skin only comes seventh, as pigs of local Laotian breeds are predominantly dark-skinned. The lack of knowledge about clinical signs may be due to the wide range of clinical manifestations associated with the disease.

Farmers in Cambodia cite indirect transmission routes first. Direct transmission routes (contact with a sick pig) only come fifth. It is interesting to note that transmission by air or wind is the third most-cited route (second in Cambodia), even though this route is still a minority in the spread of the disease, only over short distances and in confined environments (Main et al. 2022). A case study from a Chinese farm in 2023 suggests that the virus can travel by aerosol up to 10 metres, this distance being dependent on ventilation conditions and the virulence of the strain (Li et al. 2023). Certain routes of transmission are rarely mentioned, such as contact with infected wild boar. This may be due to the fact that few farmers see wild boar around their farms, and therefore do not associate this with a risk of spreading the disease. The presence of ASF has been detected in wild boar carcasses in Laos and Vietnam, but not yet in Cambodia (Denstedt et al. 2021). It seems likely that this route of transmission is underestimated in Southeast Asia and favoured by practices such as allowing pigs to roam freely (Cadenas-Fernández et al. 2022). It therefore seems justified to monitor the movement wild boar in forested areas bordering villages and to prevent contact with pigs.

It is difficult to explain the higher level of knowledge in Laos compared with Cambodia, especially as Cambodian farmers have better attitudes and practices. Several hypotheses can be put forward:

- In Cambodia, the vast majority of farmers had heard of the disease, but this did not translate into adequate knowledge. The information provided was therefore partial or superficial. In Cambodia, it has been observed that information campaigns targeted at VAHWs and district vets, who will not necessarily redistribute the information to farmers (Tornimbene et al. 2014). However, in our study, the source of information and the level of knowledge were not significantly related.

- Socio-cultural factors may explain these differences. The proportion of pork in the diet is higher in Laos than in Cambodia; the decline in the pig herd may lead Laotian farmers to take a more serious interest in the disease.

- Finally, a possible explanation is the bias induced by the questionnaire, which does not allow us to differentiate between farmers who really know something about the disease and those who responded randomly. This may, for example, explain why a number of farmers in Laos who had never heard of ASF had a relatively high clinical signs score. However, this bias should also have been present in Cambodia. We must therefore formulate the hypothesis that more farmers in Laos responded at random than in Cambodia.

IV.3. Attitudes

As presented by Janz and Becker, the attitude towards a health risk is constructed by two factors: the perceived threat (vulnerability and severity) and the estimated effectiveness of measures to guard against it (benefits and barriers) (Janz and Becker 1984).

ASF is generally perceived as an important disease in both countries. On the other hand, there is a rather hostile attitude towards biosecurity measures, most of which are considered ineffective. This unfavourable perception is more marked in Laos than in Cambodia. There are several reasons why a measure may be considered ineffective:

- Non-compliance with the title of the question, which specified that neither the cost nor the feasibility of the measures should be taken into account, but only their effectiveness. This instruction may not have been given by the interviewers in the field, or it may have been difficult to disregard the financial and material implications when answering it.

- Poor adaptation to the situation on the farm, for example the installation of a foot bath on a farm where pigs are free to roam, or incorrect implementation that compromises its effectiveness, for example quarantine but possible contact with fellow pigs through the barriers.

- The fact that the modes of transmission, which are often multiple, cannot be determined with certainty during an outbreak. This gives the impression that the measures already in place are not working (Blome et al. 2020).

- The perception of a low level of control over the event, a phenomenon described in several health-related models (Wallston et al. 1987; Goodwin et al. 2021) but which was not evaluated in our study. Farmers who are reluctant to implement biosecurity measures may feel that it is out of their hands to influence the spread of the disease because it is conditioned by external factors beyond their control. In our study, include, for example, transmission by air and by

The fact that other farmers' pigs are roaming free is the responsibility of the government.

Knowledge and attitude are positively correlated: when one increases, the other tends to increase too. All these reasons can be explained by gaps in knowledge, particularly concerning transmission routes, which prevent farmers from mentally assessing the effects of a biosecurity measure and understanding its benefits. This same phenomenon is described in a CAP study on porcine respiratory and dysgenic syndrome in Cambodia (Tornimbene et al. 2014).

IV.4. Practices

Practices include reporting an outbreak, free-ranging pigs and the application of biosecurity measures. The level of practice is generally low, and biosecurity measures are particularly poorly applied in Laos.

A number of biosafety shortcomings were identified in this survey.

70% of Laotian farmers allow their pigs to roam. This type of farming is the most risky because it is difficult to introduce biosecurity measures (FAO, OIE *and World Bank* 2010; Mutua et al. 2021). In this context, it seems essential to build pens or buildings to confine the pigs. In the open comments, a number of farmers expressed their need for materials and equipment, as well as their wish to be trained in husbandry techniques. Consequently, livestock professionals can propose solutions for obtaining materials and training in zootechnics, taking into account the economic constraints of farmers.

In both Cambodia and Laos, pig handlers and visitors rarely change clothes and footwear, or disinfect their footwear on entering the piggery. These results are similar to those obtained during a biosecurity study carried out in 2017 - 2018 in Cambodia (Chea et al. 2020). Foot bathing is a measure that is not widely implemented and is very unpopular. It is a restrictive measure because it requires financial investment in disinfectant products. In this context, if farmers are reluctant to introduce a foot bath, it would seem wise to insist on a change of footwear when entering the pigsty, with a clear demarcation between clean and dirty areas (Bremang et al. 2022).

There is also a marked difference between Cambodia and Laos when it comes to hygiene measures, which are very rarely implemented in Laos. One possible explanation is the type of housing: in Laos, 95% of pigsties are wooden pens on the ground (when the pigs are not roaming around), in contrast to Cambodia where 95% of farmers with pigsties house their animals in

building or enclosure on a concrete floor. Concrete is easier to clean, especially during the monsoon season (Figures 20 and 21).

Figure 20. **Housing in buildings in Cambodia**
Photo: Borin Sear

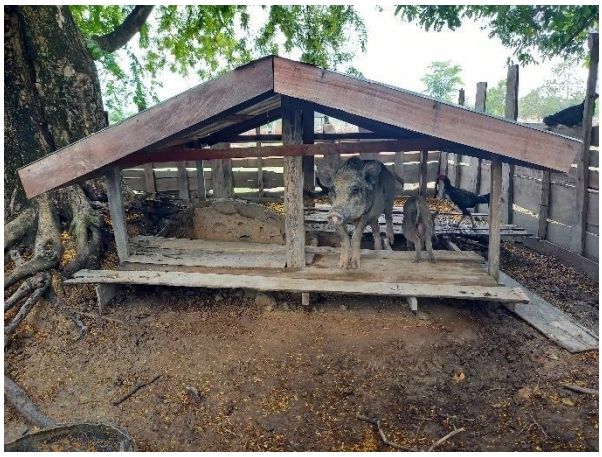

Figure 21. **Wooden enclosure and shelter in Laos**
Photo: Ariane Masson

With regard to the introduction of animals, quarantine for a minimum of two weeks is practised by only 16% of farmers in Cambodia and 40% in Laos. By way of comparison, a study of ASF among small-scale producers in Nigeria showed that 53% of farmers practised quarantine (Fasina et al. 2012). This practice maximises the risk of introducing the virus onto the farm, especially as few farmers check the free status of the place of origin of their pigs. Furthermore, limiting introductions by using replacement stock born and reared on the farm is still a minority practice. Finally, in Laos, 81% of farmers lend or borrow a boar for breeding. Surprisingly, only 28% of Cambodian farmers report lending or borrowing a boar, 82% do not own at least one on their farm. In this context, it would have been interesting to know the rate of artificial insemination. In general, reproduction on these small-scale farms is not controlled and is mostly carried out naturally (Keonouchanh et al. 2017; Chea et al. 2020).

In Cambodia, only 23% of farmers fed swill, which is different from the results of Chea et al, where 49% of farmers fed table scraps. In Laos, on the other hand, this feeding method was used by more than half the farmers. Commercial feeds are the best alternative, but their price can be a deterrent. It is therefore recommended to use local ingredients or, if swill cannot be avoided, to boil it for at least 30 minutes before feeding it to the pigs (Bremang et al. 2022).

It is interesting to note that 44% of the Cambodian farmers questioned allowed visitors, which again differs from the study by Chea et al, where the vast majority (93%) allowed them. As this study dates from before the African swine fever epidemic, a change in certain practices may have occurred at that time.

The management of carcasses also highlights risky practices. In Cambodia, more than a third of farmers sell dead pigs, compared with none in Laos. This difference can be explained by a cultural factor, the greater proportion of personal consumption among Laotian than Cambodian farmers. Dead pigs are often cooked and eaten by inviting relatives and neighbours. In both cases, these practices increase the risk of the virus spreading to other farms or even other villages.

According to the FAO (Bremang et al. 2022), repopulation of a farm following an outbreak should be carried out after a stamping-out . This recommendation is not respected by 18% of farmers, who carry out a stamping-out period of less than a month. Furthermore, particularly in Cambodia, the introduction of one or two sentinel pigs to assess the absence of risk before full repopulation (Bremang et al. 2022) is rarely carried out. Finally, the cleaning and disinfection procedure is not generally followed (cleaning only or partially, or disinfection without cleaning). Survivors are used to repopulate by more than a third of farmers, considerably increases the risk of an outbreak re-emerging. In fact, a pig that recovers from ASF continues to excrete the virus for another 30 days (FAO 2001).

Few farmers report an outbreak of ASF. The most common practice in both Laos and Cambodia is to treat a sick pig antibiotics. In these countries, access to antibiotics does not require a veterinary prescription and farmers can obtain them easily (Om, McLaws 2016; Poupaud et al. 2021). All families of antibiotics are available. However, problems of antibiotic resistance are beginning to be documented in Laos and Cambodia (Sinwat et al. 2016; Lay et al. 2021). Overuse of antibiotics to treat pigs suspected of having ASF is a dangerous practice in the long term, and farmers need to be made aware of the need for rational antibiotic therapy.

When ASF is suspected, selling sick or healthy pigs as quickly as possible seems to be the best strategy many farmers in order to avoid excessive financial losses. These 'panic sales' are found in the same context among small pig producers in Uganda, Kenya and Vietnam (Nantima et al. 2016; Chenais et al. 2017; Na et al. 2023). The lack of financial compensation for losses through a government subsidy is a known brake on farmers' cooperation in reporting cases (Guo et al. 2023) and encourages the spread of the disease, including outside the country (Na et al. 2023).

Although practices are correlated with attitude, several discrepancies between attitude and practices have been observed:

- Farmers say they are quick to call the vet (or VAHW) if a pig is ill, but in practice the vet is rarely called.

contacted. This observation is similar to that made by Tornimbene *et al* in 2014 in Cambodia. The cause is financial: farmers first prefer to treat themselves with antibiotics and wait for a potential improvement rather than having to pay veterinary costs.

- By cross-referencing the assessment of the effectiveness of the measures with their application, we can see that some measures considered effective are not applied. The question designed to investigate this phenomenon ("You answered that this measure is effective but you are not applying it, why?") received very few responses and had to be dropped from the questionnaire. One plausible explanation is the lack of financial and material resources, for example for measures requiring premises or pens (quarantine on introduction, isolation of a sick animal) or the purchase of disinfectant (foot baths). Several studies report that the cost of installing biosecurity measures is too high for farmers (Makita et al. 2020; Na et al. 2023).

- Similarly, some measures considered ineffective are applied anyway. These measures are often part of established practices that are maintained by habit, such as not visiting other farms or feeding pigs a certain type of feed.

Experience of an epidemic outbreak is surprisingly not significantly linked to better attitudes or practices. The factor
The "perception of control over the disease" mentioned in the "Attitudes section could also be to blame here: farmers feel they have a low level of control over the disease, insufficient prevent its spread. This state of mind is echoed in the study by Na et al. in Vietnam (Na et al. 2023). As with attitude, there is no significant association between socio-demographic factors and practices: the latter are mainly influenced by local traditions and culture (Chenais et al. 2017; Bremang et al. 2022).

There is a positive correlation between a measure perceived as effective and its application. So the key changing practices lies in changing perception of risk, which requires a better understanding of the long-term benefits of biosecurity measures, including financial benefits. A pilot study on the economic impact of a change in practices could be carried out to demonstrate their effectiveness to farmers (Nantima et al. 2016). In addition, innovations such as model farms applying accessible biosecurity measures are a concrete way of motivating farmers by example (Nantima et al. 2016).

Conclusion

The African swine fever epizootics currently raging in Cambodia and Laos are having serious socio-economic consequences and threatening the food security of small-scale pig farmers. A survey of these farmers has enabled us to take stock of their knowledge, attitudes and practices with regard to this disease.

Knowledge of clinical signs and transmission routes is generally low. Yet recognising clinical signs is fundamental to reacting as early as possible, just as knowing the routes of transmission helps to understand the importance of biosecurity measures. The literacy was found to be a factor in explaining the level of knowledge, as was the experience of an outbreak of African swine fever on the farm.

While farmers appear to be aware of the severity of the disease, they are nonetheless sceptical about the effectiveness of biosecurity measures. In practice, a number of biosecurity shortcomings were highlighted. The strong point of this study is that it assesses a wide range of biosecurity measures, making it possible identify those at risk and thus to target the priority actions to be implemented.

Knowledge is positively correlated with attitude, which in turn is positively correlated with practices. This further underlines the need for awareness campaigns aimed at farmers to change their perceptions and behaviour with regard to the disease. The acceptability of a measure in a community is a fundamental lever for its adoption, and effective communication must be put in place to take account of farmers' needs and concerns. A balance needs to be struck between economically restrictive biosecurity measures and the threat of losing the herd.

AVSF is therefore continuing with this survey, supplementing it with focus groups to gain a better understanding of farmers' expectations. An investigation into the players in the value chain - traders, butchers and abattoir staff - would also be relevant to understanding their role in the spread of the disease.

Because of the economic damage it has caused, the role of humans in its transmission and the role of wildlife, African swine fever is a perfect illustration of the need to adopt a *One Health* approach. Rural communities are at the heart of this concept, and strengthening their biosafety capabilities is a fundamental issue in ensuring the sustainability of their activity and their resilience in the face of disease.

References

- ADIS, 2022. *Animal Disease Information System.* [online]. 2022. [Accessed 21 October 2022]. Available à the following address: https://food.ec.europa.eu/animals/animal-diseases/animal-disease-information-system- adis_en
- ANSES, 2019. *Avis du 4 avril 2019 relatif à la mise à jour des connaissances sur les méthodes et procédés d'inactivation du virus de la peste porcine africaine. Saisine n°2018-SA-0237* [online]. Maisons-Alfort. Available : https://www.anses.fr/fr/system/files/SABA2018SA0237.pdf
- BELTRÁN-ALCRUDO, D., GALLARDO, C., ARIAS, M., KRAMER, S.A. and PENRITH, M.L., 2017. *African swine fever: detection and diagnosis - A manual for veterinarians. Food and Agriculture Organization of the United Nations (FAO)*. FAO Animal Production and Health Manual No. 19. Rome. ISBN 978-92-5-109752-6. Available at: https://www.researchgate.net/publication/318347207_African_swine_fever_detection_and_diagnosis_-_A_manual_for_veterinarians
- BERTRAM, D. Likert scales. *Retrieved November*, 2007, vol. 2, no 10, p. 1-10. Available at: https://www.researchgate.net/profile/Mahdi-Safarpour-2/post/what_is_a_logistic_regression_analysis/attachment/59d622fb79197b8077981515/AS%3A304626539139075%401449640034760/download/Likert+Scale+vs+Likert+Item.pdf
- BLOME, S., FRANZKE, K. and BEER, M., 2020. African swine fever - A review of current knowledge. *Virus Research*. octobre 2020. Vol. 287, pp. 198099. DOI 10.1016/j.virusres.2020.198099.
- BREMANG, A., HO, J., CONAN, A., TANG, H., OH, Y. and PFEIFFER, D., 2022. *Guidelines for African swine fever (ASF) prevention and control in smallholder pig farming in Asia* [online]. Food and Agriculture Organization of the United Nations. ISBN 978-92-5-134825-3. Available à https://www.fao.org/documents/card/en/c/cb9187en
- BROWN, V.R. and BEVINS, S.N., 2018. A Review of African Swine Fever and the Potential for Introduction into the United States and the Possibility of Subsequent Establishment in Feral Swine and Native Ticks. *Frontiers in Veterinary Science* [online]. 2018. Vol. 5 [Accessed September 3, 2023]. Available à the following address: https://www.frontiersin.org/articles/10.3389/fvets.2018.00011
- CADENAS-FERNÁNDEZ, E., ITO, S., AGUILAR-VEGA, C., SÁNCHEZ-VIZCAÍNO, J.M. and BOSCH, J., 2022. The Role of the Wild Boar Spreading African Swine Fever Virus in Asia: Another Underestimated Problem. *Frontiers in Veterinary Science*. 2022. Vol. 9, pp. 844209. DOI 10.3389/fvets.2022.844209.
- CARRASCO, L., BAUTISTA, M. J., MARTIN DE LAS MULAS, J, GÓMEZ-VILLAMANDOS, JC, ESPINOSA DE LOS MONTEROS, A and SIERRA, M. A., 1995. Description of a new population of fixed macrophages in the splenic cords of pigs. *J Anat.* [online]. October 1995. Available à https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1167434/

- CHEA, B., KANG, K., VIPHAM, J., TOKACH, L. and TOKACH, M., 2020. Assessment of Pig Disease Prevention of Smallholder Farmers and Village Animal Health Workers in Rural and Peri-Urban Cambodia. *Open Journal of Animal Sciences*. 2020. Vol. 10, No. 03,
  pp. 572-591. DOI 10.4236/ojas.2020.103037.
- CHENAIS, E., BOQVIST, S., STERNBERG-LEWERIN, S., EMANUELSON, U., OUMA, E., DIONE, M., ALIRO, T., CRAFOORD, F., MASEMBE, C. and STÅHL, K., 2017. Knowledge, Attitudes and Practices Related to African Swine Fever Within Smallholder Pig Production in Northern Uganda. *Transboundary and Emerging Diseases*. February 2017. Vol. 64, No. 1, pp. 101-115. DOI 10.1111/tbed.12347.
- CWYNAR, P., STOJKOV, J. and WLAZLAK, K., 2019. African Swine Fever Status in Europe. *Viruses*. 30 March 2019. Vol. 11, No. 4, pp. E310. DOI 10.3390/v11040310.
- DEKA, R.P., GRACE, P., LAPAR, M.L. and LINDAHL, J., 2014. Sharing lessons of smallholders' pig system in South Asia and Southeast Asia: A review. *International Livestock Research Institute (ILRI*) [online]. 2014. Available at: https://hdl.handle.net/10568/53928
- DENSTEDT, E., PORCO, A., HWANG, J., NGA, N.T.T., NGOC, P.T.B., CHEA, S., KHAMMAVONG, K., MILAVONG, P., SOURS, S., OSBJER, K., TUM, S., DOUANGNGEUN, B., THEPPANYA, W., VAN LONG, N., THANH PHUONG, N., TIN VINH QUANG, L., VAN HUNG, V., HOA, N.T., ANH, D.L., FINE, A. and PRUVOT, M., 2021. Detection of African swine fever virus in free-ranging wild boar in Southeast Asia. *Transboundary and Emerging Diseases*. September 2021. Vol. 68, No. 5, pp. 2669-2675. DOI 10.1111/tbed.13964.
- DIXON, L. K., SUN, H. and ROBERTS, H., 2019. African swine fever. *Antiviral Research*. 1 May 2019. Vol. 165, pp. 34-41. DOI 10.1016/j.antiviral.2019.02.018.
- EFSA PANEL ON ANIMAL HEALTH AND WELFARE (AHAW), 2014. Scientific Opinion on African Swine Fever. *EFSA - European Food Safety Authority*. *EFSA Journal* [online]. April 2014. Vol. 12, No. 4. [Accessed 11 September 2023]. DOI 10.2903/j.efsa.2014.3628. Available à https://data.europa.eu/doi/10.2903/j.efsa.2014.3628
- ESCRIBANO, J.M., GALINDO, I. and ALONSO, C., 2013. Antibody-mediated neutralization of African swine fever virus: Myths and facts. *Virus Research*. April 2013. Vol. 173, No. 1,
  pp. 101-109. DOI 10.1016/j.virusres.2012.10.012.
- FAO, 2001. Manual on the preparation of African swine fever contingency plans | Food and Agriculture Organization of the United Nations. [online]. 2001. [Accessed 7 August 2023]. Available à at: https://www.fao.org/3/Y0510E/Y0510E02.htm#ch2.1
- FAO, 2013. Smallholders and Family Farmers. *FAO - Food and Agriculture Organization of the United Nations.* [online]. 2013. [Accessed 3 August 2023]. Available at: https://www.fao.org/family-farming/detail/en/c/273864/
- FAO, 2015. The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture. *FAO - Food and Agriculture Organization of the United Nations*. In: *AO Commission on Genetic Resources for Food and Agriculture Assessments* [online]. B.D. Scherf&D. Pilling. Rome. Available at: http://www.fao.org/3/a- i4787e/index.html

- FAO, 2022. Agriculture ministry beefs up vigilance against livestock diseases. *FAO - Food and Agriculture Organization of the United Nations*. [online]. 2022. [Accessed 4 August 2023]. Available at: https://www.fao.org/lao-people- democratic-republic/news/detail-events/en/c/1471091/
- FAO, 2023a. ASF situation in Asia & Pacific update. *FAO - Food and Agriculture Organization of the United Nations*. *AnimalHealth* [online]. 2023. [Accessed 3 July 2023]. Available at: https://www.fao.org/animal- health/situation-updates/asf-in-asia-pacific/en
- FAO, 2023b. Empres-i. *FAO - Food and Agriculture Organization of the United Nations*. [online]. 2023. [Accessed 15 August 2023]. Available at: https://empres- i.apps.fao.org/
- FAO, 2023c. FAO delivered Antimicrobial Awareness Materials and African Swine Fever Guidelines to the Department of Livestock and Fisheries to help to reduce disease threats. *FAO - Food and Agriculture Organization of the United Nations.* [online]. 2023. [Accessed 4 August 2023]. Available at: https://www.fao.org/lao-people- democratic-republic/news/detail-events/en/c/1630519/
- FAO, 2023d. Special Report - 2022 FAO/WFP Crop and Food Security Assessment Mission (CFSAM) to the Lao People's Democratic Republic*. FAO - Food and Agriculture Organization of the United Nations.* [online]. 2022. [Accessed on 3 August 2023]. ISBN 978-92-5-137705-5. Available à http://www.fao.org/documents/card/en/c/cc4748en
- FAO, European Union and CIRAD. 2022. Food Systems Profile - The Lao People's Democratic Republic. Catalysing the sustainable and inclusive transformation of food systems. Rome, Brussels and Montpellier, France. https://doi.org/10.4060/cc0302en
- FAO, OIE and World Bank, 2010. Good practices for biosecurity in the pig sector - Issues and options in developing and transition countries [online]. FAO Animal Production and Health Paper No. 169. ISBN 978-92-5-106507-5. Available at: https://www.fao.org/3/i1435e/i1435e00.htm
- FAOSTAT, 2023. *FAOSTAT - Food and Agriculture Organization Corporate Statistical Database*. [online]. 2023. [Accessed 2 August 2023]. Available at: https://www.fao.org/faostat/en/#country/120
- FASINA, F. O., AGBAJE, M., AJANI, F. L., TALABI, O. A., LAZARUS, D. D., GALLARDO, C., THOMPSON, P. N. and BASTOS, A. D. S., 2012. Risk factors for farm-level African swine fever infection in major pig-producing areas in Nigeria, 1997-2011. *Preventive Veterinary Medicine*. 1 November 2012. Vol. 107, No. 1, pp. 65-75. DOI 10.1016/j.prevetmed.2012.05.011.
- GAUDREAULT, N.N., MADDEN, D.W., WILSON, W.C., TRUJILLO, J.D. and RICHT, J.A., 2020. African Swine Fever Virus: An Emerging DNA Arbovirus. *Frontiers in Veterinary Science* [online]. 2020. Vol. 7 [Accessed October 25, 2022]. Available at: https://www.frontiersin.org/articles/10.3389/fvets.2020.00215
- GÓMEZ-VILLAMANDOS, J. C., BAUTISTA, M. J., HERVÁS, J., CARRASCO, L., DE LARA, F. Chacón-M., PÉREZ, J., WILKINSON, P. J. and SIERRA, M. A., 1996. Subcellular changes in platelets in acute and subacute African swine fever. *Journal of Comparative Pathology*. 1 novembre 1996. Vol. 115, n° 4, pp. 327-341. DOI 10.1016/S0021-9975(96)80069-7.

- GÓMEZ-VILLAMANDOS, J. C., BAUTISTA, M. J., SÁNCHEZ-CORDÓN, P. J. and CARRASCO, L., 2013. Pathology of African swine fever: The role of monocyte-macrophage. *Virus Research*. 1 April 2013. Vol. 173, No. 1, pp. 140-149. DOI 10.1016/j.virusres.2013.01.017.
- GÓMEZ-VILLAMANDOS, J. C., HERVÁS, J., MÉNDEZ, A., CARRASCO, L., VILLEDA, C. J., WILKINSON, P. J. and SIERRA, M. A., 1995. Pathological changes in the renal interstitial capillaries of pigs inoculated with two different strains of african swine fever virus. *Journal of Comparative Pathology*. 1 April 1995. Vol. 112, No. 3, pp. 283-298. DOI 10.1016/S0021-9975(05)80081-7.
- GOODWIN, R., WIWATTANAPANTUWONG, J., TUICOMEPEE, A., SUTTIWAN, P., WATAKAKOSOL, R. and BEN-EZRA, M., 2021. Anxiety, perceived control and pandemic behaviour in Thailand during COVID-19: Results from a national survey. *Journal of Psychiatric Research*. March 2021. Vol. 135, pp. 212-217. DOI 10.1016/j.jpsychires.2021.01.025.
- GUINAT, C., REIS, A.L., NETHERTON, C.L., GOATLEY, L., PFEIFFER, D.U. and DIXON, L., 2014. Dynamics of African swine fever virus shedding and excretion in domestic pigs infected by intramuscular inoculation and contact transmission. *Veterinary Research*. 26 September 2014. Vol. 45, No. 1, pp. 93. DOI 10.1186/s13567-014-0093-8.
- GUO, S., LÜ, X. and HU, X., 2023. Optimal design of culling compensation policy under the African swine fever - Based on simulations of typical pig farms in China. *Journal of Integrative Agriculture*. February 2023. Vol. 22, n° 2, pp. 611-622. DOI 10.1016/j.jia.2022.12.001.
- HOLT, H.R., INTHAVONG, P., BLASZAK, K., KEOKAMPHE, C., PHONGMANY, A., BLACKSELL, S.D., DURR, P.A, GRAHAM, K., ALLEN, J., DONNELLY, B., NEWBERRY, K., GRACE, D., ALONSO, S., GILBERT, J. and UNGER, F., 2019. Production diseases in smallholder pig systems in rural Lao PDR. *Preventive Veterinary Medicine*. January 2019. Vol. 162, pp. 110-116. DOI 10.1016/j.prevetmed.2018.11.012.
- HUI, K.Y, MATSUMOTO, N., SIENGSANAN-LAMONT, J., YOUNG, J.R, KHOUNSY, S., DOUANGNEUN, B., THEPAGNA, W., PHOMMACHANH, P., BLACKSELL, S.D. et WARD, M.P., 2023. Spatiotemporal Drivers of the African Swine Fever Epidemic in Lao PDR. KORENNOY, F. (ed.), *Transboundary and Emerging Diseases*. 10 May 2023. Vol. 2023, pp. 1-9. DOI 10.1155/2023/5151813.
- JANZ, N.K and BECKER, M.H., 1984. The Health Belief Model: A Decade Later. *Health Education Quarterly*. March 1984. Vol. 11, n° 1, pp. 1-47. DOI 10.1177/109019818401100101.
- KEONOUCHANH, S. and DENGKHOUNXAY, T., 2017. Pig production and pork quality improvement in Lao PDR. *National Agriculture, Forestry and Rural Development (NAFRI), Ministry of Agriculture and Forestry (MAF)* [online]. 2017. Available at: https://www.angrin.tlri.gov.tw/meeting/2017TwVn/2017TwVn_p37-42.pdf
- KIMMARITA, L., 2021. Ban on pig imports remains intact. [online]. 1 July 2021. [Accessed 11 August 2023]. Available à the following address: https://phnompenhpost.com/national/ban-pig-imports-remain-intact
- LAO STATISTICS BUREAU, 2016. *The 4th Population and Housing Census 2015* [online]. [Accessed on 2 August 2023]. Available at :

https://lao.unfpa.org/en/publications/results-population-and-housing-census-2015-english-version

- LAO STATISTICS OFFICE, 2021. *Laos Statistical Yearbook 2021* [online]. [Accessed 2 August 2023]. Available à the address : https://laosis.lsb.gov.la/board/BoardList.do;jsessionid=V4yclo93F8V6rX2adzK-hMIUDjq7Xafn4X42QZFG.laosis-web?bbs_bbsid=B404

- LAY, K.K., JEAMSRIPONG, S., SUNN, K.P, ANGKITITRAKUL, S. PRATHAN, R., SRISANGA, S. and CHUANCHUEN, R. 2021. Colistin Resistance and ESBL Production in Salmonella and Escherichia coli from Pigs and Pork in the Thailand, Cambodia, Lao PDR, and Myanmar Border Area. *Antibiotics*. 31 May 2021. Vol. 10, No. 6, pp. 657. DOI 10.3390/antibiotics10060657.

- LI, X., HU, Z., FAN, M., TIAN, X., WU, W., GAO, W., BIAN, L. and JIANG, X., 2023. Evidence of aerosol transmission of African swine fever virus between two piggeries under field conditions: a case study. *Frontiers in Veterinary Science*. 1 June 2023. Vol. 10,
pp. 1201503. DOI 10.3389/fvets.2023.1201503.

- LURY, A., 2020. African Swine Fever: context, approach and update on activities. *AVSF - Agronomes et Vétérinaires Sans Frontières*. [Online] 2020. OIE ASF Coordination Meeting, Bangkok. Available à the address : https://rr-asia.woah.org/wp-content/uploads/2020/06/avsf-presentation-of-asf-related-activities-oie-asf-coordination-meeting_20200618-2.pdf

- MAF, 2022. https://www.maf.gov.la - Ministry Agriculture and Forestry. [online]. 2022. [Accessed 3 August 2023]. Available at: https://www.maf.gov.la/

- MAF, 2023. Suspension of the permit to import and export live pigs and pig products from Thailand and Vietnam to prevent African swine fever. If found, arrest, destroy and fine. *Lao Phattana News* [online]. 21 March 2023. [Accessed 4 August 2023]. Available at: https://www.laophattananews.com/archives/156711

- MAIN, A.R., HALASA, T., OLESEN, A.S., LOHSE, L., RASMUSSEN, T.B., BELSHAM, G.J., BOKLUND, A., BØTNER, A. and CHRISTIANSEN, L.E., 2022. Estimating transmission dynamics of African swine fever virus from experimental studies. *Transboundary and Emerging Diseases*. November 2022. Vol. 69, No. 6, pp. 3858-3867. DOI 10.1111/tbed.14757.

- MAKITA, K., STEENBERGEN, E., HARUTA, L., HOSSAIN, S., NAKAHARA, Y., TAMURA, Y., WATANABE, T., KADOWAKI, H. and ASAKURA, S., 2020. Quantitative Understanding of the Decision-Making Process for Farm Biosecurity Among Japanese Livestock Farmers Using the KAP-Capacity Framework. *Frontiers in Veterinary Science*. 11 September 2020. Vol. 7, pp. 614. DOI 10.3389/fvets.2020.00614.

- MATSUMOTO, N., SIENGSANAN-LAMONT, J., HALASA, T., YOUNG, J.R., WARD, M.P., DOUANGNGEUN, B., THEPPANGNA, W., KHOUNSY, S., TORIBIO, J.A. L. M. L., BUSH, R.D. and BLACKSELL, S.D., 2021. The impact of African swine fever virus on smallholder village pig production: An outbreak investigation in Lao PDR. *Transboundary and Emerging Diseases*. 1 September 2021. Vol. 68, n° 5, pp. 2897-2908. DOI 10.1111/tbed.14193.

- MELLOR, P.S., KITCHING, R.P. and WILKINSON, P.J., 1987. Mechanical transmission of capripox virus and African swine fever virus by Stomoxys calcitrans. *Research in*

Veterinary Science. July 1987. Vol. 43, No. 1, pp. 109-112. DOI 10.1016/S0034-5288(18)30753-7.

- MONTGOMERY, R., 1921. On A Form of Swine Fever Occurring in British East Africa (Kenya Colony). *Journal of Comparative Pathology and Therapeutics*. 1 January 1921. Vol. 34, pp. 159-191. DOI 10.1016/S0368-1742(21)80031-4.
- MONTOYA, M., FRANZONI, G., PÉREZ-NUÑEZ, D., REVILLA, Y., GALINDO, I., ALONSO, C., NETHERTON, C.L. and BLOHM, U., 2021. 3 Immune responses against African swine fever virus infection. In: IACOLINA, Laura, PENRITH, Mary-Louise, BELLINI, Silvia, CHENAIS, Erika, JORI, Ferran, MONTOYA, Maria, STÅHL, Karl and GAVIER-WIDÉN, Dolores (eds.), *Understanding and combatting African Swine Fever* [online]. The Netherlands : Wageningen Academic Publishers. pp. 63-85. [Accessed on 10 September 2023]. ISBN 978-90-8686-357-0. Available at: https://www.wageningenacademic.com/doi/10.3920/978-90-8686-910-7_3
- MULUMBA-MFUMU, L.K., SAEGERMAN, C., DIXON, L.K., MADIMBA, K.C., KAZADI, E., MUKALAKATA, N.T., OURA, C.A. L., CHENAIS, E., MASEMBE, C., STÅHL, K., THIRY, E. and PENRITH, M.L., 2019. African swine fever: Update on Eastern, Central and Southern Africa. *Transboundary and Emerging Diseases*. 2019. Vol. 66, No. 4, pp. 1462-1480. DOI 10.1111/tbed.13187.
- MUÑOZ-GÓMEZ, V., SOLODIANKIN, O., RUDOVA, N., GERILOVYCH, A., NYCHYK, S., HUDZ, N., UKHOVSKA, T., SYTIUK, M., POLISCHUK, V., MUSTRA, D., DE NARDI, M., LECHNER, I. and SCHUPPERS, M., 2021. Supporting control programs on African swine fever in Ukraine through a knowledge, attitudes, and practices survey targeting backyard farmers. *Veterinary Medicine and Science*. September 2021. Vol. 7, No. 5, pp. 1786-1799. DOI 10.1002/vms3.578.
- MUTUA, F. and DIONE, M., 2021. The Context of Application of Biosecurity for Control of African Swine Fever in Smallholder Pig Systems: Current Gaps and Recommendations. *Frontiers in Veterinary Science*. 2 August 2021. Vol. 8, pp. 689811. DOI 10.3389/fvets.2021.689811.
- NA, L., THUY, N. N., BEAULIEU, A., HANH, T. M. D. and ANH, H. H., 2023. Knowledge, Attitude, and Practices of Swine Farmers related to Livestock Biosecurity: A Case Study of African Swine Fever in Vietnam. *Journal of Agricultural Sciences - Sri Lanka*. 5 September 2023. Vol. 18, No. 3, pp. 307-328. DOI 10.4038/jas.v18i3.9780.
- NANTIMA, N., DAVIES, J., DIONE, M., OCAIDO, M., OKOTH, E., MUGISHA, A. et BISHOP, R., 2016. Enhancing knowledge and awareness of biosecurity practices for control of African swine fever among smallholder pig farmers in four districts along the Kenya-Uganda border. *Tropical Animal Health and Production*. 1 April 2016. Vol. 48, No. 4, pp. 727-734. DOI 10.1007/s11250-016-1015-8.
- NIS and MAFF, 2023. *Cambodia - Cambodia Agriculture Survey 2020* [online]. National Institute of Statistics (NIS), Ministry of Planning, Ministry of Agriculture, Forestry and Fisheries (MAFF). [Accessed 9 August 2023]. Available at: https://microdata.nis.gov.kh/index.php/catalog/38/related-materials
- WHO, 2021. OIE Terrestrial Manual 2021. *WHO - World Organisation for Animal Health.* [online]. 2021. [Accessed 8 August 2023]. Available à www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-manual- https://online-access/

- WHO, 2022. OIE Fact Sheet on African Swine Fever. *WHO - World Organisation de la Animal Health* [online]. 2022. [Accessed 18 October 2022]. Available at à https://www.woah.org/fr/document/fiche-tecnique-de-loie-sur-peste-porcine-africaine/
- WHO, 2023. African swine fever. *WHO - World Organisation for Animal Health* [online]. 2023. [Accessed 8 September 2023]. Available at: https://www.woah.org/fr/maladie/peste-porcine-africaine/
- OMSA-WAHIS, 2023. African swine fever. *WHO - World Organisation for Animal Health*, *WAHIS - World Animal Health Information System* [online]. 2023. [Accessed 4 August 2023]. Available at: https://rr-asia.woah.org/en/projects/asf/
- OLESEN, A.S., LOHSE, L., HANSEN, M.F., BOKLUND, A., HALASA, T., BELSHAM, G.J., RASMUSSEN, T.B., BØTNER, A. and BØDKER, R., 2018. Infection of pigs with African swine fever virus via ingestion of stable flies (*Stomoxys calcitrans*). *Transboundary and Emerging Diseases*. October 2018. Vol. 65, No. 5, pp. 1152-1157. DOI 10.1111/tbed.12918.
- OM, C. and MCLAWS, M.L., 2016. Antibiotics: practice and opinions of Cambodian commercial farmers, animal feed retailers and veterinarians. *Antimicrobial Resistance & Infection Control*. December 2016. Vol. 5, No. 1, pp. 42. DOI 10.1186/s13756-016-0147-y.
- OURA, C. A. L., DENYER, M. S., TAKAMATSU, H. and PARKHOUSE, R. M. E., 2005. In vivo depletion of CD8+ T lymphocytes abrogates protective immunity to African swine fever virus. *Journal of General Virology*. 1 September 2005. Vol. 86, No. 9, pp. 2445-2450. DOI 10.1099/vir.0.81038-0.
- PENRITH, M.L., 2020. How to mitigate swill hazards in animal feed? *Bulletin WHO - World Organisation for Animal Health* [online]. 2020. [Accessed 11 September 2023]. Available at: https://bulletin.woah.org/?panorama=03-8-2020-1-swill-fr&lang=fr
- PENRITH, M.L., VOSLOO, W., JORI, F. and BASTOS, A.D. S., 2013. African swine fever virus eradication in Africa. *Virus Research*. April 2013. Vol. 173, No. 1, pp. 228-246. DOI 10.1016/j.virusres.2012.10.011.
- POUPAUD, M., PUTTHANA, V., PATRIARCHI, A., CARO, D., AGUNOS, A., TANSAKUL, N. and GOUTARD, F. L., 2021. Understanding the veterinary antibiotics supply chain to address antimicrobial resistance in Lao PDR: Roles and interactions of involved stakeholders. *Acta Tropica*. 1 août 2021. Vol. 220, pp. 105943. DOI 10.1016/j.actatropica.2021.105943.
- QIU, Y., 2019. *Pig Production System and Value-Chain in South-Asia* [online]. 2019. OIE-WAHIS. Available à the address: https://rr-asia.woah.org/wp-content/uploads/2020/01/pig_value_chain_in_se_asia_1st_sge.pdf
- RAHMAN, M.S., OVERGAARD, H.J., PIENTONG, C., MAYXAY, M., EKALAKSANANAN, T., AROMSEREE, S., PHANTHANAWIBOON, S., ZAFAR, S., SHIPIN, O., PAUL, R.E., PHOMMACHANH, S., PONGVONGSA, T., VANNAVONG, N. and HAQUE, U., 2021. Knowledge, attitudes, and practices on climate change and dengue in Lao People's Democratic Republic and Thailand. *Environmental Research*. February 2021. Vol. 193, pp. 110509. DOI 10.1016/j.envres.2020.110509.

- RINCHEN, S., TENZIN, T., HALL, D., MEER, F., SHARMA, B., DUKPA, K. and CORK, S., 2019. A community-based knowledge, attitude, and practice survey on rabies among cattle owners in selected areas of Bhutan. *PLOS Neglected Tropical Diseases*. 1 April 2019. Vol. 13, No. 4, pp. e0007305. DOI 10.1371/journal.pntd.0007305.
- RITCHIE, H., ROSADO, P. and ROSER, M., 2023. Meat and Dairy Production. *Our World in Data* [online]. 2023. [Accessed 9 August 2023]. Available at: https://ourworldindata.org/meat-production
- ROWLANDS, R.J., MICHAUD, V., HEATH, L., HUTCHINGS, G., OURA, C., VOSLOO, W., DWARKA, R., ONASHVILI, T., ALBINA, E. and DIXON, L.K., 2008. African Swine Fever Virus Isolate, Georgia, 2007. *Emerging Infectious Diseases*. December 2008. Vol. 14, n° 12, pp. 1870-1874. DOI 10.3201/eid1412.080591.
- SALAS, M.L. and ANDRÉS, G., 2013. African swine fever virus morphogenesis. *Virus Research*. 1 April 2013. Vol. 173, No. 1, pp. 29-41. DOI 10.1016/j.virusres.2012.09.016.
- SALGUERO, F. J., SÁNCHEZ-CORDÓN, P. J., NÚÑEZ, A., FERNÁNDEZ DE MARCO, M. and GÓMEZ-VILLAMANDOS, J. C., 2005. Proinflammatory Cytokines Induce Lymphocyte Apoptosis in Acute African Swine Fever Infection. *Journal of Comparative Pathology*. 1 May 2005. Vol. 132, No. 4, pp. 289-302. DOI 10.1016/j.jcpa.2004.11.004.
- SÁNCHEZ-CORDÓN, P.J., VIDAÑA, B., NEIMANIS, A., NÚÑEZ, A., WIKSTRÖM, E. et GAVIER-WIDÉN, D., 2021. 4. Pathology of African swine fever. In : IACOLINA, L., PENRITH, M.L., BELLINI, S., CHENAIS, E., JORI, F., MONTOYA, M., STÅHL, K. et GAVIER-WIDÉN, D. (ed.), *Understanding and combatting African Swine Fever* [online]. The Netherlands: Wageningen Academic Publishers. pp. 87-139. [Accessed 8 August 2023]. ISBN 978-90-8686-357-0. Available at: https://www.wageningenacademic.com/doi/10.3920/978-90-8686-910-7_4
- SÁNCHEZ-VIZCAÍNO, J. M., MUR, L. and MARTÍNEZ-LÓPEZ, B., 2012. African Swine Fever: An Epidemiological Update. *Transboundary and Emerging Diseases*. 2012. Vol. 59, No. s1, pp. 27-35. DOI 10.1111/j.1865-1682.2011.01293.x.
- SÁNCHEZ-VIZCAÍNO, J.M., LADDOMADA, A. and ARIAS, M. L., 2019. African Swine Fever Virus. In: *Diseases of Swine, Eleventh Edition* [online]. Eleventh Edition. [Accessed on 25 October 2022]. ISBN 978-1-119-35092-7. Available at: https://onlinelibrary.wiley.com/doi/epub/10.1002/9781119350927
- SINWAT, N., ANGKITTITRAKUL, S., COULSON, K.F., PILAPIL, F.M.I.M.R., MEUNSENE, D. and CHUANCHUEN, R., 2016. High prevalence and molecular characteristics of multidrug-resistant Salmonella in pigs, pork and humans in Thailand and Laos provinces. *Journal of Medical Microbiology*. 18 October 2016. Vol. 65, No. 10, pp. 1182-1193. DOI 10.1099/jmm.0.000339.
- STELDER, J.J., OLESEN, A.S., BELSHAM, G.J., RASMUSSEN, T.B., BØTNER, A., KJÆR, Lene Jung, BOKLUND, Anette Ella and BØDKER, René, 2023. Potential for Introduction of African Swine Fever Virus into High-Biosecurity Pig Farms by Flying Hematophagous Insects. BYRNE, Andrew (ed.), *Transboundary and Emerging Diseases*. 12 April 2023. Vol. 2023, pp. 1-15. DOI 10.1155/2023/8787621.
- TIONGCO, M., NARROD, C., SCOTT, R., KOBAYASHI, M. and OMITI, J., 2012. Understanding Knowledge, Attitude, Perceptions, and Practices for HPAI Risks and Management Options Among Kenyan Poultry Producers. In: ZILBERMAN, D., OTTE, J., ROLAND-HOLST, D. and PFEIFFER, D. (eds.), *Health and Animal Agriculture in*

Developing Countries [online]. New York, NY: Springer. pp. 281-304. Natural Resource Management and Policy. [Accessed 29 August 2023]. ISBN 978-1-4419-7077-0. Available at: https://doi.org/10.1007/978-1-4419-7077-0_15

- TORNIMBENE, B., CHHIM, V., SORN, S., DREW, T.W. and GUITIAN, J., 2014. Knowledge, attitudes and practices of Cambodian swine producers in relation to porcine reproductive and respiratory syndrome (PRRS). *Preventive Veterinary Medicine*. October 2014. Vol. 116, No. 3, pp. 252-267. DOI 10.1016/j.prevetmed.2013.12.009.

- TRAN, X.H., LE, T.T.P., NGUYEN, Q.H., DO, T.T., NGUYEN, V.D., GAY, C.G., BORCA, M.V. and GLADUE, D.P., 2022. African swine fever virus vaccine candidate ASFV-G- **Δ** I177L efficiently protects European and native pig breeds against circulating Vietnamese field strain. *Transboundary and Emerging Diseases* [online]. July 2022. Vol. 69, No. 4. [Accessed 10 September 2023]. DOI 10.1111/tbed.14329. Available at: https://onlinelibrary.wiley.com/doi/10.1111/tbed.14329

- VONGPHACHANH, M., 2023. Laos Halts Pork Importation from Thailand and Vietnam. *Laotian Times* [online]. 22 March 2023. [Accessed 4 August 2023]. Available at: https://laotiantimes.com/2023/03/22/laos-halts-pork-importation-from-thailand- and-vietnam/

- WALLSTON, Kenneth A., WALLSTON, B.S., SMITH, S. and DOBBINS, C.J., 1987. Perceived control and health. *Current Psychology*. 1 March 1987. Vol. 6, No. 1, pp. 5-25. DOI 10.1007/BF02686633.

- WORLD BANK, 2023. World Bank Open Data. *World Bank Open Data* [online]. 2023. [Accessed 9 August 2023]. Available at: https://data.worldbank.org

- WHO (2008). Advocacy, Communication and Social Mobilization for TB Control: a Guide to Developing Knowledge, Attitude and Practice Surveys.2008. *WHO - World Health Organization*. Geneva, Switzerland. 88p.

- XAYALATH, S., ABULBASHAR, M.M., ORTEGA, A.D.S.V. and RÁTKY, J., 2022. Opportunities and challenges for pig production in Vientiane Capital, Laos: a review. *Review on Agriculture and Rural Development*. 8 December 2022. Vol. 11, No. 1-2, pp. 3-8. DOI 10.14232/rard.2022.1-2.3-8.

- XAYALATH, S., BALOGH, E. and RÁTKY, J., 2020. The role of animal breeding with special regard to native pigs of food supply and rural development in Laos. *Acta Agraria Debreceniensis*. 20 May 2020. No. 1, pp. 149-154. DOI 10.34101/actaagrar/1/3771.

- ZHOU, X., LI, N., LUO, Y., LIU, Y., MIAO, F., CHEN, T., ZHANG, S., CAO, P., LI, X., TIAN, K., QIU, H. and HU, R., 2018. Emergence of African Swine Fever in China, 2018. *Transboundary and Emerging Diseases*. 2018. Vol. 65, No. 6, pp. 1482-1484. DOI 10.1111/tbed.12989.

- ZHU, J.J., 2022. African Swine Fever Vaccinology: The Biological Challenges from Immunological Perspectives. *Viruses*. 13 September 2022. Vol. 14, No. 9, pp. 2021. DOI 10.3390/v14092021.

Appendix
Survey for pig (English)

Questionnaire 1- Individual interviews of random pig farmers on KAP regarding ASF in villages only targeted for KAP/biosecurity survey

The objectives of this interview is to obtain the general characteristics of the farm as well as the Knowledge, Attitudes and Practices (KAP) of the pig farmers regarding African swine fever (ASF) and its preventive and control measures.

This survey is completely anonymous, we will not be able to identify you based on your answers. Your name will not appear in any of the records.

Date of the interview (DD/MM/YY): ..... Name of

interviewer: .....

Part I: General information

Are you the one responsible/ taking the decisions regarding the pigs?

Yes or no? If not then stop interview as we want to interview the person responsible/ taking the decisions, not a caretaker

Country

- Cambodia
- Laos

Province

District:

- Viengkham
- Phonhong
- Toomlarn
- Ba Phnum
- Svay Chrum
- Tram Kak
- Kraol Kor
- Saang
- Or Reang Ov

Village

Farm address

GPS coordinates: .....

Gender of farmer/interviewee:

- Male
- Female

Ethnic group (*non mandatory*)

Ethnics of Lao PDR	Ethnics of Cambodia
- Lao - Katang - Makong - Oy - Ta-Oy - Sorting - Xuay - Brao - Lue - Phouthai - Khmou - Hmong - Others (Please specify)	- Khmer - Cham - Krom - Surin - Kachok - Krung - Brao - Kavet - Kuy - Phnong - Tampuan - Stieng - Mnong - Samre - Jarai - Rhade - Others (Please specify) .....

Year of birth (XXXX): .....

You have community responsibilities within the village/district?

- Farmer
- Farmer group member (AC or other)
- VVW/VAHW
- Community leader
- Traditional healer
- None
- Other (if other please precise)

Education level:

- Illiterate/no school
- Primary school
- Secondary school
- Higher education

How many persons are part of your household?

Category	**Number**
Kids (< 2 years old)	
Kids (3-5 years old)	
Kids (6-16 years old)	
Adults (>16 years old)	

What are the main sources of income for your household (reorder from the most important to the least important:

- Pigs
- Other livestock
- Crops
- Rice
- Worker
- Private business
- Employment/regular salary
- Other (if other please specify)

Part II: Farm characteristics

How long have you been involved in raising pigs?

- <1 year
- 1-2 years
- >2-5 years
- >5-10 years
- >10 years

For which purpose do you raise pigs

- For self-consumption
- Mobile capital (quick cash when needed)
- Commercial purposes (sale)
- Other

If others (Please specify) .....

What type of pig farming activity do you do? (Several answers can be selected)

- Only breeder (sell piglets)
- Only grower (buy piglets, fattens and sell for slaughter)
- Breeder & grower
- Other: please specify

If other, please specify.....

What type of housing systems do you have?

- Full time Free- ranging/scavenging
- Full time housed/fenced/penning
- Part time house/fenced/penning

If "part time housed/fenced/penning", please specify when are they kept inside and when are they free ranging?

If other, please specify.....

If full or part time house/fenced/penning:

How far is the pig pen from your house?

- Next by (100 meters)
- Close (<2km)
- Far (>2km)

What type of housing do you have?

- Wood fences / uncemented floor
- Wood fences / cemented floor
- Elevated wooden floor
- Concrete building
- Other

If other, please specify.....

How many pigs do you have now?

Adults (>6 months)		Piglets (<6 months)	
Male	Female	Male	Female

Do you have other animals on the same farms?

- Yes
- No

If yes, which one? (Select all that apply)

- Cattle
- Buffalo
- Goats
- Poultry/ducks
- Other:

If other, please specify.....

How frequently do you observe wild pigs in the surroundings of your farms?

- Several times per week
- 1 to 4 times a month
- Once every 2-3 months
- A few times per year
- Never
- I don't know

Which breed of pig do you keep?

- Native breed
  In Laos: Moo Lat, Moo Kang, Moo Cheed, Moo Hmong, I don't know, other (if other please specify....)
  In Cambodia: Kandol, Hainam, Damrey, I don't know, other (if other please specify....)
- Exotic breed
- Crossed breed
- Hybrid (Domestic pigs * wild pigs)
- Other:
- If other, please specify.....

Part III. Knowledge

Have you ever heard about ASF?

- Yes
- No

If yes how: discussion with other farmers, information from DAFOS/PAFOS, training, other (please precise)

Have you ever experienced African swine fever outbreak on your farm?

- Yes
- No

Do you feel confident that you can recognize the clinical signs of ASF?

- Yes
- No

Which of the following clinical signs do you associate with ASF in pigs?

- Fever
- Diarrhea
- Higher mortality
- Joint swelling
- Coughing
- Vomiting
- Sudden death
- Loss of appetite
- Presence of red loose skin coloration in the ventral abdomen, tips of ears or tail or distal limb
- Difficulty in breathing
- Abortion
- Increase in water intake and wallowing
- Reddening of the ears

Do you consider any other sign (not listed above) as characteristic of ASF?

- Yes
- No

If yes, (please specify) .....

Do you feel you are well-informed about how ASF can be transmitted?

- Yes
- No

Do you know anybody who has been affected by ASF?

- Yes
- No

If yes, is it:

- a friend
- a relative
- another pig farmer

If yes, is that person keeping the pigs:

- in the same village
- in another village

Did any of your pigs die from ASF (after being sick or killed by local authorities) during outbreak?

- Yes
- No

How many months after the outbreak did you restock? .....

Why?

When you restocked, how did you proceed? (only for farmers still active)

- Introduced 1-2 pigs first before full restocking
- Purchasing directly several pigs
- Others (if other, please specify)

Before restocking what did you do? (multiple choice) (only for farmers still active)

- Cleaned the pens
- Disinfected the pens (if yes, please precise with which product)
- Cleaned all the materials and equipment used for the pigs
- Disinfected all the materials and equipment used for the pigs
- Nothing special

Did you at any time use survivors (animals who were sick but did not die/recovered) for restocking on your farm?

- Yes
- No

By which of the following spread pathways can your pigs be infected by ASF? (Select all that apply)

- Direct contact with an infected pig
- Contact with pork products/carcass with contamination
- Feeding of infected pig meat/swill/offal to pigs
- Contact with infected wild boars
- Visitors spreading the germs (e.g: pig traders)
- Vehicles or equipment spreading the germs
- Through the wind/air
- Biting insects (ticks, flees...)

Do you consider any other pathways (not listed above) as outbreak routes of ASF?

- Yes
- No

If yes, please specify).....

Part IV: Attitudes /perception on ASF

Please rate your opinion on the following statements

Measure	Strongly agree 4	Agree 3	Disagree 2	Strongly disagree 1
ASF is not a very important disease				
ASF is frequent in the country, if I do not take any measures, I will have an outbreak in my farm				
My herd is protected from ASF because they are vaccinated and dewormed regularly				
ASF does not occur in the country, it is only in neighboring countries				

How efficient/ important do you consider the following measures regarding ASF prevention and control

Note: advise the interviewee that they should rate the efficiency/ importance of the measure independently of its feasibility, costs,..... Just, based on their opinion, how effective it is (if implemented) to prevent or control the disease

Description	Very efficient	Efficient	Low efficiency	Not efficient
Having a foot bath at the entrance				
Purchasing a new pig, keeping it in quarantine for at least 2 weeks before mixing it with the others				

Isolating sick pigs from the others				
Not allowing visitors (e.g.: butcher/ middle men / relatives,...) to enter the pig pen				
Asking visitors entering the farm/ the pens to change footwear				
Asking visitors entering the farm/ the pens to change cloth				
Asking visitors entering the farm/ the pens to disinfect their shoes				
Not visiting other pig farms frequently (>once/week)				
Protecting the pigs' feed from possible contamination by wildlife (Stored in a closed place)				
Keeping the pigs pens clean and dry all the time				
Not feeding pigs with swill food				
Vaccinating the pigs every 6 months				
When purchasing pigs, asking if there is an on-going outbreak in the community or farm from where you are buying the pig				
Keeping piglets, sows and boars in separated pens				
Having draining system				
Using specific tools (not used for other animals) to take care of the pigs (eg. shovels, ...)				
Using specific tools for each pig pens (eg. shovels, ...)				
Using specific clothes/footwear for taking care of pigs (Different from your daily life clothes/footwear)				
Not sharing boars between pigs farms (lending or borrowing)				
Not borrowing boars from other farms for reproduction				
Using all replacement stocks that are produced and grown within your farm / not buying pigs from outside				

Part V: Practices

What do you feed your pigs with (select all that apply)?

- Scavenging
- Local feed ingredients
- Swill/leftover food
- Local feed ingredients combined with Swill/leftover food
- Commercial feed
- Commercial feed combined with Swill/leftover food
- Other:
- If other, please specify.....

If you observe clinical signs of ASF in your pig herd, what do you do?

- I would wait a few days to see if the pigs improve or not?
- I would treat the pigs with antibiotics
- I would sell the pigs as soon as possible to avoid losing too much
- I would call the village veterinary workers or a veterinary professional
- I would report it to the DAFOs
- I would report it to the VVW/VAWH
- Others

If others (Please specify) .....

If you suspect there is an ASF outbreak in your farm/ village, what would you do:

- Wait a few days before reporting it to avoid a false report
- Wait a few days before reporting it to have the time to sell the healthy pigs and avoid too much losses
- Report it as soon as possible even if it might be a false case
- Others

If others (Please specify) .....

In which cases would you call a veterinary professional for your pigs?

- One pig not eating well/ looking sick
- Several pigs not eating well/ looking sick
- Increased mortality
- Sow not having piglets
- Preventive treatment such vaccination and/or deworming
- For technical advices (on feeding or health)
- Others .....

If others (Please specify) .....

Which of the following practices are you implementing ?

Practices	**Implementation** **o Yes o No** **o Not applicable**
Do you have a foot bath at the entrance of your pens	
The last time you purchased a new pig, did you keep it in quarantine? for at least 2 weeks before mixing them with the others?	
The last time one of your animals was sick, did you isolate it from the others?	
Do you allow visitors (e.g: butcher/ middle men / relatives,....) to enter the pig pen?	
Do you ask visitors entering the farm/ the pens to Change footwear ?	
Do you ask visitors entering the farm/ the pens to Change cloth ?	
Do you ask visitors entering the farm/ the pens to disinfect their shoes?	
Do you visit other pig farms frequently (>once/week)	
Do you protect the pigs' feed from possible contamination by wildlife? (Stored in a closed place)	
Do you keep the pigs pens clean and dry all the time?	
Do you ever feed your pigs with swill food?	
Did you vaccinate your pigs over the last 12 months?	
The last time you purchased pigs, did you ask if there was an on-going outbreak in the community or farm from where you are buying the pig?	
Are the piglets piglets, sows and boars kept in separate pens?	
Do you use a drainage system?	
Do you use specific tools when taking care of your pigs (eg.Shovels, ...) ? Meaning tools that you don't use for other animals	
Do you use specific tools only for each Pig pens (eg.Shovels, ...) ?	
Do you wear specific clothes/footwear for taking care of pigs? (Different from your daily life clothes/footwear)	
Do you use pig manure for fertilizing crops?	
Do you share boars with other farms (lend out or borrow)?	
Are all replacement stocks produced and grown within your farm?	

Carcass disposal (*pigs which died and are not consumed*)

Do you have a carcass disposal point (CDP)?

- Yes
- No

If Yes, what is the approximate distance of the CDP to your farm?

- <10 meters
- 10-20 metres
- 21-30 metres
- >30 meters

How do you dispose carcasses? (Select all that apply)

- Burning
- Burying
- Use of chemical
- Throw it into the bush
- Sell it off
- Other

If other (please specify) .....

Is there any other measure you are doing to prevent or control diseases that has not been listed? If yes please specify

You considered the following measures as important for ASF prevention and control but you are not doing it. Why ?

- Not feasible
- Takes too much time
- Too expensive
- I don't know
- Other (if so, please specify)

In view of: The Theme Director

From Oniris National School Veterinary Medicine, Food and Agriculture

François îdEURENS

Véronique Renauk

Seen: La Dit'ectrice Génei ule
From the Ecole Nationale Vétérinaire, Agroalimentaire et de l'Alimentation
Oniris
Lati"ence Deflesscll e

Pour la Directrice Générale
0(by delegation
Responsable du Service des
Formations Vétérinaires-Masters
Kari-- ROLLAND

Nantes, le 29/09/2023.

Vti :
The Chairman of the Thesis

Pt'of'esseut Catherine BELLOC

Vii : The Dean of the Faculty of Medicine, Nantes

ProfessuiPascaleÏOLLIEl

Vu et permis d'imprimer

NOM : MASSON
Prénom : Ariane

Ariane MASSON

SURVEY OF THE KNOWLEDGE, ATTITUDES AND PRACTICES OF SMALL-SCALE PIG FARMERS IN LAOS AND CAMBODIA CONCERNING AFRICAN SWINE FEVER

KNOWLEDGE, ATTITUDES AND PRACTICES OF SMALL-SCALE PIG FARMERS IN LAOS AND CAMBODIA REGARDING AFRICAN SWINE FEVER

Doctorate in Veterinary Medicine, Nantes, 20 October 2023

SUMMARY:
Since 2019, Laos and Cambodia have been hit by an epizootic of African swine fever, which is causing heavy economic losses, particularly on small-scale rural family farms. A study of the knowledge, attitudes and practices of small-scale pig farmers with regard to this disease was carried out among 382 farmers in Laos and Cambodia. The study revealed a low level of knowledge of the clinical signs and routes of transmission of the disease, which appears to be influenced by socio-demographic and contextual factors such as the literacy rate and previous experience of a household on its farm. Furthermore, although ASF is perceived as a significant risk, farmers generally consider biosecurity measures to be ineffective, and a number of biosecurity gaps were identified. Since knowledge, attitudes and practices are correlated, it would seem essential to set up targeted awareness campaigns to improve understanding of the benefits of biosecurity measures and encourage their adoption.

KEYWORDS :
- African swine fever
- Biosafety
- Survey
- Laos
- Cambodia
- Breeder
- Pig farming

SUSPENSION DATE: 20 October 2023