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African Swine Fever: Prevalence, Farm Characteristics, Farmer's Insight and Attitude toward Reporting of African Swine Fever Cases in the Northwest, West, Littoral and Southwest Regions of Cameroon

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Abstract: The African swine fever virus (ASFV) has been circulating in and ravaging the swine industry in Cameroon for decades. Annual ASFV epidemics occur in Cameroon from April to August. With the absence of vaccines and antiviral drugs against this virus, biosecurity has been the only effective control tool available. When properly applied, biosecurity measures allow control of the spread of ASFV and the eventual eradication of this virus. Many outbreak investigations by PCR were effected in Cameroon, with ASFV prevalences ranging from 15.23% to 42.80%. Considering that pre-outbreak studies are not available for Cameroon, the present study aimed at assessing the status of the animals before an outbreak. A two-stage cluster sampling study was conducted from January to March 2020. In this study, the primary unit was the farm and the secondary unit was the individual animals. In all, 97 farms were visited and 277 samples were collected. Pre-outbreak ASFV prevalence, as assessed by PCR, was 9.75%. In parallel, data were collected using a survey of farm characteristics, awareness and attitude of the farmers toward ASF. The survey results showed that 34.1% of the farms were backyard cemented piggeries with the majority having less than 10 pigs (54.1%). The majority of farmers (90.6%) had heard of and knew about the disease caused by ASF. Though 69.4% of the farmers were uninformed on the clinical signs of ASF, 73.6% of them did treat sick pigs presenting similar clinical signs to ASF (with no risk of mortality) with antibiotics, while 79.4% did not treat but sold the pigs presenting clinical signs similar to ASF with an increased risk of mortality. Sixty-three percent of the farmers had reported a case of ASF in the past and believed that reporting was useful and had no negative consequences on other farmers or third parties. We established that poor implementation of biosecurity measures in addition to poor training are contributing factors to the enzootic nature of ASFV in Cameroon and, thus, the spread of ASFV. Hence, pig farmers in Cameroon must be properly trained in ASFV awareness and the impact thereof on pig production. Furthermore, training will also facilitate the successful implementation of biosecurity measures to contain ASFV outbreaks.

Keywords: African swine fever; pre-outbreak; prevalence; biosecurity; awareness and reporting of ASF

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1. Introduction

Cameroon has the largest pig population in central Africa, with over 3.2 million pigs. In number of pigs, Cameroon is second to Nigeria (4.7 million pigs) in West Africa [1–3]. However, the pig industry contributed only 34,556 tons to the annual Cameroonian meat production of 265,816 tons in 2016. Domestic demand for pork increased from 7.286 tons in 2008 to 15.547 tons in 2015 as opposed to very little increase in pork production. This led to massive pork imports from Tchad in 2002 [4]. As of 2009, 70% of the pig farmers operated in

a traditional production system with poor biosecurity measures, while 20% and 10% were involved in the semi-intensive and intensive systems, respectively [4]. Most of the piggeries were made of wood (60%) of which 57.8% had cemented floors, 22% were free-range pigs. Moreover, 57.8% of the piggeries fed the pigs twice daily with compounded feed. Whereas 44.44% of the farmers vaccinated their pigs, 15.5% of the farms lacked disease prevention methods [5]. On the other hand, a 2013 study showed a shift of 11.1% to 70%, respectively, from traditional to mostly semi-intensive husbandry practices [6].

The African swine fever virus (ASFV) is a complex intracytoplasmic, large, double-stranded, DNA virus transmitted by ticks. ASFV is the sole member of the Asfarviridae family. It replicates mainly in macrophages and monocytes. The icosahedral virion is 200 nm in diamter. A virion consists of a nucleoid that is enveloped by the core-shell, the inner envelop, the viral capsid and an external envelope [7,8]. The viral genome varies from 170 to 190 kbp and encodes 150 to 160 different proteins, of which 50 are structural [7]. Of the 24 genotypes currently known, only genotype I is circulating in Cameroon [9,10]. The virus mainly circulates in the domestic cycle, as neither soft ticks nor warthogs have been proven to be involved in the transmission [11,12].

The disease caused by the ASFV is a deadly hemorrhagic disease of pigs. Depending on the virulence of the isolates, mortality can reach up to 100%. Low- and moderately virulent ASFV isolates may lead to chronic or subacute forms of ASF that are characterized by delayed growth, swollen joints, skin ulcers, emaciation as well as lesions from secondary bacterial infection. Chronic or subacute ASF has a lower mortality rate. Highly virulent isolates will lead to an acute form of ASF that is deadly within a few days [13].

ASFV has been and remains a major threat to the Cameronian pig industry. The ASF virus (ASFV) has been circulating in Cameroon for at least 4 decades. In 2013, a nationwide PCR-based study revealed a prevalence of ASFV in 22.85% of the 4500 studied samples [5,13]. Another PCR-based study in 2018, reported a prevalence of 15.2% with only three regions involved, i.e., center, south and southwest regions [14]. The National Veterinary Laboratory (LANAVET) conducted a PCR study from 2011 to 2018 and reported an ASFV prevalence of 42.8% [8]. A drop in ASFV incidence from 11% to less than 1% was observed during a joint effort between the Cameroon Government and the Food and Agricultural Organization (FAO) from 2000 to 2017 [15]. Despite differences in ASFV prevalence reported for Cameroon, all reports show that ASF remains a major problem in the country.

A study by the Ministry of Livestock, Fisheries and Animal Industries (MINEPIA) in 2014 revealed that 86.2% of all interviewed farmers had heard of ASF and 47% had experienced it in their pig farms, 33.7% blamed the butchers and other pig traders for their misfortune, 100% of all butchers and other pig traders and 95.4% of feed store owners acknowledged being aware of the ASFV [1]. A study conducted in the center, south and southwest regions by Ngwa et al. (2020), showed that 90% of the interviewed farmers knew ASF, 55.3% had suspected ASF in their farms, 9% had confinement facilities to avoid disease entry, 65% shunned animal care, 35.4% had nonfunctional footbaths at the entrance to their farms and 57.3% had neighboring farms that had experienced outbreaks of ASF [14]. The majority of the Cameroonian pig farmers, therefore, have sufficient knowledge of the ASFV but only a small minority implements biosecurity measures.

The zonal distribution of the major pig production Regions in Cameroon by MINEPIA placed the far north, north and the Adamawa regions into zone A, corresponding to regions where no ASF outbreaks had been declared for the past three years after 2014 [1,2]. Zone A is, thus, referred to as a low-risk zone. Zone B, a high-risk zone, was further divided into zone B1, i.e., center and littoral regions, and zone B2, i.e., southwest, west, south and northwest regions, with zone B1 being a higher-risk zone and zone B2 being a moderate-risk zone [1,2] (Figure 1).

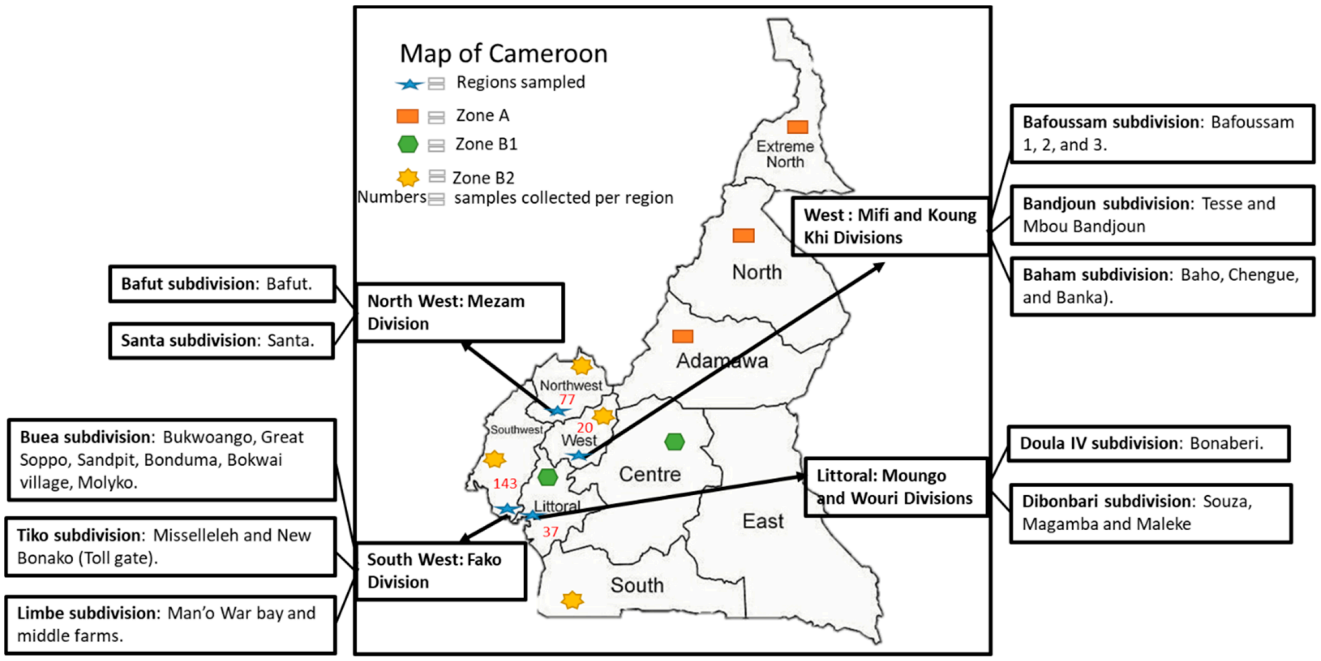


Figure 1. Map of Cameroon showing the Regions, Zonal distributions, number of samples collected per Region, Divisions and Subdivisions sampled as well as the cities or villages sampled within the different subdivisions.

Based on information from the veterinary service, the farmers and reports from MINEPIA [1,5], ASFV outbreaks mostly occur annually from April to August, which is the period corresponding to the rainy season in Cameroon [1]. The focal point of all prevalence studies has so far been outbreak studies that give an idea of the disease burden only. On the other hand, a non-outbreak prevalence study would be most informative because it reveals: (i) the health status of the animals as carriers or non-carriers of ASFV and (ii) the regions or zones with the highest risk for the next imminent outbreak (based on the carriers status). This publication focuses on the prevalence of ASF during the pre-outbreak or non-outbreak period as well as the farm characteristic, level of implementation of biosecurity measures and attitude of the farmers toward reporting of ASF in Cameroon. Results of this study may contribute to a better ASFV outbreak management in Cameroon considering that it may lead to a change of behavior in the farmers and a better understanding of the ASFV epidemiology in Cameroon.

2. Materials and Methods

2.1. Ethical Statement

The ethical approval for this project with code 3E181033 was obtained from the University of Buea Institutional Animal Care and Use Committee (UB-IACUC) on 4 September 2019. Regional authorization needed for sample collection within specific regions of the country were obtained from the regional delegations of the northwest, west, southwest and littoral regions. Blood was collected only from the pigs of farmers who gave consent for the study. The collection was done following a standard protocol for jugular vein blood collection in pigs (https://ouv.vt.edu/content/dam/ouv_vt_edu/sops/large-animal/sop-swine-blood-collection.pdf, accessed on 14 November 2021)

2.2. Study Area

The study took place from 23 January to the end of March 2020, corresponding to the pre-ASF outbreak period based on information obtained from the veterinary service and the farmers. This period is, thus, regarded as an unfavorable pig rearing period by the pig farmers due to the constant resurgence of ASF.

Four major pig production regions (littoral, west, northwest and south) located within the high-risk Zone B were selected. The selection criteria were based on areas with a high density of pig farms, pig production practices ranging from extensive to intensive systems and yearly recurrenge of ASF.

Pigs from these regions are mostly sold to butchers and other middlemen who transport them to the bigger cities such as Yaoundé and Douala. These regions might potentially function as an important hub for spreading ASF.

2.3. Study Design

A two-stage cluster sampling study was performed, in which the primary unit was the farm and the secondary unit was the individual animals. This study aimed to investigate, on one hand, pig farmers' awareness, reaction and attitudes toward the reporting of ASF cases. Ultimately aiming to identify the major route that contributes to the spread of ASFV within the regions sampled. In addition, the study focused on the principal biosecurity measures used by the farmers before, during and after an ASFV outbreak. In parallel, a sero-survey was performed to identify animals that might qualify as ASFV carriers in these regions after the last outbreak dating back to April 2019.

The sample size was estimated using the two-stage cluster sampling formula as below [16]:

$$C = 1.96^2 \times p \times (1 - p)\,[1 + (m - 1) \times rho]/\mathrm{e}^2\mathrm{m} \quad (1)$$

where e = absolute precision at 5%; p the expected prevalence of 23.8% was taken from Victor et al., 2020 [14]. The design effect (D) was calculated using the formula below to determine the number of clusters to be sampled

$$\mathrm{D} = 1 + (\mathrm{m} - 1)\,rho \quad (2)$$

where m = average number of animals per flock set at 3, *rho* = rate of homogeneity for ASFV set at 0.2 and the design effect (D) = 1.4.

The number of clusters was calculated to be 130, and the individual number of animals was calculated using:

$$n = \text{number of clusters} \times \text{average number of animals per flock} \quad (3)$$

where n = number of individual animals = 390.

2.4. Data Collection and Analysis

To understand the characteristics of and evaluate the biosecurity measures taken at the farm, as well as the farmers' awareness and attitude toward the reporting of ASF cases, a questionnaire (Supplementary Material) was administered to get first-hand information from the farmers. Each aspect was well explained to the farmers by the veterinary personnel. The collected data were analyzed using IBM SPSS Statistics v25 (IBM Corp, Armonk, NY, USA) and Excel 2016 (Microsoft, Redmond, WA, USA). The analysis was based purely on descriptive statistics within the IBM SPSS statistics software, and the obtained percentages were used to understand the farmer's knowledge on the matter.

Prevalences were calculated using the formula below:

$$\mathrm{P} = (\text{number of ASFV positive animals})/(\text{total number of animals sampled}) \times 100 \quad (4)$$

2.5. Sample Collection

Certified veterinary personnel dressed in disposable biosecurity overalls assisted in blood collection. For a total of 97 farms visited, a total of 277 blood (1 mL each) samples were collected (Table 1) from the jugular vein of the animals in EDTA vacutainer tubes and transported on ice to the Molecular and Cell Biology laboratory (MCBL) of the University of Buea, Cameroon, for genomic DNA extraction.

Table 1. Statistics on sample collection sites, number of farms visited and samples collected per farm.

Region	Division	Farm Location	Number of Farms Visited	Number of Samples Collected	Total
Littoral	Wouri	Bonaberi	1	15	37
	Moungo	Souza	4	22	
Southwest	Fako	Buea	37	69	143
		Limbe	3	26	
		Misselleleh Area	7	48	
West	Mifi	Baffousam	8	8	20
	Koung Khi	Baham	4	4	
		Bandjoun	8	8	
Northwest	Mezam	Bafut	18	22	77
		Santa	7	55	

2.6. DNA Extraction and PCR Amplification

The DNA was extracted from whole blood using the Wizard genomic DNA purification kit (Promega, Madison, WI, USA) following the manufacturer's instructions. PCR amplification was performed with PPA1 (5′-AGTTATGGGAAACCCGACCC-3′) and PPA2 (5′-CCCTGAATCGGAGCATCCT-3′) to amplify a 257 bp region of the B646L gene for 40 cycles using the following conditions: 94 °C for 2 min, 94 °C for 15 s, 62 °C for 30 s, 72 °C for 30 s and 72 °C for 5 min and a holding step at 4 °C. The PCR products were separated on a 2% agarose gel and visualized on a Gel Doc imager (Biorad, Hercules, CA, USA).

3. Results

3.1. Cluster Sampling Study

The number of farms visited and samples collected did not meet the calculated amount due to the following reasons:

Many of the farms (38 farms) were closed as the farmers lost all the animals in the previous outbreak and had no motivation to restock the farms.

For biosecurity reasons and unwillingness to participate, we were denied access to many farms by the farmers (12 farms).

A greater majority of the farms had 1 to 5 animals, these were farms in the initial stage of restocking.

The PCR results showed that the southwest region has the highest number of ASF carrier animals as opposed to the northwest region, which had the lowest number (Table 2). Of the 143 animals sampled in the southwest region, 25 were positive for ASFV while only one was a positive animal in the case of the littoral (1/23 samples), west regions (1/20 samples) and northwest (0/77) regions. Within the southwest region, the Misselleleh village had the highest rate of positive samples with 19 out of 48. In the northwest region, Santa (0/22) and Bafut (0/55) both had no infected animals among the sampled pigs.

Overall, 27 samples were positive out of 277 giving a prevalence of 9.75%. A closer look into the Misselleleh zone alone gave a prevalence of 39.58%, thus illustrating that the Misselleleh village in the southwest region has the highest proportion of carriers or ASFV-positive animals as opposed to the other regions and areas sampled.

3.2. Farm Characteristics

Investigating the farm characteristics revealed that 54.1% of the farms had less than 10 pigs and were either backyard uncemented, backyard elevated piggery on wood or backyard cemented piggeries with family members taking care of the cleaning and feeding of the pigs once or twice a day (Table 3). Overall, 49.4% of the farmers bred and finished their pigs to slaughter weight, while 4.7% sold the weaned pigs depending on the demand. Moreover, 30.6% of the pigs on the farms were mainly crosses of different exotic breeds

such as Landrace, Grand White and Duroc jersey. Very few farms continue to maintain local pig breeds due to a change in emphasis on litter size and carcass weight. These traits are less developed in the local pig breeds with an average litter size of four to five piglets per litter and a low to modest carcass weight of 40–60 kg [4]. Farmers visit other farms either to buy piglets or to cross their sows, which is a huge avenue for the spread of African swine fever.

Table 2. ASFV carrier status per subdivision sampled.

Regions	Farm Location	Number of Farms Sampled	Total Number of Samples	Positive Samples	Percentage Positive (%)
Southwest	Buea	37	69	4	6.25
	Limbe	3	26	2	7.69
	Misselleleh	7	48	19	39.58
Littoral	Souza	4	22	0	0
	Bonaberi	1	15	1	6.67
West	Baffoussam	20	20	1	5
Northwest	Santa	7	22	0	0
	Bafut	18	55	0	0
	Total Number	97	277	27	9.75

Table 3. Characteristics of the sampled farms.

Parameter	Modalities	Percentage (%)
Production type practice	(1) Breed to finish	49.4
	(2) Fattening	8.2
	(3) Sales of weaned	4.7
	(4) All three types	11.8
	(1) and (2)	1.2
	(2) and (3)	15.3
	(1) and (3)	4.7
Housing in place	Backyard uncemented piggery	15.3
	Backyard cemented piggery	34.1
	Well-constructed pig farm	18.8
	Backyard elevated piggery (on wood)	27.1
Number of pigs in the farm	<10	54.1
	10 to 50	45.9
Type of farming practice	Mixed farming	42.4
	No mixed farming	52.9
Number of workers in the farm	1 to 2	20
	3 to 5	2.4
	Family does the cleaning and feeding	70.6
Frequency of feeding pigs	Once a day in the morning	37.6
	Once a day in the evening	5.9
	Twice a day (morning and evening)	50.6

Table 3. *Cont.*

Parameter	Modalities	Percentage (%)
Farm visit frequency	Once a day	21.2
	Twice a day	35.3
	More than twice a day	37.6
Breeds of pigs on the farm	Only local breeds	4.7
	Only exotic breeds	18.8
	Mixed local and exotic breeds	11.8
	Crossed between local and exotic	30.6
	Crossed exotic breeds	27.1

3.3. The Pig Farmer's Insight into the Disease

Some farmers (10%) could not easily identify some of the clinical signs of ASF disease. This is most probably because they had only one outbreak with most of the pigs sold before pigs could develop signs of the disease. They sell to recover some costs since there are no refunds from the government for unregistered farms. The most recognizable clinical signs linked to ASF by the farmers included sluggishness but stands up when helped, abdominal cramps, empty stomach with significant weight loss, wasting (ribs, vertebrae, long hair for the animal is greatly emaciated and these parts can be seen), increased respiratory rate, paralysis of the hindquarters, red skin, loss of appetite, slightly reduced defecation and less than 50% mortality (Table 4). Most farmers reported mortality below 50% due to the fact that the pigs were sold to generate return on investment. These clinical signs are consistent with those observed in a typical case of African swine fever.

Table 4. Farmer's view of an actual ASF situation in their farms.

Parameter	Modalities	Percentage (%)
Liveliness	No abnormality	34.8
	Reduced liveliness, stand up without help	4.3
	Sluggish but stands up when helped	17.4
	Dormant, will not stand up	43.5
Posture	Uncertain	17.4
	Stiffness and bent back when standing up, will progressively correct posture	26.1
	Stiffness and bent back remain	13
	Cramps (abdominal pain)	43.5
Body shape	Uncertain	17.4
	Empty stomach (sunken flanks)	30.4
	Empty stomach with significant weight loss	26.1
	Wasting (ribs, vertebrae visible, long hair)	26.1
Breathing (assessed before animals are approached)	Uncertain	13
	Increased respiratory rate	43.5
	Significantly increased respiratory rate, abdominal breathing	13
	Difficult breathing (open mouth breathing), wheezing, coughing	30.4
Neurological signs	Uncertain	21.7
	Somewhat doubtful gait quickly corrected	17.4
	Ataxia/paralysis of the hindquarters can still walk	4.3
	Paralysis of the hindquarters, unable to stand, convulsions	56.5

Table 4. *Cont.*

Parameter	Modalities	Percentage (%)
Skin (particularly ears, snout, tail, legs, abdomen)	Uncertain	13
	Red skin	78.3
	Blue-purple discoloration of the skin, occasional skin bleeding	4.3
	Large blue/black spots, cold skin, large subcutaneous bleeding, skin necrosis/ulceration	4.3
Appetite	Uncertain	4.3
	Eats slowly	39.1
	Shows interest in food but eats little or nothing	4.3
	Will not eat, has no interest in food	52.2
Defecation	Uncertain	13
	Slightly reduced amount of feces, dry stools	65.2
	Reduced amount of feces or diarrhea	21.7
Ocular/Nasal discharge	Uncertain	56.5
	Thin discharge from nose and/or eyes (without admixtures)	26.1
	Thick discharge from nose and/or eyes (no blood)	13
	Bloody discharge from nose and/or eyes	4.3
Vomiting (emesis)	Uncertain	65.2
	Occasional emesis (1× during the observation period)	34.8
Mortality rate	No mortality	21.7
	Less than 50%	8.7
	More than 50%	47.8
	All the animals (100%)	21.7

3.4. Awareness and Reaction toward ASF Outbreak

Data analysis revealed that, although 90.6% of the farmers had heard of the disease in one way or the other, 77% had suspected ASF in their farms but 69.4% could not recognize the clinical signs of the disease. However, the majority (69.4%) knew how ASFV spreads (Table 5).

Table 5. Farmer's knowledge about ASF.

Parameter	Response	Percentage (%)
Have you heard of ASF?	Yes	90.6
	No	2.4
Have you heard of recent outbreaks?	Yes	30.6
	No	60.1
Do you know how the disease spreads?	Yes	69.7
	No	30.3
Do you know the clinical signs of ASF?	Yes	69.4
	No	30.5

When asked: "What will be your reaction if the animals had a fever, redness on the skin, reduced eating and no increase in mortality?", 73.6% preferred to wait and treat the animals with antibiotics amidst seeking the veterinarian's opinion without immediately suspecting ASF, even if the pigs' condition did not improve (Table 6).

Table 6. Farmers reaction toward fever, redness on skin, reduced eating and no increase in mortality.

Parameter	Response	Percentage (%)
Wait a few days to see whether the pigs improve or get worse	Yes	73.6
	No	26.4
Treat the affected animals with antibiotics	Yes	78.9
	No	21.1
Immediately seek vet's opinion	Yes	77.5
	No	22.5
Seek vet's opinion if nothing improves	Yes	35.7
	No	64.3
Immediately suspect ASF	Yes	45.1
	No	54.9
Wait and suspect ASF if pigs' condition did not improve	Yes	65.2
	No	37.4

However, if the pigs developed a fever, redness of the skin, reduced eating and increase in mortality, on a general scale, 79.4% of the farmers would not wait for improvement but put the sick animals on antibiotics amidst seeking the veterinarian's opinion and would immediately suspect ASF. At the same time, 66.1% would not seek advice from the veterinarian and would only suspect ASF if the situation did not improve at all (Table 7).

Table 7. Farmers reaction toward fever, redness on skin, reduced eating and no increase in mortality.

Parameter	Response	Percentage (%)
Wait a few days in case of mortality	Yes	20.6
	No	79.4
Treat the affected animals in case of mortality	Yes	38.7
	No	61.3
Seek the vet's opinion in case of mortality	Yes	60
	No	40
Seek vet's opinion if nothing improves in case of mortality	Yes	33.9
	No	66.1
Immediately suspect ASF in case of ASF	Yes	79.7
	No	20.3
Wait and suspect ASF if pigs did not improve, in case of mortality	Yes	23.7
	No	76.3

When asked why they never suspected ASF in their farms, 15.6% said they are more concerned with diseases than other ASF, 23.4% said there is a low probability of the disease occurring, 10.9% thought there is no ASF in Cameroon, 6.3% had hardly heard of ASF from other farmers, 3.1% had not heard of ASF from the newspapers or media. Nevertheless, 34.4% were not certain of the clinical signs of the ASF (Table 8).

Table 8. Major reasons for not suspecting ASF in a pig.

Parameter	Response	Percentage (%)
Reason for not suspecting ASF in your farm	You are more concerned about other diseases than ASF on your farm.	15.6
	There is a low probability of an ASF outbreak on your farm.	23.4
	There have been no ASF cases in Cameroon so far.	10.9
	You rarely hear about ASF from other farmers or vets.	6.3
	You rarely hear about ASF through media or journals.	3.1
	You are not certain about the clinical signs of ASF.	6.3
	None.	34.4

3.5. Attitude toward Reporting of ASF

When farmers were asked whether they ever did report a case of ASF in the past, 63% ascertained to have reported to the veterinary personnel. Oddly enough, 60.3% of those farmers who reported, waited a few days before reporting the ASF case, with some (22.1%) attributing this reluctance to the financial cost involved. Of those who never reported (37%), 71.6% indicated that they would promptly report an ASF case if they noticed it (Table 9).

Table 9. Time frame before reporting ASF to avoid false reporting.

Parameter	Response	Percentage (%)
Wait a few days to avoid false report	Yes	60.3
	No	39.7
Wait a few days due to financial costs involved	Yes	22.1
	No	77.9
Quickly report even if it is false	Yes	71.6
	No	28.4

Concerning reporting a case of ASF, even if it turns out to be false, 95.6% of the farmers still thought that reporting is useful, 82.1% would not feel ashamed of the act, 88.1% believed it would have no negative consequence on their farm, 88.1% believed it would not affect their relationship with other farmers, 92.5% believed it would not affect dealings with a third party and 95.5% strongly believed it would have no negative financial consequences on their farm (Table 10).

Not reporting a case of ASF may be due to a multitude of reasons, amongst others, 63.5% believed the pigs would be buried with no refund from the government since their farms were not registered [1], 65.6% would rapidly sell to earn some money and cut their losses. While 69.2% thought that amidst not reporting, their farms would not be closed since they were not registered and also not liable to receive any compensation from the government (Table 11).

3.6. Farm Biosecurity

Adequate implementation of biosecurity measures should be an integral part of every modern piggery; but in developing countries, adequate biosecurity measures are yet to be put in place. Collected data show that 81.1% of the farms in these regions had no footbath at the entrance, 68.1% had no quarantine area for incoming animals or holding pens for outgoing ones and butchers and other middlemen (83.3%) entered the farms to buy animals irrespective of where they came from.

The farmers for one reason or the other did visit other farms, 41.9% did it for the crossing of the sow or to buy piglets, 41.9% did it from time to time either because they were neighbors or they were friends, 2.4% visited either for crossing and buying of piglets

or because they were neighbors, 2.4% visited other farms every week or more often, while 10.8% did not visit other farms.

Looking at some other practices that may contribute to the spread of the ASF virus within a farm, 71.8% called the veterinarian each time they had a problem on the farm, 43.7% had the drugs and called the vet to administer, 33.8% changed the veterinarian from time to time, 59.2% vaccinated the pigs once announced, 83.1% did not use the same syringe to treat all the animals in the farm and 95.7% disinfected the farm after an outbreak.

When asked about the level of truthfulness in their response,15.7% were 100% truthful, 47.1% was between 80% and 90%, 27.1% between 60% and 70% and 4.3% were below 50%, while only 5.7% were below 10% (Table 12).

Table 10. Farmer's attitude about reporting even if reporting turns out to be false.

Parameter	Response	Percentage (%)
Do you think reporting is useful?	True	95.6
	False	4.4
You will feel ashamed or guilty.	True	17.9
	False	82.1
This will have a negative image for your farm.	True	11.9
	False	88.1
This will have a negative image on your relationship with other farmers.	True	11.9
	False	88.1
This will create a negative image with the third parties.	True	7.5
	False	92.5
There will be negative financial consequences for the farm.	True	4.5
	False	95.5

Table 11. Reasons for farmers not reporting a case of ASF.

Parameter	Response	Percentage (%)
All the pigs will be buried with no refund from the government.	True	63.5
	False	36.5
You should immediately sell to recover some funs.	True	65.6
	False	34.4
Your farm will be closed.	True	30.8
	False	69.2

Table 12. Farmers practices that may increase the spread of the virus.

Parameter	Response	Percentage (%)
I do call a vet each time I have problems on my farm.	True	71.8
	False	12.9
I have the drugs and the vet administers the treatment.	True	43.7
	False	56.3
I do the treatment myself.	Yes	28.2
	No	71.8
I do change the vet from time to time.	Yes	33.8
	No	66.2
I do vaccinate the pigs.	True	59.2
	False	40.8

Table 12. *Cont.*

Parameter	Response	Percentage (%)
The same syringe is used to treat all the animals on the farm.	True	16.9
	False	83.1
The farm is disinfected after an outbreak.	True	95.7
	False	2.9
How truthful was your response to the questions?	<10%	5.7
	<50%	4.3
	60–80%	27.1
	89–90%	47.1
	100%	15.7

4. Discussion

Awareness of the dangers of the virus and the willingness to report for proper actions to be taken by the government will go a long way to help in controlling the spread and eventually eradicating the disease from Cameroon.

ASF is endemic in Cameroon [6,9] with epidemics occurring annually between April and August. These epidemics are consistent with the rainy season [2,6,17,18]. Most epidemiological studies were conducted during this period [6,9,14] and as such were primarily outbreak investigations. This study ran from January to March 2020, which corresponds to the period prior to the outbreak in the context of Cameroon. No outbreaks were reported in either of these areas over the sampling period. The regions sampled were all in Zone B, specifically littoral in Zone B1, and southwest, northwest and west regions in Zone B2.

This work focused on determining the ASF status of pigs in Cameroon with respect to the previous outbreak in 2019 within the same regions. Earlier work by Ekue et al. [19] showed that the virus was undetectable after 30 to 45 days in recovering animals, while Karl et al. reported a 5 to 10 month period [20]. Thus, samples obtained during the outbreak period and beyond 30 to 45 days after the outbreak would have a reduced chance of viral DNA detection [19]. The sampling conducted in late January, 4 months after the outbreak window, revealed a prevalence of 9.75%, which is lower as opposed to the prevalence obtained during outbreak investigations by Wade et al. from 2011 to 2018 with a prevalence of 42.8% by PCR [9], Njayou with 22.85% by PCR in 2012 [5] and Victor et al. in 2018 with 15.2% by PCR [14].

In Misselleleh, over 80% of the farmers practiced the traditional system of pig farming with a minimum of inputs. This study shows that the virus circulated from one outbreak to the next within the domestic cycle, which is in line with the report from Ekue et al. in 1989 [11]. Critical analysis of the data obtained showed either that animals that were sick in August recovered and remained ASFV-positive after 3–4 months or that the ASFV-negative animals were newly introduced into the area during restocking of the farms or the negative animals had already been infected and recovered more than 4 months before this study.

Data from this work show that the farmers are aware of what an ASF situation looks like but choose to do away with the animals for personal gain, which ends up worsening the situation in the whole country. The sole act of selling ASFV-infected animals constitutes a major route for the spread of the virus. Our findings are in line with those of Ekue et al. [11,21] on the domestic route of ASF spread in Cameroon in the absence of soft ticks and warthogs [10]. Such a habit has to cease for effective control to step in.

The Cameroonian agricultural system is still largely in the traditional sector [4,17] although Njayou saw a shift from traditional breeding practices to semi-intensive practices in 2012 [6]. For adequate production with high yield, enhanced swine breeds with high performance must be used. The study reveals that 69.5% of the pigs were hybrids from crosses between local and exotic breeds or between exotic breeds in this study, which

is lower than the 80% from the Ministry of Livestock annual report [2,17]. Our study is in line with Joseline et al. on the housing type and involvement of family members in the day-to-day running of the piggery, hiring extra labor only when need be, 4.7% of the pigs were local breeds, which is low as compared to a larger proportion of local breeds in 1986 [18].

In this study, 90.6% of the farmers knew about ASF, and 77% had suspected it in their farms, an outcome that is similar to 90% obtained by Victor et al. in 2018 [13] and 86.2% from the report of the Ministry of Livestock in 2015 [17], although only 55.3% had suspected its presence in their farms [1,14]. Does that mean that farmers are aware of the clinical signs and the dangers of the disease? Surprisingly, yes. They were fully aware and knew the clinical signs of the disease and some preferred to treat the pigs for a few days with antibiotics and later on sell if the animals did not respond in order to recover funds. The simple act of selling ASFV-infected animals is not only spreading the disease but also of great danger to the consuming population as the withdrawal period of the antibiotics is not respected. Antibiotic residues in meat and meat products can lead to various side effects in humans, ranging from the development of antibiotic-resistant bacteria to immunopathological effects [22,23].

The reporting of African swine fever is of the utmost importance as it enables the government to take immediate steps to stop the spread of the disease. Many of the farmers did affirm having reported a case of ASF in the past and did feel that reporting was useful regardless of whether gave a negative image on their farms or not. Some of the farmers still do not think that reporting was of any use to them since there is no refund from the government, and so they sold their animals to recover some funds.

Having a pig farm is one thing and having adequate biosecurity measures implemented is another. Except for the big commercial farms that have their boar for breeding and have a footbath and a quarantine area, the majority of the farms were smallholder farms owned by families, which are not enclosed, lack a quarantine area (68.1%), have no footbath at the entrance (81.1%) and the pigs are taken from one farm to the other for breeding; meaning the farmers need to visit other farms in search of a good boar for the sows, and buyers do enter the farms irrespective of where they are coming from. Opposing results were obtained by Victor et al., 2018, with 65.5% absence of footbath and 93.2% absence of quarantine area. These practices facilitate the spread of the virus between farms, which accounts for the recurring outbreaks of the disease in Cameroon. Some of the farmers do call the veterinarian, while others prefer to do the treatment themselves, stating that the veterinarians contributed to the spread of the disease (which might or might not be true as the veterinarians do move from one farm to the next to treat the animals depending on the calls). That notwithstanding, the farmers reported disinfecting the farms before re-stocking after an outbreak; but this will not be effective since the habit of farm-to-farm movement is still the order of the day and greatly helps in the spread of the disease in Cameroon. Disinfection is mainly done using Virunet® (Laprovet, Notre-Dame-d'Oé, France), a virucidal, bactericidal and broad-spectrum fungicide disinfectant effective in the presence of organic matter.

5. Conclusions

A pre-outbreak investigation examined practices that may or may not be directly associated with the next outbreak. This work shows that the pig farming system as well as the biosecurity measures in place greatly contributes to the recurrent outbreak without the need for a wildlife cycle. One aspect is that farmers focus more on individual benefits instead of collective efforts that will help to eradicate ASFV. A pre-outbreak prevalence of 9.75% from this work is far lower than the prevalence from other outbreaks investigations. This means, if adequate control measures are instituted, then resurgence will be minimal.

Much remains to be done to improve the situation and eradicate the ASFV in Cameroon. This eradication goal will require a collective effort by all parties involved. There is cur-

rently no vaccine or antiviral drug against the virus, meaning that adequate implementation of biosecurity measures is still the focus for proper control of the virus.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/agriculture12010044/s1, Questionnaire: questionnaire for African swine fever survey.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the University of Buea Institutional Animal Care and Use Committee (UB-IACUC) on 04/09/2019. The collection was done following a standard protocol for jugular vein blood collection in pigs (https://ouv.vt.edu/content/dam/ouv_vt_edu/sops/large-animal/sop-swine-blood-collection.pdf).

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