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Research Article

Epidemiology of African Swine Fever in the South Region of Cameroon

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Abstract

African swine fever is a highly contagious infectious disease, caused by a DNA virus whose socioeconomic importance handicaps the global swine industry, and restricts trade. Food security takes a hit because there exists no vaccine or nor treatment yet. This disease is endemic in Africa, with a persistence of the foci in space and time, and a complex epidemiology due to the different hosts involved. In Cameroon, where the disease circulates in the domestic form, disease outbreaks occur in flock throughout the year, but the epidemiology remains poorly understood throughout the country. To remedy this situation, an epidemiological study was carried out in the South region of Cameroon, in order to provide past and up-to-date information on the disease in this part of the country. The retrospective study carried out for this purpose from 1999 to 2019, reveals an ever increasing evolution of the outbreaks of the disease in space and time, with a maximum of cases having occurred between 2016 and 2018 in the Dja -Lobo and Ocean divisions, and a minimum of cases between 2006 to 2015 in the Mvila and the Ntem Valley. At the end of the cross-sectional survey, a prevalence of 18,11% ± 0,34 was determined, at 95% confidence interval. Experience is the only characteristic significantly influencing the prevalence, $P < 0.029$. This study made it possible to know the evolution of the disease in the region, and to identify the departments most at risk. These results will be used to increase the country's epidemiological data, but also to revitalize surveillance and control resources in high-risk areas, and to preserve those that are less at risk.

Keywords: *African Swine Fever; Epidemiology; Socio-Professional Characteristics; South Region, Cameroon*

Abbreviations

ACEFA: Programme for the Improvement of Competitiveness of Family Agro-pastorial farms; ASF: African swine fever; DDEPIA: Departmental delegation of MINEPIA; DREPIA: Regional delegation of MINEPIA; FAO: Food and Agricultural Organization; LANAVET: National Veterinary Laboratory; MINEPIA: Ministry of Livestock, Fisheries and Animal Husbandry; NGO: Non-Governmental Organization; OIE: Office International Epizooties; PRODEL: Livestock Development Project; RESCAM: Cameroon Epidemiological Surveillance Network of Diseases

Introduction

Pork is the most consumed meat in the world with a carcass yield of 77.41% ± 1.62 [1] ahead of sheep and bovine meat which have carcass yields of 54.42% ± 12.10 [2]. The African pig herd represents 5% of the world's population and this number has doubled over the

past three decades [3]. This growth follows that of human populations on the continent which is accompanied by an increase in demand for animal protein and pork. This need will lead to the expansion of both modern and traditional pig production in sub-Saharan Africa. The consequence of the explosion of this activity is the growing number of countries infected with African swine fever (ASF) [4].

ASF is a highly contagious infectious disease that affects all pigs regardless of sex, race and age. Its causal agent is a DNA virus, of the Asfivirus genus and of the Asfarviridae family characterized by a hemorrhagic fever that spreads beyond the borders. This deadly Montgomery disease notified to the 'Office International des Epizooties' (OIE) [5], has endemically affected nearly 33 African countries where the number of outbreaks is changing considerably over time [6]. This is the case in Cameroon, where the epidemiology of African swine fever is poorly understood, despite its growing pig herd, and which is now estimated at around 4 million head [7]. According to weekly RESCAM news reports, the number of ASF outbreaks recorded throughout the year in the national territory is steadily increasing, thus reflecting the endemic nature of the disease.

Despite this endemicity in Cameroon, the resulting damage and annual losses in the pig industry is estimated at around 26 billion per year [8]. An epidemiological survey was carried out in 2003 by the Directorate of Veterinary Services of MINEPIA (Ministry of Livestock, Fisheries and Animal Husbandry) and reported a high incidence of the order of 12% [8] which has been in clear increase in the years later, recording a prevalence of 15.3% ± 1.6% by ELISA, 22.8% ± 2.2% by nested PCR in 2012 and a prevalence of 20.5% ± 2.4% by real-time PCR in 2014 [9]. Nevertheless, data on the epidemiology of ASF at the farm, regional and national levels as well as the main foci remain poorly documented. However, the fight against this cross-border disease of suidae should have regular information on its spatio-temporal evolution. Thus, the evolutionary monitoring of the disease in each region should be a major concern because of its importance, both in food security and in its economic impact, with a view to a practical and sustainable control. There is therefore a problem of lack of information on the real situation, because the number of outbreaks declared does not always reflect the situation on the ground. In addition, the archiving of statistical data is not always accessible in the various administrative services, making access to information difficult.

It is with the aim of contributing to the increase of epidemiological data, the improvement of means of prevention and control of this cross-border disease in Cameroon, that this study was carried out in South region of the country. This region belongs to a zone where the pig herd is so poorly developed despite its significant growth over the years, its many agricultural and climatic advantages, and the richness of its soil, but with a high risk due to the origin of the animals throughout the whole country. In general, it was a question of carrying out an epidemiological study of ASF in the South region. More specifically, a retrospective study of outbreaks from 1999 to 2019 was carried out on the one hand and on the other hand a cross-sectional study, providing past and updated data in the region in general. This work had two essential points; to determine:

- The profile of the African swine plague from 1999 to 2019 in the South region.
- The prevalence of African Swine Fever in the study area and describe the socioeconomic characteristics of the respondents and their farms.

Materials and Methods

Study area

This work was carried out from July to December 2020, in the four departments of the South region of Cameroon (Figure 1). The rationale for the choice of this area is the fact that, for nearly ten years, the South region has been ranked second last in the national ranking of the ten regions of the country, both in pig numbers and pig slaughter rates. And also, because of its strategic geographical position in terms of trade with neighbouring countries, and of the fact that the epidemiology of African swine fever disease is poorly understood both in this region and nationally. In addition, the region belongs to a semi-intensive and intensive production zone with high economic

consequences delimited by the ASF control program in Cameroon. The region is a moderate risk ASF zones and is considered as a meeting place between animals from various horizons.

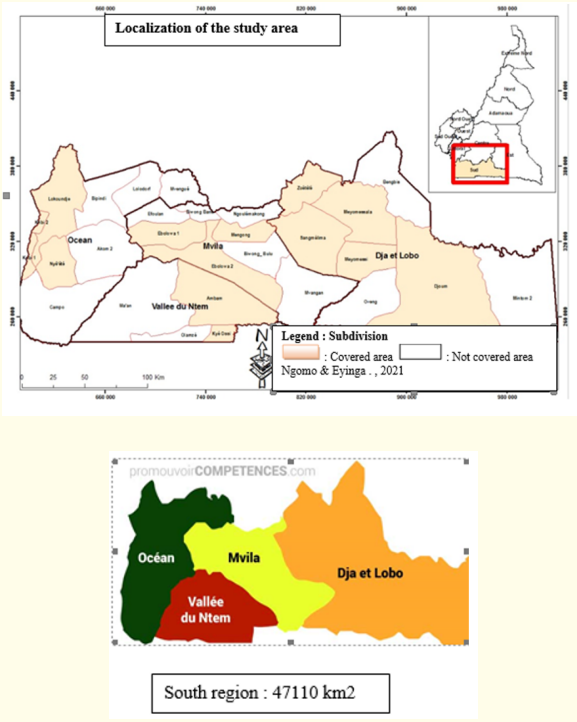

Figure 1: *Map of Cameroon showing the South region and study areas.*

Type of study

The present study is of a retrospective and transversal descriptive type. In retrospect, the aim was to present the profile of African swine fever from 2005 to 2019, as well as quantitative data (number of outbreaks, mortality and slaughter) in the South region in particular, and to map the outbreaks historical data of the country during the same period. On the basis of the archives of MINEPIA in general and those of the various departments and districts of the South region in particular, but also of the archives of RESCAM, OIE and LANAVET, it was possible to know the evolution of historical centers in space and time, both in the study region and in the entire country. At the cross-cutting level, the survey carried out made it possible to map the pig farms in the region as well as their typology on the one hand, and to determine the prevalence of ASF while describing the different socio-professional characteristics of breeders and their farms. This was possible thanks to the good collaboration of the various field agents of MINEPIA, who facilitate movement from one side to the other of the region and the fluidity of exchanges with the breeders on the other.

Situation, relief and socio-economic profile

The South region with its 153 km of coastline on the Atlantic Ocean is the only region in Cameroon that shares its natural borders with three countries namely Gabon, Equatorial Guinea and Congo (Brazzaville). The region was created by decree n° 2008/376 of November 12, 2008, with geographical coordinates ranging from 3° 30 to 6° 30 North latitude and from 13° 00 to 15° 00 East longitudes. It covers

an area of 47,100 km^2 (i.e. 10.1% of the total area of the country). Its borders to the North by the Center region to the Northwest by the Littoral region, to the South by the Republics of Congo (Brazzaville), Gabon and Equatorial Guinea, to the East by the East region and to the West by the Atlantic Ocean.

The relief of the South region is dominated as a whole by the south Cameroonian plateau, the morphological unit of which consists of a monotony of convex hills whose altitude varies from 650 to 900m. This monotony is only broken by the Ngovayang range with an altitude of 1,043m and the Ntem massifs. We find, all along the coastal plain, bands of sand which cover the basin from Compo to Kribi and which are composed of sedimentary and alluvial deposits with an altitude varying from 0 to 300m.

Pig and poultry farming occupy a prominent place in the economic sector of this region with high production (thousand) rates. Pig farming has experienced considerable development, with the establishment for years of the Sector Development Program and nowadays with the support of ACEFA in association of NGOs and PRODEL to breeders in this sector of activity.

Methodology

Retrospective study

The profile of African swine fever in the South region from 1999 to 2019 was carried out in two ways thanks to the analysis of the quarterly data collected in the archives on the one hand and the annual reports of the veterinary services of the various departmental delegations of MINEPIA (DDEPIA) of the South region, but also zoo-sanitary data from the Epidemiological Surveillance Network of Cameroon Diseases (RESCAM), from the database of the Office International des Epizooties (OIE), the national veterinary laboratory of Yaoundé (LANAVET) and the Directorate of Veterinary Services of MINEPIA on the other hand. To this end, a 500-page register in which the information sought, namely the main waves of epizootics, their places of occurrence, the various losses in terms of animals and the control measures taken were recorded.

These data made it possible to know the frequency of occurrence of historical foci not only in this part of the region, but also throughout the national territory, in time and in space.

Cross-sectional study

Sampling

The prevalence of ASF and the study of the socio-professional characteristics of the surveyed breeders and the farms were possible, thanks to the cross-sectional study conducted with the respondents and the farms. It was done using a semi-structured questionnaire on the one hand through an interview and on the other hand by direct observations. A total of 384 pig farms (minimum) were envisaged using the Thrusfield [10] formula below:

$$N = \frac{z^{2\alpha} \times P \times (1-P)}{2}$$

This minimum number of farms (384) calculated was increased to 401 farms using the Snowball method. These farms were spread over 14 districts where the pig activity is more intense. The choice of farms was conditioned by the simple random sampling method. Any owner of animals during or before the survey, but who practices pig activity continuously and regardless of the number of animals and the year of exercise, was considered as a breeder, with a view to maximizing statistical data. Was excluded from the survey any breeder who abandoned the breeding regardless of the disease or not.

Collection of retrospective data

Using a 500-page register, the information necessary for the production of the ASF profile in South region of Cameroon was recorded, during the exploitation of the various archives.

Collection of survey data and parameter studied

The information collected in each farm at the end of the questionnaire, the interview and direct observations, related on the one hand to the socio-professional characteristics of the respondents (sex, profession, marital status, level of education and experience) and breeding (the locality, the breeding system, the breeds, the type of breeding, the breeding method, the number of animals and the distance between two breeding farms). The selection of farms was made first according to the list of breeders available to the South DREPIA and each DDEPIA and then by the so-called snowball identification technique. For this, the authorities in charge of breeding, private veterinarians, identified breeders served as sources of identification of the additional units. The questionnaire used for the study was carried out by the KoBoCollect application on digital media configured and synchronized between the machine and the telephone. Each breeder was subjected to the semi-structured questionnaire, and thanks to a direct interview the respondents' choices were ticked off at the same time as the observations. In addition, the maps were made possible, thanks to the GPS coordinates recorded in each farm surveyed.

Data analysis

The characteristics of breeders and farms were grouped together using descriptive statistics. The mean prevalence of African swine fever in the study area was presented as the mean ± standard deviation. One-way analysis of variance was used to compare mean prevalences of ASF and the DUNCAN post-hoc test was used to separate these means when significant. A simple linear regression model was used to establish the relationship between the socio-professional characteristics of the respondents, the characteristics of the farms and the prevalence of ASF. The significance level of 5% was retained and the data were analyzed using Microsoft Excel 2013 AND SPSS version 20.0 software.

Results

Results of the retrospective study

Figure 2 shows the evolution of the number of outbreaks notified in the South region from 1999 to 2019. This result is the product of the synthesis of the data collected by DREPIA and DDEPIA of the South region, the OIE, the DSV and the LANAVET annex of Yaoundé. It emerges that a total number of 163 outbreaks were recorded during this period in the region, including 77 in Dja-Lobo, 5 in Mvila, 67 in the Ocean, 3 in the Ntem Valley and 12 without precision of locality.

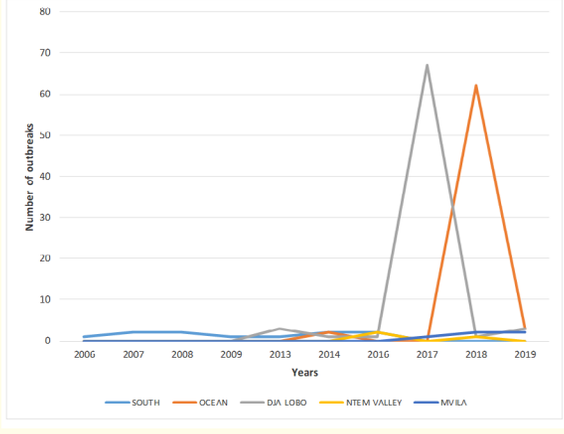

Figure 2: *Evolution of the number of outbreaks of African swine fever notified in the South region between 1999 and 2019.*

Regional and annual distribution of mortalities and slaughtering during epizootics

Figure 3 shows that few animals are slaughtered during ASF outbreaks, yet several animals are often affected, this can justify the persistent nature of the disease, because the different animals are marketed which accentuates the spread of the disease in the region.

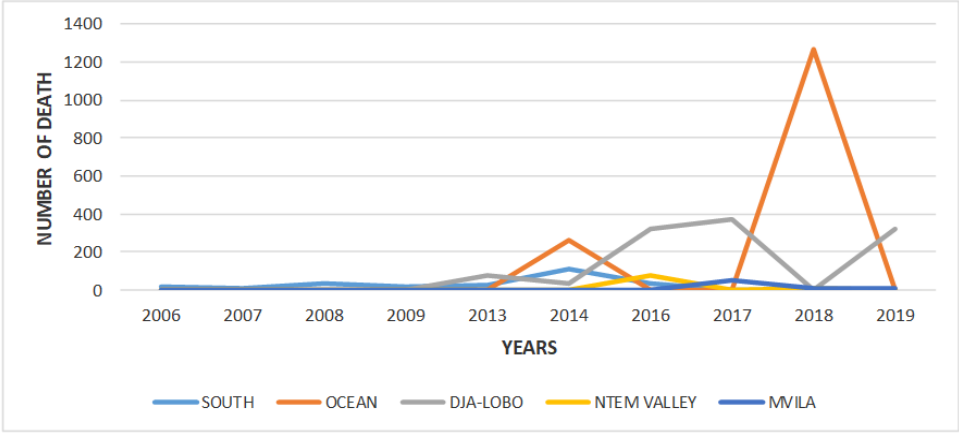

Figure 3: *Regional and annual distribution of mortality for 2006 - 2019.*

Table 1 shows the annual regional distribution of cases of slaughter during the different epizootics.

Years	South	Ocean	DJA-LOBO	Ntem Valley	MVILA
2006	0	0	0	0	0
2007	0	0	0	0	0
2008	0	0	0	0	0
2009	0	0	0	0	0
2013	0	0	0	0	0
2014	19	58	30	0	0
2016	217	0	0	0	0
2017	0	0	0	0	0
2018	0	0	0	0	0
2019	0	0	0	0	0

Table 1: *Annual distribution of cases of slaughtered pigs of different ASF epizootics in the South region of Cameroon.*

Spatio-temporal distribution of ASF in the region from 2010 to 2019

Figure 4 shows the spatiotemporal distribution of African swine fever in the South region. The years 2018-2019 represent the critical period of ASF throughout the region, as all four departments have experienced outbreaks of the disease.

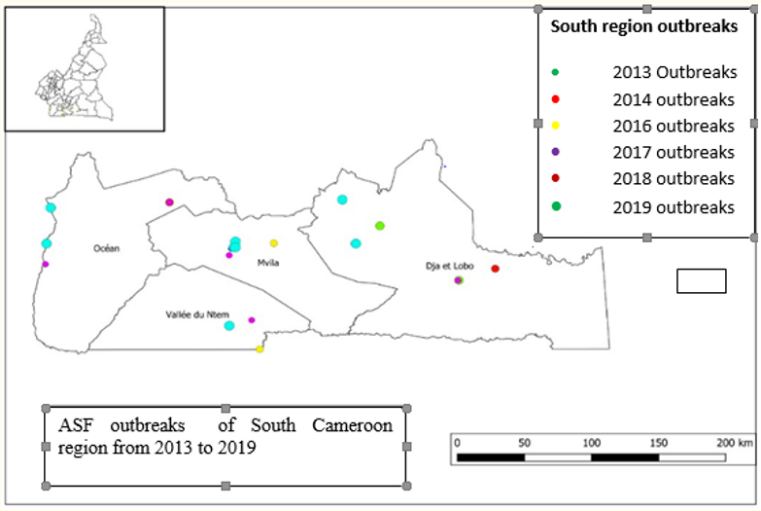

Figure 4: *Spatio-temporal distribution of ASF in the South region from 2010 to 2019.*

Figure 5 presents the epidemiological map of African swine fever in Cameroon from 2010 to 2019, which highlights the different historical foci of the disease. It emerges from this map that all the regions have experienced at least one outbreak, which reflects the endemic nature of the disease in the country. There is a maximum of outbreaks in the central, western and coastal regions, while the minimum is found in the East and Adamawa regions.

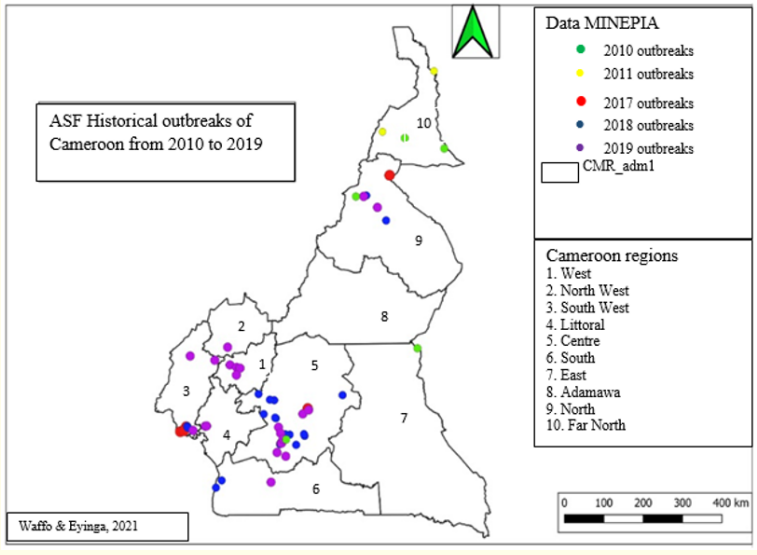

Figure 5: *Historical ASF outbreaks of Cameroon from 2010 to 2019.*

Measures taken in the south region before, during and after the epizootics of ASF

The measures taken to this end in the South region are those drawn up by the strategic plan to fight ASF. They are on the one hand those applicable in zone A known as a very high risk zone (Center and Littoral) and at moderate risk (South) and on the other hand to the general measures applied throughout the country.

These measures are taken by the competent veterinary authority, with the support and collaboration of the administrative authorities with the assistance of law enforcement departments [8]. These measures are:

- Monitoring plan: With the procedure which may differ from that proposed in the zones A: extensive production zone at high risk for the importation of contamination from Chad and consisting of the regions of Adamawa, North and Far North;
- Contingency plan: Based on the control of outbreaks which continue to be recorded in this area.
- A permanent health watch with active surveillance geared towards high-risk areas (pig markets, landing yards, etc).
- Permanent surveillance by regional and national rapid intervention teams to take charge of any outbreaks detected.
- Permanent sensitization and capacity building of actors for the improvement of biosafety in the sector and the promotion of good practices in the value chain.
- Free trade in the areas of the marketing of pigs and derived products within zone B, accompanied by rigorous health control and a formal ban on the exit of pigs from the Littoral and Central regions to other regions.
- Strengthening the epidemio-surveillance network.
- Permanent health monitoring supported by management of any outbreaks detected.
- Capacity building of checkpoints and sanitary control of pig movements within the country.
- Improving biosecurity.
- Sensitization, information and training of producers.
- The establishment of an institutional framework for the payment of compensation to disaster-stricken producers.

In practical terms, the steps for cleaning up a household are:

- Delimitation of the risk zone;
- Medical slaughter of all animals in this area (stamping out);
- Disinfections in said farms;
- Crawl space 40 days before resumption of activities.

Summary of laboratory results

Table 2 shows the three variables of the ASF virus belonging to genotype I, characterized during the various examinations carried out in the South region, according to the identified foci. These variables are similar to those encountered in neighboring countries [11].

N/S (Exam number)	Isolate code	Types of samples	Localities	Years	Repeated number
1	CAM/sangm2a/2010	Tissues	Sangmelima	2010	20
2	CAM/ebolo3a/2010	-	Ebolowa	2010	20
32		-	-	1982	19
39	CAM/myomsla224/2016	Serum	Meyomessala	2016	19
44	CAM/binbis126/2017	Tissues	Benbis	2017	19
46	CAM/kribi143b/2018	Tissues	Kribi	2018	19
47	CAM/kribi143c/2018	Tissues	Kribi	2018	19
48	CAM/mvengue42a/2018	Blood	Mvengue	2018	19
50	CAM/mvengue42b/2018	Blood	Mvengue	2018	19
52	CAM/1982 (CAJ90777)	-	-	1982	23

Table 2: *Characteristics of genotype I variables from ASF diagnoses carried out in the South region (Cameroon).*

This shows the cross-border nature of the disease, with a strong involvement of human activity through the movement of animals and their products, hence the need to establish sub-regional control methods.

Table 3 highlights the variation and persistence of the disease in the South region of Cameroon as a function of time and urgently calls for appropriate means to control this disease.

Years	2013	2014	2015	2016	2017	2018
ASF positivity (%)	40	83,3	80	100	71	40

Table 3: *Prevalence of ASF positivity in the South region (Cameroon).*

Results of the cross-sectional study

Figure 6 shows the different disease outbreaks identified in the study area. This figure shows that more than half of the breeders have already experienced the disease. This justifies urgent measures to be taken to limit losses.

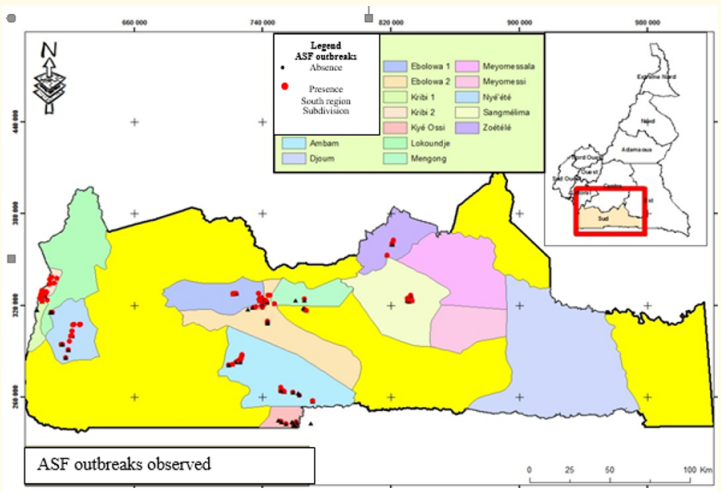

Figure 6: *Distribution map of locations of surveyed farms having or not experienced ASF in the South region.*

Socio-professional characteristics of the farmers surveyed

At the end of this survey, a total of 401 breeders were listed, of which 77.1% were men, and 22.9% were women. Regarding marital status, 76.6% are married, 22.4% single and 1% divorced. As for the level of study, 67.3% have the secondary level, 21.2% the primary level and 11.6% the higher level. In addition, 36.7% of respondents were civil servants, 25.9% traders, 16.5% farmers, 13.7% were breeders, and 7.2% retirees. Experience shown that 59.1% of respondents had experience < 5 years, 27.4% between 5 - 10 years, 6.7% belong to the 11 - 15 years interval, 4.5% years < 20 years and 4.2% over 20 years (Table 4).

Factors	Variables	Effective	Percentages %
Profession	Breeders	55 (13.7%)	13.7
	Farmers	66 (16.5%)	16.5
	Traders	104 (25.9%)	25.9
	Civil servants	147 (36.7%)	36.7
	Retired	29 (7.2%)	7.2
Sex	Male	309 (77.1%)	77.1
	Female	92 (22.9%)	22.9
Marital status	Single	90 (22.4%)	22.4
	Married	307 (76.6%)	76.6
	Divorced	4 (1.0%)	1.0
Study level	Primary	85 (21.2%)	21.2
	Secondary	270 (67.3%)	67.3
	University	46 (11.6%)	11.6
Experience	< 5 Years	237 (59.1%)	59.1
	5 - 10 Years	110 (27.4%)	27.4
	11 - 15 Years	27 (6.7%)	6.7
	≤ 20 Years	10 (2.5%)	2.5
	≥ 20 Years	17 (4.2%)	4.2

Table 4: *Socio-economic parameters of the farmers surveyed.*

Socio-professional characteristics of the farms surveyed

From this study, it shows that 19.2% of farms in the region are located in the department of Dja--Lobo, 36.4% in Mvila, 28.7% in the Ocean and only 15.7% in the Ntem valley. Among the breeding systems encountered, almost all (85.5%) were semi-intensive, 11.2% extensive and 3.2% intensive. Regarding the number of animals per farm, 91.0% of farms had a number less than 50 animals, 4.7% a number between 51 - 100 animals, 4.2% had a number greater than 100 animals. The different breeds encountered were distributed as follows: 10.5% local breeds, 44.6% hybrids and 44.9% exotic (improved) breeds. From the point of view of livestock types, more than 84.0% are fatteners-piglets breeders, 10.5% exclusively breeders and 5.5% piglets breeders. The farming method practiced in the study area is 90.8% in confinement while 9.2% are straying. The distance between the farms varies such that, 53.2% are at a distance less than 20m, 31.2% between 20 - 500m and 15.7% greater than 500m (Table 5).

Factors	Variables	Effective	Percentages %
Locality	Dja-Lobo	77 (19.2%)	19.2
	Mvila	146 (36.4%)	36.4
	Ocean	115 (28.7%)	28.7
	Ntem valley	63 (15.7%)	15.7
Breeding system	Extensive	45 (11.2%)	11.2
	Semi-intensive	343 (85.5%)	85.5
	Intensive	13 (3.2%)	3.2
Number of animals per farm	≤ 50 animals	365 (91.0%)	91.0
	51 - 100 animals	19 (4.7%)	4.7
	≥ 100 animals	17 (4.2%)	4.2
Breeds of pigs reared	Local	42 (10.5%)	10.5
	Hybrid	179 (44.6%)	44.6
	Exotic	180 (44.9%)	44.9
Breeding types	Piglets	22 (5.5%)	5.5
	Breeders-Piglets	337 (84.0%)	84.0
	Breeders	42 (10.5%)	10.5
Breeding mode	Straying	37 (9.2%)	9.2
	Confinement	364 (90.8%)	90.8
Distance between neighboring farms	≤ 20m	213 (53.3%)	53.1
	20 - 500m	122 (31.2%)	31.2
	≥ 500m	63 (15.7%)	15.7
			Total = 100%

Table 5: *Socio-economic parameters of the farms surveyed.*

Prevalence of African swine fever in the South region according to the socio-economic characteristics of the respondents and their farms

The prevalence according to the socio-professional characteristics of the respondents with their farms, and the results of the Chi-square test are shown in table 5 and 6. The overall prevalence of the region is 18.11% with a standard deviation of 34.95. The influences of socio-professional characteristics are not significant ($p > 0.05$), as shown in table 7 and 8.

Factors	Variables	Prevalence (Mean ± Standard deviation)	P
Sex	Male	0,19 ± 0,34	0,62
	Female	0,17 ± 0,35	
Profession	Breeder	0,10 ± 0,28	0,43
	Farmer	0,22 ± 0,39	
	Trader	0,18 ± 0,34	
	Civil servant	0,19 ± 0,35	
	Retired	0,20 ± 0,36	
Marital status	Single	0,13 ± 0,32	0,29
	Married	0,20 ± 0,36	
	Divorced	0,07 ± 0,15	
Study level	Primary	0,20 ± 0,37	0,77
	Secondary	0,18 ± 0,35	
	University	0,16 ± 0,31	

Table 6: *Summary of ASF prevalence according to the socio-professional characteristics of respondents in the South region.*

Factors	Variables	Prevalence	P value
Locality	Dja-Lobo	0,17 ± 0,33	0,86
	Mvila	0,17 ± 0,33	
	Ocean	0,20 ± 0,36	
	Ntem Valley	0,19 ± 0,38	
Breeding system	Extensive	0,26 ± 0,43	0,30
	Semi-intensive	0,17 ± 0,34	
	Intensive	0,20 ± 0,33	
Breeds of pigs reared	Local	0,27 ± 0,42	0,23
	Hybrid	0,18 ± 0,37	
	Exotic	0,16 ± 0,31	
Breeding mode	Straying	0,22 ± 0,42	0,52
	Confinement	0,18 ± 0,34	
Number of animals per farm	< 50 animals	0,18 ± 0,35	0,88
	50 - 100 animals	0,22 ± 0,35	
	> 100 animals	0,18 ± 0,29	
Types of Breeding	Piglets	0,10 ± 0,26	0,53
	Breeders-Piglets	0,19 ± 0,35	
	Breeders	0,17 ± 0,36	
Distance between farms	< 20m	0,18 ± 0,38	0,84
	20 - 500m	0,19 ± 0,31	
	> 500m	0,16 ± 0,30	

Table 7: *Prevalence of ASF according to the socio-economic parameters of the farms surveyed.*

Factors	Unstandardized coefficients
Locality	0.01 (-0,03; 0.05)
Sex	-0.005 (-0.09; 0.08)
Profession	0.02 (-0,01; 0.05)
Marital status	0.04 (-0,04; 0.13)
Study level	-0.03 (-0,10; 0.03)
Experience*	0.04 (0,12; 0.08) *
Breeding system	-0.07 (-0,21; 0.08)
Breeds of pigs reared	-0.04 (-0,10; 0.05)
Type of Breeding	0,07 (-0,13; 0.25)
Number of animals per farm	-0.005 (-0,09; 0.08)
Breeding mode	0.02 (-0,07; 0.10)
Distance between neighboring farms	0.01 (0,04; 0.06)
(Constancy) n = 401	0.09 (-0,63; 0.27)

Table 8: *The linear regression model of the socio-professional characteristics of the respondents with their farms and the P value. P<0.05; P*<0.029; R = 0.182ª.*

Regression coefficient and the P value

These predicted values are: a. Predicted values: (constant), distance between neighboring farms, marital status, sex, type of farms, locality, number of animals per farm, type of farm, level of study, profession, experience, bred breed, breeding system; b. Dependent variable: Prevalence.

Only the experience is the socio-professional character significantly influences the prevalence of the disease in the South region and in a positive way.

Discussion

The study was carried out in the South region of Cameroon, which is in zone B of the strategic plan for the prevention and control of African swine fever. This area is nothing more than a small pork production area, but a large consumption area [8].

Regarding the retrospective study, the results obtained highlight the real past situation of this disease in the field, even better its presence and persistence in time and space. It also made it possible to carry out a cross-sectional study in areas with high pig activity, but also at high risk for ASF.

The spatiotemporal distribution of ASF outbreaks between 2006 and 2019 reveals a total of 167 outbreaks in 13 years. This result is superior to that obtained by Magadla Noluvuyo., *et al*. [12] in a similar study from 1993 to 2011 in South Africa with a total of 31 outbreaks in 18 years. This last result can be explained by the fact that, more than 70% of the cases are declared on all the control zones (park-farms) where the study took place, which is not the case in this present study. The constantly increasing development of these outbreaks in the departments most at risk where pig activity is very intense and developed, would explain the fact that breeders rarely report cases, because of the non-compensation after the slaughtering measures provided for by law. On the contrary, they apply what is prohibited in the event of ASF, namely marketing the animals through a network of pig breeders. The consequence is the dissemination and persistence of this disease through the links in the production chain (breeders-buyers-traders-consumers). The Dja-Lobo and the Ocean are the departments with the highest risk of infection, in terms of the number of outbreaks noted. In addition, several other parameters can support the above: First, due to the fact that the epidemiology of the disease is poorly understood in the country, but also due to the lack of data on the status of animals reared [4], then due to the farming methods, namely 90, 8% semi-intensive and 9.2% rambling, which makes it difficult to apply health control measures. A similar result was obtained in a study on the effects of livestock management on the occurrence of ASF outbreaks in Sardinia [13] and the transmission of ASF virus easy, especially since the animals communicate between the different farms. A similar finding also emerges from the study carried out on the eco-epidemiology of ASF in Cameroon by Njayou [9]. Also, factors such as size, the management of farms and their distances increase the frequency of outbreaks of the disease. This was also highlighted by Muhangi., *et al* [14]. In addition, animal movements from north to south, from east to west as well as the traffic in frozen pigs across the Cameroon-Gabon-Equatorial Guinea borders may be one of the causes of these multiple outbreaks of ASF in the south. This corroborates with statements made by FAO [15] on illegal movements of infected animals and their products.

In addition, the persistence of ASF outbreaks in the southern region and its evolution would be justified by the fact that several surviving animals or even past epizootics still remain on the farms [16].

Also, the increase in the number of pigs in the South may be a risk factor for the increase in these outbreaks as reported by Penrith., *et al* [4]. Finally, the fact that ASF is endemic in domestic pigs, in most African countries, the interval between the appearances of the disease followed by the declaration, and the application of sanitary measures, would further explain the multiplication of foci in space and time. This is the situation in which many African countries find themselves [17,18], where little information is available on the disease.

In addition, the results of LANAVET carried out in the South (Cameroon) show that three variables of the TTS virus [19,20,23] circulate in the region and belong to genotype I. These variables are similar to those encountered in neighboring countries, which would thus reflect the illegal movements of infected animals and their products across borders [15]. The circulation of these variables throughout the country is demonstrated by Wade., *et al*. [11] in a study carried out on the genetic characterization of the ASF virus in Cameroon. Confirmation of the circulation of the same genotype I is demonstrated by Ngu Ngwa., *et al*. [19] on Epidemiology of African Swine Fever in Piggeries in Center, South and South-West of Cameroon.

Of the 401 respondents surveyed, more than half had already experienced cases of ASF, which gives a prevalence of (18.11% ± 34.95%). This result can be explained by the fact that few studies have been carried out, making it difficult to understand the epidemiology. Also, the fact that the South region belongs to zone B, which is said to be at very high risk, may be an explanation for the result obtained. This result is higher than those obtained in other regions of the country and neigbouring nations like the 1.79% in the farms of West Cameroon (Koung-khi-Nde-Bamboutos) [20], 5.5% in farms in the northern regions of Cameroon [21] and 1.7%) in a study conducted in the Benue state, Nigeria [22]. This difference could be explained by the fact that, in these areas, studies are carried out on a continuous basis, thus making it possible to evaluate over time and space the means of prevention and control put in place to combat ASF.

On the other hand, our results are similar to those obtained by Ngu Ngwa., *et al*. [19] in pig farms in the Center-South-South-West (15.2% ± 16%), 23.3% by Nkana [23] in pig farms in the Bafoussam area, 15.3% by Njayou [9] in farms in the north and 37% by Bisimwa., *et al*. [24] in South Kivu province of the Democratic Republic of Congo. All these results highlight the endemic nature of the disease on the one hand, and the livestock systems set up, the management of livestock, the biosecurity measures, the distribution of livestock, poverty, but also the movements of people and their property which are not respected, and thus constitute risk factors which hamper the effectiveness of prevention methods and the means of combating this cross-border disease.

Conclusion

This study shows that African swine fever is a complex disease with severe socioeconomic consequences. Due to its cross-border character, it has the capacity to expand and persist in countries where pig production is poorly understood. The epidemiology of ASF poorly understood in most African countries in general and in Cameroon in particular, probably explains the growing number of foci in space and time. This is what emerges from the retrospective analysis of this study which made it possible to know the constantly increasing evolution of households in the South region from 1999 to 2019. In addition, the transversal part made it possible to obtain data updated with a disease prevalence of 18.11% ± 34.95%, a description of the socioeconomic characteristics of the respondents and their farms, where the only factor that had a significant influence was experience. The results of this study could therefore be used to better put in place the means of struggle, to revitalize the surveillance networks in the departments most at risk, and to keep those at lower risk unharmed. The poor archiving of statistical data on the disease and the lack of data on the health status of animals reared and acquired throughout the country, make its eradication almost impossible. Since there is no vaccine or treatment for the disease to date, the mastery of epidemiology, prevention and control of infection must be well known to all, so that strategic measures are well applied, for effective and lasting control. Biosecurity measures, general hygiene rules, sanitation of farming methods, individual and collective awareness-raising and even self-discipline of breeders, control of the movement of people and goods remain the practical means to fight against this disease which hinders the development of the pig industry in the country.

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Conflicts of Interest

The authors declare no conflict of interest in the publication of this paper.

Bibliography

1. Badouard B and Berthelot N. "Le rendement des porcs charcutiers en France aujourd'hui: quelles conséquences sur les résultats de gestion?" IFIP-Institut du porc, La Motte au V (2012).

2. Mopate LY., *et al*. "Caractéristiques et performances des élevages porcins urbains et périurbains des savanes d'Afrique centrale: cas des villes de Garoua, Pala et Bangui. Savanes africaines en développement". Montpellier, CIRAD (2010): 9.

3. FAO-AU-ILRI. "Regional strategy for the control of African Swine Fever in Africa" (2017).

4. Penrith ML., *et al*. "African Swine Fever virus eradication in Africa". *Journal of Virus Research* 173.1 (2013): 228-246.

5. Petrov A and Salzungen B. "Design and validation of optimized Tools for Classical and African Swine Fever surveillance and pathogenesis research". *Inaugural-Dissertation zur Erlangung der Doktorwürde der Tierärztlichen Fakultät der Ludwig-Maximilians Universität München* (2015).

6. Penrith ML., *et al*. "Epidemiology of African Swine Fever in Africa today: Sylvatic cycle versus socio-economic imperatives". *Willy Transbandary and Emerging Diseases* (2019).

7. Minepia. "Schéma Pour le Développement des Filières de L'élevage au Cameroun"; Ministère de L'élevage, des Pêches et des Industries Animales: Yaoundé, Cameroun, Volume IV (2009).

8. Minepia. "Plan Stratégique de Prévention et de Lutte Contre la Peste Porcine Africaine (PPA) au Cameroun;" Ministère de L'élevage, des Pêches et des Industries Animals: Yaoundé, Cameroun (2015).

9. Njayou AN. "Eco-Épidémiologie de la Peste Porcine Africaine au Cameroun"; Ecole Inter-Etats de Sciences et de Médecine Vétérinaire-Université Cheikh Anta Diop: Dakar, Senegal (2016).

10. Thrusfield M. "Veterinary. Epidemiology". 3rd edition.; Blackwell Science Ltd.: Oxford, UK (2007)

11. Wade A., *et al*. "Genetic characterization of African swine fever virus in Cameroon, 2010-2018". *Journal of Microbiology* 57 (2019): 316-324.

12. Magadla NR., *et al*. "The African swine fever control zone in South Africa and its current relevance". *The Onderstepoort Journal of Veterinary Research* 83.1 (2016): a1034.

13. Mannelli A., *et al.* "Effect of husbandry methods on seropositivity to African swine fever virus in Sardinian swine herds". *Preventive Veterinary Medicine* 32.3-4 (1997): 235-241.

14. Muhangi D., *et al.* "A longitudinal survey of African swine fever in Uganda reveals high apparent disease incidence rates in domestic pigs, but absence of detectable persistent virus infections in blood and serum". *BMC Veterinary Research* 11.106 (2015).

15. FAO. " African Swine Fever (ASF) recent developments". Timely updates 6 (2012).

16. Fasina FO., *et al*. "Risk factors for farm-level African Swine Fever infection in major pig-producing areas in Nigeria", 1997-2011". *Preventive Veterinary Medicine* 107 (2012): 65-75.

17. Luther NJ., *et al*. "Polymerase chain reaction (PCR) detection of the genome of African swine fever virus (ASFV) from natural infection in a Nigerian baby warthog (*Phacochoereus aethiopicus*)". *Nigerian Veterinary Journal* 28 (2007): 63-67.

18. Misinzo G., *et al*. "Molecular characterization of African swine fever virus from domestic pigs in northern Tanzania during an outbreak in 2013". *Tropical Animal Health and Production* 46.7 (2014): 1199-1207.

19. Ngu Ngwa V., *et al.* "Epidemiology of African Swine Fever in Piggeries in the Center, South and South-West of Cameroon". *Veterinary Sciences* 7.3 (2020): 123.

20. Djuidje KM. "Prévalence de la peste porcine africaine et de la Salmonelloses dans les élevages à l'Ouest-Cameroun". ISSS-Université des Montagnes: Banganté, Cameroon (2019): 98.

21. Nguena GNR. "Epidémiologie de la Peste Porcine Africaine dans les Régions Septentrionales du Cameroun". Thèse de doctorat. Ecole des Sciences et de Médecine vétérinaire-Université de Ngaoundéré, Cameroun (2017): 76.

22. Asambe A., *et al.* "Prevalence of African swine fever virus and classical swine fever virus antibodies in pigs in Benue State, Nigeria". *Tropical Animal Health Production* 50.3 (2018): 689-692.

23. Nkana G. "Epidémiologie de la Peste porcine Africaine (PPA) Dans les Élevages Porcins de la Ville de Bafoussam (Ouest du Cameroun)". Thèse de doctorat. Ecole des Sciences et de Médecine vétérinaire ISSS-Université des Montagnes: Banganté, Cameroon (2014): 55.

24. Bisimwa NP. "Evidence for the presence of African swine fever virus in apparently healthy pigs in South-Kivu Province of the Democratic Republic of Congo". *Veterinary Microbiology* 240 (2020): 108521.

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