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African Swine Fever (ASF) Insurance Premium Estimate Test at Mont-Ngafula in Kinshasa, Democratic Republic of Congo (DRC): A Model Under Construction

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Abstract: In order to estimate the average insurable pig numbers held by breeders, their monetary value, the ASF insurance premium in the event of adoption of the product, a survey was carried out from January 2 to April 10, 2021, among 63 pig farmers. from Mont Ngafula in Kinshasa, DRC to collect information relating to the construction of a future model of local management of this risk. The average insurable pig population owned by a breeder from Mont-Ngafula in Kinshasa is *8,571 ± 3.48* and this represents an average monetary value of *2.604 ± 1.092,87* with an average ASF insurance premium of *169.27 ± 71.03 $*. The correlation matrix showed a strong link between the pig workforce, monetary value of the pig herd, ASF insurance premium, frankness and indemnification. The model of linear regression explains *77.09%* of the link between the insurable pig population held by a breeder and the premium payable in the event of adoption of ASF insurance. The equation for the line is $Y = 17.916\,x + 15.709$. The Multiple Correspondence Analysis (MCA) in turn shows that there are three variables that have a higher correlation for the management of this ASF and these are the level of study *(0.65),* the veterinary consultation *(0.55)* and the payment. of the PPA premium *(0.42)*. The alignment of the first bisector for all variables suggests that they are normally distributed. Pig farmers complain about the lack of funding and support from the state services in charge of the pig sector.

Keywords: Pig Farming, African Swine Fever, Insurance, Premium, Kinshasa

1. Introduction

Risk is an integral part of any agricultural and livestock activity. Farmers and pastoralists face a wide range of market and production risks that impact their incomes, making them volatile and unpredictable from year to year. In a context of high volatility in agricultural and livestock prices - both inputs and products - different instruments can be implemented to guarantee the income of farmers / breeders and secure their investments over time (price support, border barriers, etc.). Insurance schemes seem to have seen some interest across the world in recent years [1]. In addition, they can promote access to credit and are fully integrated into a policy of production growth but also of the development of small farms and livestock.

The prospect of developing these insurances is attractive since by making it possible to secure income and credit systems they could contribute to the development of more intensive and therefore more productive systems. The type and severity of risks faced by farmers and pastoralists are

particularly difficult for smallholders in developing countries to bear. Without proper management, agricultural and livestock risks can slow economic development, hamper poverty reduction and contribute to the emergence of humanitarian crises. Many of these risks are manageable. Farmers, pastoralists, rural communities, financial service providers, input suppliers, private insurers and humanitarian organizations each have strategies for coping with chronic and catastrophic risks [2].

Wossen, et al., 2018 cited by PARM, 2019 [3] assert that agricultural and livestock activity is exposed to several types of risks introducing as many uncertainties in production and consumption, reducing the well-being of rural households. Most traditional development actors are now interested in West Africa (WA) (Non-Governmental Organizations (NGOs), farmers' organizations (FOs), Micro-Finance Institutions (MFIs), States, large international organizations such as WFP, IFAD, UNDP, BOAD, and to add insurers and reinsurers from North and South. The Senegalese state thus created a national agricultural insurance company of Senegal (NAICS) in 2008, financed by the State and insurers, whose mission is to manage the sector. Studies and projects are multiplying, such as for example the "UEMOA crop insurance" initiative of BOAD. However, concrete achievements are still rare: insurance for cotton and corn in Mali and Burkina Faso developed by PlaNet Guarantee / GIIF), future groundnut and maize insurance in Senegal and Benin (PlaNet Guarantee, NAICS, World Bank), “livestock” and “tomato” insurance in Senegal (NAICS). Things are a little more advanced in Eastern and Southern Africa, although overall agricultural insurance in Africa only represents 1% of the world market [4].

The volatility of prices on agricultural markets around the world and the consequences of climate change have created a craze for insurance systems which in some countries constitute one of the strategic elements of agricultural and livestock policy. This is particularly the case in the United States, Canada and Spain [1]. Pigs are susceptible to a variety of diseases that affect productivity and consequently the income of all producers, whether they are raising a single stray pig or running large commercial enterprises [5]. ASF is listed as a disease in the Terrestrial Animal Health Code published by the World Organization for Animal Health. It is a disease that must be notified to the OIE (OIE Terrestrial Animal Health Code). There is no treatment described in the scientific literature or vaccine against this disease [6].

The disease is known for its economic impact on small pig farmers and emerging industrial pig farms. It negatively impacts the livelihoods of many poor households who depend on pig farming as a source of protein and income, a means of capitalizing on savings and a safety net in times of deprivation. Many of these pig farmers have lost or will lose their operations due to ASF. At the same time, market prices have skyrocketed: retail prices in China are up 78% (month-to-month) in September 2019, with knock-on effects for consumers. At the national level, among the main consequences of African swine fever are the loss of international trade status and the costs of implementing drastic measures to control the disease. In Vietnam, for example, it is estimated that nearly 6 million pigs have been culled since February 2018, or around 20% of the pig population. A significant figure in a country where the pig sector was estimated at 4.03 billion USD, or nearly 10% of the national agricultural sector [7]. According to the IOE (2020), the mortality rate can reach 100% in the small pig producer and Tona Tona et al., 2020 [8] state that the losses can go up to 24 ± 14% of the provincial or national pig herd in Kinshasa, DRC.

The control of health in pig breeding results from the balance between the presence of pathogens, the infection pressure, the immune status of the animal or herd and the environment of the animals, i.e. breeding conditions. Numerous studies highlight biosecurity, hygiene or breeding practices as protective factors for the expression of pathologies in breeding [9]. The link between health control and certain technical-economic parameters such as losses, health expenditure, productivity, average daily gain, consumption index has already been demonstrated, in pathologies with marked clinical expression such as PAD, but also pathologies with more insidious or subclinical clinical expression such as respiratory pathologies [10].

2. Material and Methods

2.1. Study Environment

The survey took place from January 02 to April 10, 2021 in Mont-Ngafula, a peri-urban commune in Kinshasa, DRC (Figure 1). The commune of Mont-Ngafula is located between 4°25'35"S and 15°17'44"N and an altitude of 350-580 m. Covering an area of 35,892 ha = 358.92 km^2 with a population of 261,004 inhabitants and a density of 727 inhabitants / km^2 [11]. Mont Ngafula is a town in the south of the city of Kinshasa province in the DRC. It is one of the new settlements, located in the hilly area. The south of the municipality is occupied by the Lukaya valley [12].

2.2. Survey and Data Collection

Information was collected from 63 pig farmers. They were selected because they willingly agreed to collaborate. A survey by interview with the pig farmer coupled with direct observations on these pig farms (PF) was carried out using a questionnaire and made it possible to collect data relating to the profile of pig farmers, size and herd structure, advice on ASF insurance, payment of the ASF insurance premium, veterinary consultation, level of education, breeding practices and especially local management of ASF. An introduction to the use of the kobocollect application in an Android phone, allowed us to map the pig farms surveyed in collaboration with the Satellite Observatory of Central African Forests in acronym SOCAF of the Faculty of Agronomic Sciences of the University of Kinshasa (UNIKIN).

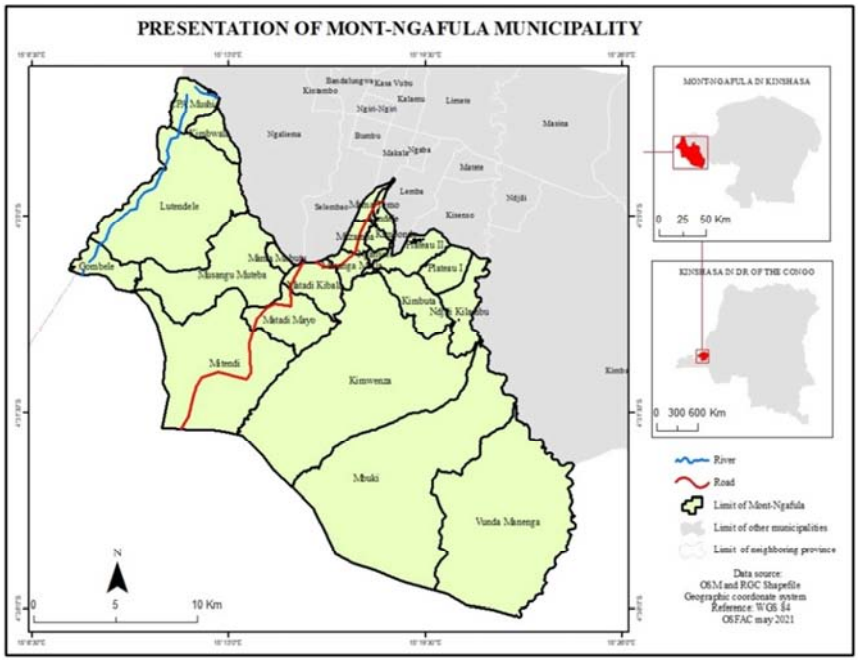

Figure 1. *Administrative map of the commune of Mont - Ngafula in Kinshasa, DRC.*

2.3. Statistical Analyzes

The data collected was recorded in Excel and analyzed with R software version4.1.0 (2021-05-18) -- "Camp Pontanezen" Copyright (C) 2021 The R Foundation for Statistical Computing Platform: i386-w64-mingw32/i386 (32-bit). For the quantitative variables, correlations matrix of the variables and a linear regression was carried out in Excel to validate the link observed between variables in PCA. As for the qualitative data, a Multiple Correspondence Analysis (MCA) was performed to measure the level of correlation of variables, modalities and pig farmers on dimensions 1 and 2.

3. Results

3.1. Mapping of Pig Farms

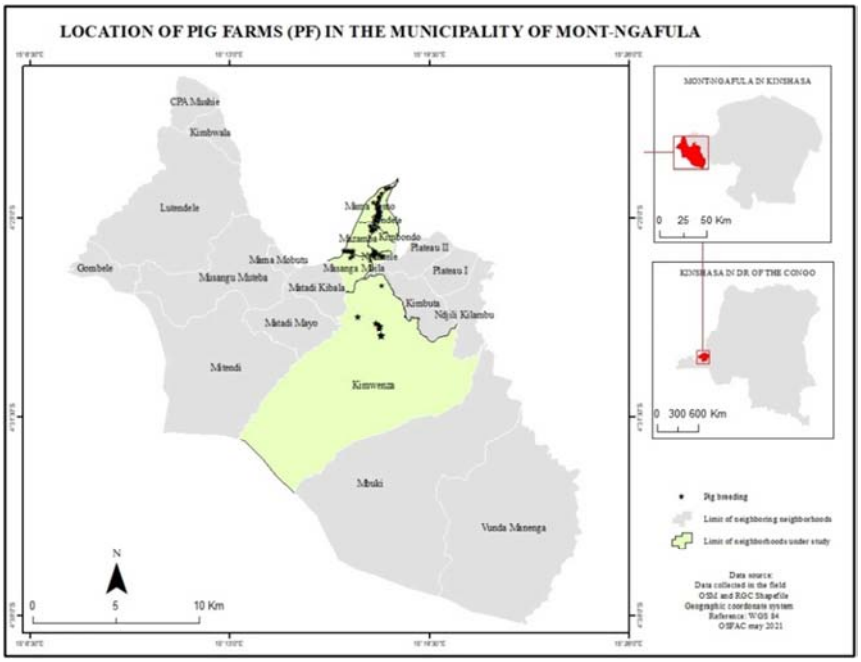

Figure 2. *Location of pig farm (PF) in the municipality of Mont-Ngafula.*

3.2. Correlation Matrix

Table 1. *Correlation matrix of variables.*

	1	2	3	4	5
1	1,0000	1,0000	1,0000	0.878019	1,0000
2	1,0000	1,0000	1,0000	0.878019	1,0000
3	1,0000	1,0000	1,0000	0.878019	1,0000
4	0.878019	0.878019	0.878019	1,0000	0.878019
5	1,0000	1,0000	1,0000	0.878019	1,0000

1: Frankness; 2: Indemnification; 3: Monetary value; 4: Pig number; 5: Premium
The total inertia is 100% (Dim 1 = 96.19% + Dim 2 = 3.81%) and this shows that the variables are strongly correlated (Figure 13.).

3.3. Multiple Correspondence Analysis (MCA) Typology

The MCA applied to fourteen variables with 22 modalities made it possible to discriminate the modalities. The analysis of the eigenvalues shows a regular decrease and that there is an apparent break between the dimensions except between dimensions 2 and 3 of the MCA. The first two axes express 47.57% of total explained inertia, that is, 47.57% of the information in the data table is contained in the first two dimensions. This also means that the diversity of profiles of pig farmers from Mont-Ngafula to Kinshasa cannot be summarized by just two dimensions. The first five axes explain 80.57% of the total inertia explained. All variables are positively correlated with respect to the foreground. The construction of the axes was more influenced by the variables level of studies, veterinary consultation, payment of ASF insurance premium, level of activity and opinion on ASF insurance. The study level variables and the veterinary consultation contributed more strongly in the construction of axes 1 and 2 of the MCA, with a correlation ratio of 0.72 and 0.55 respectively. Figure 2 presents the graphic representation of the modalities of the variables with respect to axes 1 and 2.

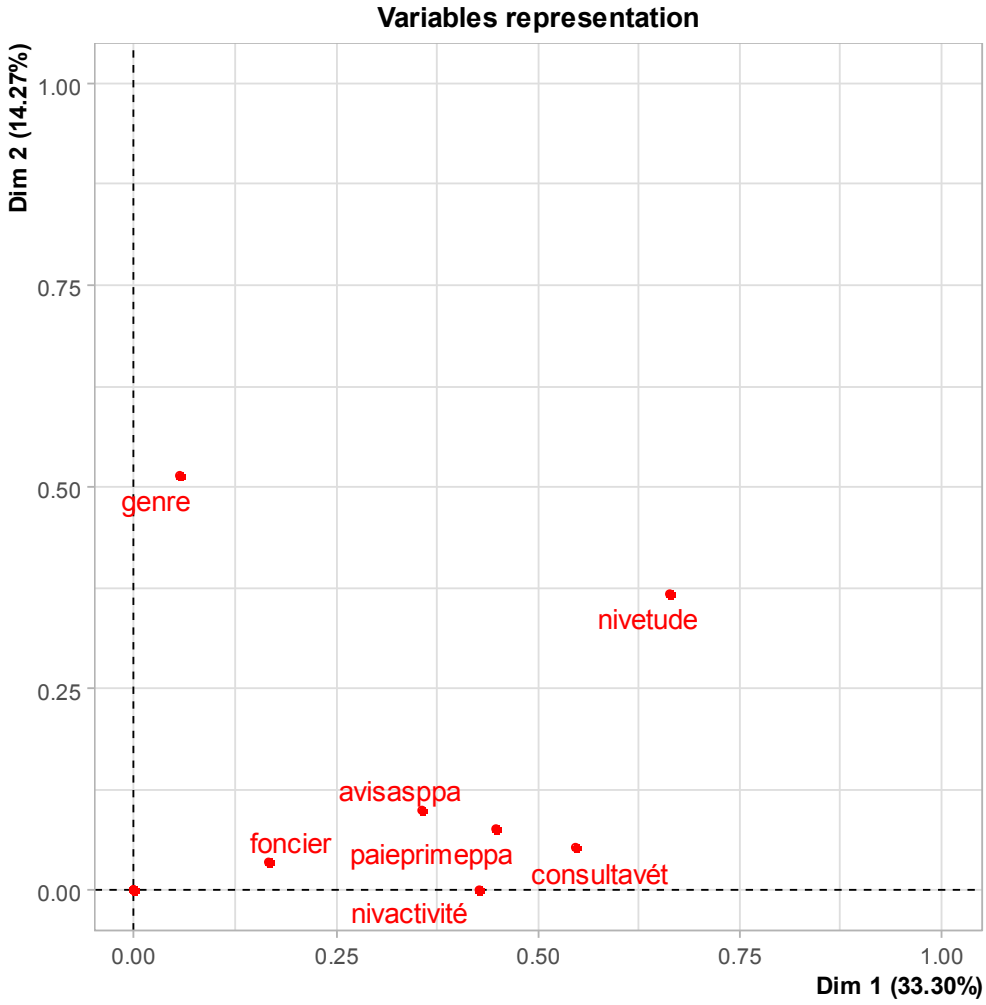

Figure 3. *Graphic representation of the variables in relation to dimensions 1 and 2.*

All the MCA variables are positively correlated, three of which are more correlated: education level (0.65), veterinary consultation (0.55) and ASF premium payment (0.42). The graph of pig farmers for the first two factorial axes (47.57% of inertia explained) is provided by figure 4. When we remove the weakly correlated variables (gender and land tenure) the percentage of explained inertia increases (59, 47%) and in the third dimension we arrive at 72.26%. There are only 6 dimensions that explain the whole phenomenon instead of 8 for the initial interpretation.

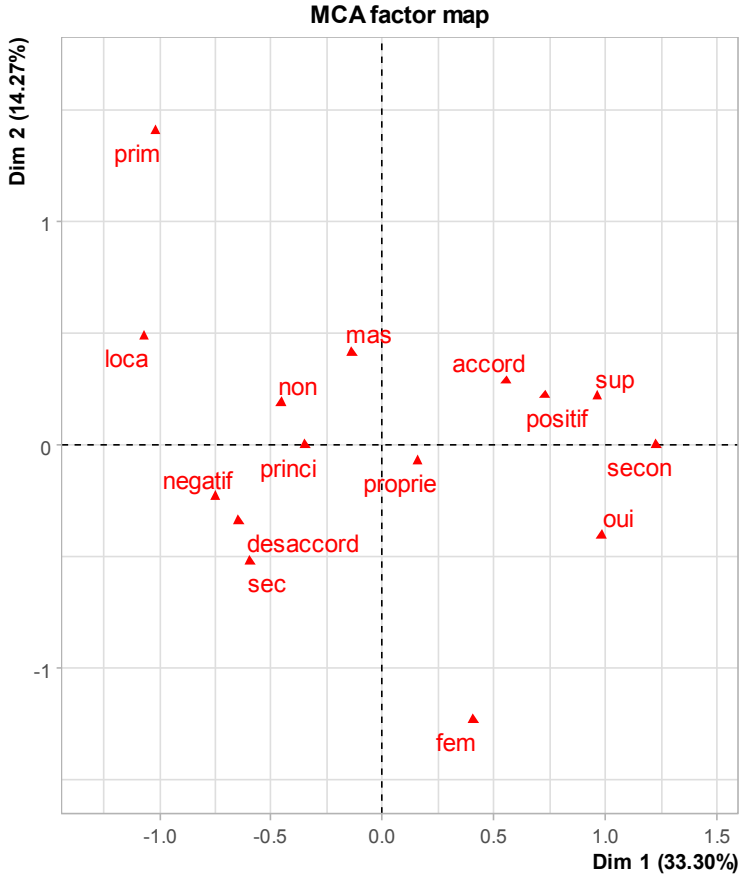

Figure 4. *Graphic representation of the modalities of the variables.*

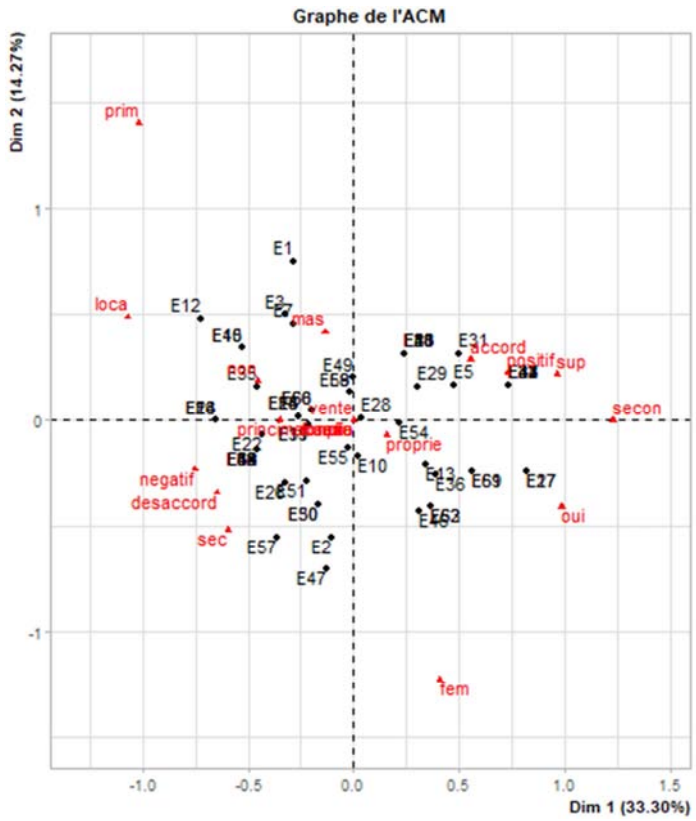

Figure 5. *Graphic representation of pig farmers and the modalities of the variables in relation to axes 1 and 2.*

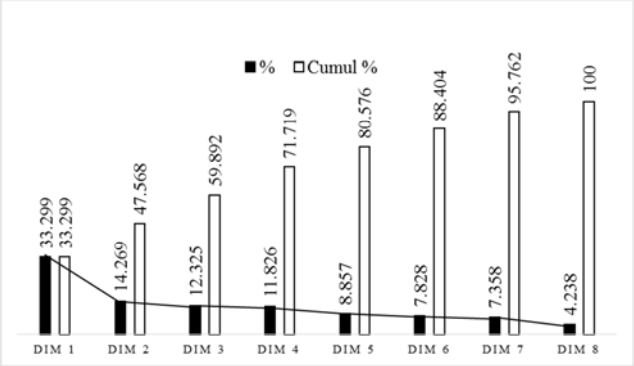

Figure 6. *Eigenvalues histogram.*

We observe a dropout (a sharp bend or break) at Sun 2, followed by a steady decrease. The Kaiser criterion encourages us to retain the factors whose percentage inertia is greater than (100/8 =) 12.5%, in other words to retain the first two factors. We will be satisfied with analyzing the first two factors, which accumulate 47.568% of the total explained inertia (33.299% for the first factor and 14.269% for the second factor).

The first cluster is made up of 45 pig farmers and represent 71.42% while the second cluster includes 18 pig farmers with 28.57%. The second cluster is in favor of veterinary consultation, ASF insurance and the payment of the ASF insurance premium. The pig farmers in cluster 2 often own the land and have a higher education level. Cluster 1 requires sensitization so that their representatives adhere to the assertion of cluster 2.

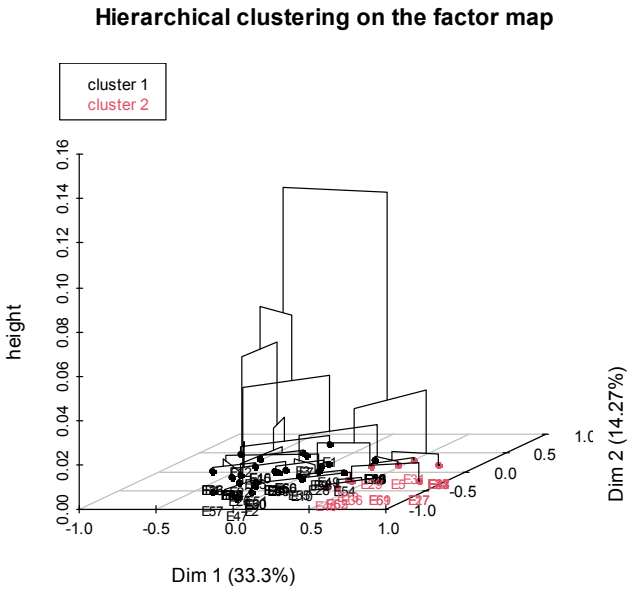

Figure 7. *Pig farm cluster.*

The linear regression model is adapted and explains at 77.09% the link between the insurable pig population owned by a breeder and the premium payable in the event of adoption of ASF insurance. This trend is similar for crossing and compensation. This observation is in agreement with the matric of correlations.

The average pig population owned by a breeder from Mont-Ngafula in Kinshasa is 8,571 ± 3.48 and this represents a monetary value of 2,604 ± 1,092.87 with a ASF payable premium of 169.27 ± 71.03 $.

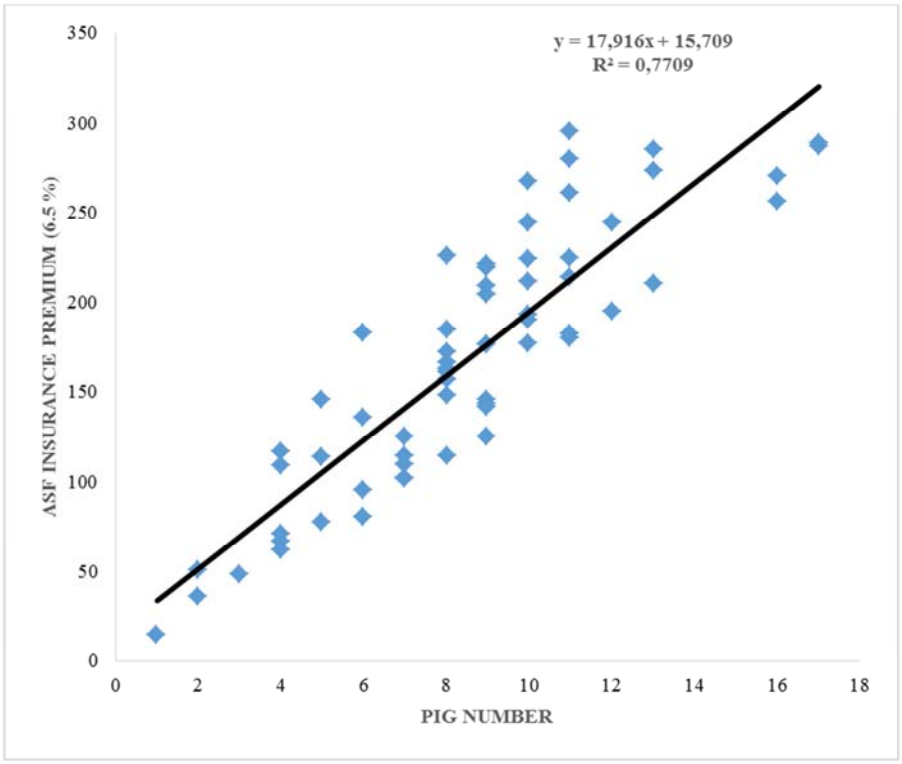

Figure 8. *Evolution of pig numbers and ASF insurance premium.*

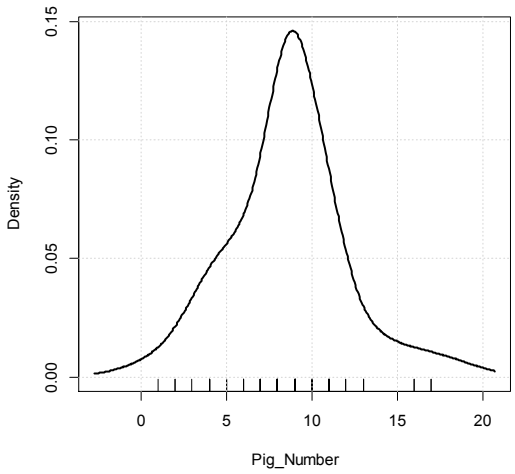

Figure 9. *Distribution of insurable pig numbers.*

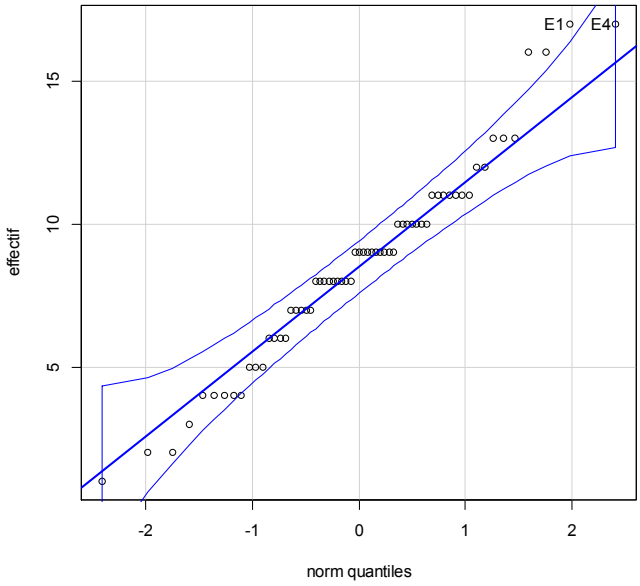

Figure 10. *Pig workforce distribution function.*

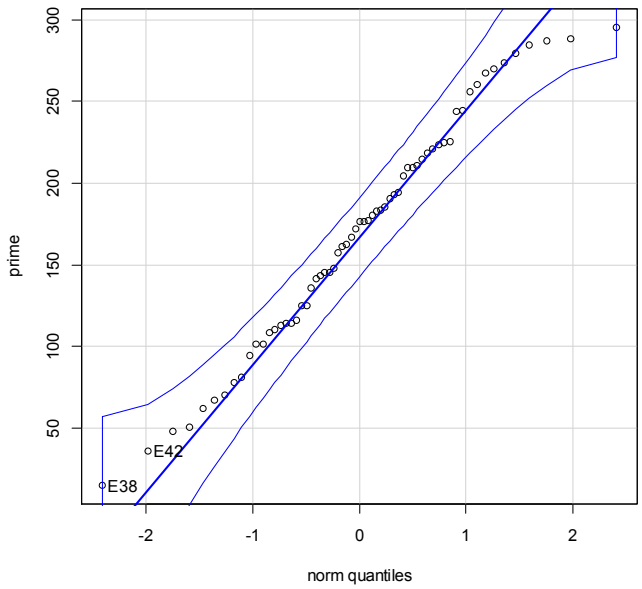

Figure 11. *ASF insurance premium allocation function.*

The alignment of the first bisector both for the pig population and for the ASF insurance premium, suggests that the observed distribution follows a normal law. The trend is similar as shown in Figures 12 and 13 on the scatter plot matrix for the monetary value of the pig herd owned by a pig farmer, the crossing and the compensation.

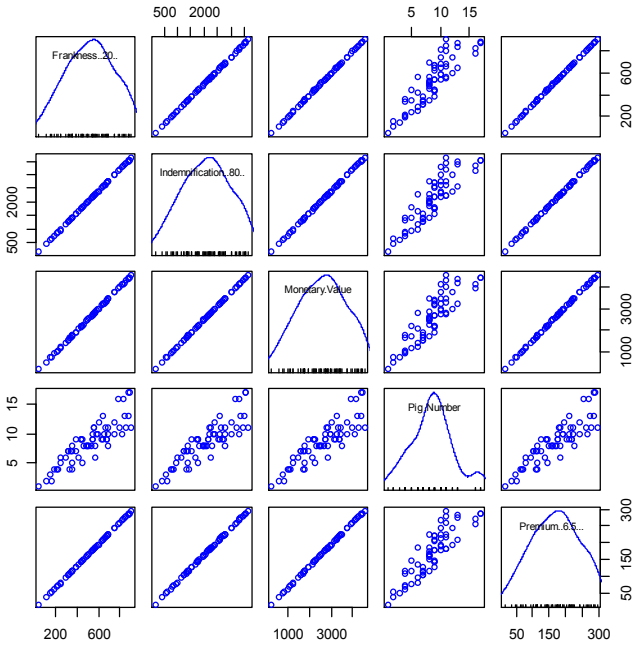

Figure 12. *Point cloud matrix of the variables included in the correlation matrix.*

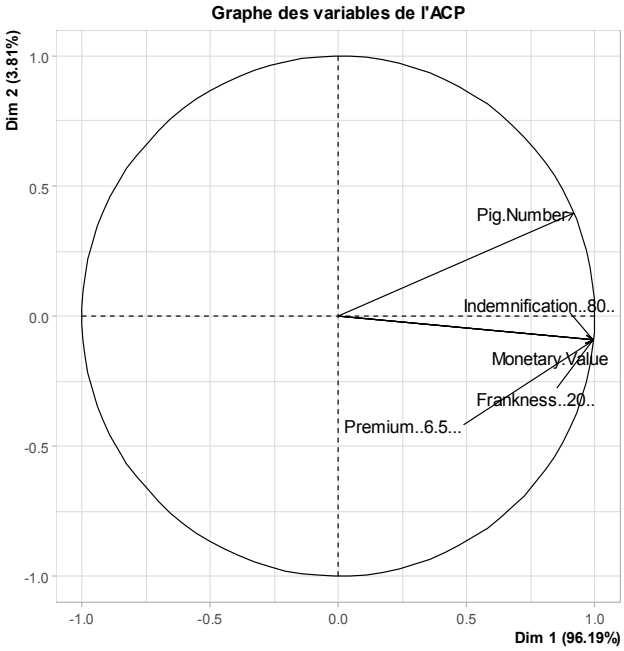

Figure 13. *Circle of correlations of variables included in the PCA.*

3.4. Difficulties for Pig Farmers

Pig farmers complain about the lack of funding and that they are not followed or supported by the state services in charge of the pig sector.

4. Discussion

Lidsky et al., 2017 [13] noted that changes in health risks and their consequences in agriculture and livestock have not been sufficiently studied. Risk management is an issue that is still emerging and is unequally valued in the approaches of the sectors and in the advice given to farmers and breeders. Prevention is insufficient. Thus, farmers and breeders can be helped by several devices. Some of them come under private insurance; others from public intervention; others, finally, of a combination of the two. Agriculture, in addition to market or currency risks, depends on unpredictable natural phenomena, such as the climate or diseases of animals and plants. These uncertainties weigh on the volume and quality of production.

Managing risks that affect many people at the same time (covariate risk) is usually very complex and expensive. Smallholders and rural communities cannot manage these risks on their own without the support of the right financial instruments [14]. In recent years, however, a growing number of pilot programs have tested an innovative tool for managing covariate risk in the agricultural sector: index insurance [15]. Globally, agricultural insurance premiums have increased rapidly over the past decade, from USD 7 billion in 2005 to USD 23.5 billion in 2011. However in developing regions, particularly in Africa and Latin America, the Agricultural insurance penetration rate remains low and a large part of the population has to live and do business without the security of insurance. To be able to develop in emerging markets, agricultural insurance needs a favorable policy framework, suitable infrastructure, innovative products, new distribution channels and advanced technologies [16].

Tona Tona et al., 2020 confirm that as part of the management of the animal health crisis, case of ASF in Kinshasa, DRC, pig producers are resorting to self-insurance and that it is important to offer a PPA insurance product. In addition, public (National Insurance Company: NIAC) and private (RAWSUR, ACTIVA, Financial Insurance Company (FIC) insurers also require the production of reliable data as a condition before offering agricultural insurance products and livestock insurance in the DRC.

Controllers and regulators therefore need to explore possible solutions. Close coordination with other policy areas, in particular agricultural policy is important [17]. The design of a good index depends on the quality of the data available and the technical knowledge necessary to define the parameters. Poorly designed policies will result in high basis risk and failure to compensate farmers who have suffered losses. Consumers need to understand how the index works in order to make informed decisions. Transparency, plain language, and consumer education measures are necessary to ensure that policyholders are effectively covered [18].

Agricultural insurance can help manage risks in the agricultural value chain, stabilize farmer income and promote investment in agriculture. It can also be used as collateral for credit. Its usefulness is crucial to harmonize production incentives, raise awareness of the need to mitigate risk and encourage investment to improve agricultural efficiency [19]. The study aims to provide the information necessary for the implementation of a ASF insurance system in favor of pig producers from Mont-Ngafula in Kinshasa, DRC.

5. Conclusion

The study showed that the variables: pig population; ASF insurance premium; monetary value of the pig herd; deductible and indemnity have a strong correlation. The different distributions of the numerical variables follow a normal law. The MCA in turn shows that there are three variables that have a higher correlation for the management of ASF and these are the level of study (0.65), the veterinary consultation (0.55) and the payment of the ASF premium (0.42). Only a minority of pig farmers (28.57%) are in favor of these three variables. The linear regression model explains at 77.09% the link between the insurable pig population owned by a breeder and the premium payable in the event of adoption of ASF insurance. The equation for the line is $Y = 17.916 x + 15.709$. Pig farmers complain about the lack of funding and that they are not followed or supported by the state services in charge of the pig sector.

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