



Zootechnical and Economic Analysis of Piglet Farming Systems in the Town of Kindu (Case of Mikelenge-Kasuku and Alunguli) Democratic Republic of Congo

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ABSTRACT

In order to better understand the zootechnical and economic characteristics of piglet farming, a diagnostic study was conducted from October to December 2019, three months with 30 pig farmers, in the form of cross-sectional and retrospective surveys in the three municipalities of the town of Kindu in the Democratic Republic of Congo. The results showed that pig farming was practiced by both married and educated men and women. They were mainly zimba, Kusu and Nande and associated livestock with agriculture, private activity or trade. They operated in two different livestock systems (traditional and semi-intensive), with a clear predominance of the traditional system (85.5% of farms). The latter was characterized by semi-intensive hog barns (51.1%), where local-bred pigs were mostly reared (90.4% of farms). The average herd size was 19.2 - 20.1 pigs. In 97% of cases, farmers fed the animals from kitchen waste and agricultural and agro-industrial by-products. The average breeding age was 7.6 -1.8 months and the average litter size was 7.4 - 2.2 piglets. This livestock subsector has real potential for poverty reduction because it generates net incomes on average of \$40 per piglet, depending on the system. Nevertheless, the lack of training of herders, inadequate pig habitats, food and health constraints remain the main factors hindering the development of pig farming in this city. It would be useful to find alternative ways to improve the habitat conditions, feeding and health monitoring of pigs, accompanied by better organisation and capacity building for producers and other players in the hog sector.

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I. Introduction

In developing countries, land use for agriculture or urbanization significantly reduces ruminant grazing areas. This decrease in space is taking place in a context of numerical increase in these animals. These limitations highlight the place of pork, which is often neglected when it is the most widely consumed animal in the world (Cirad, 2007). Pork farming produces seven to eight times more meat per year per tonne of live animals in Africa (Bathily 1975). It is an important source of protein and a secondary activity for several socio-professional categories to which it provides additional income (Missohou et al., 2001; Logténé Mopaté et al., 2010; Ndeby et al., 2009; FAO, 2012a; FAO, 2012b). It thus represents a major asset in the fight against food insecurity and the improvement incomes, particularly in Africa, where population pressure is increasing. As reported by Mopaté Logténé and Koussou (2003), the establishment of a pig farm is most often motivated by the producer's desire to carry out a project and adopt a strategy of diversification of production to combat financial and food insecurity.

The traditional breeding system is favoured by farmers for the simplicity of the techniques implemented and especially for the low investments made (Buldgen et al., 1994; Porphyry, 2009). Indigenous breeds, despite their poor

performance, are favoured by these farmers because of their low purchase price, their hardiness, as well as their great capacity to adapt and enhance waste and even certain plants (FAO, 2012a).

The Democratic Republic of Congo is a country with a strong Christian majority. In this context, pig farming is considered, even where Muslims are numerous (Lalèyè, 2007). With an estimated annual population growth of 3.2% in the DRC, pork production is not sufficient to meet the needs of consuming populations. The DRC is a country with little meat consumption: 13 kilograms per capita per year compared to 41.2 in the world of all species (Mankor, 2009; FAO, 2009). Meat production and consumption are dominated by red meat, 54% of total meats, of which 32% are cattle, 14% sheep and 8% goats (MEPA, 2015). White meat accounts for 46% of total meats (39% poultry and 7% pork). This consumption of pork (which accounts for 15% of white meat) in DR Congo is mainly made by Christians and expatriates. Imports of pork only cover very specific markets, including deli meats, with very low quantities, 1% of domestic production (Niang and Mbaye, 2013; FAOSTAT, 2015; MEPA, 2015).

Numerous studies on the hog industry show that it has been neglected in national livestock support and rural development programmes (Le Glaumec, 2006; Seck, 2007). Moreover, most of the rudimentary practices described more than 15 years ago remain in very significant proportions (Buldgen et al., 1994; Missohou et al., 2001). The objective of this study was to better understand, through a diagnostic analysis of pig production systems, the characteristics of livestock systems, zootechnical and economic performance, and the constraints associated with the development of pig farming.

Data collection

The study was conducted from October to December 2019 and covered 30 pig farms. Smith's method (2013) was used to calculate this sample by considering a margin of error of plus or minus 6% to 95% confidence level. For example, 10 pig farms were surveyed in Mikelenge commune, 10 in Kasuku and 10 in Alunguli commune. Semi-direct interviews with breeders and informants with the technical services (Provincial Inspectorate of Agriculture) and the leaders of the breeders' groups have highlighted the technical and functional characteristics of the farms.

The survey tool was a structured questionnaire to identify information on socio-economic characteristics (sex, ethnicity, marital status, education level, activities, experience, motivation and livestock objectives), practical data and techniques for managing livestock (herd size, habitat and equipment, food, reproduction and health, pig farming), as well as the main problems faced by livestock producers. This questionnaire, tested and then amended, was used by pig owners in descriptive, cross-sectional and retrospective surveys. Its surveys were carried out in pig farms to facilitate direct observations of the breeding environment and the survey of geographical coordinates. Breeders were randomly selected and reasoned, taking into account their availability. As the surveys sometimes coincided with the period of agricultural work, appointments were made through contacts in each neighbourhood. The investigation team consisted of two people. Translators were required in some piggeries where the breeders did not understand French (the language of the questionnaire).

II. Material and Methods

Study Area

The study was conducted in urban areas in three municipalities in the city of Kindu (Mikelenge, Kasuku and Alunguli) in Maniema province in the DRC.

The city of Kindu is confined:

To the north, a vertical right going from the Misubu River right bank, passing through Keka village downstream of the Congo River, to the left bank of the Congo River to the north - left of the Kindu airport runway to its intersection with the Kindu-Lokandu road at the Lwama cemeteries;

To the south, a straight line from the source of the Mikonde River to its mouth upstream of the Congo River, from the right bank to the left bank at the mouth of the Mukolochi River via Rail road to the junction of the Kibombo road;

To the east, a straight line from the source of the Mikonde River to its intersection with a high right going from the Misubu River Bridge;

To the west, from a straight line from the Lokandu crossing, alone from Lwama via the Mikelenge River Bridge on Katako - Kombe Road to Kibombo Road.

It is located between 2-57' latitude from the south and 25 to 52' east longitude, an altitude of 472 m and an area of 101,259 km².

The town of Kindu is made up of three municipalities, one on the right bank, that of Alunguli, and two more on the left bank. These are Mikelenge and Kasuku. It has an area ranging from 101,259 km² and an annual rainfall of 160ml and an average annual temperature of 25 to 27 degrees Celsius with an altitude of 497 m or 25-55 east longitudes and 2.57 of the southern latitude.

a. Sol:

Pedogenesis spawned the climate soil of three types in Maniema:

Arenoferralsol: This group of kaolisaol extends from north to south along the Congo River. It occupies eastern Lubutu, the center of Kailo including Kindu, almost all of Kibombo and southern Kasongo;

Ferralsol: it covers part of Maniema with the exception of southern Kibombo and Kasongo and northern Lubutu;

Ferralsol: a group that is individualizing in the south of Kabambare. The Yangambi ferralsol is identified in northern Lubutu.

The range of different types of soil found in Maniema comes from the variety of the mother rock, climate, altitudes and terrain. The soil being an extremely complex building, it sometimes varies quite considerably in the same ecological zone ranging from the sandy of the territory of Kibombo to the compact clay of the territories of the great forests (Pangi, Kasongo). These clay soils are of excellent agronomic quality characterized by more lush spontaneous vegetation, easier vegetation, a reserve of mineral compounds, especially lime. These soils are part of Kasongo, Kailo, Pangi and Kibombo.

b. Climate:

The climate in the town of Kindu is of the sub-equatorial type, it has two seasons:

A dry season from mid-May to mid-August with morning fog and sometimes disparate rains;

A rainy season that occurs twice a year, season A normally starts from mid-September to January and season B, which runs from February to May.

c. Vegetation

Two large plant formations cover the Maniema, namely: the dense wet forest and the savannah.

The dense forest covers the territory of Lubutu, Punia and Pangi and part of Kailo and Kibombo. This forest is rich in valuable forest species. The forest galleries cover the territory of Kasongo and Kibombo as well as part of Kabambare territory where the forest gallery is called "NIEMA", hence the origin of the name Maniema.

Grassy, shrub and wooded savannahs are found from the south to the centre of Maniema in the kibombo, Kasongo and Kailo territories respectively.

Apart from the savanicole galleries, there are also vast savannahs proper, such as the one in OKONA at 132 km² of Kindu and that of the buffer zones of Lomami in the territory of Kailo.

Grassy, shrub and wooded savannahs are found from the south to the centre of Maniema in the kibombo, Kasongo and Kailo territories respectively.

d. Hydrography

The Congo River flows through the province from south to north. It is navigable from Kindu to Ubundu (Eastern Province). It is watered by several tributaries, the most

important of which are: Lulindi, Musukuyi, Molongayi, Ulindi, Kasuku, Kunda, Lufubu, Lowe, Lueki and Elila.

Note that the town of Kindu is crossed by the Congo River that separates the commune of Alunguli from those of Kasuku and Mikelenge. The tributaries of the Congo River that are found on both sides of this part are: Mikelenge River, Luandoko, Kindu, Misenge, Kange, Mesobo, Luanonga.

On the right bank (Alunguli Commune, there are the following tributaries: the Mesobo, Kabondo, Mangobo, Kamituga, Kindu, and Mutchondo rivers, while on the left bank are the presence of tributaries such as Mikelenge, Makopo, and Kapondjo (Anonymous 2004).

These conditions are favourable for the development of livestock activities, especially that of piglets.

Statistical Analysis

The data obtained was encoded in the 2007 Microsoft Excel spreadsheet and analyzed with the R order software, version R2.13.0. Descriptive analysis of variables calculated frequencies for qualitative variables and average (standard deviation) for quantitative variables.

Due to a lack of information at the livestock level, the economic analyses were carried out according to the following hypotheses by adapting the work of Buldgen et al. (1994):

The amount of food distributed per day averaged 2.5 kg gross per pig in semi-intensive and intensive systems with a humidity level of around 11-20122%;

The amount of food distributed in the traditional system averaged 2.5 kg gross per pig per day in the dry season and 1 kg for supplementation in the rainy season;

The number of animals sold on average each year according to the breeding system (information provided by breeders);

The average live weight for sale was 90 kg in the intensive system, 80 kg in the semi-intensive system and 40 kg in the traditional system;

All intensive producers paid \$80 to deliver food per week; Carcass yield was estimated at 75% for retail sales.

Thus, the data obtained from these conjectures made it possible to estimate the annual profitability of a livestock based on the systems by the accounting approach (Keiser, 2004). Gross and net margins were determined by the following formulas:

Gross margin - gross operating income - total operating expenses

Net margin - total revenue - total expenses or net margin - gross margin - fixed expenses

Cost of producing a deli pig - total loads

Nb. pork products

III. Results

Socioeconomic profile and motivation of breeders

Pig farming is an activity that employs both men and women (50.2% of men and 49.8% of women). It is practiced by breeders from a dozen ethnic groups with a predominance Zimba (41.3%), Kusu (36.5%) Nande (10.8%).

The owners of these farms were mostly Christian (95.98%), married 65.3% and large family owners (9.4 - 5.2 people per household). The majority were educated: 31.6% had primary education and 36.2% had a secondary education.

Table I: Socio-professional profile and motivations of pig farmers in the city of Kindu-RD Congo (%) races.

Settings		Mikelenge	Kasuku	Alunguli	Average
Sex	Male	51,6	48,9	50	50,1
	Female	48,4	51,1	50	49,9
Ethnicity	Lega	4,4	6,9	7,2	6,3
	Zimba	50	50,6	18,8	36,5
	Nande	13,3	24,1	0,7	10,8
	Kusu	25,6	11,5	70,3	41,3
	Bangubangu	1,1	6,9	0	2,2
	Autres	5,6	0	2,9	2,9
Marital status	Single Bride	64,4	62,5	67,6	65,3
	Divorced	10	10,2	21,1	15
	Widower	3,3	4,5	1,4	2,8
		2,2	0	2,1	1,6
Educational level	No	20,6	23	37,5	25,9
	Primary	29,7	27,3	35,5	31,6
	Secondary	38,5	29,5	39	36,2
	Higher	8,8	5,7	5	6,2
Main activity	Public service	8,9	6,8	9,2	8,5
	Private professional	27,8	12,5	17,2	18,8
	Trader	15,6	17	17,7	16,9
	Farmer	13,3	45,4	19,1	24,8
	Breeder	20	10,2	30,5	21,9
	Other	14,4	8	6,4	9,1
Motivation	Advice of Others	4,4	3,4	6,2	4,9
	Own initiative	70,3	80,7	78,5	76,8
	Imitation Family	2,2	3,4	3,5	3,1
	Heritage	27,5	14,8	13,9	18
Production target	Self-consumption	97,8	75	74,3	81,1
	Source of Income	97,8	98,9	91,7	95,4
	Other	2,2	3,4	14,6	7,7
Training in pig farming	Yes	0	21,6	23,8	16,5
	Not	100	78,4	76,2	83,5
Experience in pig farming	< 5 years	7,7	10,2	21,8	14,6
	5-10 years	7,7	6,8	7	7,2
	> 10 years	84,6	82,9	71,1	78,2

Farmers were involved in a variety of industries, including agriculture (24.8%), trade (16.9%) (9%).

In Mikelenge commune, the livestock-farming association was dominant (45.4%), while in Kasuku, where most breeders were generally educated (79.4%), those who only farmed (30.5%) were in the majority. Most (78.2%) breeders of these in the commune of Alunguli generally had more than ten years of experience in the conduct of pigs despite their lack of training in breeding techniques (83.5%) (Table I). They also used family property (92.4%) with pigs generally acquired by purchase of pairs of weaned piglets (82.7%) received as a gift (19.8%). The hog labour force was, in most cases, family-owned (97.2%). In all three regions, hog producers started their business on their own initiative (76.8%). They also practiced this breeding for both income generation (95.4%) self-consumption (81.1%).

Piglet Farming Systems

Two livestock systems have been identified: the traditional production system and the semi-intensive system. Both systems have been defined based on criteria such as habitat type, feeding, conduct and monitoring of livestock activities. In the traditional system the habitat was made of banco or wood, or makeshift material, pigs were generally locally bred and left in rambling, without or with food supplement (kitchen remains in general), and without health monitoring on the part of the breeder. In the intensive system, the habitat was made of definitive material.

The stabulation of pigs, mostly improved breeds, was complete with a proper health monitoring plan and the diet consisted of industrial feeds mixed or not with agri-food by-products. In the semi-intensive system, halfway between the two previous systems, the habitat was in semi-definitive material or improved banco, the pigs were mixed breeds (local, mixed, improved), they received health monitoring, their stallulation was complete and the diet was more or less balanced, consisting of a mixture of two to three raw materials and agricultural waste. Our results showed that the traditional breeding system was the majority with 85.5% surveyed independently of the municipality (Figure 1).

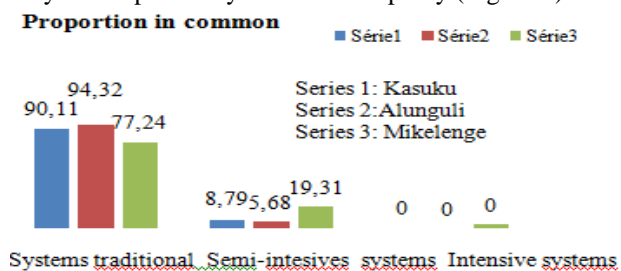


Figure 1. Distribution of livestock systems in the three municipalities of the city of Kindu

Types of production, exploited breeds, herd size

The pig farms visited were not specialized. They were both a spat and a fatterer (95.3%), and mainly exploited the local breed (90.4%) which remains very characteristic of traditional systems (94.2%) and the semi-intensive system (26.8% and 46.3%) respectively.

The proportions observed were almost identical between the municipalities.

The size and composition of the herds of the farms surveyed are shown in Table II. On average, each farm had 19.2 - 20 pigs, with a minimum of 5 and a maximum of 180 piglets.

Breeding pigs accounted for 31% of the herd (15% males and 16% females). Large numbers of pigs were encountered in Mikelenge (28.2 - 20.8). Depending on the breeding

systems, the average herd size of the piglets (28.2 - 15.6 piglets with 29%) those of the traditional system (19.4 - 21 pigs with 31% breeding stock) and the semi-intensive system (16.9 - 12.7 pigs with 24% breeding).

Porcheries and livestock equipment

Of the farms surveyed, only 14.3% did not have pig habitats. The different types of piggeries encountered were traditional shelters (61.2%), semi-modern shelters (24.5%). These consisted of small, very rudimentary piggeries, with straw roofs or rusted zinc sheets. The side walls were mainly made of wood. All had a clay floor. Traditional hog barns were an improved version of the previous ones; recovery sheets were most used as roofs, but also straws or sometimes tarpaulins. The walls were mainly made of wood or bricks on one side, and wood on the other. Semi-modern piggeries had tin or tile roofs. The side walls were built of bricks and mostly cemented.

These piggeries were equipped with a wide variety of feeders and troughs (33% dug wood, 28% dug and cut cans, 25.2% reformed kitchen utensils), and other types of equipment (14.2%). Wooden feeders or troughs were the most used (63.1%). They had the advantage of lasting a very long time but they were expensive compared to split barrels and reformed kitchen utensils. They remained the majority (65.7% of farms) in the traditional system.

They were second only to cemented and concrete feeders and troughs in other livestock systems (43.2% in semi-intensive farming). Other materials encountered were mainly buckets (70.4%) brooms (45.7%). Shovels, wheelbarrows, rakes and other equipment were intended more for agriculture than for livestock.

Driving the food

The pig's diet was mainly based on food waste and greenery. The food used was formulated on most farms (97%) by the breeders themselves and only 5.3% weighed them before distributing them to pigs. The majority of food distribution took place (64.7%) twice a day, including morning and evening. Three types of food were listed based on their nature. Type 1 consisted of kitchen scraps and other agricultural residues associated with greenery (small plants and herbs). Type 2, the most commonly used (76.1%), included a mixture of two or more raw materials to which the farmer added food waste collected from households and restaurants, greenery and other foods. Finally, the whole food (or proven) used alone or mixed with other raw materials (rice bran, mill recovery flour, etc.) characterized type 3. According to farmers' statements, the food materials most used in rations were food waste (90.1% of cases), mangoes (56%), palm nuts (54%), greens and vegetables (53%), and others (Figure 2).

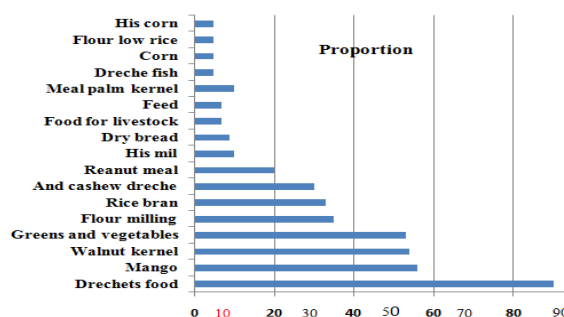


Figure 2. Frequency of food use in piglet diets

semi-intensive (19.5%) system (3.9%). Its acquisition was mainly from a feeder (77.3%) or was offered (13.6%) support for family members. However, this food, which averaged \$25 per 50 kg bag (or \$0.5/kg) was generally mixed by farmers with other less expensive inputs for economic reasons.

According to 90.2% of farmers, finding pig food was not easy. The obstacles cited were mainly the unavailability of certain raw materials (70.8%), their high cost (11%) or both (12.8%). However, the problem of access to wholemeal pork feed was a constraint on all producers, regardless of the breeding system (10.8% of the semi-intensive system and 90.2% of those in the traditional system).

Reproductive conduct and productivity

These parameters included reproductive mode, reproductive age, litter size and weaning. Breeding was done by natural uplift on all hog farms and in an uncontrolled manner (98.1%). The average age of breeding was 7.6 - 1.8 months, the average size per litter was 7.4 - 2.2 piglets and the mortality rates were 16.5% and 12.1%, respectively before and after weaning.

Table II. Size and composition (nb. of heads) of the herd of pig farms in the three municipalities of the town of Kindu.

	Mikelenge	Kasuku	Alunguli
Size by operation	28,2 ± 20,8	18,2 ± 24,2	14,3 ± 14,2
Unansaned piglets	12,0 ± 11,2	7,6 ± 9,3	5,6 ± 7,8
Growing pigs	11,7 ± 9,8	7,1 ± 7,1	6,1 ± 5,4
Breeding pigs	6,4 ± 5,3	5,7 ± 9,4	4,7 ± 4,6

However, these results were subject to variations depending on the breeding system. In the traditional system, the average age of reproduction was 7.5 to 1.7 months. In reality, the breeders did not control this parameter since breeding was most often done without their intervention due to rambling. This parameter was 7.7 to 1.6 months in the semi-intensive system. The size of the litter at birth was higher in semi-intensive (7.5-2.1) and traditional (7.3-2) systems. Pre- and post-weaning deaths were higher in semi-intensive farms (28.8% and 14.1%) respectively. traditional farms (22.3% and 12.2%)

The majority of weaning was done by the sow, which disposed of its young between 3 and 6 months in the traditional (90% of cases) and semi-intensive (70.3%) systems. It was controlled by breeders between 2 and 3 months (60% of cases).

Some practices were aimed at improving pig conformation and identification. For example, castration was practised in 45.8% of the farms surveyed, mainly by breeders (82.5%). It was performed in pigs at a range age of 3 to 5 months (31.8%), 6 and 12 months (27%) or when the animal became unruly (24%). Caudectomy was rare (14.6%), with breeders preferring ear marking (30.5%). Used as an identification, this marking, carried out by the breeders themselves (40.9%), most often occurred after the birth of the piglets (less than a month of age).

Health management

The supply of veterinary services was low and health care for pig farms remained largely traditional with sometimes questionable medical practices. Piggery cleaning was carried out in 77.4% of farms without disinfectant (76%). Vaccination was not widely practiced (14.7%) and breeders were unaware of the diseases against which it is carried out (53.1%) products (50%). In 33.3% of farms, farmers reported deworming. However, the most commonly used products such as salt (4.9%), Cresyl (1.2%), and other traditional products (34.6%) or unknown to breeders (25.9%, urine for example) were not recognized as antiparasitahants in veterinary medicine.

In the event of illness, either the farmers did not intervene (33.9%), or they treated the pigs with traditional products (35%) veterinary drugs (21.2%). A small proportion of breeders (9.8%) combined these two types of treatments. In these farms, health monitoring was the responsibility of the breeder (81.1%), with the exception of 4% who used the services of a veterinarian.

How pigs are operated

The pigs were exploited mainly for self-consumption and the quest for income through sales. In terms of self-consumption, 87.4% of farmers harvested an average of 3.9 - 2.7 pigs per year, representing 20.3% of the herd. This was often taken during religious holidays and ceremonies (93.9%), but also for the family's ordinary consumption needs (68.9%).

In relation to the sale of pigs, our study revealed the existence of two marketing systems: foot and retail. The first, the most common, was practiced by 82.2% of breeders. The latter was very rarely exercised alone (1%) and frequently associated foot sales (16.9%). However, there were no places in the markets for the sale of pigs. For example, animals were sold primarily at home (96.5%) on the farmer's decision and prices were debated to estimate the value (95%). The average price of a pig on feet and the number of pigs sold per year varied from one breeding system to another. The highest sales (40 pigs) and the best prices (\$45-\$75/porcelets, \$4-\$6/kg live weight, \$2/kg of meat) were encountered in the semi-intensive system.

The lower sales were recorded in the traditional system (9 pigs sold for \$35 each) and the semi-intensive system (10 pigs sold for \$50 each, \$4/kg live weight, \$2/kg of meat). Selling by live weight or meat was the prerogative of semi-intensive systems. These modes of sale were absent from the traditional system where the sale based on the estimate prevailed. The major periods of hog sales were during the holidays, Christian ceremonies (48.5%), the dry season (25.9%), or at any time for some breeders (21.4%).

The pigs' faeces were not traded. They were mainly used as manure in application (30%) in the agricultural activity of

Table III. Average breeding performance in pig farming systems in the town of Kindu (RD Congo).

Reproduction settings	Traditional system	Semi-intensive system	Système intensif
Reproductive age (months)	7,5 ± 1,7	7,7 ± 1,6	-
Age at 1st birth (months)	13,5 ± 5,6	13,8 ± 7	-
No. of gestations / sow/year	1,9 ± 0,3	1,8 ± 0,4	-
No. of litters / sow / year	1,9 ± 0,3	1,9 ± 0,3	-
Abortions/year	0,4 ± 0,9	0,5 ± 1	-
Medium size/range	7,3 ± 2,1	7,5 ± 2,1	-
Stillborn	0,6 ± 0,9	0,7 ± 1,6	-
Born alive	6,7 ± 2	6,6 ± 2,8	-
Pre-weaning mortality (%)	22,3	28,8	-
Size of weaning litter	5,7 ± 2,2	5,4 ± 2,5	-
Post-weaning mortality (%)	12,1	14,1	-

herders, and incidentally offered to neighbors and friends, or thrown into the wild in the absence of demand (70%).

Pigs were mainly sold for financial purposes (90.9%) (58,9 %) households (57.2%). In descending order, the city was shopping more in the municipality of Mikelenge (93.2%) Kasuku (83.9%) Alunguli (20%). On the other hand, local employees were the majority (75.4%) in Kasuku commune Pig farming was an informal activity in the absence of performance monitoring tools and the recording of economic technical data (97% of farms). However, the marketing of the products according to the breeders' statements was profitable. For example, 67.5% rated their business as fairly profitable. Few breeders of traditional systems (16.9%) and semi-intensive (14.3%) considered their breeding to be an unprofitable activity.

Production costs and profitability

The economic results (Table V) were for feeder-breeding farms. They were preliminary and calculated on the basis of the breeders' estimates and statements. The analyses show that food costs were the determining factor in the profitability of pig farms. They accounted for an average of 65.3% of expenditures than in semi-intensive systems (47.6%) (69.7%).

The same trend was observed for annual gross margin, with the highest value of \$4618 recorded in the semi-intensive system.

Furthermore, the results showed that the average production costs of a pig is \$151 in the traditional system while in the semi-intensive system \$490 respectively for pigs of 40, 80 and 90 kg respectively.

Considering the selling price of a piglet and the different methods of selling according to the breeding system, a net profit of \$45 was collected. This benefit was slightly higher than estimated in traditional (\$20/piglet) and semi-intensive (\$40/porcelet) systems.

IV. Discussion

Socioeconomic profile of breeders

The proportion of men who own pigs (50.1%) was almost equivalent to that of women (49.9%). This result seems unique, because in West and Central Africa, pig farming is dominated by either men (Ayssiwede et al., 2008; Youssao et al., 2008; Ndebi et al., 2009; Umutoni, 2012) by women (FAO, 2012a; FAO, 2012b; Missohou et al., 2001; Sambou, 2008). This difference can be explained by the breeding system. Indeed, in studies where men pred were, the farms had a more or less traditional or semi-intensive profile. On the other hand, women pred were in studies of farms formerly practiced for family subsistence (consumption, donations) and which associated pig farming with the recycling of organic waste from landfills (FAO, 2012a; Sambou, 2008). Over an interval of 15 years, since the work of Missohou et al. (2001) in the lower Casamance, men were more interested in pig farming. Unemployment or the search for diversification of sources of income would explain this new

trend. Indeed, on the distribution of activities between men and women, Mbetid-Bessane and Mohamed (2003) concluded that the gender distribution of activities is not irreversible. Man may change behaviour as long as an activity traditionally carried out by women becomes sufficiently remunerative to constitute an annuity activity. The sale of tilapia zillii or nilotica fish in the town of Kindu, for example, was a trade practiced by women as they took care of food and it was used only for self-consumption. As soon as it became quite remunerative, men became interested in it. This change in behaviour in any activity seemed to us to be quite relevant and explained how income-seeking was the main production objective common to 95.4% of the surveyed breeders. This was all the more true since most (76.8%) had undertaken this activity on their own initiative.

In addition, the results show the multi-ethnic character of breeders with a preponderance of the Nande ethnic group (41.3%). These results are consistent with those of Missohou et al. (2001), Fall (2008), and Secka (2011), but they do not match those of Buldgen et al. (1994), and Sambou (2008). The latter report that 87% of pig farmers belong to the Zimba ethnic group and 86.7% of pig farmers are of the Kusu ethnic group. We believe that this difference is due to the historically unequal distribution of ethnic groups between the different municipalities of the city.

In addition, almost 25% of respondents associated pig farming with agriculture. Our results are similar to those obtained in the city of Kindu by Kabondo et al. (2014) in DR Congo, and Mopaté Logténé et al. (2010) in Chad. As observed by the CSE (2007), livestock farming is practiced by farmers in whom rainfed crops are a source of additional income and account for 10-50% of gross income in the town of Kindu. However, our results differ from those of authors who have worked on periurban farms in African cities such as Dakar, Cotonou, Abomey-Calavi and Bobo-Dioulasso (Sambou, 2008; Youssao et al., 2008; Doumana, 2011; Umutoni, 2012). In these studies, the majority of herders are civil servants (50%), those who raise only (80%), housewives (53.3%), and craftsmen (44%).

Finally, our results showed that most hog farmers in the town of Kindu (78.2%) have more than ten years of experience in this activity, and few breeders (14.6%) adopted it less than five years ago. The non-involvement of new breeders, in contrast to Kabondo '2014' results in DR Congo (46.2%) and Ndebi et al. (2009) in Cameroon (40.9%), is believed to be due to discouragement. It follows various constraints, in particular high prices, access to food and space, weak technical services, socio-cultural and religious barriers, and pathologies (Ossebi et al., 2018). Among these pathologies, African swine fever, with seroprevalence between 30 and 32% in the city of Kindu (Seck, 2007; Akpaki et al., unpublished data), is a real scourge for this breeding because of its endemic nature.

Table IV. Reasons for Commercial Exploitation of Pigs and Major Customers in the City of Kindu.

Settings		Mikelenge	Kasuku	Alunguli	Average
Reasons for sale	Need money	90,9	91,2	90,8	90,9
	Reform	5,7	3,7	10,9	7,3
	Destocking	38,6	28,7	26	30,7
	Fear of epidemics	9,1	27,5	5,9	12,9
	Fear of theft	2,3	0	2,5	1,7
Customers	Dealer dealer Charcuterie, restaurant, and hotel	6,8	16	14,6	12,7
	Local and private employee	3,4	1,2	25,4	12,4
	Expatriate	43,2	43,2	75,4	57,2
	Other breeder or villager	7,9	3,7	8,5	7
	City of Kindu	18,2	17,3	27,7	22,1
		93,2	83,9	20	58,9

Functional characteristics of livestock farms

Livestock systems and herd size

In the town of Kindu in DR Congo, the traditional pig-farming system remains by far the predominant (85.5%), and the local breed is the most exploited compared to the Métis and exotic breeds. These results corroborate those of Buldgen et al. (1994) in the arachidier basin of Senegal, Missohou et al. (2001). In Central and West Africa several authors (Ayssiwede et al., 2008; Tra Bi Tra, 2009; Ndebi et al., 2009; Umutooni, 2012; Agbokounou et al., 2016b) report that the traditional system is mainly found in peasants and forests.

Moreover, the average size of the farms visited (19.2 pigs) was close to that reported by Sambou (2008) in Dakar (20.8 pigs), but low compared to that recorded by Ayssiwede et al. (2008) in Benin (40.65 pigs). This difference can be explained by the differential level of development of pig farming practices, socio-cultural burdens and especially the market. In Benin, there are many Christians and animists (Houndonougbo et al., 2012) and the demand for pork is much higher than in DR Congo. This result is higher than that obtained by Le Goulven et al. (1999) in Vietnam (two pigs). Similarly, it is more important than those of Buldgen et al. (1994) and Missohou et al. (2001) found two pigs per farm in the Senegalese arachidier basin and 11-9.1 pigs in the town of Kindu, respectively. In DR Congo, the change in the number of people over time (growth of 3.2%) and the time of year may justify this discrepancy.

In addition, during the rainy season, the mandatory stalling associated with a food shortage does not allow farmers to keep high numbers of pigs. Sociocultural and religious burdens such as theft, poisoning (Lalèyè, 2007) and the cohabitation of Christians and Muslims also contribute to the limitation of pig numbers by herders.

Porcheries and livestock equipment

Habitats were mainly improved traditional hog barns (51.1%) and makeshift shelters (28.4%). Our results are similar to those reported in Africa in general by Logténé et al. (2010), Ndebi et al. (2009), Secka (2011), and Agbokounou et al. (2016b).

However, they are different from other work carried out in DR Congo (Sambou, 2008; Bassene, 2010; Doumana, 2011), Benin (Ayssiwede et al., 2008) and Burkina Faso (Umutooni, 2012) which note that improved or semi-modern buildings are the majority. This difference can be explained by the location of the farms surveyed. Livestock farms in suburban areas of the main economic centres are most often improved. Owners of periurban lands often have other sources of income and have access to the financial system that allows them to make the necessary investments.

(Filmer and Fox, 2014). On the other hand, for agroproducers, the majority in our study, the practices are to hoard the excess cash in order to build up the capital needed to make the investments (Mbetid-Bessane et al., 2003). The characteristics of the breeding material in our study were similar to those reported by Abdallah-Nguertoum (1997), and Agbokounou et al. (2016b).

Driving the food

The results showed that the farmers prepared the food themselves and did not take into account the nutritional balance of the ration.

These results are consistent with those of Buldgen et al. (1994), and Agbokounou et al. (2016b) which reports that leftover meals, cooking, palm cakes, rice bran, cassava or sweet potato peels, fishmeal and oyster shells serve as the basis for diets. The rational use of local food resources can be

an alternative way to improve pig feed. However, the results obtained in Côte d'Ivoire by Tra Bi Tra (2009) and in Benin by Ayssiwede et al. (2008) differ from ours. These authors state that more than 90% of farmers use feed, especially in urban and periurban areas, to feed their pigs. The level of development of the hog industry in each country would explain this difference. In DR Congo specifically in the city of Kindu, piglet feed is ordered from rice mills, milling and local markets (more than 5 kilometres away), which increases their cost and limits their availability and use. Only farmers with financial resources could source from the pig farms where the feed companies are located.

These pig food production units are still few in number compared to other West African countries. Indeed, in Côte d'Ivoire and Benin, categories of pork feed have been developed to meet their needs according to the physiological stage. Pig farming in Africa, particularly in DR Congo in the town of Kindu, is generally practised in extensive mode and the feeding of pigs regulated by the calendar of agricultural activities (Agbokounou; Kabondo et al., 2016b).

Reproductive conduct and productivity

The average age at breeding and the average size per litter were 7.6 months and 7.4 piglets, respectively. These results are consistent with those obtained in Central Africa (Abdallah-Nguertoum, 1997), Chad (Mopaté Logténé et al., 2010), Senegal (Missohou et al., 2001; Sambou, 2008), Benin (Ayssiwede et al., 2008), Côte d'Ivoire (Tra Bi Tra, 2009) and other African countries (Agbokounou et al., 2016a). However, the average litter size at birth was different from that reported by Umutooni (2012) in Burkina Faso (10 piglets). The breed of pigs studied may be the cause of this difference. Indeed, our study focused on traditional farms where the local breed was predominant (90.4% of farms) while in Umutooni (2012), the main breed exploited was the Large White (70% of the farms concerned).

Weaning occurred between three and six months, most often at the initiative of the sow (86.1%). These results differ from those of Umutooni (2012) in Burkina Faso (66.5 days), FAO (2012b) in the Democratic Republic of Congo (42 days) and Ayssiwede et al. (2008) in Benin (2.2 months) due to the majority traditional system in our study compared to the systems studied by these authors. Pre- and post-weaning mortality rates for piglets were close to those found by Agbokounou et al. (2016a) and significantly higher than those noted by Buldgen et al. However, no cases of post-weaning mortality were reported during investigations in the semi-intensive system. This result seems implausible and would be akin to the lack of information in the current state of knowledge that places the post-weaning deaths on semi-modern farms between 3 and 8% (Gaudré, 2011). Castration was mainly practiced between three and five months in 96.8% of the farms surveyed. This corroborates the results reported to Benin by Ayssiwede et al. (2008), and Senegal by Buldgen et al. (1994), which are 3.6 months and four to five months respectively.

Health management

Medical assistance for pigs in DR Congo, Kindu, is mixed (low interventions by veterinary agents, near-absence of veterinary medicines), which promotes, on the one hand, the expansion of traditional medicine and, on the other hand, the inaction of breeders in the event of the appearance of disease. These observations are consistent with those described by other authors in Senegal and The Gambia (Buldgen et al., 1994; Missohou et al., 2001; Sambou, 2008; Bassene, 2010; Secka, 2011) that note a low level of investment in the health

sector. They are, however, very different from those of Ayssiwede et al. (2008) in Benin, where 54.5% of pig farmers have updated prophylactic measures to preserve their farms against infectious diseases. This difference is due to the context in which the work of the latter is carried out.

Indeed, they conducted their study after the outbreak of African swine fever in Benin in 1997, as part of a programme to revive the pig industry where farmers were very aware and trained on the management of pig farming.

Marketing of pigs and profitability of livestock

Traditional farming, a production system based on rudimentary practices (habitat, precarious feeding, equipment, breeding method), operated pigs generally of local breed generating a net profit of 23% of the selling price of pork but with lower production costs. Semi-intensive farming, a production system based on improved breeding practices, employed mixed-breed pigs generating a net profit of 14% of the selling price of pork with relatively large loads. The semi-intensive system, based on semi-modern production practices, operated mainly improved-breed pigs with a larger average herd size (28 pigs).

In this system, four times as many pigs were marketed per year than in previous systems, for a net profit of 14% of the selling price of pork with higher production costs. These discrepancies can be justified by the best zootechnical performance (size of litter at birth, control of weaning, live weight for sale) and economic. Traditional systems were mainly found in the Alunguli commune, where local employees and individuals were the vast majority of the main customers (75.4%). These customers paid close attention to the conformation of the animals and preferred to buy the best subjects.

In addition, there is a dynamic association of pig farmers in the same commune that raises awareness of the importance and need to develop the hog industry and harmonize methods and selling prices. In the other two municipalities, these associations exist only by name. This lack of collaboration between producers would justify the significant presence of customers: 93.2% in Kasuku and 83.9% in Mikelenge, compared to 20% in Alunguli.

On the other hand, the net income (\$20) per piglet raised in the traditional system without considering the family labour force was slightly higher than that of semi-intensive systems (\$40 per piglet included). This can be justified by the high costs of food, veterinary care and the significant labour force in these systems. It goes without saying that consideration of labour would reduce this benefit in the traditional system. In this sense, Le Goulven et al. (1999) noted that the margin per hog is higher when certain factors of production come from the farm. Thus, the margin of \$40/pig obtained by these authors in a production system where everything was purchased corresponds to that of the semi-intensive system of our study.

Studies on the economic performance of hog farms in West Africa are mainly focused on semi-intensive or intensive systems (Ayssiwede et al., 2009; Tra Bi Tra, 2009; Umutoni, 2012). In this case, the annual gross margin ranges from \$5882, which is much higher than ours (\$1673 for the traditional system and \$4618 for the semi-intensive system). This difference can be explained by the selling price, the weight on sale and the number of animals sold per year. These factors depend on the level of development of the hog subsector in each country.

This difference would also come from methodological approaches, as our economic analyses are based on certain theoretical values derived from extrapolation.

For the traditional system, few studies have been able to determine its profitability because of its complexity, lack of data and its conduct based mainly on rambling. Some authors prefer to target the socio-economic performance of this livestock (Mopaté Logténé et al., 2010) or do a longitudinal study to record farm inflows and outputs for a certain period of time (Sambou, 2008; Doumana, 2001).

The results of this study on net cash income per deli pig in both livestock systems were much lower than those obtained by Sambou (2008) in the suburban area of Dakar (20,080, 22,075 and 31,943 FCFA respectively for traditional, semi-intensive and intensive systems). These farms use year-round recycling of waste from the Mbeubeus landfill when the costs of feeding in the study area were very high, especially during the wintering season. They also benefit from the selling prices of incentive pigs because of their proximity to the largest of the country's consumer centre.

Conclusion

This study, conducted as part of the implementation of the project to improve pig production from traditional and semi-intensive farms in the Democratic Republic of Congo, Kinshasa City, Maniema Province, showed that pig farming remains an important subsector in the diversification of food and monetary resources. However, traditional practices continue to do so in significant proportions.

Pig farming, often associated with agriculture, is practised by predominantly educated women and men. Traditional livestock systems are predominant with uncontrolled breeding practices, a diet based on rambling and dependent on the availability of household waste. In terms of health, the weakness of veterinary drug services and the market is reflected in the inaction or use of traditional treatments for disease. Economic results show that pig farming can help fight poverty, and this contribution would be all the more important if the constraints that undermine it were lifted.

In strategies to improve this sector, it is essential to provide technical supervision of breeders through training on the conduct and health management of the herd. In addition, it is important to find ways to enhance locally available food resources to mitigate the effects of rambling and better organize and strengthen the capacity of producers and other actors.

References

- Abdallah-Nguertoum E., 1997. Pig farming in the suburban region of Bangui (Central Africa). Doct thesis. Vet., Inter-State School of Veterinary Science and Medicine, Dakar, Senegal, 111 pp.
- Agbokounou A.M., Ahounou G.S., Karim I.Y.A., Mensah G.A., Koutinhoun B., Hornick J.L., 2016a. Ethnology and potentialities of local African pork. *J. Anim. Plant Sci.*, 29 (3): 4665-4677
- Agbokounou A.M., Ahounou G.S., Karim I.Y.A., Mensah G.A., Koutinhoun B., Hornick J.L., 2016b. Characteristics of local African pork farming. *J. Anim. Plant Sci.*, 30 (1): 4701-4713
- Ayssiwede S.B., Mankor A., Missohou A., Abiola F., 2009. Marketing and consumption of pork in Benin. *Rev. Afr. Health Prod. Anim.*, 7
- Ayssiwede S.B., Missohou A., Abiola F., 2008. Pig farming systems in Benin. *Rev. Afr. Health Prod. Anim.*, 6 (3-4): 213-219

- Bassene E.C., 2010. Typological study of pig farms in Jagoo (Dakar) and proposal for an improvement in the living environment of farmers. Doct thesis. Vet., Inter-State School of Veterinary Science and Medicine, Dakar, Senegal, 110 pp.
- Bathily P.B., 1975. Contribution to the meat economy in Senegal. Doct thesis. Vet., Inter-State School of Veterinary Science and Medicine, Dakar, Senegal, 111 pp.
- Buldgen A., Piraux M., Dieng A., Schmit G., Compere R., 1994. Traditional pig farms in the Senegalese arachidier basin. *Rev. Mond. Zootech.*, 81: 63-70
- CIRAD, 2007. Swine populations in West Africa. http://pigtrop.cirad.fr/sp/recurso/encyclopedie/les_porcs_du_monde/les_populations_porcines_en_afrique_de_l_ouest (consulted 27 Sept. 2015)
- CSE, 2007. Characterization of agricultural production systems in Senegal. Ecological Monitoring Centre, Dakar, Senegal, 39 pp., www.ntiposoft.com/domaine_200/pdf/caractspasenegal.pdf (consulted 10 Oct 2016)
- Doumana J.B., 2011. Effect of building development on the living environment, animal productivity and income generation of pig farmers in the Jagoo district (Dakar). Doct thesis. Vet., Inter-State School of Veterinary Science and Medicine, Dakar, Senegal, 107 pp.
- Fall C.A., 2008. Second report on the state of plant genetic resources for food and agriculture worldwide. ISRA, Dakar, Senegal /
- FAO, 2009. Livestock update: change in the livestock sector (9-33). FAO, Rome, Italy, 25 pp.
- FAO, 2012a. Pig sector in Burkina Faso. Animal Production and Health, FAO, Rome, Italy, 93 pp. (National Livestock Reviews; 1)
- FAO, 2012b. Pork sector in the Democratic Republic of Congo. FAO, Rome, Italy, www.fao.org/docrep/013/i1500e/Senegal.pdf (consulted 15 Seps 2017)
- FAOSTAT, 2015. Statistical database on livestock production. Filmer D., Fox L., 2014. Youth employment in sub-Saharan Africa.
- Gaudré D., 2011. Impacts of post-weaning and breeding conditions on fattening performance. *TechniPorc*, 34 (1): 21-26
- Houndonougbo M.F., Adjolohoun S., Aboh B.A., Singbo A., Chrysotome C.A.A.M., 2012. Characteristics of the pig farming system in southeastern Benin. *Bull. Rech. Agron. Benin (Special Breeding No. - Wildlife)*: 15-21 <http://faostat3.fao.org/browse/Q/QA/F> (access 31 May 2015) http://fsg.afre.msu.edu/promisam_II.2/Etude_exportation_b%C3%A9tail_Mali_S%C3%A9gal_Rapport_final.pdf (consulted 13 Jan 2017)
- Kabondo R, 2014. Study on some routine methods of pig farming used by pig farmers in Kindu- case of Kasuku commune;
- Keiser A.M., 2004. Financial management, 7th Ed. ESKA, Paris, France, 622 pp. (Coll.Management)
- Lalèyè B.O., 2007. The pig industry in Senegal: marketing and consumption of pork and warthog meat in the departments of Dakar, Fatick, Ziguinchor and Kolda. Doct thesis. Vet., Inter-State School of Veterinary Science and Medicine, Dakar, Senegal, 130 pp.
- The Glaumec L.G.A.L., 2006. Epidemiological study of the wild cycle of African swine fever in the Sine Saloum region of Senegal. Doct thesis. Vet., Veterinary School, Toulouse, France, 122 pp.
- Le Goulven K., Boutonnet J.P., Codron J.M., 1999. Marketing an agricultural production in a "transition" economy: pork marketing chain from Nam Thanh to Hai Phong (Vietnam). *Rev. High up. Med. Vet. Country too*, 52 (3-4): 305-312, doi: 10.19182/remvt.9679
- Mankor A., 2009. Urban meat consumption in West Africa: the example of Dakar. *Grain Salt* (46-47): 16-17
- Mbetid-Bessane E., Gafsi M., 2003. Weakness of the family workforce and diversification of activities on farms in the cotton area of the Central African Republic: what education for the management council to farmers? In: *Colloq Acts. African savannahs: changing spaces, actors facing new challenges*, Garoua, Cameroon, May 2002 (eds Jamin J.-Y., Seiny Boukar L., Floret C.). Prasac, N'Djamena, Chad / Cirad, Montpellier, France, 7 pp.
- MEPA, 2015. Statistics on the production and imports of animal products in Senegal in 2014. Ministry of Livestock and Animal Productions, Direl, Studies and Planning Cells, Dakar, Senegal, 7 pp.
- Missohou A., Niang M., Foucher H., Dieye N.N., 2001. Pig farming systems in Lower Casamance (Senegal). *Search note. Cah. Agric.*, 10:405-408
- Mopaté Logténé Y., Koussou M.O., 2003. Pig farming, a breeding ignored but yet well established in the rural and periurban agro-systems of Chad. In: *Colloq Acts. African savannahs: changing spaces, actors facing new challenges*, Garoua, Cameroon, May 2002 (eds Jamin J.-Y., Seiny Boukar L., Floret C.). Prasac, N'Djamena, Chad / Cirad, Montpellier, France, 9 pp.
- Mopaté Logténé Y., Koussou M.O., Nguertoum E.A., Ngo Tama A.C., Lakouténé T., Awa D.N., Mal Mal H.E., 2010. Characteristics and performance of urban and periurban pig farms in the central African savannahs: the towns of Garoua, Pala and Bangui. *Colloq acts. Developing African savannahs: innovating to last*, Garoua, Cameroon, 20-23 Apr. 2009 (eds Seinyboukar L., Boumard P.). Cirad, Montpellier, France
- Ndebi G., Kamajou J., Ongla J., 2009. Analysis of constraints to the development of hog production in Cameroon. *Tropicicultura*, 27 (2): 70-76
- Niang M., Mbaye M., 2013. Development of Malian livestock exports to Senegal following recent crises. Final report. APCAM/MSU/USAID, 43 pp.,
- Ossebi W., Ayssiwede S.B., Nimbona F., Malou R., Djettin A.E., Diop M., Missohou A., 2018. Obstacles to the development of the pig value chain in Casamance (Senegal): what do actors of the subsector say? *Rev. High up. Med. Vet. Country too*, 71 (1-2): 15-22, doi: 10.19182/remvt.31286
- Porphyry V., 2009. Issues and constraints of the hog industry in West Africa. *Grain Salt* (46-47): 26-27
- Animal Production and Health, FAO, Rome, Italy, 85 pp. (National Livestock Reviews; 2)
- Sambou G., 2008. Analysis of the impacts of the Mbeubeuss landfill (Dakar) on the surrounding pig farms. Doct thesis. Vet., Inter-State School of Veterinary Science and Medicine, Dakar, Senegal, 138 pp.
- Seck I., 2007. Epidemiology of African swine fever in Senegal: estimate of the prevalence of the disease in the Fatick, Kolda and Ziguinchor regions. Doct thesis. Vet., Inter-State School of Veterinary Science and Medicine, Dakar, Senegal, 119 pp.
- Secka A., 2011. Pig production system, marketing chain and cysticercosis awareness in the Gambia and Senegal. *Bull. Anim. Health, I'm going to have Prod. Afr.*, 59: 459-469
- Smith P., 2013. Sampling and estimation for business surveys. In: *Designing and conducting business surveys* (Eds. Snijkers G., HaraLdsen G., Jones J., Willimack D.). Wiley, NJ, USA, 165-218, doi: 10.1002/9781118447895.ch05

Tra Bi Tra C., 2009. Pork line in Côte d'Ivoire: production, improvement proposals and development prospects. Doct thesis. Vet., Inter-State School of Veterinary Science and Medicine, Dakar, Senegal, 146 pp.

Umutoni C., 2012. Technical and economic evaluation of pig farms in Bobo-Dioulasso (Burkina Faso). Memory Master Prod. Anim. Dev. Inter-State School of Veterinary Science and Medicine, Dakar, Senegal, 45 percent

Washington, DC, World Bank, 317 pp. (Ser. Africa Development Forum)

Youssao A.K.I., Koutinhoun G.B., Kpodekon T.M., Bonou A.G., Adjakpa A., Dotcho C.D.G., Atodjinou F.T.R., 2008. Pig production and indigenous genetic resources in suburban areas of Cotonou and Abomey-Calavi in Benin. Rev. High up. Med. Vet. Country too, 61 (3-4): 235-243, doi: 10.19182/remvt.9995.