Participatory innovation analysis along livestock value chains: Case of swine value chain in Benin

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A B S T R A C T

Rural poverty in Sub-Saharan Africa remains a huge challenge despite the successive agricultural development policies, most of which have failed to involve stakeholders actively. The present rise of pork demand in Benin calls for an assessment of the swine value chain (VC) to envision its development. A participatory approach is here proposed to join this assessment to a stimulation of innovation among stakeholders. The approach is divided in four stages: i) identification of actors and direct links along the VC, ii) characterisation of innovation practices, iii) identification of bottlenecks and opportunities using innovation system framework, and iv) measurement of agreement among VC actors about constraints and value-added sharing, using proportional piling tool. A second survey, two full years after the first one, assessed the impact of actions conducted with VC actors. A typological analysis of innovation practices was conducted to define "innovation profiles" among each of the three main categories of actors: swine stockbreeders ($n = 134$), pork butchers ($n = 45$) and input suppliers ($n = 25$). Three innovation profiles were retained for each category, which may be understood as covering 2 distinct innovator profiles and one non-innovator profile. The profiles qualified as "innovators" accounted for 82%, 84%, and 76%, respectively in stockbreeders, pork butchers and input suppliers. The lack of professionalisation appeared to actors as the main constraint. The Kendall's coefficient of concordance (W) indicated that actors agreed to state that pork butchers gained the most part of the value-added, followed by input suppliers. The second survey showed favorable impacts of the approach and follow-up activities on exchanges and organisation within the VC. It is here advocated that the present participatory method, while characterising the value-chain in a rapid way, further sets the basis for the dialogue between actors and the stimulation of innovation along the VC, which can be further sustained through an exchange platform.

1. Introduction

The upgrade of food value chains in low and middle-income countries still stands as an important challenge to scientists and practitioners (Gómez et al., 2011). However, the "top down" character of development programs is pointed as a cause of failure and a source of negative social side-effects (Berthet et al., 2018). Indeed, governmental projects often ignore stakeholder's involvement and therefore lack both efficacy and viability (Duteurtre and Faye, 2009). To counter this failure, participation or partnership concept engages dynamically multiple stakeholders for dealing with the complex and socially constructed issues surrounding sustainability (Van Mierlo et al., 2010a,b). Investigating value chains by mobilising stakeholders' participation raises trust among them and helps building innovative and sustainable solutions, as earlier developed under the concept of participatory market chain approach (Berthet and Hickey, 2018; Bernet et al., 2011 PSRSA-Benin, 2011; Devaux et al., 2011; Thiele et al., 2009). Participation further helps to assess and increase the acceptability of interventions. This willingness to spur stakeholders' participation in agricultural development has conducted to the ongoing multiplication of such participatory initiatives under the label of Innovation Platforms, which are becoming increasingly popular in development projects (Davies et al., 2018; Schut et al., 2018). Participation is expected to increase the efficiency, productivity and quality of research results for relevant and sustainable development (White and Pettit, 2007). Recent review of experiences have indeed highlighted the increase of social capital of stakeholders as

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the prime mediator of this change (Davies et al., 2018).

The growing demand for animal proteins in Benin, together with the decrease of interest in agricultural activities, drove us to investigate livestock production in the country. Swine production strategically contributes to food security and business development for small family production units in urban and peri-urban settings, because it shows a short reproductive cycle and is prone to intensification. In accordance with this strategic advantage, the swine value chain is identified as a key value chain in national policy strategy documents (PSRSA-Benin, 2011). Particularly in the southern part of the country, it provides significant income to a wide diversity of stakeholders, contributing to poverty alleviation (Agbokounou et al., 2016; Youssao et al., 2008). Despite the growing demand and dynamic market, most actors in the sector do not duly benefit from their labor (Codjia and Assogbadjo, 2004). In addition, the lack of positive interactions between actors within and between different levels of the value chain inhibits the development of innovative processes (Wanyoike et al., 2015; Rich et al., 2009).

The present work fits into a wider intervention, within the scope of Innovation Platforms that aims at stimulating endogenous innovation, both technical and organisational, along the swine value chain in Benin. More precisely, taking place in the early steps of the intended stimulation, the study aims at identifying the relevant strategy by providing a better understanding of ongoing innovation processes and constraints throughout the chain (Schut et al., 2018). To this end, this study proposes a methodology in four steps to analyse the swine value chain with a focus on identifying and understanding innovation behaviors of actors. By this methodology, stakeholders are integrated through participatory research, adopting here a particular innovation-oriented focus within the wide array of VC methodologies (Trienekens, 2011). Innovation as an evolutionary process is highlighted in stakeholders' activities of the swine value chain to identify ways forward, through internal organisation or with participation of external supports (Maru, 2018). To assess the impact of the methodology itself on the value chain, a second survey was conducted two full years after the first process.

2. Material and methods

2.1. Study area

This study has been conducted in two departments of Southern Benin, the Ouémé and the Plateau. The study area was divided into 3 zones based on the agro-climatic conditions (Fig. 1). Porto Novo is a coastal region with 1000–1400 mm of rainfall where improved breeds are raised in confined flocks. Vallée area is dominated by a floodplain with 1100 to 1300 mm of rainfall. The zone of plateau is widely represented by plateau where rainfall varied from 1087 to 1132 mm (Sossou-Agbo, 2013). In the two last areas, stockbreeding practices are dominated by free-ranging flocks of local breed. Districts were then chosen in each zone based on these a priori knowledge of stockbreeding practices and of the presence of different links of the swine value chain (stockbreeders, pork butchers, traders/brokers, input suppliers, veterinary services, draff sellers), as collected from professional organisations and livestock support services. Hence, the study zone of Porto-Novo included the districts of Sèmè Podji, Porto-Novo and Adjara. The zone of Vallée included the districts of Dangbo and Bonou and the zone of Plateau included the districts of Sakété and Kétou.

2.2. Target groups

The principles of triangulation and saturation in participatory analysis make it necessary to involve a diversity of stakeholders for crosschecking information. Therefore, in the present study, the different stakeholders of the swine value chain are involved in each of the targeted districts (Table 1). Interviewed actors of the swine value chain

were identified through progressive on-site sampling, partly guided through the recommendations of actors already met (known as respondent-driven or snowball sampling). The different categories were stockbreeders, traders/brokers, pork butchers, draff sellers (used as pig feed), feed millers, as well as support services active in the livestock sector (field agents from technical services and micro-credit agencies). In the zone of Porto-Novo, harbouring the direction of technical services, key managers of the latter services were recruited as participants. A diversity of profiles was also sought inside each category of actors in an attempt to represent the whole range of practices in the different links of the value chain. The possibility for missing particular profiles have been checked by confronting the final sampling with key-informants and non-sampled stakeholders.

2.3. Overall design of participatory process and validity principles

Surveys were conducted from February to October 2014. The approach was divided in four steps (Fig. 2), which are described in further detail here below. First, the different value chain links and actors were identified in each district and swine value chain organisation was characterised through in-depth individual semi-structured interviews with stakeholders. Second, individual interviews were conducted to highlight innovations undertaken in the last 10 years in each type of activity. Third, the Innovation System framework (Van Mierlo et al., 2010a,b; Geels, 2004) was applied to conduct reflexive workshops to identify opportunities and challenges linked to stakeholders' activities, as well as their attitudes and behaviors facing those. Fourth and finally, focus group discussions were held with representatives of different professional associations in the three zones to gather stakeholders' agreement upon relative priority of challenges and opportunities, as well as the repartition of value added along the chain. Detailed reading of exchanges in focus groups allowed identifying recurrent arguments and interpreting the gathered data.

On May 2017, a second survey was conducted in three focus groups by using the fourth step to observe potential outcomes of different actions led with the value chain actors in terms of changes of behaviors.

Throughout the investigation process, validity of results was ensured, including the avoidance of major biases in sampling, through a strict application of the triangulation principle. In individual interviews, actor's own information was crosschecked with direct observations of the researcher and with documents when available. Stated information about history and context was crosschecked between independent interviews. In focus group discussions, triangulation was applied by crosschecking the main outputs between focus groups discussions and with short individual interviews with at least three independent interviewees. The saturation principle applied to the sampling of individual interviews of stockbreeders, meaning that no additional interviewee was sought when information gathered became repetitive despite the search of distinct situations. For other stakeholders, who are less numerous, the sampling aimed at reaching a maximal number of actors, actively seeking a diversity of situations.

2.4. Step I: The value chain links identification

The purpose at this stage is to map value chain links and the trade patterns of live animals and products. The trader/broker was taken as a starting point. The checklist for these semi-structured interviews included: identification and description of direct and indirect stakeholders, VC governance (vertical and horizontal coordination mechanism), including different professional organisations of stakeholders, their functioning and history. All data collected at this step were qualitative in nature. Each actor was also asked to provide contact information of his business relations. The cited stakeholders were then contacted in order to identify all actors, who are horizontally or vertically involved. This phase lasted two months (February to April) due to actors' availability. A total of 134 stockbreeders, 45 pork
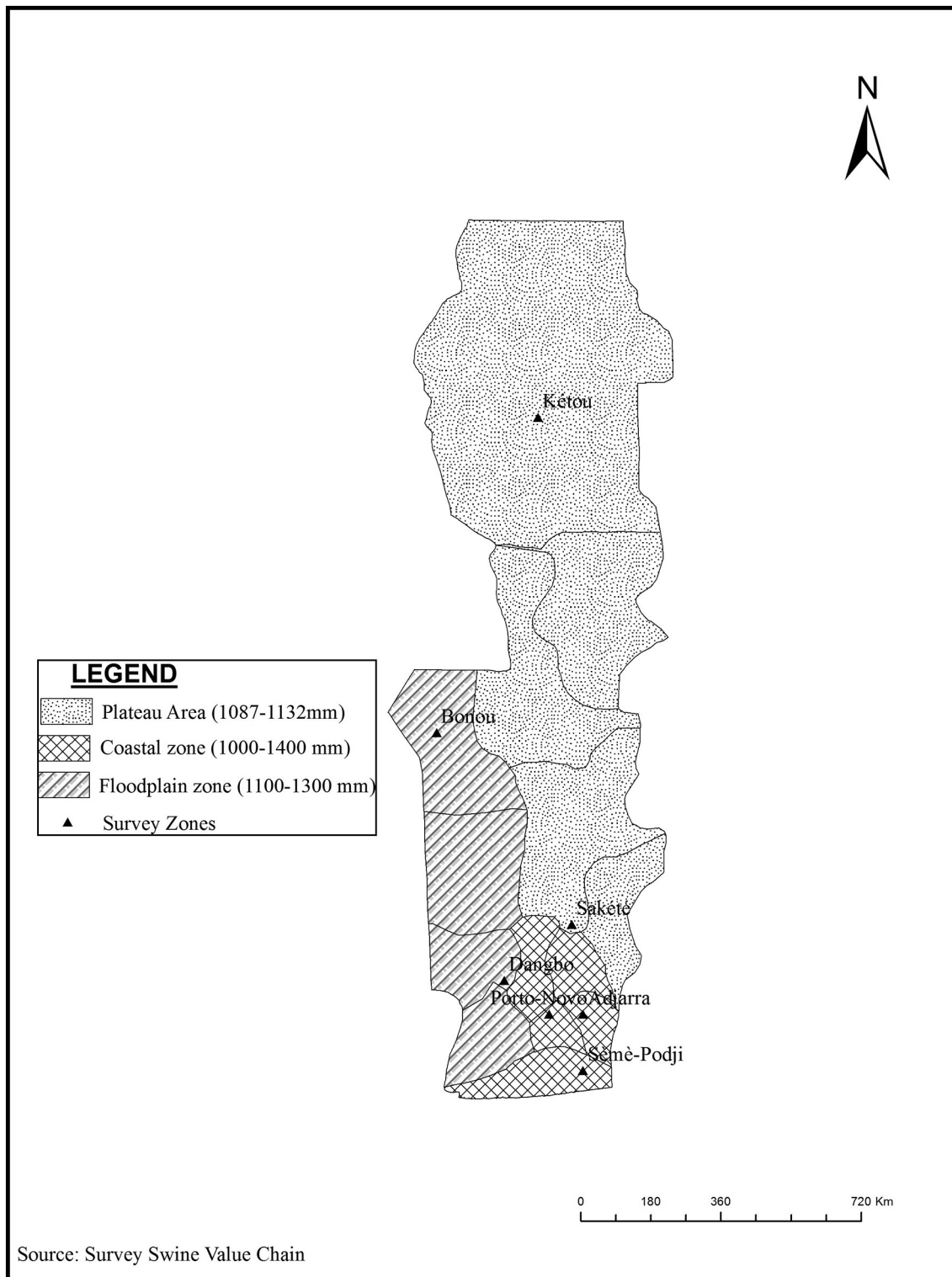
Fig. 1. Study areas of Ouémé and Plateau departments, South-east Benin.

butchers, 21 pig traders, 25 input suppliers and 15 support services agents were interviewed, as compiled in Table 1.

2.5. Step II: Innovations characterisation

Previously interviewed stakeholders were contacted again, focussing on the stockbreeders ($n = 134$), pork butchers ($n = 45$) and input suppliers ($n = 25$), for individual semi-structured interviews and

observation of their activity. This part of the study was conducted from April to June 2014. The goal was to characterise innovations implemented by stakeholders. An innovation was considered in the discussions with stakeholders as "any change in their practices or the way they organise their work, individually or with others". Innovations were considered as adopted only in cases where it could be confirmed by direct observation of the researcher or triangulated through other sources. The description of the change was then compiled in the

Table 1
Characteristics of sampled swine value chain stakeholders in South-east Benin.

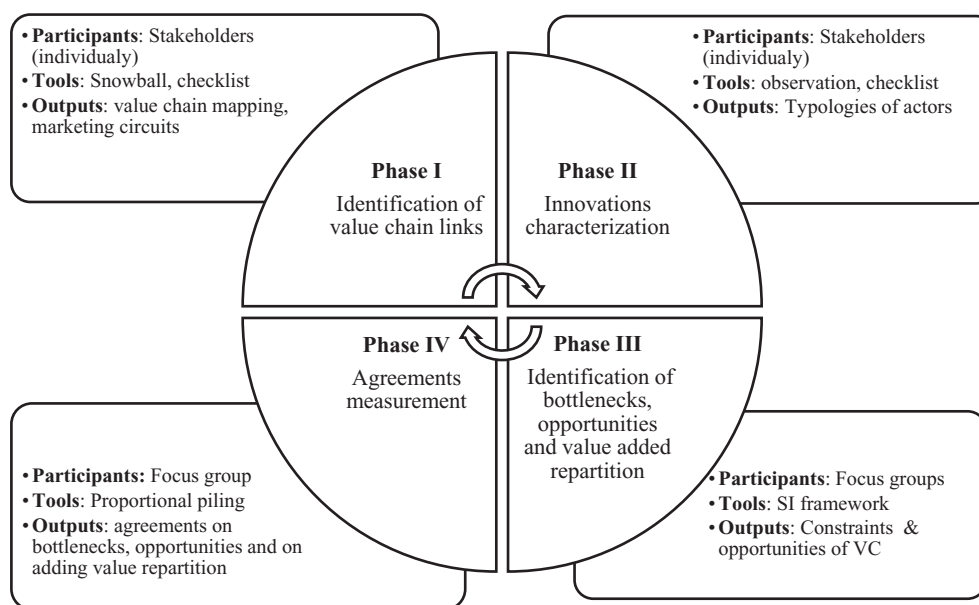| Variables		Stakeholders					Significance
		Stock-breeders	Pork butchers	Pig traders	Input suppliers	Support services	
Number by study zone	Porto-Novo	58	21	9	13	7	
	Plateau	38	12	6	6	4	
	Vallée	38	12	6	6	4	
	Total	134	45	21	25	15	
Mean age (years)		47.3 ± 9.8	43.4 ± 8.1	48.7 ± 5.7	44.0 ± 15.1	39.0 ± 10.6	NS
Marital status (%)		97.7	100	80	100	100	NS
Children mean (n)		5.9 ± 3.3	4.6 ± 2.8	5.6 ± 1.9	3.5 ± 3.1	3.0 ± 1.4	*
Women involvement (%)		7	13	0	21	0	NS
Farming Experience (years)		22.0 ± 9.6	25.1 ± 10.7	30.9 ± 10.4	12.0 ± 8.1	15.0 ± 10.8	*
Religion (%)							
Christian		58	46	38	59	86	NS
Traditional beliefs		42	54	62	41	0	NS
Muslim		0	0	0	0	14	NS
Co-op member (%)		82	44.4	100	44.0		NS

NS: Non-significant.

* p value < 0.05.

Fig. 2. Step-wise approach for participatory value chain analysis.

narrative form and modalities Yes/No were used to confirm or not the actual implementation.

2.6. Step III: Identification of bottlenecks and opportunities

In each study zone, one half-day focus group discussion was held with key-actors identified during step I, hence a total of three focus group discussions. Each of those group discussions gathered 28 persons, presenting the same balance between stakeholder types: 12 stock-breeders, 7 pork butchers, 3 traders/brokers, 2 input suppliers and 4 support services. The discussions were facilitated with the collaboration of main organisations in the three zones. The purpose at this step was to identify bottlenecks (defined with interviewees as challenges and constraints they face in their efforts for improving their income) and to explore businesses opportunities. The expression of the views of all participants was ensured through a process based on the collection of short written contributions to key-questions and short oral contributions going around the table. In addition, the animator paid attention to elicit a diversity of views and manage dominant speakers by distributing speech times.

The Innovation System framework has been retained for this step because of its reciprocity, reflexivity and feedback mechanism features (Van Mierlo et al., 2010a,b). The method is based on the use of a matrix to animate discussion and guide reflexions. The matrix displays columns representing sectors of activity and rows listing the dimensions along which bottlenecks and opportunities were identified (Van Mierlo et al., 2010a,b).

This matrix defines 7 categories:

I) Physical infrastructure that actors need in order to function (communication tools used by actors, researchers availability, government responsibility in addressing infrastructural need);

II) Know-how infrastructure (how the creation and the use of knowledge is organised, training, education, the value chain facilitates or obstructs access to development of research);

III) Hard institution (formal institutional mechanism which may hinder the value chain: laws, regulation);

IV) Soft institution (social value and norms, willingness to share information, economic context and the way business is done);

V) Interaction (strength or weakness, motives and modalities);

VI) Capabilities (adequate labour qualifications, entrepreneurship, capability to adapt to new technologies);

VII) Market structure (monopoly, oligopoly, transparency, supply and demand).

The matrix was represented on a flipchart sheet for stakeholders' readability. After explanation of the matrix, stakeholders based on their knowledge and experiences were asked to write down in cells and to present to the group the main bottlenecks, as well as the relevant opportunities of their businesses. Discussions in groups have allowed selecting the commonly identified bottlenecks and opportunities.

2.7. Step IV: Agreement measurement and attitudes

The last step aimed at measuring participants' agreement on different subjects addressed in focus groups discussions. The same composition of focus groups as in step III was applied, gathering the same participants on a second occasion. Also, the same animation techniques were implemented to facilitate the expression of all viewpoints. The objective pursued in this phase was to get a shared point of view of all stakeholders about the relative importance of challenges and opportunities. This step mobilised the proportional piling tool as follows: interviewees were asked to distribute a hundred counters between the different categories of challenges first and then opportunities (represented on a flipchart by labelled circles), according to the priority they ascribed to each. The tool was also applied to study the repartition of value added along the value chain, the counters being then distributed among circles representing value chain links, according to the share of the value added perceived to be gained by actors of each link.

2.8. Impacts diagram

Between the first and second survey, trainings, meetings, exchanges visits and contact were established between stakeholders via a social network smartphone application (WhatsApp) of discussion in an attempt to stimulate innovations along the value chain. The objective of this part of the study was to assess the impacts of the proposed approach, using the present method for the follow-up of changes. Hence, focus group meetings were held on May 2017 in the three zones, taking half a day each. It brought together the same representatives of professional organisation who had been gathered in the fourth step of the study. Participants had to focus on i) the identification of the methodology outcomes and ii) ranking these outcomes by using proportional piling according to the frequencies of occurrence of impacts.

2.9. Data analysis

From step I, interview notes and recordings were transcribed in commented narratives about VC organisation. These narratives were then analysed through the following categories: actors and activities, governance, and marketing chain (product flows). This information has been summarised in a textual description and a diagram of VC.

Step II collected a description of innovations as implemented by a variety of stakeholders. Innovations were listed and similar innovations were gathered under a common descriptive innovation name. For each category of actors, innovations were then coded as binary variables (modalities: implemented or not implemented). Descriptive statistics, multiple correspondence analysis (MCA) and hierarchical classification analysis (HCA, ward's algorithm) were then performed to establish actors' profiles based on the innovations they had implemented (package FactoMineR, function MCA and HCPC). All gathered innovation variables were inserted in MCA and HCA for each actor category, i.e. 12 variables for stockbreeders ($n = 134$), 9 variables for pork butchers ($n = 45$), and 9 variables for input suppliers ($n = 25$). Table 2 presents variables used. Hence, innovator profiles were established separately for stockbreeders, pork butchers and input suppliers based

Table 2
Frequency of observed technical and organisational innovations along the swine value chain in South-east Benin by stakeholder type.

	Innovations description	Frequency
Breeders ($n = 134$)		
Technical	Raising exotic crossbred	87 (64.9%)
	Building pigsty	85 (63.4%)
	Foot bath for biosecurity	72 (53.7%)
	Veterinary follow-up	2 (1.4%)
Organisational	Active participation in association	110 (82%)
	Selling animals through co-ops	110 (82%)
	Paying a membership fee	81 (60.4%)
	Paying social share	81 (60.4%)
	Bulk purchase	77 (57.4%)
	Tontine to fund herd size increase	75 (55.9%)
	Taking part in exchanges and visits	30 (22.3%)
	Contract with butchers	3 (2.2%)
Pork butchers ($n = 45$)		
Technical	New preparation of pork meat	41 (91.1%)
	Clean, aerated, hard-wall restaurant	38 (84.4%)
	Veterinarian inspection	38 (84.4%)
Organisational	Other activities out of pig VC	38 (84.4%)
	Planning for credits payment	21 (46.6%)
	Active participation in association	20 (44.4%)
	Tontine to support cash flow	18 (40%)
	Paying a membership fees	12 (26.6%)
	Contract with stockbreeders	2 (4.4%)
Input supplier ($n = 25$)		
Technical	Using modern feed mill	13 (52%)
	Computerised stock management	11 (44%)
Organisational	Selling feed on credit	20 (80%)
	Diversification out of pig VC	20 (80%)
	Active participation in association	11 (44%)
	Paying a membership fee	9 (36%)
	Contract with stockbreeders	9 (36%)
	Subcontracting for large company	7 (28%)

on the full set of innovations identified for each. Chi-square tests were conducted to evaluate the dependency between typological groups and categorical variables as well as between these variables.

From step III, bottlenecks and opportunities were qualitatively described and classified with stakeholders along the innovation system matrix (Van Mierlo et al., 2010a,b).

The semi-quantitative data obtained through proportional piling in step IV was subject to an assessment of the degree of agreement between interviewees. This assessment was realised by computing Kendall's coefficient of concordance (W), which was obtained through permutation test (package vegan, function *Kendall.global, function Kendall.post*) with the correction for *ex aequo* scores (Legendre, 2005).

3. Results

3.1. Step 1: Identification of links of the value chain

3.1.1. Sampled actors

An overview of characteristics of swine VC actors and their household is provided in Table 1. The ages of the actors are similar at the different VC links (p > 0.05). No women are involved in pork butchering and pork retailing. Actors interviewed in these two activities mostly belong to co-operatives.

3.1.2. Swine value chain mapping

The different actors of the VC are presented in Fig. 3. The VC is simple and stakeholders can be easily identified, although marketing channels may be complex, as described here below. Stockbreeders appeared to be the most numerous and widely scattered actors of the value chain. This was acknowledged by stockbreeders themselves and confirmed by other actors. Pork butchers are less numerous and better organised. The direct upstream sector is characterised by a quasi-
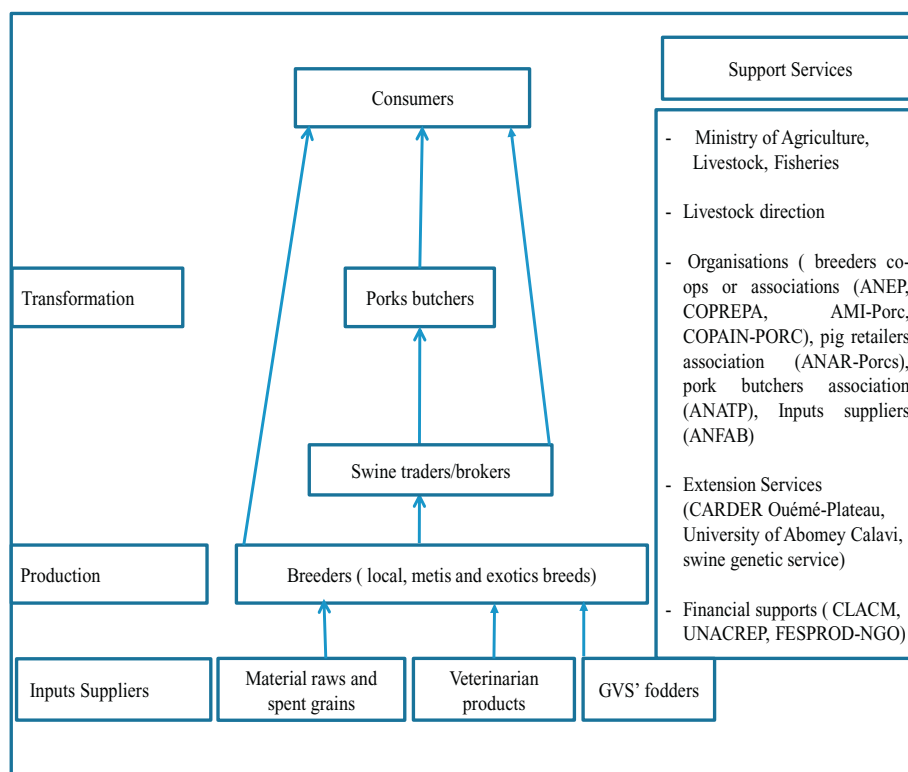
Fig. 3. Overall mapping of swine value chain and marketing channels in South-east Benin.

monopolistic configuration regarding mixed feed and veterinary drugs, with one major actor concentrating both activities. Other actors are private veterinary technicians, public veterinary services, small-scale sellers of raw material for feed, as well as draff sellers. No private actor had specialised in the supply of genetics.

In the category of indirect actors, the ministry of agriculture, animal husbandry and fisheries, represented by extension services in different districts, plays the role of technical support and provider of improved breeds of swine. However, these genetic services had a very weak outreach due to costs felt as far too expensive by interviewed stock-breeders. Direct import of improved breeds from Nigeria then came as the main practice for genetic improvement, conducted by individuals or small cooperatives. Three private microfinance institutions could be identified for financial supports. However, according to stakeholders, "*capital requirement of financial institutions do not encourage investment in animal production*", which these institutions justify by "*the difficulty to recover the loans*".

3.1.3. Governance in the value chain

The different links of the VC are conducted by umbrella organisa-tions established by the government in the aftermath of the first out-breaks of African swine fever in 1997. Four national associations were created to organise stakeholders, to serve as an intermediary with the government, and to defend the interests of the profession. These four associations hence organised separately stockbreeders (ANEP), pork butchers (ANATP), feed suppliers (ANFAB), and pig traders (ANAR-Porc). These are structured at the national level with antennas in each department and even districts. The status of their functioning never-theless differs between associations. The ANATP and ANAR-Porc still hold a very active role in the VC while stakeholders point to the ANEP and ANFAB as presently inactive and needing a renewal of its govern-ance.

Facing this inactivity, in some districts, private co-operatives have been established on the stockbreeders' own initiative. For instance, three active co-operatives were identified in Adjara: COPREPA (16

members), AMI-PORC (37 members), and COPAIN-PORCS (14 mem-bers). One was localised in Dangbo: Affossogbé (11 members). Members come together each week. Social shares and membership fees are paid, which are used for buying farming inputs. Exchange visits are organised for experience sharing between members. Group saving (*tontines*) is also organised for providing appropriate investment in stockbreeding ac-tivity.

3.1.4. Swine marketing channel

In total, twenty-seven sub-chains of swine marketing may be de-scribed. The most frequent path is as follows: *stockbreeder-trader-butcher-consumer*.

Consumers buy mainly cooked meat from pork butchers in specia-lised restaurants. Seldom, pork is bought as a take-away food to be consumed at home. Only in important religious ceremonies (funerals, baptism, first communion, wedding), live animals may be bought from stockbreeders or traders/brokers to be slaughtered at home and cooked for guests. Cooked pork in restaurants is thus the dominant outlet. Fresh meat selling is not frequent and the term "pork butcher" is there used as a synonym of restaurant holder. Pork butchers are a pivotal link in the VC, being well organised and concentrating the quasi-totality of ani-mals' flows. Stakeholders identified this group as the one dominating the VC, despite the monopolistic situation at the input providers level.

Traders buy live animals at local markets or in neighboring coun-tries (Burkina Faso, Niger, Nigeria, and Togo) for resale at the final urban market. They may commission middlemen to sell animals on final markets and mobilise their relationships network to reach buyers, mostly pork butchers, i.e. restaurants holders. The latter may also im-port swine directly through the same routes, without any recourse to middlemen and traders.

3.2. Step II: The value chain actors' innovation characterisation

3.2.1. On-going innovations

Across the three zones, stockbreeder' group allowed identifying 12

Table 3
Coefficients of correlation between innovations and the first two axes of principal component analysis in three categories of stakeholders of swine value chain in South-east Benin.

Stakeholders	Variables	Axis 1	Axis 2
Stockbreeders	Social share	0.8***	–
	Bulk purchase	0.8***	–
	Crossbreeding	− 0.6***	–
	Building pigsty	− 0.6**	–
	Biosecurity	− 0.4**	0.1
	Exchanges/visit	− 0.2	− 0.0
	Adhesion to associations	–	0.8***
	Sale through co-operatives	–	0.8***
	Work under contrat	–	–
	Veterinary follow-up	− 0.0	− 0.0
Butchers	Hard-wall restaurant	− 0.9***	–
	Veterinarian inspection	− 0.9***	–
	Credit payment planning	–	0.5**
	New preparation of pork	–	− 0.2
	Diversification	− 0.9***	
	Adhesion to associations	0.1	0.4*
	Membership fees	–	–
	Group saving (tontine)	0.1	0.3
	Work under contract		0.2
Inputs suppliers	Membership fees	− 0.7***	–
	Adhesion to associations	− 0.6**	–
	Subcontracting	0.4*	–
	Diversification	0.3	0.5*
	Sell on credit	− 0.3	− 0.5*
	Computerised stock	–	–
	Modern feed mill	–	− 0.2
	Contract with stockbreeders	–	–

* *p value < 0.05.*
** *p value < 0.01.*
*** *p value < 0.001.*

innovations, while the butcher group delivered 9 innovations and input suppliers 8 innovations (Table 2).

3.2.1.1. Stockbreeders (n = 134). From stockbreeders, 4 technical and 8 organisational innovations were identified. As for technical innovations, "*raising exotic crossbred*" was observed 87 times, "*building pigsty*" 85 times, and "*foot bath for biosecurity*" 72 times. As regards organisational innovations, "*belonging to an association*" was the most cited, with 110 occurrences. All adherent stockbreeders sold their animals through their association. These associations further enabled actors to adopt innovations as group saving or group purchase of feed to access bulk pricing. Nevertheless, only around two-thirds of adherent stockbreeders did have recourse to those innovations. Over the 72 stockbreeders having adopted biosecurity measures, 71 belonged to associations and, over the 24 non-adherent stockbreeders only one had adopted biosecurity measures (Chi-square, p < 0.001). Stockbreeders also commonly took part in exchanges of information and mutual visits, with 30 occurrences.

Innovations like "*contract with butchers*" and "*veterinary follow-up*" received less attention. According to stakeholders' narratives, veterinary services are considered "too expensive" and contract commitments as an "irrelevant practice to small-scale farmers".

3.2.1.2. Pork butchers (n = 45). Three out of 8 innovations of pork butchers were technical in nature. Most interviewed butchers (38) mentioned the recourse to a veterinarian inspection as an innovation, which in fact has been implemented through legal obligation. The most prevalent endogenous innovation was the investment in "*new preparation of pork meat*", with 41 occurrences. Butchers specialised themselves increasingly in grilled pork, which was the most appreciated preparation. A minority also had diversified to prepare pork sausage to valorise a more diverse set of animal parts. This illustrates the variety of consumers' taste and the diversification of the offer, which was before

restricted to fried pork or pork soup. As for organisational innovations, the most observed was "*diversification of activity*" to resist to shocks (38). To support cash flow, 18 adhesions to saving groups (*tontine*) were observed and the active engagement in a voluntary association was observed 20 times. The goal of these voluntary associations is mainly sharing information and maintaining group solidarity. No involvement of these associations in buying, selling or contracting was reported. The adhesion to most of these groups was subject to the payment of a membership fee (12 membership fee payments over 20 associations). Several butchers described having newly adopted a financial planning to make sure they reimburse animals bought on credit. Two butchers began establishing contracts with stockbreeders.

3.2.1.3. Input suppliers (n = 25). Input suppliers reported two technical and six organisational innovations. Eleven suppliers had adopted a computerised stock management and thirteen had invested in a modern feed mill. As for organisational innovations, twenty input suppliers had diversified their activities outside of the swine VC. Nine had established contracts with stockbreeders and seven of them had begun acting as a sub-contractor for the dominant feed company. Eleven input suppliers participated in associations, the adhesion to which was conditioned by the payment of a fee. However, 2 actors did not pay a membership fee, temporarily, due to financial constraints, which was accepted by the group.

3.2.2. Typologies of actors according to innovation

The results from the three multiple correspondence analyses (MCA) and hierarchical clustering analyses (HCA) are described here under for each of the three stakeholder groups: stockbreeders, pork butchers, and input suppliers. For all three MCA, two axes were retained for analysis, conserving 62.4%, 51.2%, and 58.6% of total sample variability in stockbreeders, pork butchers and input suppliers, respectively. The statistically significant dependence between variables and the first two axes from each MCA, as established through variance analysis, are mentioned in Table 3. From HCA, three groups were retained for each actor category, stockbreeders conserving a variance between groups of 80% of total variability, pork butchers 71.5% and input suppliers 55.6%. Table 4 shows variables characterising statistically the partition of clusters. Fig. 4 represents, for each actor category, the groups as established through HCA on the 2 MCA-defined axes.

3.2.2.1. Stockbreeders. For stockbreeders, axis 1 is negatively correlated to the adoption of crossbreeding and biosecurity measures, as well as to the building of pigsty (p < 0.001) (Table 3). It is positively correlated to the payment of social shares and the bulk purchase. Axis is mainly characterised by its positive correlation with the adhesion to associations (hence, to the sale through co-operatives).

Stockbreeders' clusters are partitioned by their adhesion to associations (hence, sale through co-operatives), the payment of social share, the bulk purchase, and the crossbreeding (p < 0.001). The building of pigsty and adoption of biosecurity are also significantly partitioning the clusters (p < 0.01). Cluster 1 (*n* = 67, 50%) presents an overall innovative behavior but does not widely practice exchanges and visits. Cluster 2 (*n* = 24, 18%) is characterised by high positive values on axis 2, indicating their overall non-innovating behavior despite their adhesion to association but 4 of them were nonetheless interested in biosecurity measures. Crosschecking with their detailed interview data revealed that these stockbreeders are frequently affected by swine diseases and are located in peri-urban areas. Cluster 3 (*n* = 43, 32%) gathers stakeholders belonging to co-operatives but not participating financially and therefore not benefitting from joint actions, except the sale of animals. Their interest in associations first lied in the latter aspect and partially in learning about technical innovations as crossbreeding, pigsty and biosecurity.

3.2.2.2. Pork butchers. For pork butchers, axis 1 is negatively

Table 4
Repartition of sampled swine value chain stakeholders of South-east Benin in clusters according to the most relevant innovations.

Stakeholders	Variables	Clusters		
		1	2	3
Stockbreeders	Number	67	24	43
	Social share	100	–	0
	Membership fees	100	–	0
	Adhesion to associations	100	0	100
	Sale through co-ops	100	0	100
	Bulk purchase	98.5	–	0
	Tontine	92.5	–	–
	Crossbreeding	92.5	–	25.5
	Pigsty	91	–	25.5
	Biosecurity	86.5	16.6	23.2
	Exchanges/visit	40.2	–	2.3
Butchers	Number	13	25	7
	Adhesion to associations	100	24.4	–
	Tontine	84.6	24.4	–
	Diversification	–	100	0
	Veterinarian inspection	–	100	0
	Hard-wall restaurant	–	100	0
	New preparation of pork	–	100	–
Input suppliers	Number	14	6	5
	Diversification	100	–	0
	Sell on credit	100	–	0
	Adhesion to associations	14.2	100	–
	Subcontracting	7.1	66.6	–
	Membership fees	–	100	–

0 is used to indicate that no actor in the category adopted the innovation considered. Empty cells show clusters are not characterised by innovation mentioned.

correlated to the adoption of veterinary inspection, diversification and hard-wall restaurants. Axis 2 is positively correlated to the planning of credit payments and the adhesion to associations (Table 3).

The clusters of pork butchers are partitioned by 5 innovations: hard-wall restaurant, veterinary inspection, diversification, adhesion to associations and new preparations of pork (p < 0.001) (Table 4). Cluster 1 (n = 13, 29%) gathers butchers having mainly adopted organisational innovations, i.e. adhesion to associations and tontines. Butchers from cluster 2 (n = 25, 55%) have adopted most of technical innovations but proved less interested in collective actions. Crosschecking of individual interview data revealed this cluster mainly gathered peri-urban restaurants, rather isolated and located on the main roads. Cluster 3 (n = 7, 16%) gathers butchers not showing any innovation behavior.

3.2.2.3. Input suppliers. As for inputs suppliers, both axes are negatively correlated to the sale of feed on credit. Axis 1 is characterised by a negative correlation with the adhesion to association (hence the payment of membership fees) and positive correlation with the subcontracting for a large company. Axis 2 is characterised by its negative correlation with the use of modern feed mills and positive correlation with diversification (Table 3).

The clusters of input suppliers are partitioned according to the diversification, the sale of feed on credit, the adhesion to associations (hence, payment of membership fees), and the subcontracting for a large company (p < 0.001) (Table 4). Input suppliers from cluster 2 are much more attached to organisational innovations than input suppliers from cluster 1, who are the most interested in business arrangements. Input suppliers from cluster 3 are not interested in innovations.

3.3. Step III - Bottlenecks and opportunities identification

Focus group discussion identified the lack of professionalism and organisation of actors as relevant knowledge infrastructure issue at different level (Fig. 5). The absence of a vaccine against African swine fever was cited in this category as swine production limit. The poor investments in animal production by the government had been indicated to be at the origin of these issues. The lack of innovation framework for reinforcing stakeholders' capacity was also pinpointed, which was further complicated by the lack of exchanges between actors. For market structure, the swine market circuit was depicted as poorly organised and dominated by importations from neighboring countries. Input suppliers and pork butchers considered the poor availability of raw materials for animal feeding as the major issue. For these actors, the external market of live pig rivals the internal market because raw materials used for pig feeding are more readily available in the countries from where animals are imported. According to microfinance agent, the nonpayment of debts do not encourage investment of resources for swine market revitalisation.

As opportunities, stakeholders agree on the fact that the overall socio-economic context (economic growth) is favorable for swine production in the two departments. The increasing demand for pork thus appeared as a market opportunity. The agricultural productions in Benin are not subjected to taxes.

3.4. Step IV - Measurement of agreements about bottlenecks, opportunities and repartition of value added

A consensus emerged about the proportional repartition of the value added among stakeholder categories: butchers ranked first, input
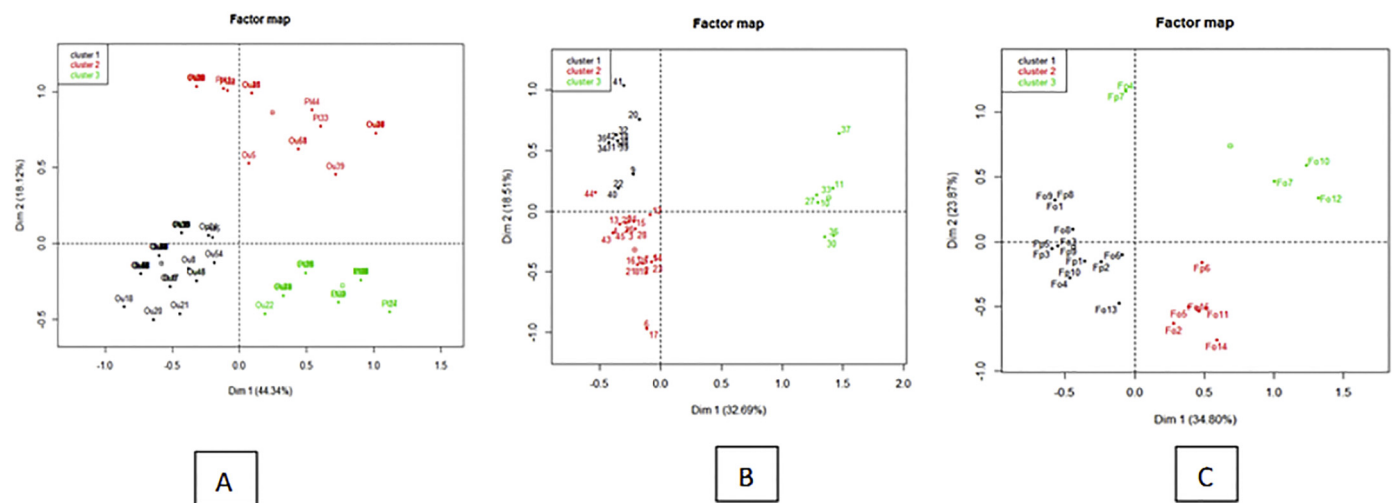

Fig. 4. Repartition of sampled swine VC actors based on current endogenous innovations.
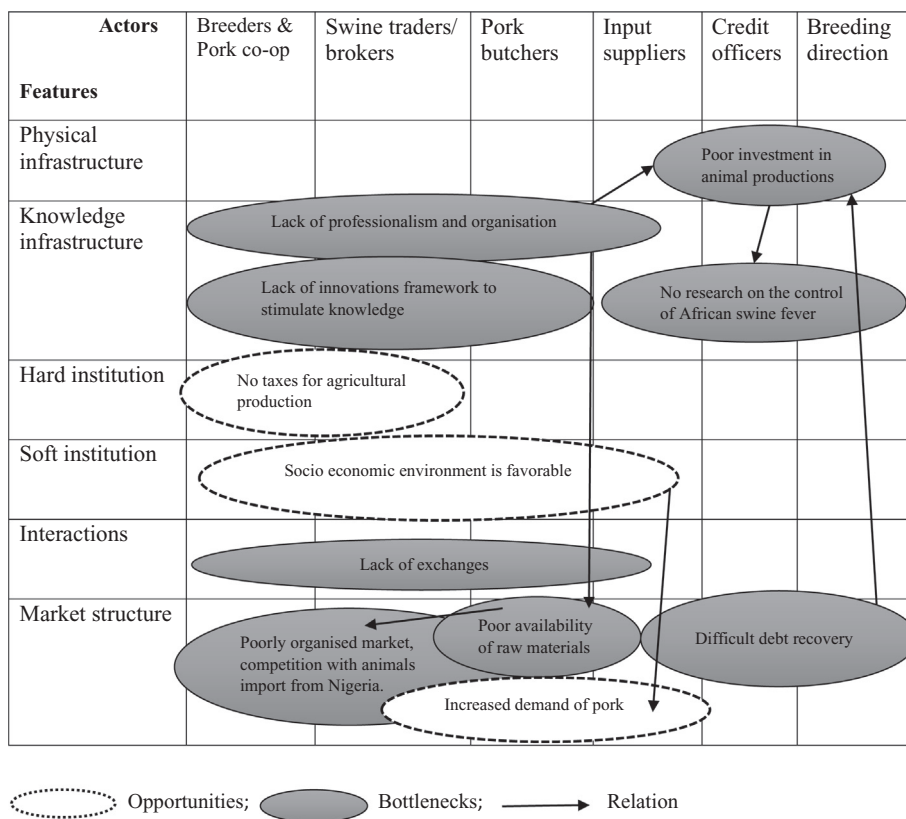
Fig. 5. Focus group's output on the analysis of opportunities and constraints along the swine value chain in South-East Benin.

Table 5
Stakeholders' agreements on bottlenecks, opportunities and repartition of value-added along the swine value chain in the three study zones of South-east Benin.

Zones	Kendall's coefficient of concordance (W)					
	Bottlenecks		Opportunities		Value added Repartition[1]	
	Intra-zones	Inter-zones	Intra-zone	Inter-zone	Intra-zone	Inter-zone
Porto-Novo	0.5	0.6*	0.7	0.7*	0.8	0.8**
Vallée	0.4		0.6		0.8	
Plateau	0.3		0.7		0.7	

* or ** indicate a statistically significant difference between zones at p-value levels of 0.05 and 0.01, respectively.
[1] The consensual ranking was as follows: 1) butchers, 2) input suppliers, 3) pig traders, 4) stockbreeders.

suppliers second, pig traders third and stockbreeders last (Table 5). This consensus was reached rapidly in focus group discussions without noticeable conflicts. The Kendall's coefficients of concordance on these opinions and for opportunities generated by the VC indicated high levels of agreement between actors (inter zones: 0.8 for value added repartition, 0.7 for opportunities). The level of agreement on bottlenecks indicated more divergent agreements, indicating that bottlenecks are analysed differently across the value chain, as also observed in Step III.

3.5. Impact diagram (post-study evaluation)

After two full years, four main impacts have been identified. The first impact reported by actors with a high level of agreement (W = 0.8) is related to the umbrella organisation of swine breeders (ANEP) who after discussions in focus groups have sped up the implementation of the Ouémé-Plateau antenna of the national association of stockbreeders (ANEP). One of the ANEP representatives reported: "*We were sleeping, this methodology aroused us. We will create co-operatives of breeders in each commune in the departments in order to work more closely with breeders as the new recommendation of ECOWAS also suggested*". The second shared observation (W = 0.7) refers to the stakeholders' enthusiasm to join the innovation platform and WhatsApp discussion group. Third, swine traders reported that the exchanges about issues of the VC had helped them progressing towards a better organisation of their association (W = 0.7). The fourth observation is the reinforcement of the dialogue between swine actors in the departments because stakeholders are exchanging more than in the past (W = 0.5).

4. Discussion

4.1. Social characteristics of actors

Social characterisation of actors shows the VC attracts a large number of young investors (average age of 44.0 ± 15.1). These profiles also highlight a gender issue, with a very weak presence of women in the VC. On that topic, a stockbreeder comments: "*Women are less represented because swine stockbreeding is time consuming and involves too much work for women who have already household tasks*". A pork butcher explained this underrepresentation as "*a sociocultural fact in Benin*". Let us note that, in reverse situations, in VCs that traditionally include a significant part, if not a majority of women, an increase in profit due to improvements may attract men to the expense of women (Moula et al., 2012; Coulibaly et al., 2008; Corniaux et al., 2005). In the present case, the challenge will be to support the involvement of women in an already profitable activity, with particularly well organised parts of the VC thus creating potential barriers at the entry.

4.2. Swine value chain mapping, marketing channels and governance

The mapping of a given VC is as much an analysis tool as a communication tool. This representation highlights opportunities to upgrade the performance, the governance of the VC and its profitability (Taylor, 2006). Through establishing this in focus groups with participatory methods, it helps highlighting the interdependency between actors and the shared goal. Upstream, many stockbreeders operate on a small scale. They are the most numerous and the least organised link in the VC. Raising swine was described as a "*sociocultural fact*" in south Benin by several stockbreeders, the term expressing that these did not consider the possibility to engage in wider scale operations as a main profession. For some of those stockbreeders, the cultural obligation to slaughter pigs for burial ceremonies stood as a major motivation to engage in this activity.

This large number of actors each operating at a small scale is a feature that stockbreeders share with traders. Both groups then suffer of a lack of organisation, contrary to butchers, who constitute a highly organised and even closed profession. This imbalance creates a situation comparable to a captive value chain, the fragmented sector of supply being captive of their organised buyers (Gereffi et al., 2005). Generally, in these conditions, switching costs or transaction costs are supported by the less-organised actors, since these display weaker bargaining power facing other stakeholders. This is further supported by the consensual recognition of pork butchers as concentrating most of the value added in the chain. This specific status and power of pork butchers, tied to wide profit margins compared to other stakeholders in the VC, had already been pinpointed by Lokossou (1986). The lobbies of butchers (and to lesser extent of traders) discourage the installation of newcomers. The access to the profession is inherited from father to son, or handed over between heirs. An outsider will find it difficult to get involved in the sector despite authorities' agreements, due to the threat represented by established butchers, who are furthermore locally believed to hold mystical power. The direct import of live animals from Nigeria (which was also rendered financially attractive in that period due to the Naira's relative weakness) by butchers comes in that logic as a practice creating a bargaining advantage for them facing local stockbreeders. Therefore, the place held by swine importation among bottlenecks analysis and divergences in that analysis are of particular interest to progress towards shared solutions, by also involving input suppliers.

The high number of different marketing channels (27) points to these organisational issues in the VC. Carron et al. (2017) reported that the increase of transaction costs in longer value chain occured at the expense of farmers. Let us underline here that traders and brokers did not hold a dominant role in the present VC as they might in other VCs in West Africa. Also, the value added of brokers has to be well understood and mobilised within the future developments of the VC, since these actors are key in establishing contacts between buyers and traders and fitting demand with supply in poorly organised markets (Negassa et al., 2008).

Hence, both the horizontal coordination of the weakest links and the vertical coordination along the VC will be important steps in resolving these issues (Onono et al., 2018). The creation of the stockbreeders national association (ANEP) aimed at fulfilling this role of horizontal coordination. As reported here, the inactivity of this State-created structure led actors to progressively organise themselves in smaller cooperatives. Similarly, Camara et al. (2018) link the failure of genetic selection programs in developing countries to the lack of stakeholders' involvement. This illustrates the poor success generally observed in similar situations by purely top-down innovations and the need to foster the participation of stakeholders (Lacombe et al., 2018; Sayer et al., 2013; Davis, 2008). In the present situation, top-down and bottom-up might gradually bridge and began to do so based on this action-research.

4.3. Innovations in swine value chain

For each of the analysed category of actor, i.e. stockbreeders, butchers and input suppliers, 3 types were finally described through the typological process, with 2 types appearing as distinctly innovating groups and one as a non-innovating or conservative group. For innovative groups of stockbreeders (cluster 1 and 3), the adhesion to co-operatives proved a fundamental step, enabling a set of innovation, as technical innovations through the sharing of knowledge and experience for the resolution of issues and through joint actions. While one group (1) was fully benefitting of this dynamic, the other (3) proved less innovative and interested in a more restricted set of the services an association may deliver. Similarly, Altieri and Toledo (2011) illustrated how the empowerment of peasants associations allows for the introduction of innovations and improvement of food security. Interestingly, among the conservative group biosecurity dispositions were nevertheless adopted, illustrating the importance of African swine fever locally and its potential to be a driver of innovation in the VC (Klerkx et al., 2012). Probably, the distribution in three clusters may recall the classical theory of innovation adoption curve, distinguishing between early adopting groups, a late majority group and latecomers (Rogers, 2002).

For pork butchers and input suppliers, innovations were obviously directed towards offering customers better products with the objective to increase their incomes. For instance, selling animal feeds on credit allows building loyalty of customers. However, an interesting case can be made of the introduction by some butchers of a "*planning to make sure the credits are reimbursed to traders or stockbreeders*". This points to a frequent problem of lack of reimbursement, partly due to weak managerial abilities in the sector but also to the non-respect of commitments towards actors of the VC in weaker bargaining positions. Indeed, the dominant position of butchers seems to allow for such abnormalities to persist, with stockbreeders describing the situation as an established fact: "*Pork butchers usually buy animal on credit and reimburse debts after selling the pork meat. Some of them reimburse just a part of the debt*". The gradual organisation of stockbreeders appears key in the here-observed emergence of a more balanced business relationship, including the respect of financial commitments.

The role of associations appears also important for butchers and input suppliers. Hence, a pork butcher explained: "*In our association, we work together; we try to adopt better behaviors and educate our members to reject the bad behaviors*". Therefore, the idea of an innovation platform is not at odd with the present dynamic inside the VC, and rather prolongs the logic that began at the level of each link. It is expected that such an innovation platform would increase the efficiency of the VC and help managing the risk it is exposed to (Hounkonnou et al., 2016; Klerkx et al., 2012).

4.4. Bottlenecks and opportunities

The IS framework allowed stakeholders to express bottlenecks and opportunities of the VC, as well as causal links between these. They showed a good degree of agreement inside and between the study zones. Limited investment in agricultural development is targeted as the origin of the issues stakeholders encountered. A special focus was given on research on African swine fever, a disease that is pointed as discouraging pig farmers and for which no vaccine is available. Interestingly, the lack of communication was cited as an important constraint in the VC. Once again, the setting-up of innovation platforms appears interesting to fill this gap (Kilelu et al., 2013).

4.5. Advantage and limitations of the method

This study served as a pilot study testing a methodology in four phases to characterise and evaluate innovation in an agricultural VC. The detailed information provided here has many implications for

innovation stimulation as well as VC governance (Berthet and Hickey, 2018). The phases are interlocked with one another to offer an effective evaluation approach. So, the impact diagram identified allowed confirming that stakeholders' participation may entail positive changes.

Nevertheless, the present methodology presented some limits to be considered when interpreting results. Much of the data collected is qualitative or semi-quantitative in nature, which might overstate the numerical importance of some facts while understating others. The operational focus of the method precludes the use of extensive qualitative analysis of the data collected, meaning that it probably conceals more than what could be extracted through our analytical choices. A special mention can be made of the management of focus groups, in which ensuring for each one to express his position may be a difficult task requiring experience.

The higher number of stockbreeders within focus groups was aimed at allowing an inclusion of a diversity of profiles from this wide stakeholder group. However, this higher number should not be interpreted as an overrepresentation of stockbreeders, due to the qualitative nature of the approach and the diversity of stockbreeders profiles. The method has to be considered as providing perceptual data that is important to understand the viewpoint of actors on their VC. Rather than the exact figures obtained, the important output of this method consists of the discussions generated on this occasion and the consensus on the relative importance of ranked items, as for the dominance of butchers in the VC.

5. Conclusion

The proposed methodology allowed characterising and identifying the main stakes and dynamics along the VC, and more particularly innovations practices, constraints and opportunities. It opens the way to further investigations to assess the impacts of these innovations on VC performance and sustainability. The stakeholders' participation is used here in contrast with top-down approaches adopted in most interventions aimed at stimulating agricultural innovation. Oganisational innovations came out of this study as central in the progress of the VC. Also, the idea of an innovation platform appears as suited in such contexts where collective actions already took place in a bottom-up approach. An innovation platform might thus help bridging the gap between those bottom-up initiatives and the previously implemented top-down policies.

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