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Social network analysis of innovation platforms in the local rice value chains in Benin: Shield or showcase for endogenous innovation?

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Innovation platforms (IPs) bring agricultural value chain stakeholders together to successfully overcome constraints in agricultural systems. In Bénin, they are introduced to foster collaboration, partnership, and mutual focus to generate innovation on the commodity such as the local rice production and processing systems. Based on Social Networks Analysis, this research examines this IPs in influencing the innovative capacity of local rice value chain stakeholders in the Glazoué Rice Hub. The findings show a network with low density which hinders the dissemination of information on rice innovations in the IPs. Further, the innovation capacity of rice stakeholders is not necessarily associated with their central position either by degree, closeness or betweenness centrality. Ultimately, the rice stakeholder knowledge and resources determine his innovative capacity.

Key words: Innovation Platform, rice, endogenous innovation, social network, Benin

INTRODUCTION

Agriculture in sub-Saharan Africa, that underpins the livelihoods of over two thirds of the regions' poor, has been stagnating for many years due to social, political, cultural and economic considerations (Adekunle et al., 2012; Zossou et al., 2020). In Benin, rice the second most consumed staple food crops after maize that the Government of Benin is focusing on to ensure food security and poverty alleviation (Houngue and Nonvide, 2020). Despite this, rice production potential is not achieved because of the lack of opportunities due to the

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low competitiveness of locally produced rice (Africa Rice, 2012). Among the strategies to curb these constraints, the research for development sector in Benin (such as Africa Rice and the National Agricultural Research System) have invested in technological innovations such as new varieties, steaming kits, seedling wheel and weeders to improve rice productivity and quality, and therefore contribute to increase the income of rice stakeholders (Hinnou, 2013). Nevertheless, the adoption of innovations by rice producers and parboilers is often disappointing (Loko et al., 2022). The often-mentioned reasons are related to the lack of attention for farmers' knowledge (Zossou et al., 2020). However, farmers have built new knowledge and practices and they participated in the construction of new standards in rice production (Hinnou, 2013). Unfortunately, such local knowledge and practices are less known or not-valued for the promotion of different value chains (Hinnou, 2013) in a context where this promotion emerges as a relevant strategy that would address market expectations and ensure the supply-demand loop governing the market economy. The IP approach is increasingly being proposed in agricultural research for development to bridge the gap between formal research conducted by scientists and informal research being conducted by farmers and other stakeholders. In doing so, IPs provides a channel for connection, interaction and networking between stakeholders could be the spearhead for access improvement to agricultural innovations and markets for smallholders (Gildemacher and Mur, 2012). Many smallholder farmers receiving little or no support from public research and development institutions, innovate actively, individually and collectively to solve problems, improve their cropping system and their income and seize opportunities (JOLISAA, 2013).

Innovation platforms were first initiated in Benin in the 2010s through development projects aimed at disseminating and adopting technologies that were not widely known or used. This should allow for the consideration of the factors that determine the low adoption of technologies, particularly the social, cultural and economic contexts. Thus, IPs are introduced to facilitate interactions and social learning among rice stakeholders aiming at improvement in the local rice production and processing systems. The major challenge is to seek solutions in collaboration with all stakeholders in the rice value chain (producers, processors, traders, financing structures, input suppliers, agricultural research, and extension services) to improve the quantity and quality of locally produced rice in Benin. However, the collaboration of rice producers and parboilers with other stakeholders could help them to access resources that are necessary for innovation. Such interactions would make development organizations less dominants and would stimulate social learning which is social more beneficial for local stakeholder's innovation capacity hatching (Hermans et al., 2017). That is why IPs can enable farmers to design their farming systems. Although several recent studies have focused on the structure and functioning of IPs, they do not provide a clear understanding of how and why these platforms are shaping the innovation process based on local knowledge and practices (Kilelu et al., 2013). Social Network Analysis is used to understand the relationship between IP and those local knowledge and practices. If IPs enable collaboration and interaction between the stakeholders to design new process, it is still difficult to measure their impact because the achievements are often influenced by factors of the environment in which these platforms are emerging or initiated (Swaans et al., 2013). However, it is important to develop an evidence-base of how the platforms help to bring about changes (both technical modifications and social organizations operations) to sustainably improve the livelihoods of rural people. It is also important to understand the extent to which these changes are (and should be) maintained over time (Gildemacher et al., 2011). Moreover, if IPs remain an opportunity to facilitate exchanges, it is not obvious that it is a source of motivation for endogenous initiatives.

This article applies a social network analysis (SNA) approach to assess the influence of IPs on the innovative capacity of stakeholders according to their relationships. In fact, the apprehension of rice farmers' positions and the relations they have in their social network could help to better understand their innovative capacity. Measuring the impact of the reinforcement of the relations between stakeholders about the innovation process constitute a click for the implementation of IPs. This is also a channel for diffusion of innovations introduced by research and effectiveness of IPs.

Social network theory: an application to local rice value chains

Social networks are made up by a set of social units (individuals, informal groups or formal organizations) and relationships that these social units have with each other, directly or indirectly, through chains of varying lengths (Yousefi Nooraie et al., 2018). Relations between the elements express the forms of social interaction which are diverse by nature. These social interactions can be of various types: family, emotional (strong ties) or more distant: affinity, business relationship, work (weak ties) (Granovetter, 1983). From this perspective, innovation platform, which is a mechanism to facilitate interaction and collaboration among farmers, input suppliers, traders, processors, researchers, government officials, etc., constitutes a social network (Schut et al., 2016; Swaans et al., 2013). Network which provides an arena for experimentation, learning and negotiation between various social units made of the agricultural value chains stakeholders (Hermans et al., 2017; Schut et al., 2016). Hence, it is increasingly seen as a promising vehicle for agricultural innovation in developing countries (Schut et al., 2016). Ultimately, platforms therefore play a key role in facilitating the process of innovation in agriculture, justifying its choice in solving agricultural problems (Kilelu et al., 2013; Schut et al., 2015) Many social scientists agree that the interactions within social networks are generating social capital that is a key driver for innovation (Cofré-Bravo et al., 2019). This innovation incorporates an organizational and social dimension that includes the knowledge and actions of all stakeholders involved (Defoer and Dugué, 2012). In other words, endogenous innovation, in this paper, is understood as as any practices or knowledge introduced by local rice producers and parboilers to stem the constraints they faced in their activities. However, these practices perceived as local transformations are neither to be opposed to any improved technology introduced from the outside nor to be confused to it (Hinnou et al., 2018). Thus, the interactions between the different stakeholders in the innovation platforms lead to information and knowledge exchanges that are conducive to the introduction of new ideas or practices that rice producers and parboilers use to tackle their challenges. The choice of social network theory in this article is justified by its structuralism assumptions which take as first unit of analysis, interpersonal relationships (Ramirez et al., 2018).

Indeed, the SNA postulates that behaviour or opinions of individuals' dependent on the structures in which they are inserted. Moreover, two developments are fundamental in the SNA: the graph theory and the linear algebra (matrix) application to relational data (Yousefi Nooraie et al., 2018). As such, SNA provides information on individual or collective stakeholders' interconnection in social processes such as communication flows or decision making situations, the transfer channels and the position relative to each other within a social network (Hoppe and Reinlt, 2010). This approach illustrates the concept of positioning through the viewing of rice stakeholders (node or vertex) and links (relationships or edges) between the interviewees. This position has been measured through geodesic distance, clustering coefficient stakeholder's connexity and centrality in the studied social network. The SNA approach has been applied to better understand multi-stakeholder platform dynamics related to innovation and scaling of innovation (Hermans et al., 2017).

Density and connectivity of the social network (the strength of ties)

The density of a network refers to the number of links regarding the maximum number that may exist in this network (Hoppe and Reinlt, 2010; Yousefi Nooraie et al., 2018). The criterion of density is often associated to the rapid flow of information. When the density is high, the probability that information in rice sector reaches rice stakeholders is greater. Moreover, social learning occurs most effectively by solving jointly problems and sharing of experiences and ideas within social networks. Thus, strong ties are defined by family or friendship relationships while weak ties are related to more distant or strictly professional relationship (Bachelet, 2014). The same way, social relationship between rice producers and parboilers could determine the nature and the type of exchange their have in the rice social network. Denser the relationship or connexion between rice stakeholders, more intense will be their collaboration. This induces the exchange of information useful for innovation. To this end, we propose the following hypothesis:

H_1: The rice social network is characterized by low density limiting the dissemination of information within the rice IP.

Stakeholders' centrality in the rice social network and endogenous innovation

Centrality is a key parameter used in structural analysis to assess stakeholders' positions in undirected graphs[i] (Lemieux and Ouimet, 2004; Yousefi Nooraie et al., 2018). Within the network, stakeholders are not equivalent. While some can be highly connected, others may serve to connect two vertices (bridge role), and there are some who are relatively isolated (Das et al., 2018; Hoppe and Reinlt, 2010). Thus, rice producers and parboilers don't play the same role and they don't occupy the same positions in their social network. This applies both to rice IP members of the same category within the value chain and those who have vertical relationship. Therefore, to apprehend the links between rice farmers' positions and their innovative capacity, three centrality measures will be used including: degree centrality, the betweenness centrality and the closeness centrality (Das et al., 2018). Degree centrality is a measure that determines the direct relational activity of someone and is an indicator of communicative activity or popularity of an actor (Das et al., 2018). To that extent, the actor who occupies the central position in a graph is the one with the largest number of direct connections (Lemieux and Ouimet, 2004). This actor will therefore have more information coming from others. The closeness centrality shows the integration or isolation of network members (Müller-Prothmann, 2007) and measure the number of paces between stakeholders in the network (Das et al., 2018). Strong closeness centrality states greater autonomy of the individual, because he could easily reach other members (Das et al., 2018; Lemieux and

Ouimet, 2004). Therefore, the closeness position of a stakeholder in the network could have an influence on him or her, in the process of adaptation or the introduction of a significant change in its agricultural system. The betweenness centrality of a point in a graph is a potential indicator of a node (stakeholder) who plays the role of a broker or a bridge. He can often control the information flow in the network (Das et al., 2018; Müller-Prothmann, 2007). Hoppe and Reinlt (2010) stated that these "bridges" provide valuable opportunities for innovation. Also, they are often "good informants" during an assessment because of their access and knowledge of the larger network. In communication networks where access to information is restricted, one who by his or her position could be an intermediary may draw a great advantage (Degenne, 2013). It is therefore possible that information on various activities for the IP might be controlled by stakeholders who occupy this intermediary position. In view of this, we assumed that:

H_2: In the rice social network, the position of a stakeholder is strongly correlated with its ability to innovate in its local rice production or parboiling system.

That is, rice stakeholder members of an IP with the more central, closeness or betweeness position have inevitably more capacity to introduce major and significant changes in their production and processing system.

MATERIALS AND METHODS

Study area and sampling

Based on mixed design, this research was conducted in the rice hub[ii] of Glazoué in the district of Collines in Benin. First, data were collected through focus groups discussion (FGDs) of 12 to 15 members of rice producers and parboilers organisations. After the stratification of these organisations according to their membership in an IP or not, a simple random sampling was used to select organisations to interview. The advantage of this method is to create certain homogeneity in heterogeneous groups and give the same chance for stakeholders to be sampled. In total, 20 focus group discussions of producers and parboilers were conducted in 16 sites. This sample size was defined by the saturation effect of the information collected (Creswell and Poth, 2016). Both rice IPs in the hub were studied. Secondly, we used a combination of the "nominalist approach" and "names generators approach" to define the rice stakeholders' network to interview on endogenous innovation (Butts, 2008). Thus, the nominalist approach was adopted to establish a base population of the rice social network. Indeed, during focus group discussions conducted in the exploratory phase, participants were requested to indicate the names of the people to whom they go for productive resource requirements (inputs, land, credit, technical information, advises, etc.) or for the marketing of their products. But the establishment of the list was somewhat acceptable for interviewees who found it difficult to agree on some names. To remedy this, when collecting relational data, we use the "name generator" approach to ask the interviewees to indicate, regardless of the initially defined list, other people with whom they have any relationship. In total, a sample of 36 rice stakeholders (8 producers and 28 parboilers) was formed.

Methods of data collection

Three essential steps have shaped the data collection stage. There is the literature review, the qualitative data collection and quantitative data collection. All these steps were reinforced by participatory observations. The qualitative survey is made through comprehensive interviews. This technique has helped to render the interview situation, a situation in which speech collected was considered as discursive material valid for research (Yin, 2016). These data were collected through facilitated discussion groups with producers, parboilers and some individual informants as responsible of structures members of the IP. The quantitative and relational data with individual rice social network stakeholders was performed using a semi-structured interview (Table 1). In this study, only the rice producers and parboilers most likely to innovate were surveyed.

Data analysis

Two methods were used for analytical basis in this chapter. Qualitative data were submitted to continued thematic content analysis (Paille and Mucchielli, 2013) supported by descriptive statistics and statistical tests. Regarding relational data, SNA has been used to bring out graphs and interpreting clues. Thus, social relations are represented in terms of nodes and links: nodes are rice stakeholders (producers and parboilers) while links represent the relationships between them. In this research, the roles played by each of the stakeholders in the network, in terms of communication or exchange of informational resources or not, were quantified by calculating measures of centrality. Respondents were asked to say within their rice social network, stakeholders (producers, parboilers) with whom they have knowledge/information exchange about rice production and processing practices. Based on the collected relational data, an adjacent matrix was created to show the links between different stakeholders interviewed. The elements of the matrix a_{ij} are numerical values (1 if there is relationship between two stakeholders and 0 if not) attached to the relationship between the pairs of stakeholders or nodes. A visual representation is made as a network graph with nodes representing stakeholders and edges (lines connecting two nodes) representing the relationships between them (Das et al., 2018; Hoppe and Reinlt, 2010). The main indices measured are: density, network connectivity, degree centrality, closeness centrality and betweenness centrality (Table 1). The software SPSS 21.0 has been used to compute descriptive statistics and structural analysis is made with UCINET version 6.204 and Netdraw.

RESULTS

Endogenous innovations itineraries in local rice value chains

Rice stakeholders develop endogenous strategies to either contain or adapt to the constraints inherent in their production system (Table 2). This section outlines some endogenous responses to certain constraints in value chains of local rice on the one hand, and an inventory of

Table 1. Methods, collected information and data sources.

Method	Type of information	Sources
Literature review	Introduced rice innovations, rural practices, IPs coverage areas and structuration	AfricaRice, INRAB, Universities
Facilitated Discussion Group (qualitative)	Innovations (introduced and endogenous) linked to constraints, social network perceptions, rice network roles, social integration, vertical et horizontal relationship among stakeholders, stakeholders influence	Producers, parboilers and IPs members (ATDA, MFI and NGO)
Semi-structured interviews (quantitative)	Relationship existence (« yes » or « no »), nature (distance, familial, professional) and purpose (credit, extension, inputs, market, etc.) of the relationships, rice actor's sources of information	Rice producers and parboilers

Source: Authors

Table 2. Endogenous responses of constraints in the rice hub of Glazoué.

Major constraints	Endogenous transformations	Stakeholders	Introduced technologies
Lack of water (rain scarcity)	- Reduce by half the exploitation 'size in favor of cash crop - Sacrificial practice invoking God and ancestors' spirits - Negotiation with the municipality center for drilling in the rice fields	E11, E6, E28	- New short cycle varieties - resistant varieties to drought
difficult access to quality water for parboiling	- Negotiation with the municipality center for drilling in the rice fields	E28	- Forage + Water Tower
Poor access to a lucrative market	- Conversion in another Income generating activity as profitable as rice - Engage other products to maintain customer (by the permanent presence) and profitable commercial activity - Contract with Nigerians and other semi-wholesalers	E4, P8, E10, P4	- Packaging
No mechanization of labor	- Ridging + Installing leguminous plants	E4, E11, E19	- Tractor, Animal haulage
Insufficiency / bad quality of parboiling equipment	- Using the bottom (perforated plate basins) deposited in the pot for parboiling	E7, E4	- GEM, 396,83 lb Kits
Limited quality of paddy	- Participation in the harvest and purchasing of paddy on in the field - Pre-financing of production / assistance to rice producers	E17, E28	- Good Agricultural Practices (GAP)

Source: Survey data, 2018-2019.

the technologies introduced by research

Social network density and convexity as vector of endogenous innovation

The spread of specific information on rice production and parboiling is appreciated through the density of the social network formed by stakeholders of the local rice value chains. Thus, the structural analysis shows that the density of the rice network is very low (Table 3). Indeed, only 13 % of the possible relationships are made (d = 0.127; SD = 0.33). Moreover, the local rice value chains stakeholders do not have enough contact with each

Table 3. Rice network density and social capital.

Parameters	Value
Density	0.127
Standard Deviation	0.33
Average distance between nodes	2.5 (2.9)
Number of links (k)	160
Number of stakeholders (n)	36
Degree of density	4.44
Alpha	0.84

Source: Survey data, 2018-2019

other. Indeed, the average distance between these rice stakeholders is 2.5. This means that an average of 3 links is needed to connect an actor to another. It appears from these findings that relationships between rice stakeholders (either producers or parboilers) are slightly denser. This low density of the rice network inevitably explains the great information asymmetry observed in the local rice value chains in the study area. Moreover, the degree of connection of rice stakeholders in the network valued at 4.44 reflecting the existence of a hierarchy among the stakeholders of the social network. In other words, some rice stakeholders hold control over the information that requires their peers to use them. But this remedy does not necessarily mean access to the right information sought. However, there exists within this network some who by their openness to other networks took personal initiatives to reduce their stress.

Local rice stakeholder's social network and innovative capacity

Central position of local rice stakeholders

The positional stakeholder analysis shows that there is a selective process of establishing relationships with other producers or parboilers within this social network. Reading the Table 4, it is clear, that there is a high variation of the degree centrality in the rice network with an important deviation between the most central stakeholder and the most isolated. Only stakeholders E12 and P8 have the highest degree centrality respectively estimated at about 63 and 43. They thus appear as the most central stakeholders in the rice network and hold the largest number of direct connections with others. Therefore, by their central position in the social network, they are nodes through which information passes before reaching the other stakeholders. Obviously, these two stakeholders are respectively responsible of the ridge of parboilers and producers' organizations. However, only P8 initiated an endogenous response to mitigate the limited access to remunerative market (Table 2). In addition, stakeholders who do not belong to any IP show a very low degree centrality compared to those who are members. This position requires them to establish relations with IP stakeholders to access information and / or specific rice knowledge.

When rice stakeholder's independence reinforces their innovative capacity

The results indicate that the stakeholders in our study area have very good closeness centrality with a high average of 42 and a relatively low standard deviation of 8.96 (Table 4). This implies that rice parboilers and rice producers should generally have better access to information sources. Further analysis shows that stakeholders E12, E19, P1 and P8 have higher closeness centrality and therefore are closer to information sources. The social status of these stakeholders within their professional organization certainly favoured their closeness in the rice network without major influence on their innovative capacity. Indeed, only the parboiler E19 and the producer P8 had individually introduced major changes in their production and marketing systems to respectively face the challenge of water and sales market (Table 2). An IP membership analysis shows that E10 and P4 have taken initiatives to improve access to more remunerative rice market although they don't belong to any IP. This could be explained; firstly, by the resources these stakeholders mobilise from other social networks. On the other hand, these stakeholders are remote, only two links, from E12 and P8 who appear as the most central stakeholders in the rice social network.

Rice stakeholders betweenness position

Structural analysis (Table 4) shows, overall, an average betweenness centrality of 4.38 (SD = 10.16). In the rice network, only the parboiler E12 has a very strong position

Table 4. Stakeholders centralization in the rice IP.

Stakeholders	Degree centrality	Closeness centrality	Betweenness centrality	IP membership	Innovative initiation
E1	5.714	44.304	11.092	Yes	No
E2	20.000	47.297	0.846	Yes	No
E3	11.429	44.304	0.000	Yes	No
E4	8.571	43.750	0.000	No	Yes
P1	31.429	50.725	7.751	Yes	No
E5	5.714	42.683	0.000	No	No
E6	20.000	47.945	5.966	Yes	Yes
E7	2.857	32.710	0.000	Yes	Yes
E8	2.857	24.138	0.000	No	No
P2	2.857	33.981	0.000	No	No
E9	5.714	31.532	5.714	No	No
P3	2.857	42.169	0.000	No	No
E10	2.857	42.169	0.000	No	Yes
E11	17.143	46.667	0.720	Yes	Yes
E12	62.857	71.429	58.826	Yes	No
E13	14.286	44.304	0.042	Yes	No
E14	17.114	46.053	0.630	Yes	No
E15	11.429	43.750	0.000	Yes	No
E16	2.857	31.532	0.000	No	No
E17	14.286	45.455	11.261	Yes	Yes
P4	2.857	31.532	0.000	No	Yes
E18	2.857	33.654	0.000	No	No
E19	25.714	50.000	14.301	Yes	Yes
E20	2.857	33.654	0.000	No	No
E21	11.429	46.667	11.261	Yes	No
E22	2.857	32.110	0.000	No	No
E23	2.857	32.110	0.000	No	No
P5	11.429	46.053	0.252	Yes	No
E24	17.114	46.667	5.874	Yes	No
E25	2.857	32.110	0.000	No	No
P6	17.143	47.945	1.084	Yes	No
P7	17.143	46.667	6.817	Yes	No
E26	2.857	32.110	0.000	No	No
E27	8.571	38.043	0.462	Yes	No
P8	42.857	57.377	12.165	Yes	Yes
E28	22.857	49.296	2.750	Yes	Yes
Average	12.698	42.025	4.384		
Standard deviation	12.589	8.965	10.162		
Minimum	2.857	24.138	0.000		
Maximum	62.857	71.429	58.826		
Total	36.000	36.000	36.000		

Source: Survey data, 2018-2019

with an intermediate centrality of 58.83. It is followed by E19, P8, E1, E17 and E21 with decreasing betweenness centralities of 14.30 to 11.26. So, these stakeholders, mainly E12, position themselves as the most important relay of the rice network in the hub. They play a key role in the control and dissemination of specific information in the local rice value chain. Such results are obvious due to the proximity position of most of these stakeholders from

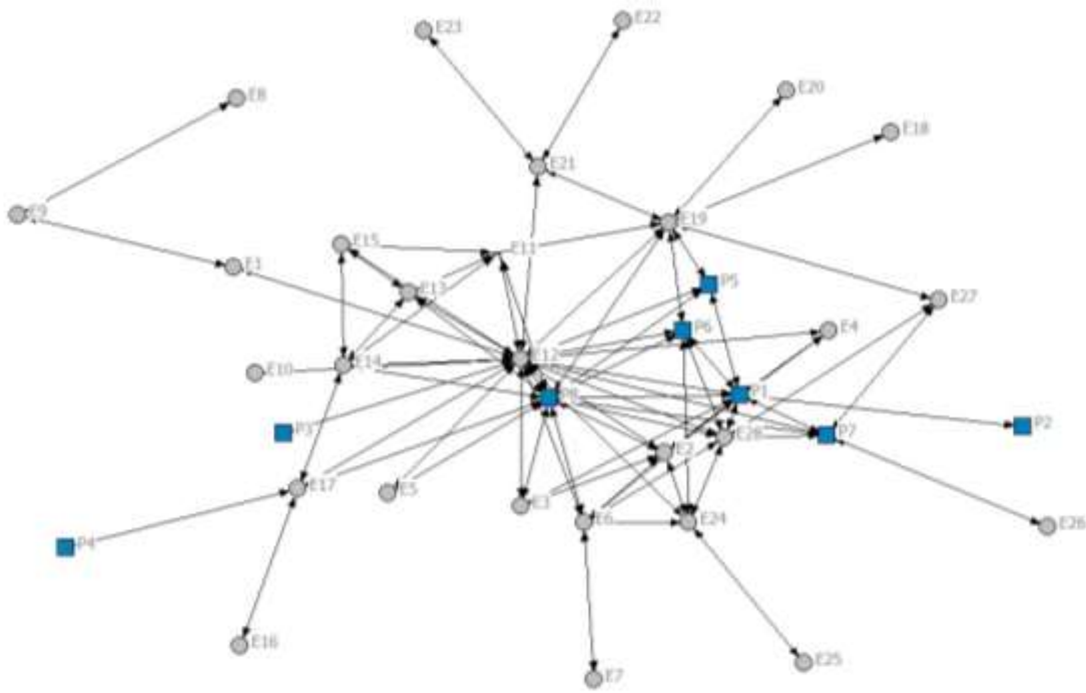

Figure 1. Sociogram of rice hub of Glazoué.
Source: Drawn from survey data 2018-2019.

their peers. Nevertheless, despite the strategic location of E12 and information control power, she has no major changes in her production and / or processing system (as presented in Table 2). Furthermore, more than half of the surveyed stakeholders have a betweenness centrality equal to zero. These stakeholders do not serve at all as a channel of distribution of information or knowledge on rice. Accordingly, the information is poorly distributed within the rice social network. This is the case of E4, E7, E10 and P4 which introduced major changes in their production systems but by their position may not distribute. Obviously, most of these stakeholders don't belong to any IP and their connection with the social network stakeholders is very limited. The sociogram (Figure 1) illustrates the configuration of the social network of the stakeholders in the rice hub of Glazoué. Rice producers are represented by a blue square and parboilers by grey circles.

DISCUSSION

The SNA adopted to assess the stakeholders' interconnectivity has shown that the density of the rice network is very low. This network studied density is 0.13, meaning not all possible ties between stakeholders are established with low density since social relationships cost to initiate and sustain. It should be recalled that the density of a network refers to the degree to which stakeholders in the network are linked with other stakeholders in the network (Das et al., 2018). Otherwise, when the density of a network is 1, it means that all possible relationships really exist or that the network is dense (Hoppe and Reinlt, 2010; Yousefi Nooraie et al., 2018; Chollet, 2002). This finding is contrary to the thesis of Scott (1991) stating that the more a social network is built on acquaintance relationships than friends and the smaller it is, the denser that network tends to be. This image of rice social network induces an asymmetry in the spread and sharing of information and knowledge related to the local rice value chains. The information flow is very slow in the rice social network of Glazoué and induces high transaction cost in terms of accessing to rice specific information. The density is often associated with the speed of information flow due to stakeholders' interactions (interconnectivity of the network) as studied by Hoppe and Reinlt (2010) and Chollet (2002). Thus, the greater the density, the higher the probability that an information about rice will reach all interconnected stakeholders in the network. This finding is reinforced by the studies of Bellamy et al. (2014). Based on further structural analysis, they had showed that the integrated nature of the ties in the supply networks influence knowledge and information flow within networks. The analysis of the stakeholders' centrality in the rice network reveals a diversity of information sources. Degree centrality is an indicator of the communicative activity or popularity of a stakeholder (Abbasi et al., 2011; Das et al., 2018).

In line with previous research (Borgatti, 2005; Lemieux and Ouimet, 2004) it is found that the rice stakeholder with a large number of direct connections with others occupies a more central position in the social network and is more exposed to innovation. However, the correlation with the central position of rice stakeholders and their innovative capacity remains very weak. Moreover, this position is significantly influenced by membership in an innovation platform. This means that the central position of a rice stakeholder alone was not sufficient to trigger innovation; since there are producers and parboilers who do not belong to any innovation platform, but have undertaken individual and endogenous initiatives to overcome their difficulties. Moreover, the closeness position of stakeholders who are not members of an innovation platform could explain their innovative capacity. Obviously, closeness centrality is an indicator of integration or isolation of network members (Müller-Prothmann, 2007). Thus, a strong closeness centrality indicates a greater autonomy of the individual (Hanneman and Riddle, 2005; Das et al., 2018; Lemieux and Ouimet, 2004). This autonomy could also reflect the behaviour and choices made by the rice producers and parboilers. Indeed, the social capital which is the source of innovation is gradually built within diversified relational networks that are open and rich in structural holes (Burt, 1995). As a result, the link between the closeness centrality of a stakeholder due to his membership of an innovation platform and his capacity to innovate is not obvious. Similarly, stakeholders in a betweenness position are not always the stakeholders who have been more innovative. These findinds are contrary to previous work in the literature. Degenne (2013) had shown that the actor who enjoys a betweenness position, in communication networks where access to information is restricted, can benefit greatly from it. Also, this stakeholder can easily control the information flows in the network (Hanneman and Riddle, 2005; Das et al., 2018; Müller-Prothmann, 2007) and thus has a higher innovation capacity (Hoppe and Reinelt, 2010).

Finally, this study shows that the more or less central, closeness or betweeness position of a rice stakeholder does not inevitably justify his capacity to introduce major and significant changes in his production and processing system. Moreover, the different transformations introduced by the rice stakeholders were possible because of their interactions and relationships and their openness to other social networks in the study area. Moreover, the innovation process requires the actor to incorporate personal resources from his knowledge capital (Cofré-Bravo et al., 2019; Hermans et al., 2017). In the same vein, Saglietto (2013) argue that relational wealth alone does not constitute social capital but also depends on the structural characteristics of these relationships. In other words, if the privilege a stakeholder has in a social network gives him a central position in the network, the quality of the social capital held by this stakeholder is also decisive (Burt, 1995) for innovation. Like Wellman (2007), the emphasis is on social structure and the facilitation of certain actions by stakeholders within their social network.

CONCLUSIONS AND IMPLICATION

Based on existing studies on social network analysis (SNA), this paper examined the relationships between the innovative capacity of local rice producers or processors and their position in the rice social network, and their membership in an innovation platform. We can posit that innovative capacity of rice value chain stakeholders is not necessarily associated with their central position, whether it be of degree, closeness or betweenness. On the other hand, this position is highly and positively correlated with membership of an innovation platform. That is, the resources mobilised by rice producers and processors due to their membership in an innovation platform are not a determining factor in inducing innovation at the level of these stakeholders. Given the current influence of IPs on the stakeholder ability to innovate, capacity building for a more dynamic liveliness of this platform is necessary. This strategy could influence the quality, speed and cost of information shared in the social network. These conclusions call on development partners and political actors to readjust their intervention strategy, which is still more oriented towards the material and financial capacity building of local stakeholders. It seems more efficient to review the value chains financing mechanism through IPs to attract beneficiary stakeholders to contribute to investment. Otherwise, the traditional model of development of local rice value chains, dominated by institutions and/or support structures, may not be conducive to social learning and consequently to endogenous innovation.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Notes

[i] The undirected graph is the representation of relationships in which there is no unilateral transmissions from one actor to another.
[ii] The rice hub is an agro-ecological zone with a concentration of research and extension work integrated along the value rice chain for more impact. This division includes four municipalities of the department of Collines.