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Full Length Research Paper

Shifting rural women livelihood in cocoa-based system in Cote d'Ivoire by cassava-based innovation process

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This paper is a case study of how agricultural innovation system implementation in the Nawa region (Southwest Cote d'Ivoire) allowed improving cassava-based business through improving women skills for production and processing and therefore increased women livelihood and increased food security in the village of Krohon. This region is known as a major cocoa-producing area where food crops diversification appeared as a dire need. Different types of actors were mainstreamed in the multistakeholder process through three types of platforms. The research for development platform (R4DP) performed the situation analysis of food crops production and identified in interaction with others stakeholders' women as core actors of food crop production. The R4DP also implemented trials together with women farmers who were in charge of data collection. The innovation platform (IP) defined agricultural issues and challenges in the region and identified entry theme of the project to be implemented. Village innovation platforms (VIPs) were operational platforms that implemented field activities closely with researchers. The strong interactions within and between platforms allowed continuously performed field- and post-harvest 'demand-driven' oriented activities. The strong implication of women farmers in trials and trainings also allowed them to select the best fit innovations in accordance with their aspirations.

Keywords: agricultural innovation system, platforms, 'demand-driven' activities, woman farmers, cassava, Nawa region.

ABBREVIATIONS

AIS: Agricultural Innovation System
IAR4D: Integrated Agriculture Research for Development
IP: innovation platform
R4DP: Research for Development Platform
VIP: Village Innovation Platform

INTRODUCTION

Agriculture is a key sector for people sovereignty. Most Sub-Saharan African countries are facing the challenge of food sovereignty despite their great agricultural potential. Agricultural sector accounts for a significant part of GDP and occupies a large part of population. In Côte d'Ivoire, agriculture provides 24% of GDP, occupies about 45% of the active population and constitutes a source of income for two-thirds of the population. Ivoirian population is composed by 49.7% of rural population (AFD, 2015). Ivorian agriculture is dominated by cocoa

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that plays a major role in the economy of the country and contributes to about 15% of its GDP. Cocoa supports more than six million households, equivalent to a quarter of the Ivorian population. The country is the world's leading cocoa producer accounting for 40% of world production (ICCO, 2015). The current cocoa production system is characterized by the predominance of small-scale farmers operating at subsistence level with 3-5 ha of lands (ENSEA, 2016).

The dominance of cocoa and others tree crops (coffee, rubber and oil palm) to the detriment of food crops increases food insecurity that varied in Côte d'Ivoire from 10.6% in urban areas to 15% in rural areas. In the Nawa region (Southwest Cote d'Ivoire), prevalence of food insecurity is of 1.3% in urban areas, while it rises to 10.5% in rural areas (INS, 2015). This situation is largely explained by orientation of agricultural activities towards tree crops that occupy most of arable lands limiting food crops chance for extension. Moreover, as human population increases in the Nawa region, women and youth access to land and new productive technologies diminish while opportunities for income from off-farm activities are limited. As a result, this active and strategic part of the population rely on marginal soils or enter sharecropping agreements. This shaky situation needs to be addressed for empowering women and youth and for therefore contributing to preserve the national park of Tai which is a global heritage.

An integrated agriculture research for development (IAR4D) was carried out in the Nawa region for sustainable intensification of smallholder agriculture. IAR4D was proposed as an alternative to the conventional linear approach of transfer of technology. It is a process driven approach that engages multiplicity of stakeholders embedded in a given commodity's value chain (Laurent et al., 2016). This IAR4D was carried out as part of an integrated systems approach focused not on a single commodity like in conventional approach but in integrated systems approach with several commodities and livelihood components. Integrated systems deal with Agricultural Innovation System (AIS), defined as "a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect the way different agents interact, share, access, exchange and use knowledge" (Hall et al., 2006). As such, AIS is a multistakeholder approach bringing together several organizations working toward technological, managerial, organizational, and institutional change (Bisseleua and Degrande, 2017). IAR4D is strengthened by innovation platforms (IPs) (Schut et al., 2017) which are increasingly seen as a promising vehicle for agricultural innovation in developing countries (Kilelu et al., 2013; Ngwenya and Hagmann, 2011; Swaans et al., 2014; Schut et al. 2017).

This IAR4D aimed to (1) performing situational analysis of food crop systems in the Nawa region for defining strategies to improved production systems; (2) assessing and implementing innovative agricultural intensification options; (3) building farmers' capacities on agricultural intensification options; (4) sensitizing people for food crop diversification and (5) improving smallholder farmers' livelihoods. In the current IAR4D, we set up three types of platforms which were (1) a research for development platform (R4DP) for highlighting research question based on situational analysis, designing and implementing trials and training actions, etc., (2) an IP for that strongly interacted with R4DP from situational analysis to trials implementation and evaluation of performed actions; (3) village innovation platforms (VIPs) as components of the IP where field activities were carried out. In this paper, we describe how cassava was selected as entry commodity and steps that leaded to success story of the process.

MATERIAL AND METHODS

Study area and site

This study was carried out in the Nawa region (South-West Cote d'Ivoire). With an area of about 9000 km², this region is one of the most densely populated regions of the country due to cocoa economy which attracts many migrants from other parts of the country and from West African countries (Smoot et al., 2013). It represented the first cocoa producing zones with 30% of the national production in 2004 (*Conseil Café-Cacao*, 2014). The Nawa region is neighboured, on the west side, with the Tai National Park (Figure 1). These park benefits of the status of biosphere reserve of UNESCO since 1978 and considered as a global heritage since 1982 (Tiedou et al., 2018). For reducing anthropic pressure on the park, many projects are pursued for improved riverine populations' livelihood. The landscape of the Nawa region is very heterogeneous and dominated by husbandry with mosaic of tree crop plantations and food crops (Diby et al., 2014).

Krohon (05.34 °N; 06.52 °W) is a village of the study area located in the department of Méagui at 3 km on the axis Méagui San-Pedro. The choice of this village was motivated by his accessibility and by existence of women groups at the beginning of the project. The main constraint to food crop production and women activities in this village is scarcity of lands due to tree crop plantations.

Methodological approach

The study was performed in the framework of an integrated system research based on a multistakeholder process for providing an effective and coherent system able to change rural populations' living conditions.

Three components involved in the process

Three components interacted during meetings and field activities: a research for development platform (R4DP), an innovation platform (IP) and village innovation platforms (VIPs).

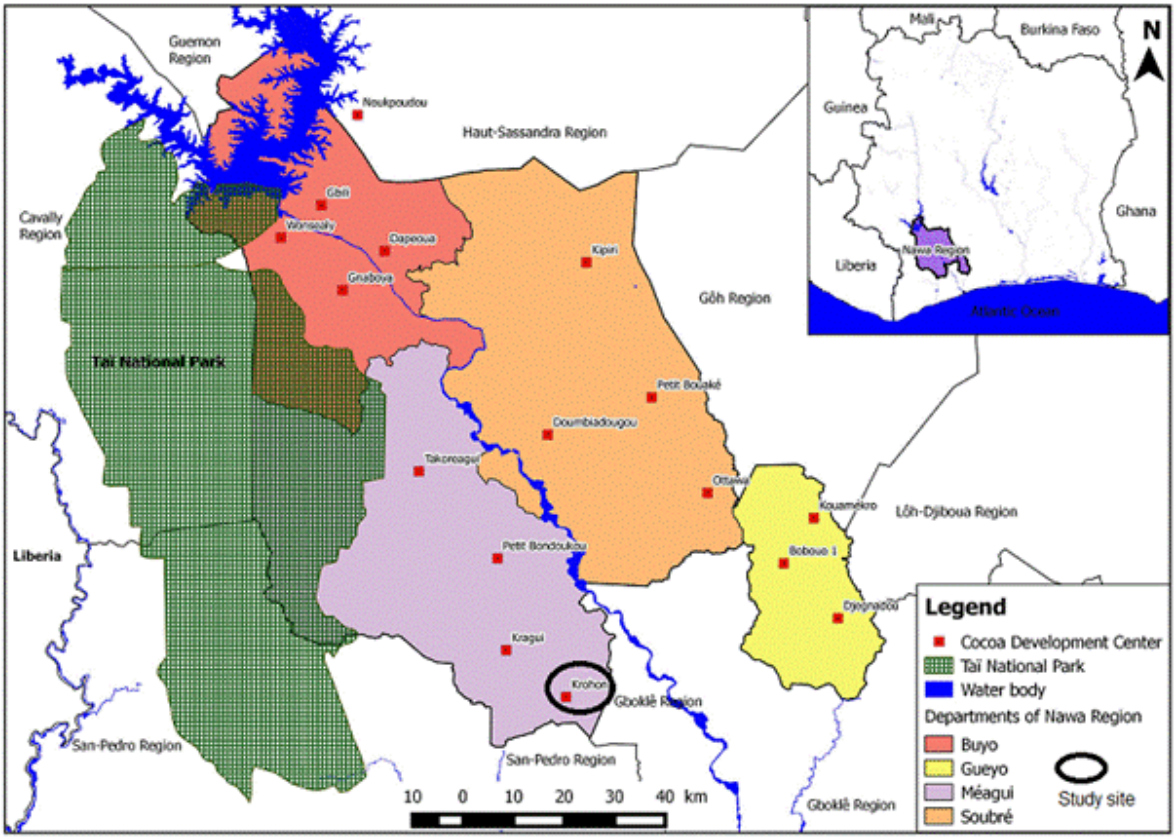

Fig 1. Map of the Nawa region showing the 16 villages covered by the survey on food crops and the village of Krohon (Source: ICRAF Cote d'Ivoire).

Research for Development Platform

The R4DP included national partners from research and development systems – *Ecole Supérieure d'Agronomie* (High School of Agronomy), Peleforo Gon Coulibali University, *Centre National de Recherche Agronomique* (National Centre for Agronomic Research), *Centre de Recherche en Ecologie* (Centre for Research in Ecology), *Agence Nationale d'Appui au Développement Rural* (National Agency for Rural Development) and World Agroforestry Centre (ICRAF). The R4DP performed the situation analysis using field surveys and identified intensification pathways based participatory diagnosis. The R4DP was responsible for trials implementation, trainee student supervision and collected data.

Innovation platform

The IP was established at regional level and composed of administrative authorities from the four departments of the region, Regional Agriculture Directorate, representatives of R4DP, farmers, etc. The IP defined agricultural issues and challenges in the region and identified the entry theme: *'Diversification and intensification of food crops in cocoa-based farming system'*. Reflective/monitoring meetings and field visits pursued at IP level allowed to adapt interventions and to develop scaling action strategies. IP also made commitments for smallholder farmer's benefit.

Village innovation platform of Krohon

The VIPs were established at village level and included women farmers, village authorities and local development committee. VIPs performed field activities and meetings that allowed to make feedback to the IP. In Krohon, three women groups, established through ICRAF in the framework of the *Vision for Change* project, were the core actors of Krohon innovation platform. These groups differed by origins: *Afedjropa* ('Work together') composed of 60 native women; *Kloleh* ('Love') composed of 50 other Ivorian communities' women; *Relwindé* ('we rely on God') composed of 96 women originated mainly from Burkina Faso.

Critical appraisal of food system and participatory selection of entry commodities

The process started with a critical appraisal that consisted in a cross-sectional survey performed in 16 cocoa producing villages disseminated in the whole

Nawa region followed by a participatory diagnosis. The 16 cocoa producing villages were the cocoa development centres (Figure 1) set up in the framework of the Vision For change project lead by ICRAF. For the survey, a draft questionnaire, developed and validated by researchers, tested in two villages and download in smartphones using ODK collect. A pilot phase when 60 farmers surveyed, was performed to train 10 enumerators. Then the questionnaire was refined and administered in all the 16 villages. In total of 636 food crop farmers surveyed. The Data analysis allowed R4DP to highlight the main food crops and production constraints. After critical reflection, participatory diagnoses performed in three villages, including Krohon; cassava and maize were identified as entry commodities.

Participatory trials based on 'mother-and-baby' trial approach

After identification of entry commodities, the R4DP designed trials based on soil fertility integrated management including introduction of new varieties. Trials were then set up for participatory assessment of food crops intensification best for introducing innovative technologies and improving women skills in agricultural practices. Trials were set up based on the 'mother-and-baby' trial approach (Snapp, 2002). The 'mother' plots were jointly set up by researchers and women groups while the 'baby' plots consisted in several one-replicate satellite plots managed individually by women. This approach allowed women to perform agronomic comparison of four cassava varieties (Table 1): two improved cassava varieties (*Yavo* and *BoCou 1*) and two traditional varieties (*Yacé* and *Bonoua*) provided by women themselves. During trials, women were also trained on different agricultural modules: row cropping, cassava-maize-legume association, use of (chemical and organic) fertilizers in food crop production, production of cuttings during cassava production. This last module allowed increase dissemination of the improved cassava varieties in the Nawa region.

Evaluation of cassava yields

Cassava yields were determined for each variety on 'mother' plots 12 months after planting. Yields' evaluation was performed on unfertilized subplots with a 1 m x 1 m density (10000 plants per ha) where cassava was planted alone. 20 cassava plants were harvested and fresh tubers weighted using a scale (Lexius 30 Kg Max). The total weight of these 20 plants was multiplied per 1000 for obtaining cassava yield (T/ha). Data were reported as average ± standard-errors of the three 'mother' plots.
In addition to 'mother' plots data, women harvested nine cassava tubers and 12 months after planting on their own 'baby' plots. This allowed them to individually identify best cassava varieties. As same, reduction of weeding, in relation to plant growth, and aptitude for crop association were evaluated.

Improving women skills on cassava processing and sustaining *attiéké* production

Through this 'demand-driven research' approach adopted in this process, the idea of training women on improved skills on cassava processing emerged during a VIP meeting. Then after trial implementation, 30 women from the three groups were trained on different modules for processing cassava into attiéké: (1) Importance of cassava and valorisation in Côte d'Ivoire and elsewhere; (2) equipment, different steps of processing process, some tips, valorisation by-products, health and safety; (3) Assessment of sensorial quality of attiéké; (4) Management of an attiéké manufacturing unit: human resource organization and operating account. After the theoretical training, cassava tubers were harvested and introduced in a processing process as part of practical training covering three modules: (1) production of the ferment (*magnan*), critical points for obtaining good attiéké texture; (2) different steps from fresh tubers to fresh semolina using improved equipment; (3) maintenance of equipment. In order to sustain attiéké production after the training on cassava processing, women were suggested to develop working subgroups of 3 to 6 women composed by trained women and those who were not.

Evaluation of organoleptic quality of *attiéké* of each variety

The quality of *attiéké* was assessed by 30 panellists trained on site for that purpose. The evaluation was done based on a rating sheet with a 1 to 5 scale (1= very bad; 2= bad; 3= acceptable; 4= good and 5= very good) based on the method of Lateur et al. (2001) for six indicators: flavour (Slightly tart with a slightly sweet aftertaste); colour (Light yellow more or less dark); aroma (fermented or vegetable); fibre index (as low as possible), grain size (medium size) and consistency (firm grains with medium cohesion).

Evaluation of the project impact on women' livelihood one year later

One year after the multistakeholder process, an evaluation of activity impacts was performed in the perspective of developing a transition plan and learning outline. During this evaluation, women were asked to answer whether the IP was still relevant and why. We surveyed 45 women to know if they continued producing *attiéké* in group or alone.

Data collection, treatment and statistical analyses

Descriptive statistics were used for survey data (percen-

Table 1. Characteristics of traditional and improved cassava varieties.

Variety	Description	Cycle (months)	Dry matter rate (%)	Agronomic characteristics*	Suitable for*
BoCou1	White skin and pulp 64.3%**	12 - 24	39%	Large canopy - Sensitive to mites and mealy bugs 20 – 25 T/ha***	*Attiéké*[1] *Placali*[2] *Foutou*[3] (good taste)
Yavo	White skin and pulp 71.4**	12 - 20	40%	30 T/ha ***	
Bonoua	Pinkish skin and white pulp – 72.2**	12 - 20	40%	Sensitive to mosaic and mealy bugs 15T/ha***	*Foutou*[3](good taste)
Yacé	white skin and pulp 67.1**	11 - 20	40%	Sensitive to mosaic, mites and mealy bugs 20 T/ha***	*Attiéké*[1]

[1]*Attiéké* is a fermented steamed cooked cassava semolina similar to couscous with probable acid taste.

[2]*Placali* is a paste with high starch content consumed with sticky or thick sauce.

3 *Foutou* is a mixed of pounded plantain and cassava.

* Data related to agronomic and food technology characteristics provided from Boni et. al. (2013) and Akpingny & Koulou (2017).

** Pulp content in tuber (%) determined during the training on cassava processing from fresh tubers provided from trials plots.

*** Yields reported as average farmer performance (Akpingny & Koulou, 2017).

tage and means) for descriptions of variables. Agronomic data were reported as average ± standard-errors and performed with STATISTICA 7.1 using one-way non-parametric Kruskal-Wallis ANOVA for cassava yield and dry matter. Significant differences tested using U-Mann-Whitney test ($p = 0.05$).

RESULTS

Characterization of cassava and food crops production system

The situational analysis of food crops showed that cassava was the main food crop produced in the region (Figure 2). Women were most involved in this production with 59.50% of women surveyed against 44.85% for men. Most farmers produced cassava both for sale and consumption (70.86%) when 24.57% declared produce cassava only for consumption. This showed that cassava was produced for consumption in about 96% cases (Table 2).

Cassava was produced in monocropping system (79.71% of respondents) on very small areas (0.47 ha ± 0.25) and farmers didn't practice fallowing in their food production system (48 % of respondents). In case fallowing was practiced, the length was about a year (46 %) or one to three year maximum (50 %). Cassava production was generally performed without use of fertilizers (about 97% of cases). Planting material were mainly provided by farmers themselves (91.14%) or from others farmers (8.57%) (Table 2).

The main challenges that faced cassava production system were low sale price of fresh tubers (39.77%), market opportunity (23.30%), transportation (19.88%), high perishability of fresh tubers (10.23%) and road harassment (6.82%). This last concerned all products (Table 2).

Cassava was the main food crop with high potential of processing. 52% of cassava growers declared adding value to fresh tubers while only 9.43% of maize growers processed maize for sale. Various cassava processed products were registered during the survey but the main products were *attiéké* in 87.91% cases and *placali* in 70.32% cases (Table 2).

In Krohon, cassava was mainly sold as fresh tubers (75% of respondents). The processed products recorded were *placali* (8%), *attiéké* (7%), *gari* (5%) and *tapioca* (5%) (Figure 3).

Agronomic performances of cassava varieties

ANOVA performed on cassava yields and dry biomass highlighted significant differences between cassava varieties. The improved varieties *BoCou 1* and *Yavo* harboured similar and high yields compared to the traditional variety *Bonoua* and *Yacé* with lowest yields. Concerning dry matter, the improved variety Yavo and the traditional variety Yacé had highest values.

Quality of the*attiéké* resulting from the four tested varieties

The assessment of the quality of *attiéké* after training showed that the quality was mainly due to women skills for processing cassava. The impact of cassava variety was less important. Indeed, during evaluation, the four varieties had almost the same scores. All the indicators of quality (colour, taste, aroma, fibre index, grain size and consistency) were ranked from 4.4 to 4.8 in the scale of 1 to 5 whatever cassava variety. The most sensitive differences were observed for fibre index, grain size and

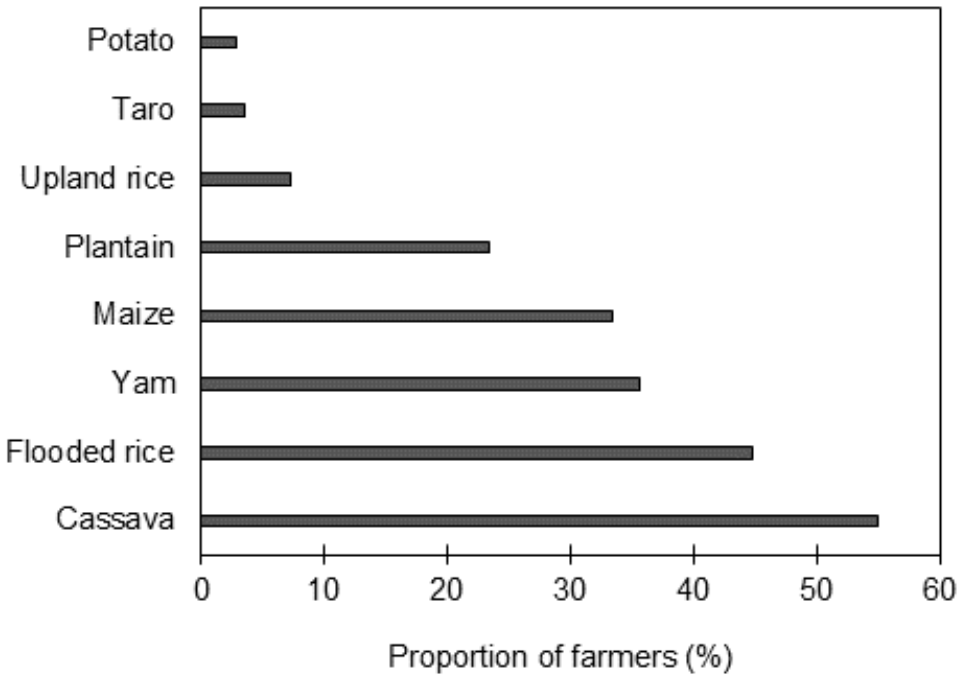

Fig 2. Significance of food crops in term of production in the Nawa region (n = 636).

colour. For these indicators, *BoCou 1* had the lowest scores (between 4.4 and 4.6) while *Yacé* had the highest scores (between 4.7 and 4.8). For aroma, consistency and taste, differences were even less pronounced (Figure 5).

Classification of cassava varieties based on agronomic and technological criteria

The field trials and the training on improved processing skills, allowed women to appreciate the four varieties based on agronomic and technologic criteria. Most women (68%) appreciated the variety *BoCou 1* for it important vegetative growth that allows reducing weeding. For the precocity (tubers development at 9 months), the variety *Yacé* was the most appreciated (35% of respondents). At 12 months (period recommended for harvesting), the best variety in term of cassava tuber production was the variety *Yavo* (29%). Concerning cassava processing into attiéké, *Yavo* was the most appreciated variety with 43% of respondents against 24%, 21% and 13% respective for Bonoua, Yacé and *BoCou 1*. As far as concern cassava processing into placali, *Yavo* (32%) and *Bonoua* (31%) were the most appreciated while 25% and 12% respective preferred the varieties *Yacé* and *BoCou 1*. Comprehensively, the varieties were ranked as followed: *Yavo* (40%), *Bonoua* (28%), *Yacé* (19%) and *BoCou 1* (13%) (Figure 6).

Impact of the project one year later on women' livelihood

One year after the project, women groups were still operational and most of women continued cassava-based activities in groups. Only 4.4% of respondents declared pursue sole cassava production while 44.5% pursued cassava production in groups. In most cases (51.1%), women pursued cassava production both in group and alone. All of them belonged to a group of attiéké production: 75.6% realized this activity only in group while 24.4% realize this activity alone as well. For others cassava-based products (*placali*, *gari*, etc.), 37.8% of respondents declared working sole, 20% worked in groups while 42.2% of them pursued others cassava-based activities sole and in groups.Here again, women were strongly involved in groups activities (Table 3).

During the participatory evaluation of the project one year later, the stakeholders agreed that developing a scaling transition plan was a relevant and worthwhile goal. Asked about the significance and the relevance of the IP, women indicated different reasons of the need for maintaining the IP). The main reason was the opportunity of mobilizing funds for financing business (56% of respondents). One year later, women were engaged in the business of attiéké and expected continuous maintenance of the innovation platform for improved skills on financial management and group management for scaling up *attiéké* production (26.67%). They were also aware of the fact that the platform strongly developed cohesion (22.22%) in the village and increased confidence. Other reasons were also identified: people mobilization (11.11%), market opportunities (6.67%), material support

Table 1. Characteristics of cassava production systems in the Nawa region (n = 636).

Variables	Description	Number of respondents	Total surveyed	(%)
Farmers surveyed	Female	442	636	69.50
	Male	194		30.50
Cassava growers	Female	263	442	59.50
	Male	87	194	44.85
Main reasons behind growing cassava	Sale	16	350	4.57
	Consumption	86		24.57
	Sale + consumption	248		70.86
Cassava cropping system	Monocropping	279	350	79.71
	Mixed cropping	71		20.29
Fallow practice in food crop production	No	310	636	48.74
	Yes	326		51.26
Fallow length	< 1 year	149	326	45.71
	1-3 years	163		50.00
	> 3 years	14		4.29
Use of fertilizers in cassava production	Yes	12	350	3.43
	No	338		96.57
Origin of planting material	From field	319	350	91.14
	Other farmer	30		8.57
	Extension agency	1		0.29
Processing food crops before sale	Cassava	182	350	52.00
	Maize	20	212	9.43
	Rice	11	331	3.32
	Yam	0	227	0.00
Cassava-based processed products	*Attiéké*	160	182	87.91
	Placali	128		70.32
	Kokondé	22		12.09
	Gari	8		4.40
Post-harvest constraints related to cassava	Low sale price	70	176	39.77
	Market	41		23.30
	Transportation	35		19.88
	Highly perishable	18		10.23
	Road harassment	12		6.82
Cassava cultivated area as mean±standard-error (ha)			0.47±0.25	

(6.67%), etc. (Figure 7).

DISCUSSION

This study was pursued in the framework of an integrated system research carried out through continuous reflective process for performing 'demand-driven' activities. The relevance of this approach was the initial critical appraisal that allowed identifying entry commodities based on crop socio-economic characteristics and farmers' willingness.

Cassava as a strategic crop for improved women' livelihood

Cassava was a strategic food crop insofar it was produced both for consumption and for sale. The import-

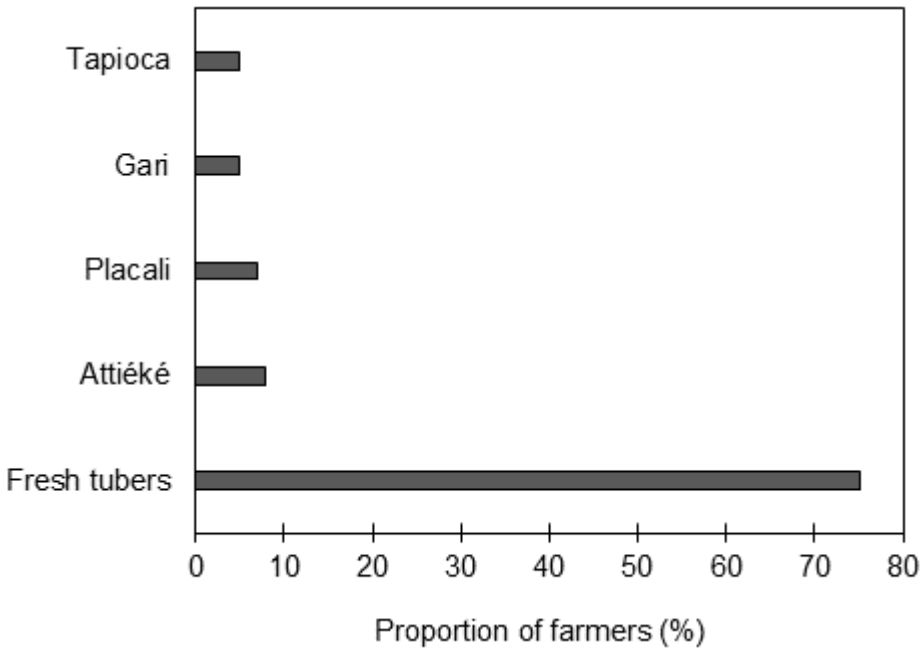

Fig 3. Main forms under which cassava was sold before theprojectin Krohon (n = 60).

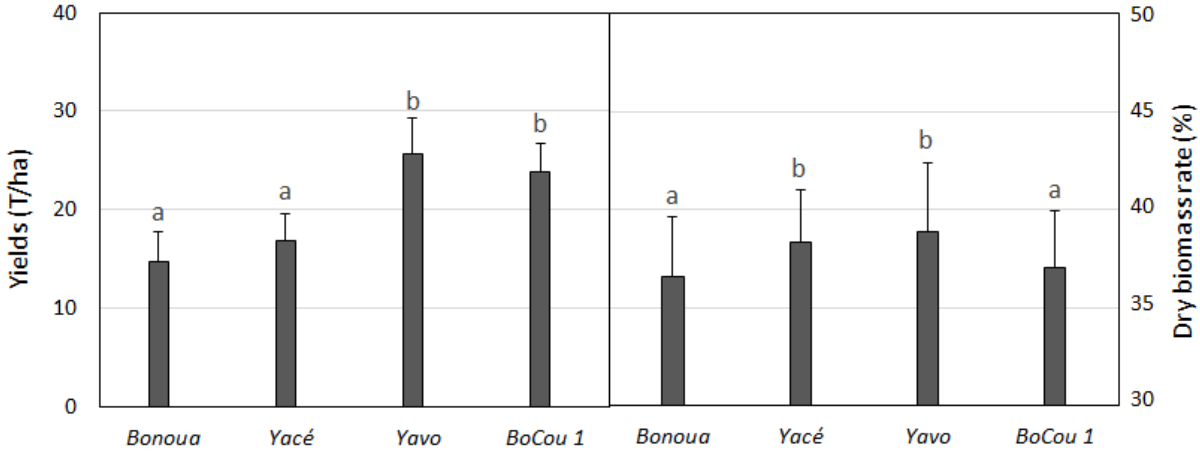

Fig 3. Cassava yields and dry biomass rate in tubers of the four varieties tested reported as average ± standard-error.

ance of cassava for food security and its high potential to generate income go beyond the Nawa region. The strategic character of cassava extends to the national level and sub-Saharan African countries. It was selected in National Plan for Agriculture Investment (*Programme National d'Investissement Agricole*, PNIA) to reach the first strategic objective that was promotion of strategic commodities for food security and food sovereignty (Perrin et al., 2015).

In Nigeria for instance, cassava accounts for about 75% of the daily caloric intake to more than 50 million Nigerians (Ezike et al., 2011). It has a high potential for generating income compared to others staple foods (Obisesan, 2012). Women farmers prioritized cassava in this project because of its rapid growth, nutritive and economic importance and ability to grow with minimal use of inputs. Numerous and complementary

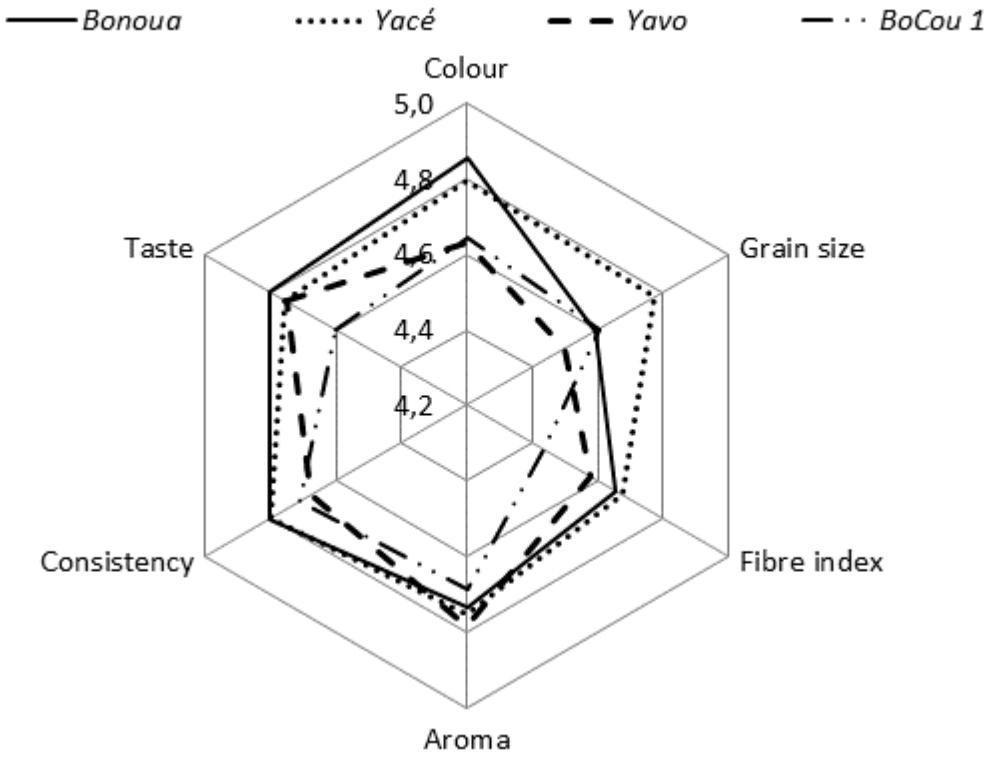

Figure 5. Assessment of quality of *attiéké* manufactured with fresh tubers of the different cassava varieties after women's training.

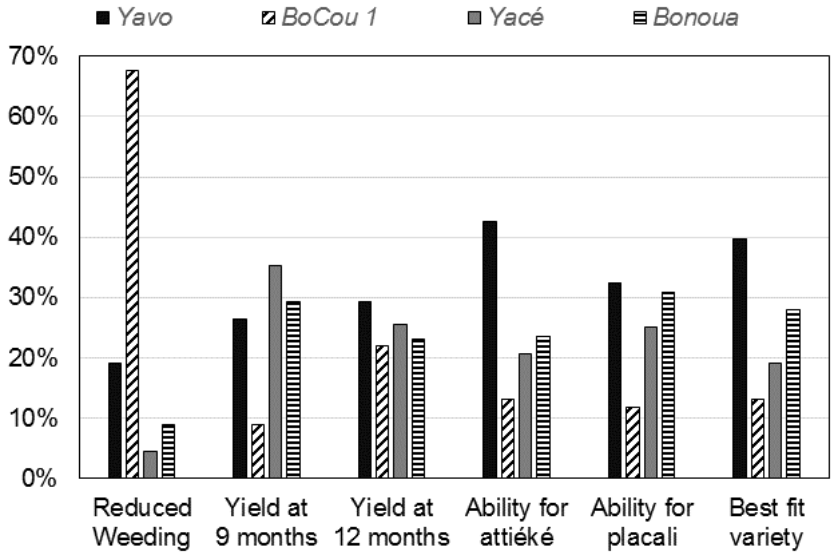

Fig 4. Comparison of cassava variety based on different criteria.

cassava-focused projects and actions were pursued in the region. The West Africa Agriculture Productivity Program (WAAPP) introduced improved cassava varieties (*BoCou 1* and *Yavo*) in the region and supported training on cassava conservation, transformation and trading. The Project of adaptation for climate change and stabilisation of rural population livelihood in the Southwest region (PACCS) established demonstration fields with improved cassava varieties and trained women on cassava processing. Furthermore, the PACCS set up

Table 2. Distribution of respondents women (n = 45) based on cassava related activities.

Variables	Description	Number	%
Cassava production	Alone	2	4.4
	In group	20	44.5
	Alone and in group	23	51.1
Attiéké production	Alone	0	0.0
	In group	34	75.6
	Alone and in group	11	24.4
Others cassava products	Alone	17	37.8
	In group	9	20.0
	Alone and in group	19	42.2

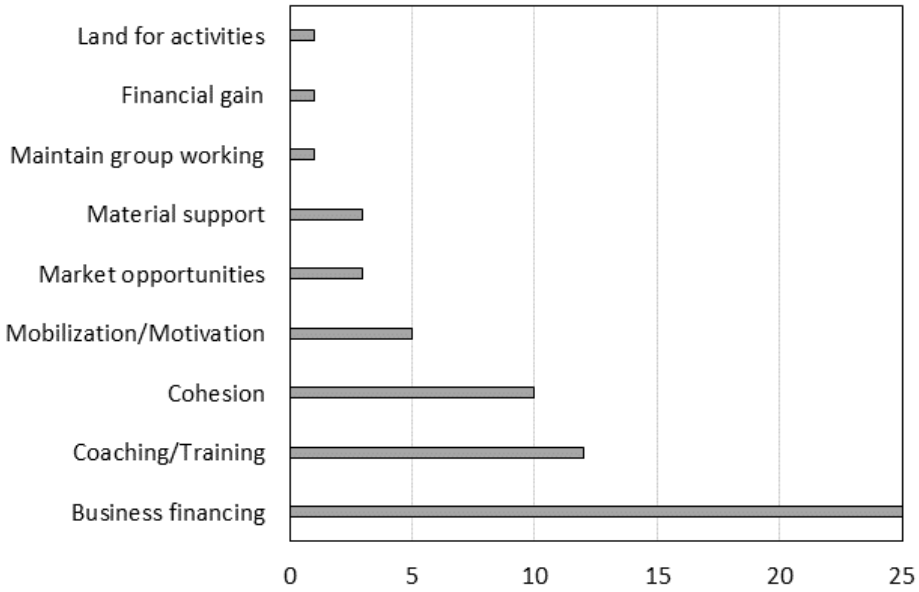

Fig 5. Reasons of the relevance of maintaining the innovation platform.

cassava added value chain-based platforms and trained farmers on business management. In the four departments, focal points were established for facilitating commercial exchange between actors. The innovative nature of the integrated system research was the 'demand-driven' approach with strong farmer-research partnership. So, cassava related activities as well as those related to other commodities (maize, rice, poultry, etc.) were pursued following continuous reflective interactions between the three components of the multistakeholder process.

Agricultural innovation system for prioritization of needs and behavioural change

Innovation systems needs to mainstream the needs of all stakeholders, including end users, farmers, research scientists, development practitioners, policy-makers, and so on (Spielman and Birner, 2008; World Bank, 2006). The choice of cassava as entry commodity was based on the purpose of food sovereignty desired by the local authorities and farmers' willingness. One of the major constraint was scarcity of arable land that strongly shifted agricultural practices in the region. From fallowing-based extensive production systems, agricultural practices changed into intensive production systems without real soil fertility management approach. Besides agronomic constraints, cassava value chain faced various others constraints such as market unavailability and low sale price. In this context, reflections went both toward agronomic and post-harvest considerations including processing and market development.

Field activities consisted of a participatory trial approach named as 'mother-and-baby' model that allowed trained women on different modules and compared performances of different agricultural technologies including cassava varieties. The R4DP evaluation ranked the improved variety *Yavo* at the top based on fresh tuber yield and dry biomass rate. This result was consistent with Akpingny and Koulou (2017) that ranked *Yavo* as the highest yield variety with average farmer performance of 30 T/ha and about 40% dry biomass. Trainings were performed on 'mother' plots and 'baby' plots allowed women to individually repeat technologies on their own fields (Snapp, 2002). Most women preferred *Yavo* and *Yacé* for yield at 12 months. This last variety harboured the highest root biomass, nine months after plantation. Women were also trained on improved skills for cassava processing. This training was determinant for variety adoption and appeared as a triggering action for enhancing *attiéké* production business in Krohon. After women training on improved cassava processing skills, *Yavo* was selected as the best fit variety. The innovation provided by the training and that comprehensively showed that *attiéké* of good quality can be obtained regardless of the variety, deeply changed women appreciation of the traditional variety *Bonoua*. This variety was selected as the second best fit variety. This appreciation went against usual recommendations that *Bonoua* was not suitable for attiéké production (N'Zué et al., 2013; Akpingny and Koulou, 2017). The innovation consisted in women ability to produce good *attiéké* created a behavioural change both at women farmers and at people of Krohon levels. Currently more women are involved in attiéké production as main income generating activity and people integrate more attiéké in their diet.

Integrated system as a sustainable approach for impactful research for development

Integrated systems, or systems integration, is the process of bringing together component sub-systems into one functional system. It provides a system with coherence by making the parts or components work together, or 'building or creating a whole from parts' (Langford, 2013). Integrated agriculture research for development (IAR4D) is about change or innovation as an outcome, not just about information, knowledge or technology as a product (Hawkins et al., 2009). The fact to setup of IAR4D is a way to bring farmers into innovation process to generate and use knowledge. The multistakeholder process implemented for co-construction between the R4DP, the IP and the VIPs was a success story in the village of Krohon. Currently more women are involved in *attiéké* production as main source of income and people integrate more *attiéké* in their diet. The women organization in small groups of three to eight individuals based on affinity after the training was also an innovation that contributed in sustaining *attiéké* production activity that need labour force and good work organization. The behavioural change of people by adoption of *attiéké* in their diet strongly fostered the production of more *attiéké*. The second type of customers was composed by people of Meagui distant to Krohon from 3 km and surrounding villages. The situation of Krohon along a national road was an opportunity for sustaining and scaling of *attiéké* production. The success made by *attiéké* production in Krohon should strongly contribute to improve women livelihoods and nutrition in the village.

CONCLUSION

Agricultural development in Africa requires to take into account farmers' aspirations in decision making. Beneficiaries must be considered as core actors in co-construction processes and not as mere consumers of technologies. Implementation of research projects for development through integrated systems allows both to mainstream all the potential stakeholders and to consider all development aspects. These include issues related to production and post-harvest activities but also institutional and political aspects. In the context of this project, answering to women farmers needs through training on improved cassava processing skills for producing attiéké of good quality and organizing them into working groups led to settlement of income generating activity in the village of Krohon. This contributed both to improved women livelihood and increased food security. The improved skills for production and processing also allowed women to select best fit innovations that meet their aspirations.

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