Yam Cropping System in Cote d'Ivoire: Current Practices and Constraints

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Abstract

Yam is the first food crop in Côte d'Ivoire. It is being cultivated under a traditional technique system with low output. Detailed profiling of the current practices and opportunities for improvement is essential to increase the benefits of yam for food security and income in the country. This study diagnosed the current practices, constraints, and requirements in order to gain insight on the yam cropping system for research and development in Côte d'Ivoire. The surveys were conducted in seven (7) regions in the main yam production area. Groups of 60 producers per region were investigated. Individual surveys were also conducted on-farm, particularly for diagnosing the physical environment and yam-based production systems. As results, yam-based production systems are characterized by mixed cropping (cassava, corn and vegetable crops) and/or rotation with various other crops (rice, groundnut, vegetable crops, …). Preferred plots for yam cultivation are forest, savannah or fallow areas. The major constraints in yam cultivation were the effects of environmental stresses, labor scarcity, pest damage, tuber and seed storage difficulties as well as the low market value of yam. The most cultivated yam varieties are Bètè-Bètè and Florido for *Dioscorea alata* and Lokpa for *Dioscorea rotundata*. The cropping system, the species and varieties vary according to the region, the topo sequence and the type of soil. Knowledge-building that take into account constraints related to yam cultivation, for each production area, can serve as guidance for variety breeding and cultivation environment redefinition.

Keywords: Yam, Cropping systems, Land use, Cultivation environment, Côte d'Ivoire

Introduction

Yam (*Dioscorea spp*) is a tuber crop cultivated in the tropical and sub-tropical areas of Africa, the Caribbean, Oceania and South Asia by smallholders. It is the staple food of more than 300 million people worldwide because of its high nutritional value (Asiedu and Sartie, 2010; Cornet, 2015; Alabi *et al.*, 2019). Yam plays a very important role in food security and livelihood systems for at least 60 million people in West Africa. It is mainly cultivated in the secondary savannah and the Southern Guinea savannah (FAO, 1997 and 1999; Chukwu et Ikwelle, 2000). About 67.31 million tons of yam (that is, 92% of world production) are produced annually on 7.96 million hectares in West Africa, mainly in five countries, namely Benin, Côte d'Ivoire, Ghana, Nigeria and Togo (Faostat, 2019). Nigeria is the largest producer and alone accounts for about 66% of world production, followed in third position by Côte d'Ivoire, where yam is the largest food crop by volume, with an annual production of around 7.148 million tons (Faostat, 2019).

Yam is the most important source of calories in Côte d'Ivoire and is one of the top three contributors in Benin and Ghana, also making a substantial contribution in terms of protein to the diet (Dibi *et al.*, 2014). Yam is increasingly becoming a source of income (Doumbia *et al.*, 2006). In Côte d'Ivoire, yam production is mainly located in the northeastern, central and eastern parts of the country, above the 8th parallel north, where it is a staple food for populations (Doumbia *et al.*, 2006; N'Goran *et al.*, 2007). However, yam production, in the South of the country, as a food crop supporting the creation of new coffee and cocoa plantations is far from negligible (Doumbia *et al.*, 2006). Despite this important production, yields are below the potential of this crop. The attained yield ranges from 8 to 12 t/ha (Ettien *et al.*, 2003; N'Goran *et al.*, 2007), while the potential is around 65 t/ha (Kowal and Kassam, 1978; FAO, 1999).

Number of factors contributed to the huge yield gap in yams. The most important are yield gap contributor including (i) the scarcity and high cost of quality yam seeds; (ii) losses incurred during harvest and post-harvest; (iii) low soil fertility; (iv) lack of robust varieties adapted to agro-ecological environments of the savannah under climatic constraints; (v) increasing pressure of diseases and pests; (vi) low potential of yam markets for ware and seed yam (vii) limited opportunities for smallholders, particularly women, in terms of yam production and marketing, and (viii) limitation of current breeding capacities that can help develop both resistant and nutritious yam varieties (Cornet, 2004; Ampofo *et al.*, 2010).

Besides, the traditional cropping system based on the long fallow, slash-and-burn shifting cultivation (Ndabalishye, 1995; Doumbia, 1998) and the almost exclusive use of landraces, is unproductive and depletes natural resources (Ettien *et al.*, 2003; N'Goran *et al.*, 2007). Such cropping systems, also extensive, unfortunately provide low yields (9 t/ha for the species *Dioscorea rotundata* and 12 t/ha for the species *Dioscorea alata*).

This study aimed at profiling the current yam production practices for a further redefinition of yam cultivation environments in Côte d'Ivoire that better support the research and development effort for the crop in the country.

Methodological approach

Selection of study areas

The approach adopted for a judicious selection of regions, consisted in identifying the pilot sites based on the criteria “large area of yam production in Côte d'Ivoire” and “agro-ecological location”. Thus, based on previous works conducted (Doumbia *et al.*, 2006), seven (7) major regions of the yam production basin in Côte d'Ivoire (figure 1 and table 1) were selected. These were the Poro (Korhogo), Tchologo (Ferkessédougou), Hambol (Katiola), Gontougo (Bondoukou), Boukani (Bouna), Gbèkê (Bouaké) and Gôh (Gagnoa) regions.

Surveys

This study was conducted using the agronomic diagnosis approach (Ferraton *et al.*, 2002). By a systemic approach, it allows a global understanding of the functioning of agriculture in a given region. This consists in moving from the general to the particular and in precisely placing yam cultivation in relation with the context of local agriculture. The main levels of organization of the rural environment (Bedu *et al.*, 1987; Jouve, 1992) were considered. They included the yam production area, the production regions and departments and the village and/or encampments. Two types of surveys were conducted, namely, group surveys and individual surveys. Group surveys were carried out on the basis of interviews and discussions during participatory workshops involving local government officials, extension agents, farmers (producers), transporters and traders. Individual surveys were conducted at the farm level based on interviews. In each region, 2 villages were selected. A sample of 30 producers was selected per village. A total of 420 producers were interviewed for the 7 regions. The surveys were semi-structured in order to fully give the opportunity to the interlocutor to express concerns not planned by the study.

Data collected and analysis

Data collection was mainly done by observing the environment and conducting surveys. For group surveys, each working group provided, from a base map of the production region and a questionnaire, the following information's: (i) the dominant types of soils, (ii) accessibility by road, (iii) the yam cropping systems, (iv) the dominant species of yam and all other species, (v) the main challenges in yam production and (vi) the names of dominant yam varieties and intercrops. Individual surveys focused on: (i) the yam production systems practiced by smallholders, (ii) the socio-demographic characteristics of the farmer, (iii) the importance of yam cultivation and the cropping systems practiced, (iv) the farm management (farm characteristics, cropping practices), and (v) the major constraints related to the cultivation.

Data analysis was based on descriptive statistics with STATA software. The Chi² test and the Monte Carlo method were used to compare the different proportions. In case of significant differences, the Marascuilo procedure was used to form homogeneous groups (Sunanda *et al.*, 2016). *ArcGIS* 10.0.1 and *MapInfo* 11 software were used for the development of thematic maps. *WockWare* 15 software enabled the conversion of DMS (Degrees, Minutes and Seconds) geographic coordinates into UTM (*Universal Transverse Mercator*) for better projection of production regions into the cartographic systems. *Paint* software made it possible to finalize the maps. Thematic maps were developed using spatial interpolation methods, and also using the nearest neighbor method of *ArcGis* (*Assign Proximity*) software. A codification of the different parameters had been made beforehand.

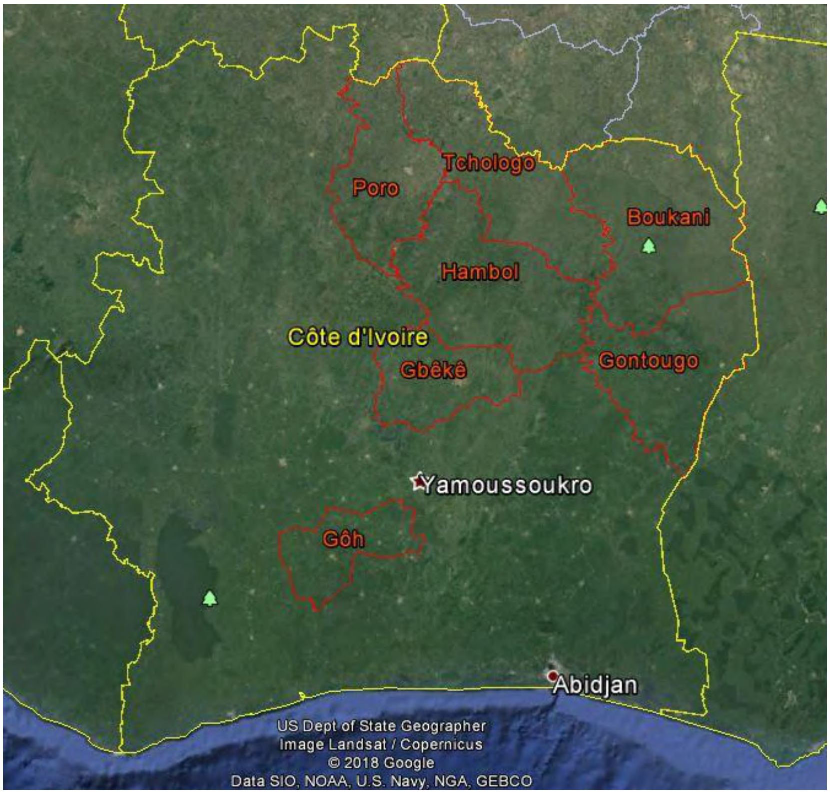

Figure 1. Study regions of the yam production basin in Côte d'Ivoire

Table 5. Regions, departments and study sites according to yam production areas

Production areas	Regions	Departments	Survey sites
North	Poro	Korhogo, Dikodougou	Poundia, Nerkéné
	Tchologo	Ferkessédougou	Kolon
North-East	Boukani	Bouna, Nassian (Sominassé)	Siriki-Bango, Ondéfidouo
	Gontougo	Bondoukou (Sorobango), Tanda	Tambi, Ahibongo
Center	Hambol	Katiola, Dabakala, Niakara,	N'Gorla, Taggbonon-Bambarasso, Kanawolo
	Gbèkê	Bouaké, Sakassou	Kpêtébonou, Languibonou
West-central	Gôh	Gagnoa	Ony-Babré
Total	07	13	13

Results

Yam species and varieties cultivated in Côte d'Ivoire

The frequency calculation is based on the proportions of producers who cited the variety in first, second or third place according to the importance of production (table 2, figures 2 and 3). A larger number of producers (26.89%) cited Bètè-Bètè in first place, then 25.94% of producers cited Florido in second place and 18.27% of producers cited Lokpa in third place. It appeared that the three varieties Bètè-Bètè and Florido of *D. alata* species and Lokpa of *D. rotundata* species were the most cultivated yam varieties in Côte d'Ivoire. The results of the surveys also revealed the cultivation of *D. cayenensis* variety Kangba (0.98%), in the Central region. It should also be noted the presence of a very wide range of yam varieties poorly cultivated by producers. Moreover, three improved varieties, namely Florido, Azaguié and C18 (*D. alata*), were listed. Three yam species (*D. alata*, *D. rotundata* and *D. cayenensis*) are cultivated in Côte d'Ivoire (table 2).

Table 6. Frequency of yams varieties cultivated in all regions investigated in Côte d'Ivoire

Varieties	Species	1st position	2nd position	3rd position
Bètè-Bètè	*D. alata*	26.89	23.69	17.34
Kponan	*D. rotundata*	16.87	3.74	2.48
Krenglè	*D. rotundata*	14.18	9.98	10.22
Wacrou	*D. rotundata*	10.76	0.50	0.62
Lokpa	*D. rotundata*	8.80	10.97	18.27
Florido	*D. alata*	8.31	25.94	23.53
Azaguie	*D. alata*	5.62	2	0.31
Anader	*D. alata*	2.2	1.5	0.31
N'Za	*D. alata*	2.2	5.99	3.41
Kangba	*D. cayenensis*	0.98	1	4.33
Sopian	*D. alata*	0.73	2.74	2.48
Kpassadjo or kpalkpadjo	*D. cayenensis*	0.73	1.5	2.3
Logoperi	*D. rotundata*	0.49	1.25	3.1
Cameroun	*D. alata*	0.24	0.5	1.55
Gnan	*D. rotundata*	0.24		
Sopere	*D. rotundata*	0.24		
Cocomsene	*D. cayenensis*	0.24		
Kpongo	*D. rotundata*	0.24		
Pahinte	*D. rotundata*	0.24	2.24	
Trela	*D. rotundata*	0.24		
Américain or Florido	*D. alata*		0.5	0.31
Assawa	*D. rotundata*		1.5	0.62
Brésil or C18	*D. alata*		0.25	
Koudjan	*D. rotundata*			0.31
Cocoassie	*D. rotundata*		0.25	
Pahinte	*D. rotundata*		0.25	4.02
Soule Kouam	*D. cayenensis*			0.31
Bolodja	*D. rotundata*		0.75	0.62
Djinangbo	*D. rotundata*		0.25	1.24

It appeared that two yam species, namely *D. rotundata* and *D. alata*, are exclusively cultivated in the Poro, Tchologo, Hambol and Boukani production regions. Whereas, all the three species, *D. cayenensis*, *D. rotundata* and *D.*

alata, are cultivated in the Gontougo, Gbêkê and Goh production regions, with a higher proportion in the Gontougo and Gbêkê regions (figure 2).

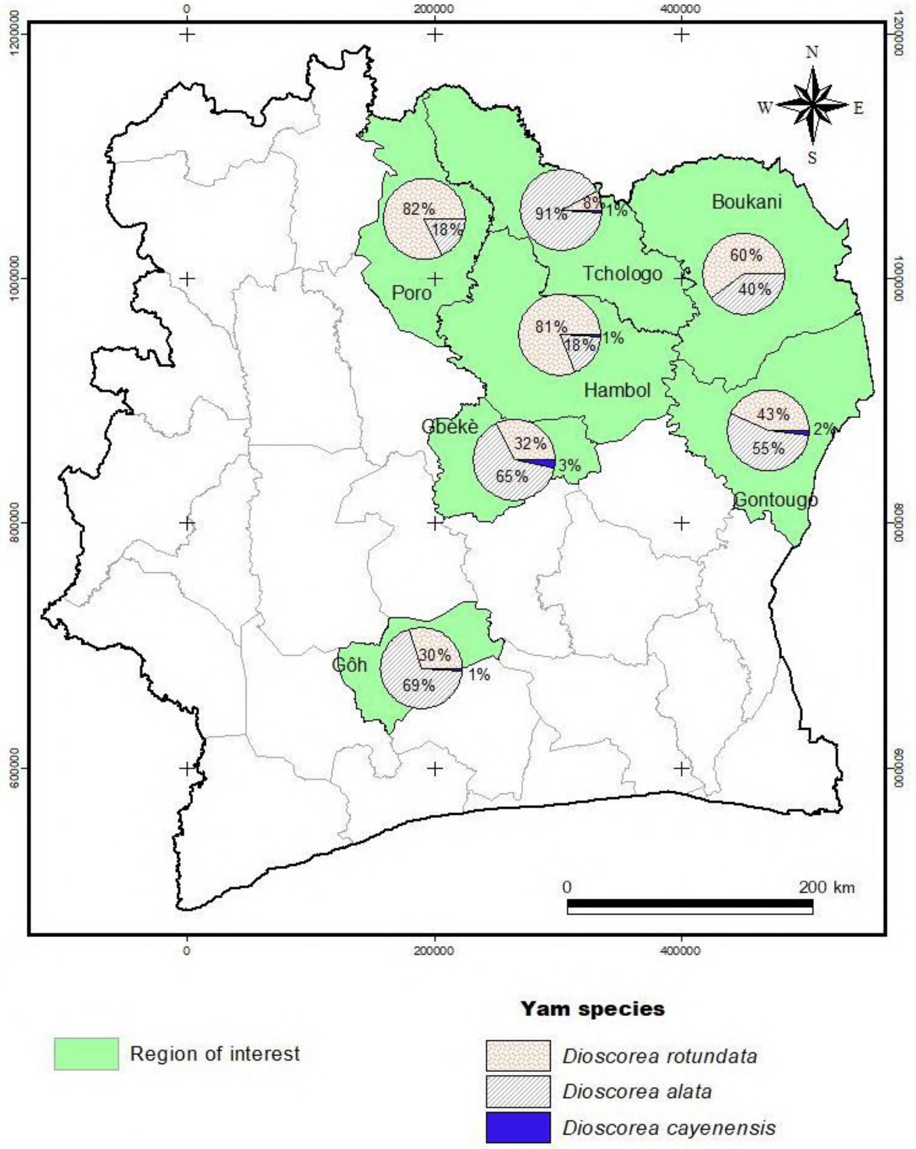

Figure 2. Importance of yam species cultivated in the yam production areas

The distribution of the yam varieties cultivated (figure 3), showed that the varietal groups (Kponan or Wacrou, Krengle and Koudjan or Pahinté) of the *D. rotundata* species were the most cultivated and came most time at first position in the Northern (Poro and Tchologo) and Northeastern (Gontougo and Boukani) regions, and Florido or Américain and C18 or Anader of the *D. alata* species were found at the second position.

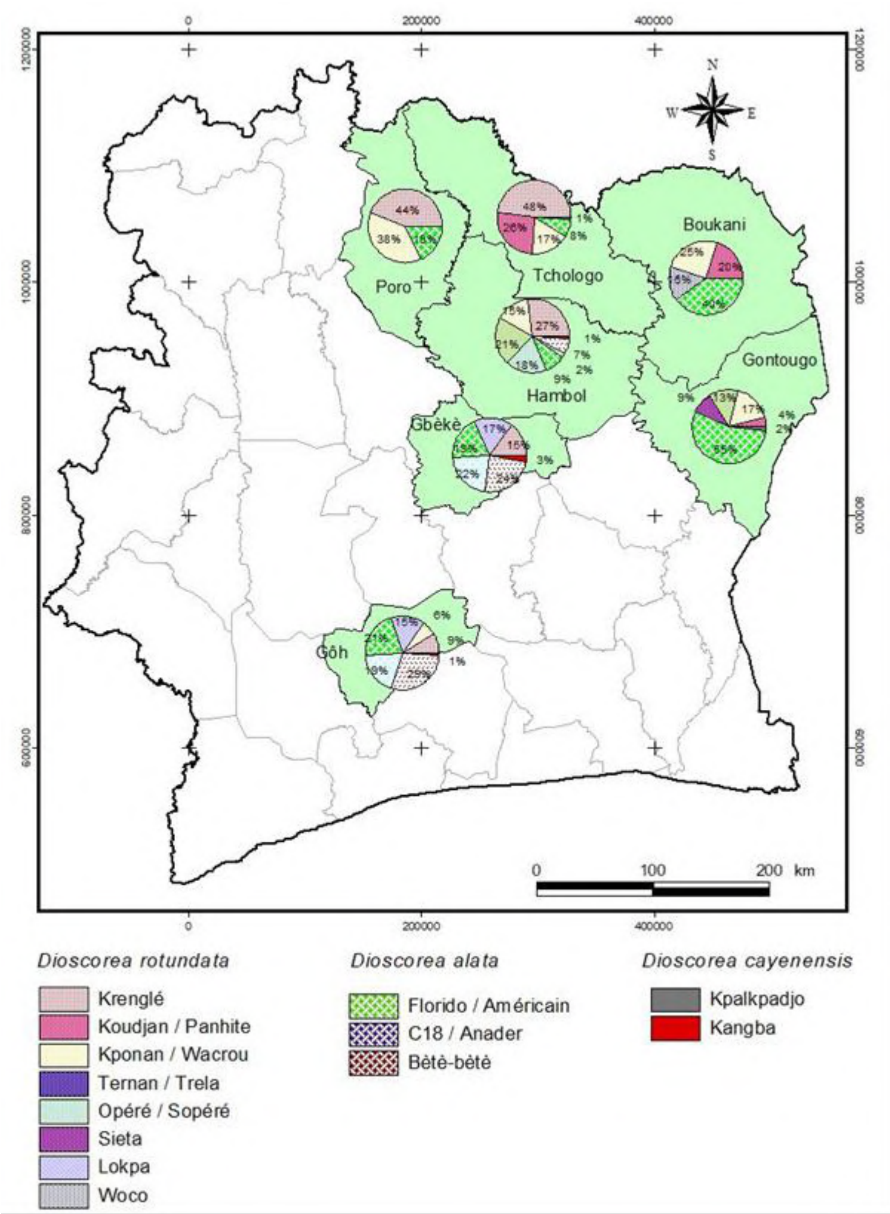

Figure 3. Yam varieties cultivated in yam production areas

Conversely, for the Central (Hambol and Gbêkê) and West-central (Gôh) production areas, the varieties Bétè-bètè, Florido or Américain and C18 or Anader, of *D. alata* were the ones cultivated in order of importance and listed in first position. It also appeared that for these two large regions, only Lokpa and Krengle were the two varieties of *D. rotundata* exclusively cultivated. In addition, it appears from these analyses that two (2) varieties from the *D. cayenensis* group, in particular Kpassadjo or kpalkpadjo in the North-East (Gontougo) and Kangba in the Centre (Gbêkê), are also grown.

Figures 4 and 5 presents the distribution of varieties with regard to the soil landscape and the topographic positions. The water yam varieties occupied the plateau topographic segments and/or upper hillside, while white yam varieties are cultivated in lower hillside topographic position. However, in the West-central region (Gôh), regardless of the soil landscape, no white yam (*D. rotundata)* variety was found.

Agronomic characteristics of farms, cropping systems and cropping practices

The characteristics of yam producers' household farms in Côte d'Ivoire, as well as the cropping systems and farming practices, are shown in tables 3 and 4, respectively. The analysis showed that yam producers had farms of varying sizes. These sizes varied from 0.02 to 30 ha for yam and 0.01 to 42 ha for other commodities. The average sizes were 2.62 ha for yam; 7.10 ha for other crops and 7.91 ha for fallow land (table 3).

Concerning the characteristics of yam-based cropping systems practiced in all the production areas in Côte d'Ivoire (table 4), the most significantly crops combined with yam, in order of importance, were the following: corn (74.94%), cassava (74.28%) and vegetable crops (56.10%). Crops most grown in rotation with yam were significantly groundnuts (98.31%), vegetable crops (96.30%), cassava (93.06%), corn (92.52%), rainfed rice (87.75%), yam (78.31%) and millet (76%). Thus, the leading rotational crops were essentially groundnuts and vegetable crops.

The rotation cycles varied according to the crops (3.85 years for rainfed rice, 1.81 years for groundnut, 1.20 years for vegetable crops, 1.72 years for cassava, 1.82 years for corn and 1.30 years for yam. Millet (17.07%), sorghum (9.53%) and fonio (2%) were rarely combined with yam and the rotation cycles were longer (4 to 6 years). The average fallow duration ranged from 3.6 to 5.66 years. Yam succeeded to yam in some rotations.

Local knowledge and rural strategies for the perception of soil fertility for the choice of the land for yam cultivation

The endogenous criteria of plot choice by farmers for yam cultivation are shown in table 5. These criteria essentially included the type of vegetation, the type of preceding crop and the presence of perennial crops. Concerning the type of vegetation, forests were significantly the first chosen (53.86%) followed by savannahs (40.68%). Fallow (42.36%) and perennial crops (35.45%) are significantly the most preferred as preceding crops.

For soil type, the textural aspect of the soil (sandy or clayey, 47.62%) is the most determinant factor followed by the surface condition (gravelly or non-gravelly, 36.05%). However, the color of the soil and the topographic position were less important. Swampy soils and areas previously used for annual crops were less preferred by farmers for yam cultivation.

Constraints encountered in yam cultivation

The constraints encountered in yam cultivation described by the producers are presented in table 6. At the vegetative stage, the most important significant constraints were firstly the effects of rain/water supply through the instability of the dry and rainy seasons disrupting the crop calendar (37.59%), then labor scarcity (21.99%). Thirdly, there is work arduousness (11.35), lack of financial resources (9.46%), pest damage (6.85%) and decline of soil fertility (6.15%). The least frequent constraints were land pressure, plant diseases, weed pressure and poor seed quality.

At the harvest and post-harvest stages, the significant major constraints were pest damage (22.28%), tuber and seed rot (18.75%) and yam storage difficulties (15.76%) followed by environmental stresses (11.96%). Low productivity of varieties (7.61%) and the need of training for the producers (7.34%) were also mentioned by producers. At the market level, the difficulties expressed were firstly the low sales price (50.21%) and secondly the lack of adequate means for yam transportation (17.17%). In a smaller proportion, the difficulties for yam sellers to access yam fields (8.58%), price fluctuation (8.58%) and the scarcity of purchasers (5.58%) were also listed.

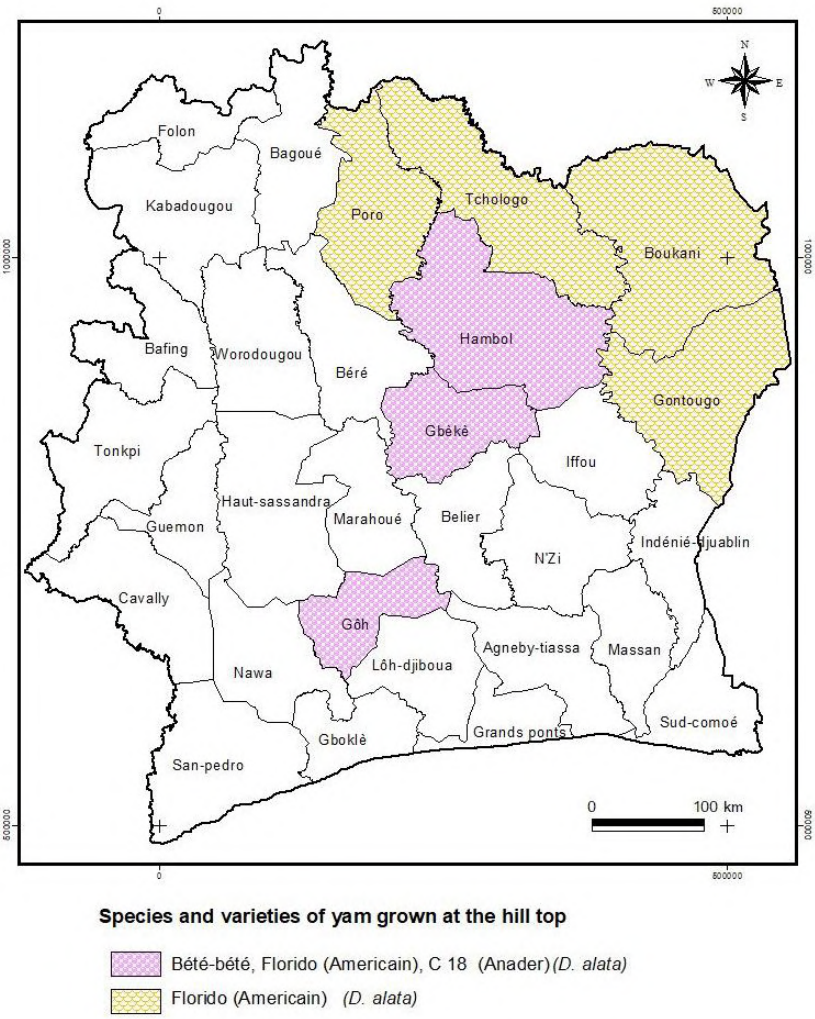

Figure 4. Yam species and varieties cultivated on plateau topographic position in the study areas

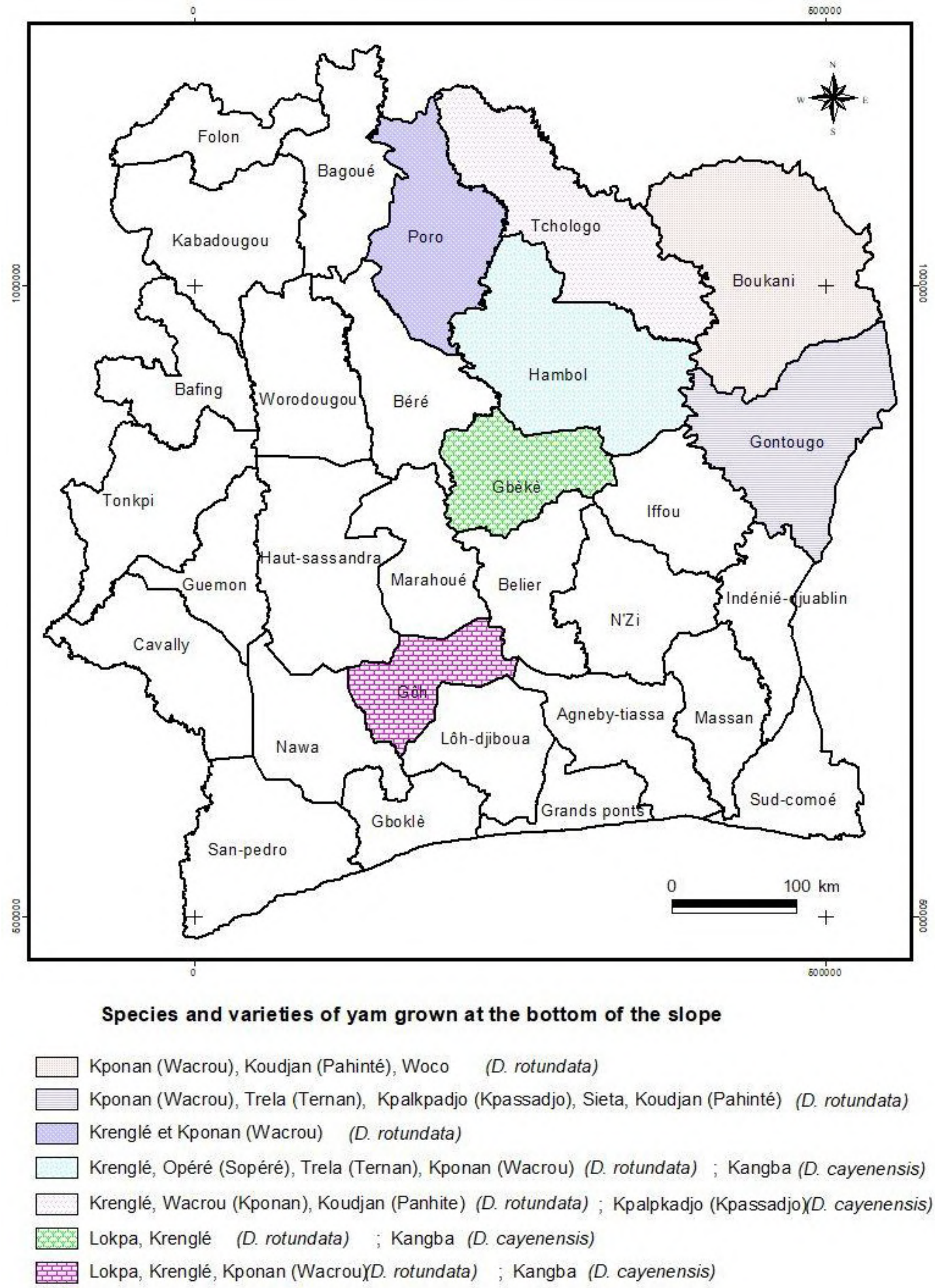

Figure 5. Yam species and varieties cultivated on lower hillside topographic position in yam production areas

Table 7. Characteristics of yam producers' household farms

Variables (units)	Minimum	Maximum	Average	Standard deviation
Surface areas of crops (ha)	0.01	42	7.10	7.23
Surface areas of yam plots (ha)	0.02	30	2.62	3.89
Surface areas of fallows (ha)	0	99	7.91	9.34
Number of cropping cycles	1	9	1.56	1.09

Table 8. Yam-based cropping systems in all production areas

Variables	Crop combination (%)	Crop rotation (%)	Rotation cycle (years)			Fallow duration (years)		
Crops	Yes	Yes	Min	Max	Average	Min	Max	Average
Yam	-	78.31a	0	10	1.30	0	30	4.07
Cassava	74.28a	93.06a	0	15	1.72	0	15	4.71
Rainfed rice	7.76de	87.75a	0	12	3.85	1	10	3.6
Corn	74.94a	92.52a	1	15	1.82	0	20	4.22
Groundnut	27.94bcd	98.31a	0	15	1.81	0	20	3.48
Millet	17.07cde	76a	1	15	5.55	0	15	5.66
Sorghum	9.53cde	22.22b	1	15	4.08	-	-	-
Fonio	2.00e	-	-	-	-	-	-	-
Vegetable crops	56.10ab	96.30a	1	4	1.20	0	8	3.43
Perennial	35.25bc	-	-	-	-	-	-	-

Frequencies followed by the same letter are not significantly different ($P \leq 0.05$)

Table 9. Endogenous sol selection criteria for yam cultivation

Endogenous selection criteria	Modalities	Importance Frequencies (%)
Vegetation type	Forests	53.86a
	Savannahs	40.68b
	Swamps	-
	Other	5.45c
Preceding crop	Perennial crops	35.45a
	Annual crops	19.02b
	Fallow	42.36a
	Other	3.17c
Type de sol	Textural appearance of the soil (sandy or clayey)	47.62a
	Surface condition (gravelly or non-gravelly)	36.05b
	Soil color (red, black or greyish)	15.42c
	Topographic position (plateau, middle hillside or lower hillside)	0.91d

Frequencies of each criteria followed by the same letter are not significantly different ($P \leq 0.05$)

Table 10. Constraints and their importance to yam cultivation in Côte d'Ivoire

Stages	Constraints	Importance frequencies (%)
Vegetative stage	Rain/water supply	37.59a
	Labor scarcity	21.99b
	Work arduousness	11.35c
	Lack of financial resources	9.46cd
	Pest damage	6.85cd
	Soil fertility decline	6.15cd
	Land pressure	3.78de
	Plant diseases	0.47e
	Adventitious plant pressure	0.24e
	Poor seed quality	0.24e
Post-harvest	Pest damage	22.28a
	Tuber and seed rot	18.75ab
	Yam storage difficulties	15.76ab
	Environmental stresses	11.96bc
	Low productivity of varieties	7.61c
	Need for training	7.34c
Marketing	Low sales price	50.21a
	Lack of yam transportation means	17.17b
	Difficult access of purchasers to farms	8.58c
	Price fluctuation	8.58c
	Purchaser scarcity	5.58c

Frequencies of each constraint in a stage followed by the same letter are not significantly different ($P \leq 0.05$)

Discussion

This study diagnosed the current status of cropping practices and the yam cultivation environments in Côte d'Ivoire. Many factors were involved in the yam production and these varied within and among regions. *Dioscorea alata* and *Dioscorea rotundata* were the two main species of yam cultivated in Côte d'Ivoire, with about thirty varieties listed. The production is dominated by the landraces: Bêtê-Bêtê for *D. alata* and Lokpa, Kponan, Krenglè for *D. rotundata*. These results are consistent with the findings of Doumbia *et al*., (2006), Kouakou *et al*., (2012), Bakayoko *et al*., (2017), who also noted the predominance of landraces and the low proportion of improved varieties represented by Florido, Azaguié and C18 of the *D. alata* species. The importance of yam species and varieties varied across regions. In Central Côte d'Ivoire, the *D. alata* species is predominant, whereas in the North and North-east the *D. rotundata* species is most cultivated (Orkwor and Asadu, 1998 and Doumbia *et al*., 2006). However, this study showed that the *D. alata* species, particularly the variety Florido, is also well cultivated in the Northeastern regions (Bouna). This is opposed to the results of). The varieties Bètè-bètè and Florido which are *D. alata*, were the most cultivated in the West-central area which is not favorable or suitable to the *D. rotundata* (Doumbia *et al*, 2006). Indeed, the West-central area which is a humid forest zone with a high pressure of diseases has become a new yam production area, following the migration of people from the Center and the North to this region (Doumbia *et al*, 2006). But the virus diseases limit the development of the varieties of *Dioscorea rotundata*.

General confusion were noticed on the nomenclature of yam varieties cultivated by producers. For example, the improved varieties C18 and Florido are called Cameroun or Americain by the farmers. The works of Kouakou (2010) and Kouakou *et al.* (2015) gave agro-morphological criteria for the identification of varietal groups for *D. alata*.

The results relating to the agronomic characteristics of farms confirmed the smallness of yam-cultivated surface areas with an average of 2.5 hectares for all the areas of the production basin. These results corroborate the works of Floquet *et al*. (2012) and Dibi *et al*. (2014), which showed that such smallness of surface areas could be explained by the scarcity and high cost of seeds at the time of planting. Moreover, the lack of labor might also limit the will of producers to have large surface areas. Indeed, yam cultivation is entirely manual, despite the existing opportunities for its mechanization (Doumbia *et al*., 2006; Dibi *et al*., 2014).

Yam is usually grown in mixed crop with other crops. Rice and cassava are the most common combinations in the savannah area. In the forest area, cocoa and coffee were planted simultaneously with yam. Yam always leads rotation. Fallows period becomes shorter remaining below ten (10) years. Yam often comes back to rotation after two (2) years, in some cases, with quadrennial and triennial rotations in cropping systems (Le Buanec and Jacob, 1981; Kalms and Chabalier, 1981; Yeboua, 1990; Doumbia, 1998). This is a very substantial reduction compared to the ten (10) years generally indicated by some authors (Pieri, 1989; Dumont, 1997; Carsky *et al*., 1998a). Indeed, the long duration of fallow is justified by the fact that despite the importance of yam, traditional methods of production continue to be used, such as cultivation without input, leading to rotation because of its high nutrient requirements, particularly nitrogen and potassium (with average input estimated at 3 - 5 kg N, 0.4 - 0.5 kg P, 3 - 5 kg K per ton of fresh material produced. As indicated by the numerous works of Degras (1986), Vernier (1998), Carsky *et al.* (1998b), Cornet *et al.* (2014), Cornet (2015), Diby *et al.* (2009), Diby *et al*. 2012) and Hgaza *et al*. (2012), soil fertility remains one of the main constraints encountered in traditional cultivation.

This study also revealed that yam can be cultivated during two successive cropping seasons on the same soil. However, in such case, greater difficulties of emergence were observed (Maliki 2006, Floquet *et al.*, 2012).

Yam producers have indigenous knowledge that determines their choices for the establishment of the crop. Thus, yam varieties of the *D. alata* species are found in forest areas or in woodland savannahs, whereas *D. rotundata* varieties are established in savannah areas. Degras (1986) has shown that gravelly soils that degrade yam quality, and swampy lands are not suitable for yam cultivation. These notions are well known by producers. In the same environment, soil typology, textural aspect and surface conditions are the most determinant factors for yam producers in the choice of their plot; but the color of the soil and the topographic position were less important for them in this study. However, soil heterogeneity, through its color, is a handicap for the management of its fertility and a constraint in agronomic experiments. Approaches to characterize this variability have been developed previously by Moreau (1990) in the forest zone and Vauclin and Chopart (1991), and Koné and Assa (2008) in the forest-savannah transition area and in the savannah. These authors indicated that the surface horizon of the soil and its color can be used to identify samples with variable aspects. Seubert *et al*. (1977) and Sanchez *et al*. (1983), reported the effect of agricultural practices such as clearing or bush fires as sources of this variability. The heterogeneity described by the color of the soil could be explained by the dynamics of water along the toposequence inducing a hierarchy of the color of the ferralitic soils along this one (Koné, 2007).

This study shows that despite their great knowledge of yam cultivation, producers have little knowledge of yam diseases. Indeed, farmers did not give any importance to the diseases as constraints. However, there is evidence that the disease can cause losses of up to 80% of the crop (Lebot, 2009; Richard et al., 2010). The economic impacts of the major biotic constraints (nematodes, viral diseases and anthracnose) will increase with the intensification of yam production systems, unless resistant varieties and beneficial cropping practices are adopted. Furthermore, from planting to storage, both tubers and yam plants are subject to various attacks. A study conducted by the International Institute of Tropical Agriculture (IITA) in Nigeria found that insects cause more damage to yam in Africa, and beetles are the most important of this group (Lebot, 2009). Also, Goudou-Shina (1995) noted that losses during storage can reach 40%. It is therefore crucial to train farmers on recognition and control of yam diseases and pests.

Producers did not consider the problem of seeds among the first constraints. Though, in the traditional yam production technique, the demand for seed is so high that some producers are forced to reduce cultivated areas. Indeed, 30 to 40% of the tubers harvested are used as seed (Dibi *et al*., 2014).

To this unavailability of planting material, is added the ageing of this planting material. In a study conducted in Benin, Dansi (2003) it is noted that more than 80% of the varieties used by farmers were inherited from their parents.

Farmers identified the effects of rain supply through the instability of the dry and rainy as the most important significant constraints at the vegetative stage. In fact, environmental stresses through the instability of dry and rainy seasons disrupts the cropping calendar of yam. Thus, despite its resilience, as yam cultivation is rainfed, it is subject to climatic uncertainties. The establishments are more and more delayed and the cropping cycles are reduced, thus limiting yields. Farmers are now aware of this phenomenon despite the traditional considerations attached to it (Bell *et al.*, 2000; Lebot 2009; O'Sullivan *et al.,* 2008; O'Sullivan and Jane Nancy, 2010). These findings are consistent with the work of Sinsin and Kampmann (2010) which showed that it is the decrease of the quantity of water gradually as the temperature increases, coupled with a decrease in the relative humidity of air, which affect the growth of plants. Indeed, an unprecedented rate of degradation of the natural resources of the countries of West Africa were observed during these last decades. In addition, deforestation in the tropics which is caused at 60%by slash and burn agriculture, directly releases 40 to 50% of total carbon through biomass burning (FAO, 2002). As a consequence, carbon emissions contribute to the global warming of the earth, which is probably at the root of climate change, characterized inter alia by the seasonal variability of rainfall (rainfall delays and pockets of drought of varying lengths) and floods, followed by biodiversity degradation (Dansi *et al.*, 2013).

Thus, variability in yam yield is generally attributed to soil fertility depletion (Diby *et al*., 2009), pests and diseases (Coyne *et al*., 2006), farmers' decisions regarding resource allocation (Nkonya *et al*., 2005) and their agronomics practices (Mutsaers *et al*., 1997), or the combinations of these all factors (Samake *et al*., 2006). In contrast, Ghosh *et al*. (1988) and Ike and Inoni (2006) consider rainfall delays as one of the main sources of yam production decline. This work corroborates those of Dansi *et al*. (2013) and Ehounou (2014), showing water requirements for yam cultivation, especially after germination of the crop and then between the fourteenth and twentieth weeks of growth. As a result, the work of Tittonell *et al*. (2007), have indicated that agronomic management decisions should influence the efficiency of resource use (land, inputs, water, etc.) and therefore the productivity of the crop.

Conclusion

This study on the identification of current cropping practices and yam cultivation environment, which took place in seven (7) regions of the yam production basin in Côte d'Ivoire, has helped describing the characteristics of yam production systems. With average yields still below the potential of the crop, constraints such as virus diseases, unsuitability of the planting material, the poor soil fertility, the post-harvest losses, the traditional cropping systems without inputs and the weeds are the weakness of yam production in Côte d'Ivoire. The constraints having been identified, it remains to take them into account, in order to develop relevant guidance and decision-making tools for variety breeding and cultivation environment redefinition.

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