Food Science State of Knowledge Report

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CONTENTS

Table of Contents

1. SOK BOILED YAM – FOOD SCIENCE

CONTENTS

List of Tables

List of Figures

Introduction

Yams (*Dioscorea spp*) are a major staple in the tropics and subtropics of Africa, as source of energy and other nutrients for the population (Egesi et al., 2003). In Benin, yam is prepared for consumption in a variety of ways, including boiled slices, pounded yam, porridge, fried yam and yam flour (Akissoé et al., 2001). The quality of the yam products is affected by the variability in the food chain, including breeding, cultivation, and processing and consumers' preference. In this respect, a food chain approach is needed to understand and conceptualise the main quality traits of vegetal products, including of boiled yam which is the subject of this report.

Boiled yam is considered an important food product in Benin, and throughout West Africa more generally. It is consumed for all meals (breakfast, lunch and dinner) and also as a street food in both rural and urban areas of Benin. However, not all yam varieties are suitable for the different yam products, in terms of their suitability for cooking (Loko et al., 2015). Cooking can influence the product's sensory characteristics that may or may not be preferred by consumers, in addition to the physicochemical and nutritional quality of the yam of the final product (Bhandari and Kawabata, 2006; Ezeocha and Ojimelukwe, 2012; Maziya-Dixon et al., 2017).

Improving the quality of yams to be used for cooked yam is an ongoing challenge for yam breeders and food scientists, as it requires knowledge of the quality criteria of raw yam and boiled yam for consumers (who may have varying preferences), and the impact of cooking on the physicochemical characteristics of the yam. This State of Knowledge (SoK) report presents the findings from a literature review and key informant interviews related to boiled yam that is largely focused on Benin but draws on findings from other countries where relevant. The aim of the SoK is to address following research questions:

1. What are the characteristics of the raw material that will give a good quality product with focus on differences between processing methods, regions, ethnicity etc.?
2. What are the key steps in processing and preparation that will give a good quality product noting differences between processing methods, regions, ethnicity etc.?
3. What are the known quality characteristics of the raw material associated with each stage of processing and preparation, to the final product?
4. What are the know quality characteristics of the final product?

The findings from the key information interviews and document review related to these questions are summarized in this report.

1.1. Methodology

1.1.1. Sampling for Key informant interviews (KII)

Six (06) key informants from different disciplines were identified at the three main universities of Benin to participate in interviews (Table 1). They were selected based on their expertise on yam.

Table 1 Sample of KII

Name	University	Faculty	Disciplines	Gender
AFFOKPON Antoine	Abomey-Calavi	Agronomic science (FSA)	Enthomologist	Male
ADIFON Fiacre	Abomey-Calavi	Agronomic science (FSA)	Enthomologist	Male
DALODE Générose	Abomey-Calavi	Agronomic science (FSA)	Food scientist	Female
HONGBETE Franck	Parakou (UP)	Agronomy (FA)	Food scientist	Male
PADONOU Wilfrid	Ketou (UAK)	Agriculture	Food scientist	Male
FAKOREDE Jeanette	Abomey-Calavi	Technical Science (FAST)	Breeder	Female

1.1.2. Document review

Two types of documents were gathered: 'grey' and peer-reviewed literature.

The 'grey' literature was selected from unpublished documents including theses, project reports (existing in our library), and studies by national or international research institutions. The peer-reviewed literature is related to our own papers as well as others from international literature through google scholar and journals web sites. The document citation and the countries and regions where the work was undertaken are summarized in the Table 2.

Table 2 Citations sources

	CITATION LOG	COUNTRY AND REGION FOCUS
Akissoé et al. 2001	Physical, chemical and sensory evaluation of dried yam (*Dioscorea rotundata*) tubers, flour and amala, a flour-derived product	Bénin
Baah, 2009	Characterization of water yam (*dioscorea alata*) for existing and potential food products	Nigeria
Amegbeto et al. 2008	Estimating market demand for fresh yam characteristics using contingent valuation: implications for crop breeding and production choices. Agricultural economics	Togo, Lomè
Barlagne et al. 2007	Consumers' preferences for fresh yam: a focus group study	Guadeloupe
Bhandari, 2006	Cooking effects on oxalate, phytate, trypsin and alpha-amylase inhibitors of wild yam tubers of Nepal	Nepal
Brical et al. 1997	Le développement de la filière cossettes d'igname en Afrique de l'Ouest	Bénin,
Egesi et al. 2003	Genetic diversity of organoleptic properties in water yam (*Dioscorea alata* L)	Nigeria
Ezeocha, 2012	The impact of cooking on the proximate composition and anti-nutritional factors of water yam	Nigeria
Hounhouigan et al. 2003	Les caractéristiques culinaires des ignames recherchées en milieu urbain au Bénin	Bénin,
Lebot et al. 2006	Physico-chemical characterisation of yam (*Dioscorea alata* L.) tubers from Vanuatu	Islands, Vanuatu archipelago
Loko et al. 2015	Participatory evaluation of Guinea yam (*Dioscorea cayenensis Lam.–D. rotundata* Poir. complex) landraces from Benin and agro-morphological characterization of cultivars	Benin, center and north Benin
Maziya-Dixon et al. 2017	Retention of iron and zinc in yam flour and boiled yam processed from white yam	Nigeria
Naziha, 2002	La consommation et les critères de qualité des ignames au Bénin et au Nigeria	Benin, south and north Benin
Otegbayo et al. 2005	Microstructure of boiled yam (Dioscorea spp.) and its implication for assessment of textural quality	Nigeria
Otoo, 2009	The last hurdle in varietal development of yams (*Dioscorea rotundata*, poir) in Ghana	Ghana
Zannou et al. 2007	Socio-cultural factors influencing and maintaining yam and cowpea diversity in Benin	Benin, center Benin

1.2. Synthesis report

1.2.1. Key information outputs for food science

Fresh raw tuber characteristics according KII

The external aspect/texture of skin/surface (eg. rough to the feel, smooth skin [*Texture au toucher]* and the size of tuber [*Taille/grosseur*] are quality criteria of raw yam tuber important for cooking boiled yam pieces. Thus, tubers with smooth skin are good for boiled yam, while the ones with « rough to the feel » skin/surface lead to poor quality boiled yam pieces. However, as far as the size is concerned, some people like big sized tuber while others prefer the middle sized or small sized tuber for making boiled yam piece.

The age or maturity of tuber [*Age du tubercule, maturité du tubercule : Bout du tubercule donnant l'apparence d'être mûre*] was cited as one of the important traits for raw yam tuber intended for boiled yam. In addition, the older yam tuber, that has been stored longer after harvesting loses weight over time and has a firm texture after cooking. The planting duration of the tuber depends on the variety as well and affects the quality of boiled yam. The end of tuber (distal portion) should show traits of a mature tuber which are tubers with low/weak length of whitish watered distal portion. The low water content of a fresh tuber is considered important for the quality of boiled yam. The colour and the type of variety are also important for processors. In short, the two or three most important traits of raw tuber are the **texture of skin** (*smooth skin being preferred*), the **weight of tuber** and the **maturity of tuber**.

Processing and quality criteria of boiled yam piece according to KII

Boiled yam pieces are obtained by peeling, washing, slicing and boiling the yam pieces in water. Boiling is done by completely immersing the tuber in water during cooking or by cooking the tuber by directly exposing it to hot steam. According to some key informants, the boiling procedure affects the texture and the taste of boiled yam pieces, and only « soft to the feel » yam pieces can be steam cooked. Accordingly, the choice of cooking method (boil or steam) must match to the preference of processors and consumers. The preparation of boiled yam involves: peeling, washing, slicing and cooking the tuber by steam or boiling (Figure 1).

When peeling yam, processors recognise a good yam variety for making boiled yam when the white starch from the yam sticks to the knife. Thus, the amount of starch that sticks to the knife is an indication of a high quality of yam tuber for making boiled yam pieces. Accordingly, when the amount of starch is low, the tuber is good for boiled yam. According to some key informants, the ease of peeling is also a positive characteristic of a good quality boiled yam variety.

When slicing the tuber into pieces, the ease of cutting is a good indicator of the level of softness of a boiled yam, and a soft boiled yam is preferred by consumers. At this stage, the lack/absence of browning of a sliced piece is a desirable quality trait. Furthermore, the cooking duration (short duration being good) and the water absorption capacity (a mid one is preferred) influence the quality of boiled yam.

The main quality criteria of boiled yam pieces at consumption stage are: attractive colour (white, creamy or yellowish), soft texture, slightly sweet taste, aroma like yam odour, compact during chewing.

The table 3 summarises the quality characteristics of raw and boiled yam according to key informants, disaggregated by gender.

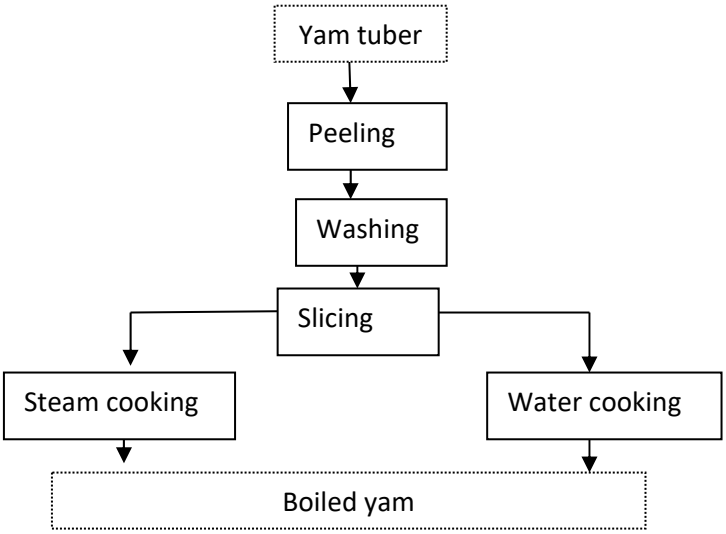

Figure 1 Flow diagram of the preparation of a boiled yam

Table 3 Quality characteristics of raw and boiled yam according to key informant gendered

	FRESH TUBER/RAW MATERIAL				*BOILED YAM*				
Key informants by gender	***Raw material characteristics***	***Differences in preferred characteristic by region, processing method, ethnicity, gender***	***Evidence or experience do you have that would substantiate this***	***Two or three most important quality characteristics? Specify for who, where***	***Processing and / or preparation steps to make the product***	***Differences in the quality characteristic by region, processing method, ethnicity, gender etc***	***Known physical, chemical, and quality characteristics at each step of the process to the final product (consumer preferences)***	***Known physical, chemical, nutritional, sensory qualities characteristics of the final product***	***The two or three most important quality characteristics? Specify for who, where etc***
Women (n=2)	The age or maturity of tuber [*Age du tubercule, maturité du tubercule : Bout du tubercule donnant l'apparence d'être mûre*]. The external aspect/texture of skin/surface (eg. rough to the feel, smooth skin) [*Texture au toucher]*.	The preference for the characteristics doesn't depend on the region, the ethnicity and the gender.	A person has been cooking at home for over 30 years for her husband and children	The two or three most important traits of raw tuber are the appearance/texture of skin, the weight of tuber and the colour of the flesh. The texture is specific for the processors, the weight of tuber is important for the farmers and the colour is important for the processors and consumers	Peeling, washing, slicing and boiling the pieces in water with a little salt	No difference by region, ethnicity or gender	During peeling, the whiter the knife is the more important the starch that sticks to the knife; as a result, the importance/amount of starch that sticks to the knife is an indication of the ability of yam tuber for boiled yam piece. In this regard, when the amount of starch is low, the tuber is good for boiled yam piece.	Attractive colour, soft, elastic, slightly sweet taste, good odour, compact during chewing	Attractive colour, softness, sweet taste

	FRESH TUBER/RAW MATERIAL				***BOILED YAM***				
Key informants by gender	***Raw material characteristics***	***Differences in preferred characteristic by region, processing method, ethnicity, gender***	***Evidence or experience do you have that would substantiate this***	***Two or three most important quality characteristics? Specify for who, where***	***Processing and / or preparation steps to make the product***	***Differences in the quality characteristic by region, processing method, ethnicity, gender etc***	***Known <u>physical, chemical, and quality</u> characteristics at each step of the process to the final product (consumer preferences)***	***Known <u>physical, chemical, nutritional, sensory qualities</u> characteristics of the final product***	***The two or three most important quality characteristics? Specify for who, where etc***
Women (n=2)	The attractive colour (white or yellow) during peeling. Low oxidation during peeling, no change in colour Low water content of fresh tuber	They depend on the type of variety and the processing methods.	The second woman worked on yam for less than 5 years		The boiling can be done with hot steam or the tuber is completely immersed in water for boiling	The boiling method affects the texture and the taste of boiled yam. The choice of boiling method is achieved according to the preference of processor and consumer and only the soft yam can be steam cooked	During washing, the fresh tuber sticks to the fingers. The fresh tuber had also an aroma characteristic of yam. During slicing, the ease to cut is a good indicator of the softness for boiled yam During cooking, the cooking duration and the water absorption capacity influence the quality of boiled yam		

	FRESH TUBER/RAW MATERIAL				***BOILED YAM***				
Key informants by gender	***Raw material characteristics***	***Differences in preferred characteristic by region, processing method, ethnicity, gender***	***Evidence or experience do you have that would substantiate this***	***Two or three most important quality characteristics? Specify for who, where***	***Processing and / or preparation steps to make the product***	***Differences in the quality characteristic by region, processing method, ethnicity, gender etc***	***Known <u>physical, chemical, and quality</u> characteristics at each step of the process to the final product (consumer preferences)***	***Known <u>physical, chemical, nutritional, sensory qualities</u> characteristics of the final product***	***The two or three most important quality characteristics? Specify for who, where etc***
Men (n = 4)	The size of tuber [*Taille/grosseur*] is an important quality criterion. Some people like big sized tuber while the other the middle sized or small sized tuber for boiled piece. The external aspect/texture of skin/surface(eg. rough to the feel, smooth skin [*Texture au toucher]*). Yam stored for a long time is not good for boiling. Yam too old loses weight and has a texture too firm after cooking. The end of tuber (distal portion) should show traits of mature tuber. The type of variety		Two persons are food scientists and the other are soil scientists Two people (food and soil scientists) worked on many yam projects. The two other worked on yam for less than 5 years	The two most important traits of raw tuber are the texture of skin, the weight of tuber and the maturity of tuber and they are specific for the farmers and processors	Peeling, washing, slicing and boiling the pieces in water with a little salt		The ease of peeling is a positive criterion for the ability to boil. During slicing, the parenchyma must be firm but not too hard and it doesn't brown. During cooking, the colour of water should be white-milky	Soft, sweet taste, white, yellow, sweet aftertaste	Colour, softness, sweet taste and sweet after taste

1.2.2. Documents review outputs for food science

Importance of yam for food security

Yam is an important tuber crop that highly contributes to food security and poverty alleviation in Benin. Benin is the top fourth African producer of yam, following Nigeria, Ghana and Côte d'Ivoire. Yam is a commercial and food crop that provides income to farmers and is consumed as a food staple for home consumption. Zannou et al. (2007) reported that 78% and 67% of the interviewed farmers (N=194) considered yam very important for home consumption and income, respectively. Yam is consumed in a fewer number of products compared to cassava, as it is mainly boiled and/or pounded, fried, made into porridge or roasted as a snack food. Yam tubers are also dried and milled into flour for products such as amala and wassa-wassa (couscous). Boiled yam pieces, pounded yam and amala are the most consumed yam products in West Africa, especially in Benin and Nigeria (Akissoé et al., 2001).

In terms of the location of the consumption of yam products, boiled yam, in addition to pounded, porridge and fried yam are mainly consumed in the home afor domestic consumption. However, Amala and Wassa wassa yam products are is mostly consumed as street food (Table 4, Nazhia, 2002). As far as boiled yam pieces are concerned, only 15.1% are sold (street-food and restaurant combined), compared to pounded yam, porridge, and fried yam.

Table 4 Location of consumption of different yam products and their importance

Total (N=600)	Pounded yam	Boiled yam	Porridge	Fried yam	Amala	Wassa wassa
Domestic consumption	89.5**	96.4	95.9	97.4	70.5	41.3
Street-food	14.3	7.9	9.2	4.9	69.3	71.4
Restaurant	15.1	7.2	0.8	0.6	1.6	2.1
other	1	1	1	0	0	3.7
Total	119.9	112.5	106.9	102.9	141.4	118.5
	(n*=391)	(n=419)	(n=512)	(n=347)	(n=501)	(n=189)

Note: The total percentage is over 100 because it is a multiple response question

Source: Naziha (2002), *: Total of respondents, **: % of respondents

Yam is available in market throughout the year however the quantity of yam available varies. There are periods of relative abundance of fresh yams, from August to February, and periods of scarcity, from May to July. As a result, consumer prices in urban markets can vary by a factor of 1 to 6 (Bricas et al., 1997) and the preferred cultivars are not available all along the year. Reasonably, yam tuber is relatively more expensive than other alternative starchy foods such as cassava or cereals. The mean prices for different yam varieties, depending on the quality of raw tuber, are summarized in table 5.

Table 5 Price of some yam cultivars in Dantokpa market, Cotonou (mean value in 2000)

Variety local name	Price (FCFA/Kg)
Laboko	816.99
Kratchi	471.21
Moroko	413.58
Gnalabo	406.8
Gnidou	376.29
Kangni	372.9
Adani	349.17
Ala	342.39
Sakata	284.76
Boniouré	230.52
Kokoro	230.52
Kokoro	163

Source: Naziha (2002)

In all the yam producing countries of West Africa and particularly in Benin, several species of yam are cultivated. The most important species are white yam (*Dioscorea alata*) and the African complex *D. cayenensis–D. rotundata*, also referred to as Guinea yam (Loko et al., 2015). However, the diversity of the crop poses a serious challenge to researchers in the development of superior varieties that have high and stable yields, disease resistance, adaptation to physical environment, and suitability to various end-uses and food qualities. Scientists currently do not know the priority characteristics of producers to bundle in new varieties in order to achieve these goals (Amegbeto et al., 2008). In Benin, the cultivated yams *D. cayenensis– D. rotundata* complex occupy more than 95% of the planting area, with a production estimated to 3.041.245 tonnes in 2015 (FAOSTAT, 2016). This species had many cultivars with different traits and end-users preference. For instance, Loko et al. (2015) reported that out of the 426 cultivars (subject to synonymy) of Guinea yam initially inventoried in Benin and evaluated by 30–40 producers using participatory evaluation, 209, 267 and 269 cultivars, respectively, were recognized to have post-harvest storage aptitude, quality for pounding and quality for boiling. Naziha (2002) reported from the interviews with 72 yam farmers that only the *D. rotoundata* cultivars called « Laboko », « Ala » « Kokoro », « Gangni » and « Morokoro » were recognized by farmers for being used for boiled yam pieces (Figure 2). Beside their aptitude for boiled yam, « Laboko » was preferred for both social and economic needs, and « Ala » for its adaptability to poor soils and its ability to be stored for long periods, which is important for ensuring the food security during the pre-harvest hungry season (Zannou et al., 2007). Some of characteristics of raw yam tuber are listed in table 6 (*Dansi et al., 1995*).

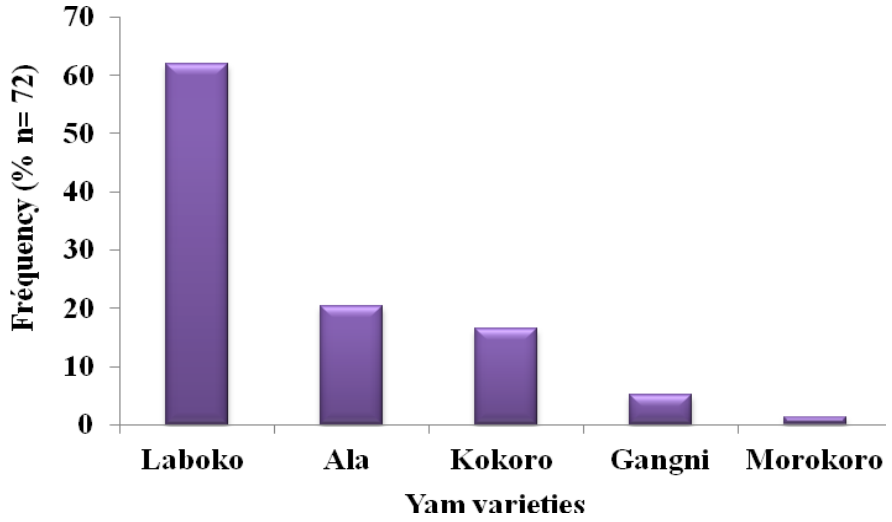

Figure 2 Major local yam varieties for boiling Source: Naziha (2002)

Table 6 Principal yam cultivars sold at urban markets of Benin and their main traits

Principal name (local language)	Other local name/by ethnicity	Species	Nb. Harvest /year	Tuber characteristics*
Laboko (MF)	Kponan (Ba)	*D. rotundata*	2	Big size, long, cylindrical, smooth,
Kokoro	Asna (Pila-pila)	*D rotundata*	1	Small size, smooth
Ala (MF)	Ala n'kojewoué, Oboti, Gbidoko (Na)	*D. rotundata*	2	Big size, long, often high thorny
Gnidou (Na)	Agbantehounnonkin (MF) Daguidagui (Na), Doyesserou, Idjitedeteka (Kot)	*D. rotundata*	2	Regular, long, cylindrical, smooth,
Kangni (MF)		*D. rotundata*	1	Rarely forked, smooth
Morokoro(MF)	Morokorou (Ba), Woho(Ba), Anago (Na)	*D. rotundata*	2	Big size, cylindrical, smooth
Gnalabo (MF)	Aguida, Nami (Na)	*D. rotundata*	1	Regular, not forked
Kratchi (MF)	Klachi, Bakpanatini (Kot)	*D. rotundata*	1	Rarely forked
Baniouré (Ba)	Oloukobi, Banioure souan, Wirou, Worou, Guihi woga (Ba), Outchankouehan, Damoko (Na) Baniuje (Peu), Woutamabou (Wan), Kiwa (Bo) ;	*D. rotundata*	2	Long, or middle size, often curved/bent
Sakata	Aga, Kpète	*D. alata*	1	Big size, smooth
Adani (Ba)	Oroutanai (Peu), Akpekpe, Fananan, Kablitona, Koudjou, Mafobo, Odoi, Omoulé (Na) Bebetinga, Peya (Ber) Koumassi nonbou (wam) Koumassi kpeina (Nat),Tchoutchounga (Bo)	*D. rotundata*	2	Big size, smooth
Soussou (Ba)		*D. rotundata*	2	Long, sometimes forked
Kpakara (Ba)	Danwari (Ba), Heleabalo Kotokiliana (Lo), Tronpeti (Nat)	*D. rotundata*	1	Big size and long
Tamdwé	Nom générique pour les variétés précoces à deux récoltes	*D. rotundata*	2	
Glazoué (MF)	Tognibo (MF)	*D. rotundata*	2	Cylindrical
Djougou	Igname provenant de la zone de Djougou	*D. rotundata*		

* : translated from French to English

Languages/ethinicity : F= Fon, MF= Mahi,Fon, Na= Nago, Ba=Bariba, Kot= Kotokoli, Peu= Peuhl, Lo= Lokpa, Nat= Natimba, Lo= Lokpa, Ber= Ber. Source pour les noms et caractéristiques des tubercules : Dansi et al., 1995

Processing and consumption of boiled yam

Boiled yam is obtained through a very simple process, including peeling the yam tuber, slicing and boiling the pieces in water until the cores are soft (Hounhouigan et al., 2003). Generally, the tuber is cut into 1 to 2 cm in depth in the direction of its length, maintaining the tuber diameter. In usual practice, during boiling, processors add a little salt to enhance the taste of boiled yam. In Benin, people consumed boiled yam at all times of the day, especially at lunch and breakfast for 75% and 20%, respectively (Naziha, 2002). It is consumed plain, with bean soup or with palm oil, peanut,

tomato sauce by all economic classes of the population, and particularly in rural areas. Boiled yam is prepared in households or sold as street foods (Table 4). The Beninese prefer to consume it warm because after cooling its texture becomes less soft (eg hard) and therefore disliked.

Quality criteria of yam varieties and boiled yam pieces

This paragraph reports, quality criteria of boiled yam by consumers and associated characteristics of preferred yam cultivars. Indeed, in varietal development, quality criteria are not only the most important hurdle (varying within and between actors) but also a major determinant of acceptability, as well as a major determinant in the subsequent adoption and use of the variety (Otoo and Asiedu, 2009). Regarding yam cultivars, little is known about consumer preferences of end-product quality, and the drivers of adoption. Depending on the end-product, it was recognized that organoleptic characteristics are major factors in the choice of yam tuber by farmers. In Benin, Naziha (2002) reported from interviews with 600 yam farmers that the quality of product needed, the appearance of tuber and the post-harvest storage aptitude had high relative importance in the choice of varieties (Table 7). Otoo and Asiedu (2009) reported in Ghana that the enzymatic oxidation appearance and colour attractiveness of peeled tubers are other main criteria for end uses. Barlagne et al. (2017) reported from the focus group discussion with 31 Guadeloupean yam purchasers and consumers that the purchasing criteria of yam were the lack external damage (93%), the size (64%), the origin (local or improved) (61%), the freshness (58%) and the variety (51%). For these authors, the last criteria considered important were the cooking mode and the cooking time.

Table 7 Criteria in the choice of yam tuber

Criteria	Percentage (N=600)
Quality of product needed	54.6
Yam tuber appearance	49.5
Storage aptitude	41.0
Ease of use	32.6
Tuber size	29.1
Production zone	11.0

Reference: adapted from Naziha (2002)

Regarding the boiled yam, texture, colour, taste, smell and digestibility are the major drivers of the preferences of Beninese consumers (Naziha, 2002, Zannou et al., 2007). Each of these criteria is detailed in Table 8 with their relative importance in Figure 2. Naziha (2002) reported three quality attributes for texture of boiled yam (soft, mealy/smooth, no black spots), one for taste (slightly sweet), three for colour (very white, cream and yellow) and four for digestibility (satiating, easy to digest, no distending and no constipation) (Figure 2). Taste preferences of boiled yam differs by context: in Benin consumers dislike bitterness , while for Guadeloupean consumers Barlagne et al. (2017) reported that the taste of boiled yam should be sweet or bitter, neutral, wild and refined. Baah (2009) focused the boiled yam evaluation on the sensory attributes such as colour, wetness, taste, hardness and mealiness. Those attributes were obtained from group discussions with fifteen (15) panellists. Except for a few differences with Baah (2009) findings, the same sensory attributes (colour, mealiness and taste/flavour) were also reported to be key quality parameters of boiled yam (Abass *et al*., 2003 and Egesi *et. al.*, 2003)

Table 8 Quality criteria of boiled yam

Complex quality characteristics	Detailed criteria
Texture	Soft
	Mealy / friable
	No black spots
Taste	Slightly sugared / sweet
Colour	Very white
	White / cream
	Yellow
Digestibility	Satiating
	Easy to digest
	No distending
	No constipation

Reference: adapted from Naziha (2002)

Regarding the colour of boiled yam flesh, Barlagne et al. (2017) reported the terms white, yellow and plain and clear are indicators of good quality yam, in contrast to brownish, grayish and the presence of black spots that indicate rotting and thus, poor quality yam. Zannou et al. (2007) indicated that the smell of a variety is considered also as a determinant of quality for the boiled yam. For Otegbayo et al. (2005), the main textural characteristics of boiled yam preferred by common understanding are mealiness, waxiness, sogginess, stickness, and hardness. Mealiness was found to be important (Lebot et al., 2006) and Otoo and Asiedu (2009) defined this term as the ease of disintegration of the boiled yam while waxiness is the extent to which the yam remains intact and does not disintegrate easily when pressed with fingers or in the mouth. The relative importance of these attributes is presented in Figure 3.

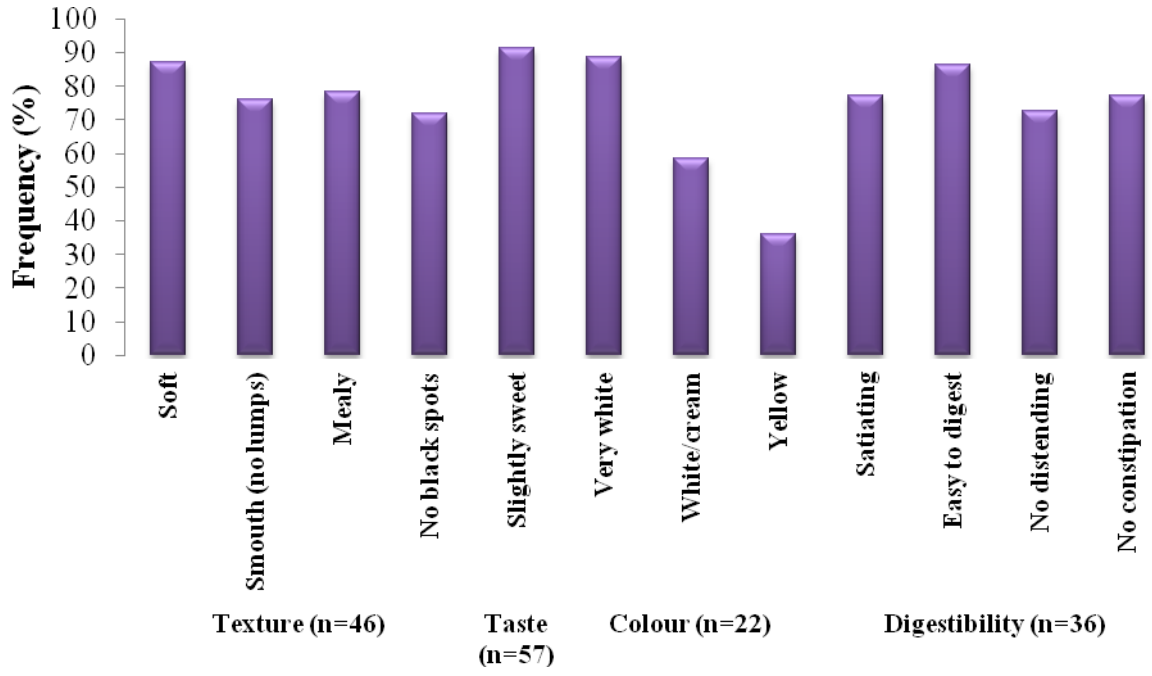

Figure 3 Importance of quality criteria of boiled yam

1.2.3. Gaps in knowledge from the document review

The quality characteristics of yam tuber and boiled yam pieces were reported by several research works. Most of the research was collected through surveys or focus group discussion. Although, some

surveys (Nazhia, 2002) were designed at urban and rural levels, data were analysed without focusing on those factors. In general practice, data obtained were not disaggregated between or by gender and other factors of social difference such as ethnicity, richness, age, marital status etc.

Furthermore, most of the mean ranges for the quality characteristics were not available from literature. As far as this SOK is concerned, the confidence in the information gathered along the food chain is high for some quality attributes of **raw yam** (*maturity of tuber, variety types, colour, tuber size*), **processing steps** (*no oxidation/no browning, cooking duration, white to milky boiling water*) and **boiled yam piece** (*colour, texture, taste*). However, the confidence in the information is still medium for other attributes. Thus, the WP1 activity 3 will help confirming the confidence of the latter. No study integrating all food chain actors for quality traits identification is available. Activity 3 uses the approach that takes into account all actors in the chain in order to generate strong, confident and robust data. As preliminary findings, Table 9 gives an overview of quality traits of yam tuber appropriate for boiling and the characteristics of products at each step of the preparation of boiled yam pieces.

Table 9 Overview table of quality characteristics

		Quality Characteristics (and range, if possible) to achieve a good product	**Mean ranges for the quality characteristics** (from literature if available)	**Evidence to substantiate** (refer interviews and/or add citation sources)	**Your confidence in the information** (low, med, high)
Raw material		Colour (white – creamy- yellowish)	(white – creamy-yellowish)	Interviews and citations	High
		Low humidity/wetness	Not available	Interviews	Med
		Smooth skin		Interviews and citations	Med
		Tuber size (small - big)		Interviews and citations	High
		Type of variety		Interviews and citations	High
		Maturity of the end of tuber (distal portion)		Interviews	Med
		Planting duration/maturity of tuber		Interviews and citations	High
		Weight of tuber (high - middle)		Interviews	Med
		Low amount of starch		Interviews	Med
		Shelf life after harvest (low - high)		Interviews and citations	Med
Preparation steps	**Peeling**	Ease to peel		Interviews	Med
		No oxidation during peeling		Interviews and citations	High
		No change of colour druring peeling		Interviews and citations	High
	Washing	Tuber sticks to the fingers		Interviews	Med
	Slicing	Firm parenchyma but not too hard		Interviews	Med
		Ease to slice		Interviews	Med
		Importance/amount of starch that sticks to the knife		Interviews	Med
	Boiling	White to milky of water		Interviews	High
		Cooking duration (low - middle)		Interviews and citations	High
		Water absoprtion capacity (low-middle)	(low-middle)	Interviews	High

	Quality Characteristics (and range, if possible) to achieve a good product	**Mean ranges for the quality characteristics** (from literature if available)	**Evidence to substantiate** (refer interviews and/or add citation sources)	**Your confidence in the information** (low, med, high)
Boiled yam	Sweet taste (light)		Interviews and citations	High
	Sweet aftertaste		Interviews	Med
	Attractive colour (white, creamy - yellowish)	(white, creamy - yellowish)	Interviews and citations	High
	Softness/not hard		Interviews	High
	Mealiness	Mealiness	Interviews and citations	High
	Odour of yam	Odour of yam	Interviews and citations	High
	Ease to digest		Citations	Med
	No constipation		Citations	Med

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2. SoK Boiled Yam – Gender and Socio-Cultural Context of Yam and Boiled Yam in Benin

CONTENTS

List of Table

List of Figures

List of Acronyms

AgriFam: Family Farming (Identification of the strength of the policy for the best adoption of the research by the Agricultural Exploitation Family of Africa)

CeRPA. : Rural Center for Agricultural Promotion

CIRAD: Center for International Cooperation in Agronomic Research for Development

CORAF: West and Central African Council for Agricultural Research and Development

CRA: Agricultural Research Center

FAO: Food and Agriculture Organization of the United Nations

FAST: Faculty of Science and Technology

IFAD: International Fund for Agricultural Development

FSA: Faculty of Agricultural Sciences

IITA: International Institute of Tropical Agriculture

INRAB: National Institute of Agricultural Research of Benin

MAEP: Ministry of Agriculture and Fisheries

Key findings

- The most important species are Dioscorea alata (greater or water yam), Dioscorea rotundata (white guinea yam), Dioscorea cayenensis (yellow guinea yam).
- The most common varieties are Gangni, Gnidou, Laboko, Morukorou, Orukonai (early varieties); Kokoro and Florido-Dioscoreaalata (late varieties) in the major production areas of Zou, Central and Northern Benin.
- The domestication of yams D. abyssinica and D.praehensilis is practiced in some areas of Benin. Some farmers also collect wild yams.
- Yam is an indicator of wealth and well-being in rural areas. It is also used to fulfil social and ritualistic obligations and represent social prestige. Yam production is considered to require divinatory guidance through Fâ (or god). Specific varieties are used for cultural and ritualistic practices e.g. Laboko and Gangni.
- Male yam growers were slightly more likely to grow varieties with high socio-cultural importance compared to women. Women also prefer varieties that are less labour intensive, particularly for pounding, as they are mainly involved in processing.
- Farmers also specialize in varieties with a higher market price, and surplus production is sold on the market. Yam fields require clearing, making mounds, mowing and planting. Separation while planting is important. Yam is not often stored, but there is promotion of storage practices such as in pits or sheds.
- The main yam harvest is from mid-July to August for early varieties, but it can be harvested year round.
- The main causes of yam loss are: high water content of yam tubers, damage during transport, poor storage conditions (heat) and attacks of micro-organisms.
- Yams are consumed eaten in crushed, roasted, fried, local couscous called "wassa-wassa" or yam chopped into flour. It is also used in traditional pharmacopoeia, specifically treating high cholesterol and diabetes.
- Interestingly, in Couffo, women are more involved in production then men
- Assets required for yam include finance, well decomposed organic manure, seeds for yams and fertilizer. This is mostly the domain of men.
- The yam trade historically declined with competition from Nigeria. There are three main yam markets – based on specific ethnic group for each market e.g. Fon traders tend to trade in fresh yams. The majority of traders are Bariba and Tchabè. Smaller traders are usually women, whereas wholesalers are mainly men, except in Bariba- Tchabè where they are mainly women
- The main market issues are access to transportation, access to the marketplace and access to customers.
- Generally, women do not grow yams, it is men who do so because it needs enough strength and is very difficult to cultivate. Women are mostly in processing and marketing. Nevertheless, in some areas of the North and Center as in the South, some women make it a minority; except in the Couffo where they are in the majority.
- Concerning boiled yam, women, young girls manly are the ones who make its sale although they are a minority compared to the ones who sell the pounded yam. Men are only involved rarely when they are hungry in the field or at home when their wives or children are not at home. They do not market it for the sake of honor because they say "It's the women's thing"

Introduction

In Benin, yam is an important crop in the food culture of local communities in the Transitional Guinea-Sudan Zone of Benin. It is essential to the vital needs of households and communities, and also plays an essential role in the rituals and ceremonies of the agrarian civilizations of Benin. Benin is the fourth largest producer of yam in the world, behind Nigeria and Côte d'Ivoire, with production exceeding 3 million tons in 2013. Yam is grown in Benin from latitude 7 ° N to above 11 ° N and is an essential staple for the people of this region. The departments of North and Center Benin are the areas conducive to its production. More than 70% of the national production is supplied by the departments of Atacora (19%), Borgou (30%), the Hills (24%), to which are added the department of Zou to satisfy domestic demand and exported, and the deficient Mono and Ouémé departments, which only cover a small proportion of their yam requirements (MAEP, 2013).

Yam is indeed the most important crop after maize and remains the staple food of the populations of the Center and the North regions of the country (Aboudou and Auriole, 2006), and also is a product of choice for the people of southern Benin. In addition to its importance as a staple food, yam is an important source of income for producers and is also culturally important (Koudande and Houedjissin, 2010). Nevertheless, despite the high importance of yam in the Beninese diet and in terms of tonnage in the Republic of Benin, the crop has been a low priority in Benin's agricultural policy and is subject to numerous constraints such as the lack of organization of its actors and very little research has been done on it (Adanguidi, 2000; AGBANDOU, 2013)

Thus, there is a need for enhancing the capacity of farmers and researchers in the development of improved tubers like yam. The RTB foods Project breeding programs aims to implement and define demand-led and gender responsive breeding priorities, integrating traits to meet multi-user demands and needs, and adding value. However, producing new knowledge on user characteristics and preferences, socio-cultural and gender issues in broader food systems for RTB crop products to inform demand-led RTB breeding programs cannot occur without understanding the state of knowledge already available. So, this present state of knowledge (SoK) report, a baseline study, aims to provide an overview of the current state of knowledge on yam and boiled yam in Benin from a literature review and key informant interviews, particularly focused on Benin. The focus of this SoK is on the gender and socio-cultural context of yam in Benin and is based on the following research questions:

1. What are the agronomic norms and practices of the crop in Benin?
2. Have new varieties of the crop associated with the product been introduced in the country and is there expertise or evidence on the factors influencing adoption in this context?
3. What are the different uses, products of the crop, gender dimensions of the product value chain and the main alternative uses or products of the crop resources associated with the different uses and levels of access?
4. 4. Are there trade-offs between different uses of the crop? Does this affect different groups of people's participation, workload and benefit from the crop/product?
5. 5. What are the gender-based constraints and opportunities in yam production in Benin?

The findings from the key informant interviews and document review related to these questions are summarized in this report.

2.1. Methodology

2.1.1. Sampling for Key Informant Interviews (KII)

The key informants (8 yam specialists) were randomly selected from Beninese universities and research institutes, for example, I the University of Abomey-Calavi and its scientific faculties (FAST, FSA), IITA, ad National Institute of Agricultural Research in Benin. Firstly, to select key informants, we

identified and listed the names of yam specialists from the institutes. The specialists were contacted in advance to be informed about the objective of the study. After the detailed presentation of the research objectives, the specialists who were for present in the country gave their time for an interview and we corresponded via email with those who were not present in the country for an interview. . Data were collected during May to August, 2018. In each research institute or university, interviews were conducted with the specialists by one of the members of RTBfoods-IITA team. Some specialists were identified and met with the help of the leaders of the team involved in the study to facilitate the organization of the meetings and the data collection. In addition, some responses were received by e-mail from yam specialists. Also, the specialists were asked to send (e-mail) the research team other supportive documentation such as articles, books, films, Journals, Websites related to Yam in Benin, to compile the state knowledge or our baseline study. So, through a literature review and the data collected from these specialists, we have written this report. This upstream exercise and the exchanges with these various people made it possible. This exchange was based on the following criteria, in order of importance:

- Key informants' availability
- Their experience in yam study
- Gender aspects (presence of men and female specialists in the list).

Eight (08) key informants from different disciplines were identified at the three main institute (UAC, IITA, and INRAB) of Benin to participate in interviews (Table 1).

Table 1: Sample of KII

Name	University/Institution	Faculty	Disciplines	Gender
AFFOKPON Antoine	Abomey-Calavi	Agronomic science (FSA)	Entomologist	Male
KOUDANDE Delphin	Abomey-Calavi	Agronomic science (FSA)	Genetic specialist	Male
FLOQUET Anne	Abomey-Calavi	Agronomic science (FSA)	Agro economic	Female
LOKO Laura	DASSA	Technical Science (FAST)	Entomologist	Female
MESSAH Serge	Cotonou (INRAB)	Agronomic science (FSA)	AGRIFAM Promoter	Male
MIGNOUNA DJANA	Cotonou (IITA)	Agronomic science	Agro economist Entomologist	Male
COFFI Nevrile Elodie	Abomey-Calavi	Agronomic science (FSA)		Female
ATCHADE Christian	Abomey-Calavi	Agronomic science (FSA)	Entomologist	Male

2.1.2. Document review

Two types of documents were gathered: 'grey' and peer-reviewed literature.

The 'grey' literature was selected from unpublished documents including a masters' thesis, project reports (existing in our library), and studies by national or international research institutions. The peer-reviewed literature is international literature identified through google and journals web sites. The document citation, and the countries and regions where the work was undertaken are summarized in the Table 2.

Table 2: Citations sources

CITATION LOG		COUNTRY AND REGION FOCUS
Aboudou Y.M.A. et AURIOLE L., (2004)	*Impacts de la croissance urbaine sur les filières agricoles en Afrique de l'ouest : cas de l'igname à Parakou au Bénin*	North Benin
Adanguidi J. (2000)	Réseaux, Marchés et courtage : la filière igname au Bénin	Benin
Adegbola, P.Y. et S.A. Adekambi (2010)	Taux et déterminants de l'adoption des technologies agricoles: cas des variétés améliorées d'igname TDrs au Bénin	Benin
Floquet *and al.*, (2012).	Évolution des systèmes de production de l'igname dans la zone soudano-guinéenne du Bénin	Benin
Baco, M.N., (2007)	Gestion locale de la diversité cultivée au Nord Bénin : éléments pour une politique publique de conservation de l'agro biodiversité de l'igname (*Dioscorea spp.).* Thèse de doctorat en Socio-anthropologie	North Benin
Aighewi and *al.*, (2017)	The Challenge of Improving Soil Fertility in Yam Cropping Systems of West Africa	West Africa
Floquet *and al.*, (2015)	Facteurs sociodémographiques influençant les choix par les producteurs de systèmes de culture à igname dans la zone soudano-guinéenne du Bénin.	
DOSSOU H. P. Calixte (2013)	Mémoire d'ingénieur sur les Innovations connues, développées et adoptées au niveau de la production d'igname : Cas de la commune de Tchaourou au Bénin	Benin Center
DPP/MAEP (2012)	*Annuaire Statistique*, campagne agricole 2009-2012	Benin
Dumont et al. (2010)	Origine et diversité des ignames *Dioscorea rotundata Poir*. Comment le savoir-faire des paysans africains leur permet d'utiliser la biodiversité sauvage dans l'agriculture.	Africa
IFAD (2010)	Programme de développement de la culture des racines et tubercules: Évaluation finale	West Africa
H. Chair and J. L. Pham, (2008)	Study & Preserve the diversity of yams grown in Africa	Africa
MABOUDOU, (2003)	Adoption et diffusion de technologies améliorées de stockage du maïs en milieu paysan dans le centre et le nord du Benin, DEA, Université de Lomé.	North and Benin Center
Maliki and al., (2012)	Evaluating Yam-Based Cropping Systems Using Herbaceous Leguminous Plants in the Savannah Transitional Agro ecological Zone of Benin	Benin

CITATION LOG		COUNTRY AND REGION FOCUS
Maliki and al., (2017)	Sedentary yam-based cropping systems in West Africa: Benefits of the use of herbaceous cover-crop legumes and rotation lessons and challenges	West Africa
Richard C. HOUEDJISSIN, DELPHIN O. KOUDANDE (2010)	Projet de renforcement de capacités de recherche pour le développement de l'igname en Afrique de l'Ouest et du centre : Etat des lieux de la recherche sur l'igame au Bénin; Rapport Final. Groupe d'Etats Africains, des Caraïbes et du Pacifique de la Communauté Européenne (UE)	Benin
Romuald A. DOSSOU, Mohamed Nasser BACO et Kouessi AIHOU (2010)	Diagnostic de la production, conservation, transformation et commercialisation de l'igname au Bénin : éléments pour l'élaboration d'un programme de recherche régional sur l'igname.	Benin
Coursey D.F., (1967)	*Yam; an account of the nature, origins, cultivation and utilization of the useful members of the dioscoreacae*. Londres, Tropical Products Institute, 230 p.	Africa
Dumon and al., (2005)	Biodiversité et domestication des Ignames en Afrique de l'Ouest	West Africa
Jean Adanguidi (2000)	Les interactions rural-urbain : circulation et mobilisation des ressources ; La personnalisation de l'impersonnel. Réflexion autour du commerce de l'igname à Cotonou	Benin south
CELCOR /PADYP (2012)	Module Production végétale Fiche 2 : La culture d'igname	Benin
LOKO and al., (2013)	Indigenous knowledge and management of yam (*Dioscorea Cayenensis-Dioscorea rotundata complex)Pests and diseases in Northern Benin*	
GBANDOU BAKAWA (2013)	Thesis for the requirement of master degree on raw yam markets and Marketing channels from Tchaourou and governance of the chain	Benin center

2.2. Synthesis Report

2.2.1. Key information outputs for the varieties, norms and practices of the crop

Yam Varieties in Benin

Yam is of primary importance in West and Central Africa. Benin is part of the yam belt defined by Coursey (1967) and extends from central Côte d'Ivoire to the mountain ranges of Cameroon. This zone produces nearly 90% of the world yam crop (Adanguidi, 2000). Benin ranks fourth among producers on the African continent behind Nigeria, Ghana and the Ivory Coast (FAO statistics, 2010). Figure 1 shows the world production of yams in tons per country in 2011.

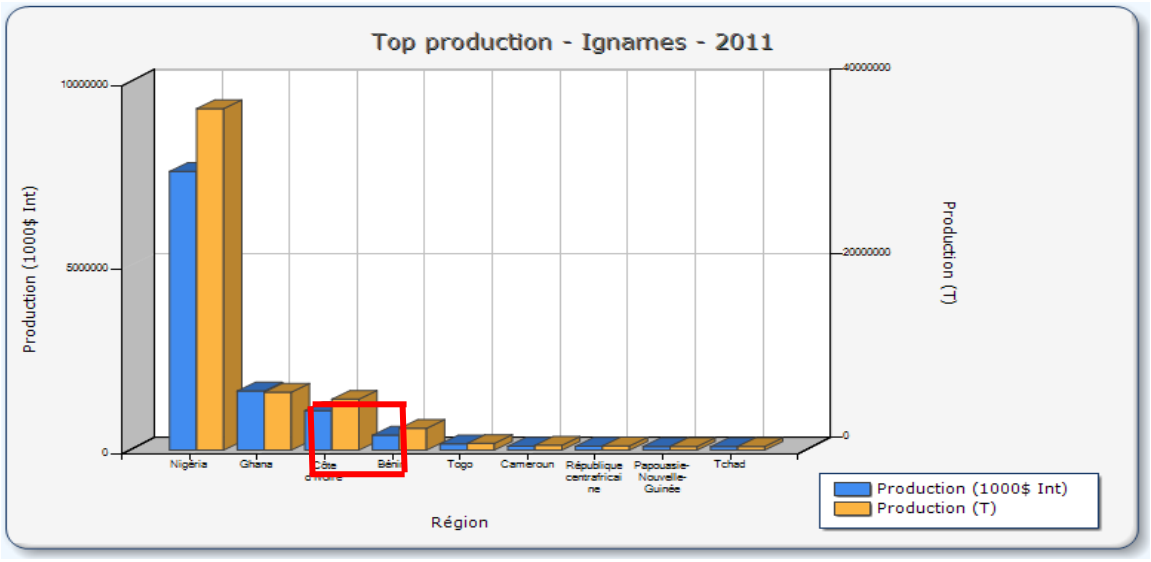

Figure 4: World yam production by country in 2011 (Source: FAOSTAT)

The Figure 2 below shows yam production as a percentage by department in Benin.

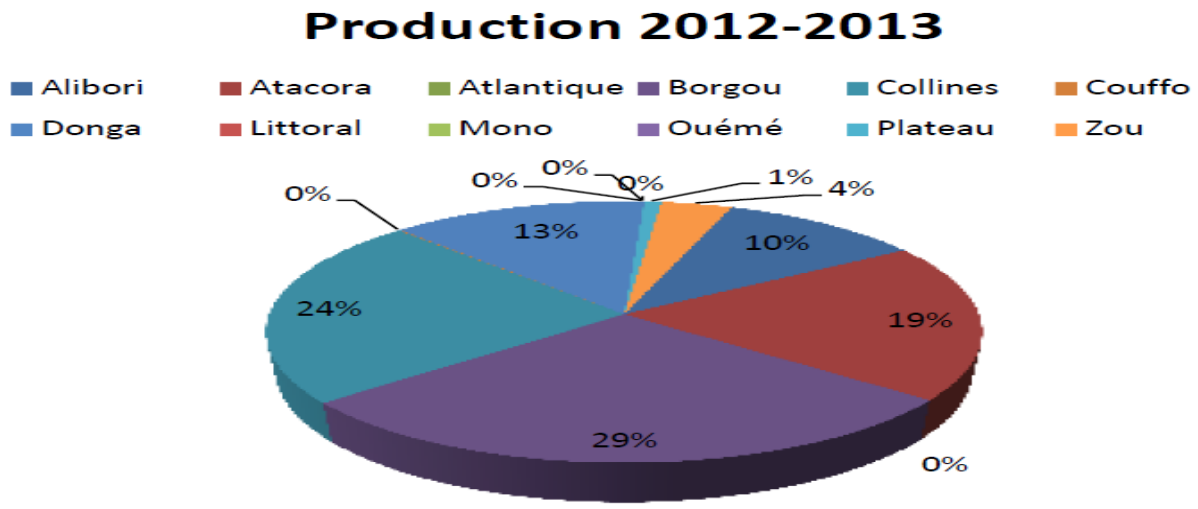

Figure 5: Percentage of yam production by department (Source: MAEP, 2013)

With regard to the varietal diversity of yams, Dumont et al. (2010) showed that there are several varieties of *D. rotundata* yams. Thus, these authors counted three cultivars encountered the most in Africa: early, late and intermediate cultivars. Dumont (1997) identified forty-two varieties related to four species of yam: 36 varieties of *D. cayenensis-rotundata*, four varieties of *D. alata,* and one of *D. dumetorum* and *D. bulbifera* in a Bariba village in northern Benin. On the other hand, Dansi et *al*. (2003) counted 87 varieties of yams in Benin. Yam (Dioscorea spp.) is a tuber crop grown by smallholders throughout the tropics (Andres et al., 2017). The most important species are *Dioscorea alata* (greater or water yam), *Dioscorea rotundata* (white guinea yam), *Dioscorea cayenensis* (yellow guinea yam), and *Dioscorea esculenta* (lesser yam) (Arnau et al., 2010). In addition to this, we cannot forget to emphasize on the introduction of a new variety between 1970 and 2000 through IITA and INRAB. It is the variety "Florido" of the species *D. alata*, which can be sustained and grow easily more than the other varieties in poor soils and and with this variety it's easy-to-obtain seeds. It has a good level of tolerance to infections and gives a yield of up to 20 tonnes / ha (Baco et al, 2010). However, locally known as the "Côte d'Ivoire variety", the cultivation of this variety, popularized by INRAB, is considered as a secondary yam compared to yams of the *rotundata* species. In Benin, the

introduction and spread of this variety, did not produce the effect as hoped. Despite the fact that its attributes are recognized, the areas allocated to the variety remains marginal (KOUDANDE 2010).

Farmer's perception of the *rotundata* yam is positive and is the cultivated more than other varieties of *D. alata* because of its association to important socio-economic characteristics (easily sold on the market, long shelf life, ability to mix and several organoleptic qualities) (Baco et al., 2007). Also, the domestication of yams *D. abyssinica* and *D.praehensilis* is a practice encountered in some areas of Benin.

There are also certain varieties of yam that are planted according to food consumption needs for farmers. As Zannou et al., (2006) reported, the consumption of pounded yam throughout the year enhances yam diversity as they then need to have early- and late-maturing varieties suited to pounding. Year round supply is assisted by selecting some types which can be processed into dried chips (cossettes) from which a paste can later be reconstituted (p. 59).

Table 3 : Number (%) of farmers indicating different uses of yam (Zannou et al., 2006)

Ethnic community	Number of farmers	Home consumption n (%)	Income n (%)	Cultural rites n (%)	Gift n (%)
Bariba	74	54 (73)	39 (53)	20 (27)	26 (35)
Mahi	47	41 (87)	35 (74)	36 (77)	10 (21)
Idatcha	44	39 (89)	38 (86)	34 (77)	25 (57)
Tchabè	29	18 (62)	18 (62)	10 (34)	0 (0)
Total	**194**	**142 (78)**	**130 (67)**	**100 (52)**	**61 (31)**

Key Informant Interviews (KII) revealed that in the whole of Benin the three largest species of yam generally cultivated are *Dioscorea alata* (greater or water yam), *Dioscorea rotundata* (white guinea yam), *Dioscorea cayenensis* (yellow guinea yam). There are more species of yam thatare cultivated but these three varieties mentioned above are the most common. Moreover, some hybrid varieties of *Dioscorea rotundata* (TDr) from IITA have been introduced in the past. Similarly, the variety Florido (*Dioscorea alata*) from Puerto Rico was introduced in Benin, especially at the Center, to compensate for poor soils. Unlike TDr, Florido has been adopted by many producers. There was a difference in adoption among the population because of the poor quality of the crushed yam of Florido.

It also appears that the big producers cultivate more varieties with two harvests and the small producers fall back more frequently on the varieties with a harvest and on D. alata, less demanding in fertile lands and in labor. In terms of quantities produced, late varieties dominate, but in terms of contribution to income, early varieties are maintained. The two-crop varieties contribute 75% of the value of the total production, of which 27% for the single variety "lamboko", while the production of "kokoro" and "alata" reaches 11.7 and 10.9% of the total production. (Floquet et al., 2012)

According to Houedjissin and Koudande, 2010, the most common varieties are Gangni, Gnidou, Laboko, Morukorou, Orukonai (early varieties); Kokoro and Florido-Dioscorea alata (late varieties) in the major production areas of Zou, Central and Northern Benin. This seems to be justified by specificities related to each of these varieties:

- Laboko gives a good yield on hydromorphic soil and offers a better organoleptic quality and a very high commercial value;
- Moroukorou gives a good yield and shows a good aptitude for the production of the seeds;
- Gnidou shows good resistance to diseases, nematodes and is easy to grow but of poor quality;
- Kokoro shows good aptitude for the conservation and production of yam chips;

- Florido (*Dioscorea alata*) come from Porto Rico introduced in Benin particularly in Centre to reduce of the poverty of the land, shows a good aptitude for poor soils and gives a good yield and its seeds are easy to obtain.

Many specific varieties also show important cultural value in ritualist practices in the country. For example, in Kokotin festivities, the newly harvested yam is dedicated to Kokotin each year. In this custom, each male family member is responsible for growing early-maturing varieties, mainly the **Laboko variety**, for the offering in exchange for the protection of his family. After this, the officiating priest eats boiled yam, followed by an offering of pounded yam. Within the Idatcha community, Laboko is the ancestral sacred yam variety and is grown by farmers who are considered to be "good yam growers" because it is a challenging variety to grow. People believe that productivity of Laboko is a result of their faith. They offer the variety to the God Kouchaati. For the Otammari, **the Gangni variety** is a 'son' yam and the Kokoro variety a 'daughter' yam, which are both important varieties for Kouchaati rituals and are considered an inheritance from the ancestors and a sign of peace (Zannou et al., 2006).

In the (Zannou et al., 2006) study, gender differences were found between the number of varieties men and women grew for socio-cultural and economic purposes, and those for food security during food shortages, on their own yam fields. Female yam growers were found to grow an average of 2.0 varieties with high socio-cultural importance compared to 2.1 for food security during periods of food shortage. In comparison, it was 2.8 and 2.0 for men, respectively, which was a statistically significant difference according to gender.

Table 4 : Mean number of yam varieties grown with high socio-cultural and economic value, and for food security during shortage, by socio-cultural characteristics of farmers (Source: Zannou et al., 2006)

Farmers' socio-cultural characteristics	Levels	No. of farmers	Varieties of high socio-cultural and economic values:		Varieties for food security in food shortage period		t-statistic[1]
			Mean	S.D.	Mean	S.D.	
Sex	Male	87	2.8	1.56	2.0	0.77	4.50***
	Female	13	2.0	1.08	2.1	0.64	0.22
	F-statistic[2]		F=3.21*		F=0.25		
Religion	Traditional	13	3.3	1.42	2.0	0.76	2.92***
	Modern	87	2.6	1.53	2.0	0.75	3.45***
	F-statistic		F=1.82		F=0.09		
Ethnicity	*Idatcha*	69	2.4	1.49	2.0	0.70	2.27**
	Mahi	24	3.3	1.49	2.0	0.80	3.97***
	Otammari	7	3.6	1.13	2.4	0.97	2.02*
	F-statistic		F=4.98***		F=1.35		
Age (years)	< 31	31	2.5	1.43	1.8	0.67	2.61***
	31–50	45	2.8	1.50	2.0	0.74	3.03***
	> 50	24	2.8	1.73	2.1	0.85	1.59
	F-statistic		F=1.80		F=0.33		
Household size	1 to 5	36	2.7	1.51	2.0	0.75	2.57**
	> 5	64	2.7	1.55	2.0	0.76	3.34***
	F-statistic		F=0.03		F=0.12		
All categories together		100	2.7	1.53	2.0	0.75	4.23***

Games-Howell multiple comparisons with ethnicity[2]

Varietal groups	(I) Ethnicity	(J) Ethnicity	Mean Difference (I-J)	S.E.
Varieties of high socio-cultural and economic values:	*Idatcha*	*Mahi*	–0.94**	0.354
		Otammari	–1.18*	0.464
	Mahi	*Idatcha*	0.94**	0.354
		Otammari	–0.24	0.526
	Otammari	*Idatcha*	1.18*	0.464
		Mahi	0.24	0.526
Varieties for food security in food shortage period	*Idatcha*	*Mahi*	–0.02	0.185
		Otammari	–0.49	0.378
	Mahi	*Idatcha*	0.02	0.185
		Otammari	–0.47	0.404
	Otammari	*Idatcha*	0.49	0.378
		Mahi	0.47	0.404

[1] Results using SAS 8e;
[2] Results from SPSS 12.0.1; Level of significance: 1%:***; 5%:**; 10%:*

(n=100)

Considering the yam production areas, we have the following most common varieties:

Table 5: Yam Varieties in Benin (Dansi et al.,2003)

Benin region	Early varieties (6months before harvesting)	Late varieties (9-10 months)
Fon-Mahi region (center Benin)	Dodo, Gangnin, Gnidou, Klatchi, Laboko, Mondji	Alougan, Gnalabo, Hounbonon Kokoro, Kokowonde
Bariba region **(North Benin)**	Adam, Agogo, Ahimon, Angbawobe Bakinissourou, Danwari, Douroubayessirou, Guirissi, Kéé Kokouma, Kpakara, Kpanhoura, Kpouna, Morokoro, Olodo, Orouhingou, Soagona, Soussou Soussounou, Tankouando, Terkokonou, wossou	Assourouwoguiri, Banioure, Baniyakpa, Dourou, Gambarougninou, Gourossa, Kagourou, Kinkérékou, Konto, Kourakouro gouroko, Kpiroukpita, Nadéba, Omonya ,Oroubinsi, Singo, Singou, Tabane Wonmaaka, Yakarango, Yassousika, Yonbouanri
Nago region **(Center Benin)**	Anago, Dodo, Gangnin, Gnidou, Klatchi Kodjéwé, Laboko, Mafobo, Mondji, Ofègui	Aguida, Gnalabo, Kokoroowo, Kpadjibakokpo
Lokpa region **(North Benin)**	Aloupa, Ankploman, Ekpétile, Hê-abalo Walassi, Wotanam	Alassola, Ewotolo, Kologo, Kpassa, Wolouchahabim
Wama region **(North Benin)**	Fakoni, Chanwounbaafa, Morokourou, Koumassi kpeina, Nondapéchi, Soussouka ,Tartimanin ,Wokorou	Banioure, Biwokou, Komopéina, Kpatchiri, Kpérékpéré, Tabane, Tchététchérékou, Tchiguita, Wourouwona
Yom region **(North Benin)**	Gorei Idolo, Noolasse, Nounin Sossorasse, Tarasse; Assinabaro, Assinapeina, Bakaroume, Brizi, Djersine, Kadjokraoun, Kokone	Kpakagnina, Sossohanhan Tanwounbiaha, Tanwounma, Wmai

Norms and Agronomic practices

Farming practices in Benin, can in part be explained through belief systems. Zannou et al. (2006) study found that having an abundant yam is an indicator of wealth and well-being in rural areas. It is also used to fulfil social and ritualistic obligations and represent social prestige. The study also found

that farmers specialized their varieties that had a higher market price, and surplus production is sold on the market. Vodoun is an integral part of belief systems in the country and beyond, which are a belief in spiritual forces that regulate the natural order including farming. For example, Hèviosso spirt, which represents thunder and can intervene with God for rain. Dan is the force regulating economic prosperity, through which farmers implore benediction for the success of their farm activities (Zannou et al., 2006)

Yam production is an activity that is considered to require divinatory guidance through Fâ (or God), which is reported to be related to the significant degree of yield variation and the challenges involved in yam production. The Fâ priest called Bokonon has to sacrifice the newly harvested yam to the Fâ before anybody can eat it. Farmers also offer their first roots of a harvest to ancestors in exchange for benefits from God. For example, for Egungun festivities, communities offer newly harvested yam to the divinities before the community can consume it. With the Mahi it starts on 14 July, climaxing on 15 August each year in Savalou, a district in the central part of Benin. Masquerades come from other towns such as Porto-Novo, Cotonou and Abomey to participate in these festivities (Zannou et al., 2006).

With regard to the agronomic practices of cultivation, the yam growing system in Benin is extensive. The installation of a yam field requires clearing, mounding, mowing and planting. The emergence takes place over a period of 15-20 days after planting for late varieties and for a longer period for early ones. Spacing of 1.20mx 1.20m is recommended for large marketable yam tubers and many seedlings (PDRT 2002). The various ways of obtaining identified seeds are: part of the previous harvest, purchase, donation, exchange, retribution of physical effort. The care of the yam boils down to protection from sunlight and rodent and termite attack, rats, staking, and weeding. There are several cultural systems namely, those:

- on slash and over-burn land
- in forest with early varieties on large mounds
- in forest with various varieties on average mounds
- with the yam of clearing on small hillocks (classified forests)
- in old fields with late varieties on medium mounds
- in old fields with various varieties on big buttes
- in exhausted field fields with small buttes
- in the lowlands, not to mention yam growing in cashew plantations
- of yam-based culture with animal manure after cattle yarding
- Yam-based culture on old fields with cover plants
- Indeed, creating a yam field is the result of several cultural operations which are:

a. Clearing

This is the first of the activities performed on the chosen field. It consists clearing the field of cultivation except for the trees and shrubs that will serve as guardians. In the past, clearing would be followed by plowing before making mounds. Tilling the field loosens the soil and facilitates the decomposition of biomass (root system) remaining in the soil after clearing. It makes therefore the making of mounds less difficult and allows one to obtain mounds of larger sizes. Tilling remains a vivid reminder in the memory of elders. This decline in activity is not synonymous with a loss of importance but reflects its arduousness (Tossou, 2004).

b. The making of mounds

Mounds are elevations of soil into which seed is introduced at planting. The average planting density is 7,800 mounds per hectare and can reach 9000 mounds per hectare depending on the variety and the labor force used (the hired labor produces 7800 mounds per hectare while the family workforce usually makes more). The average number of lines is 600 per hectare (Okry, 2000)

c. Burning

It is a technique that consists of burning trees to clear the land. The resultant dead wood will serve as stakes for yam plants and later for charcoal production.

d. Planting

It takes place during the first hours of the day. Planting time is usually finished around 11 o'clock in the morning but can be stopped at any time with the sun intensity. It is done with a hoe or a wooden punch. The hillock is open and the seed is introduced; the film carrying part being in contact with the ground for some producers, the head turned upwards for the others. The hillock is then closed. Great attention is paid to the distance separating the seed from the top of the hillock. When it is too big the emergence of the seedling is compromised. When it is too weak, the seed and / or seedling is dried out by the sun's rays (Okry 2000).

e. Maintenance operations

They boil down to the defense of culture through the fight against pests and especially against weeds. The number of weeding observed is two or three times when it is a field grown in yams (for two successive years) (Okry, 2000).

f. Weeding

Weeding is the process of clearing the field of weeds to facilitate crop development. The number of times weeding occurs varies between at least two to three per year at the most for yam.

g. Harvesting

Harvesting occurs in principle from the maturity of the tubers from mid-July to August for early varieties. It crowns the efforts and investments of the producer. The table below shows the amount of labor used to harvest one hectare of yam.

h. Conditioning and storage

The high water content of yam tubers, the wounds they receive on the skin during harvest or transport, poor storage conditions (heat) and attacks of micro-organisms are the main causes of yam losses (CELCOR / PADYP, 2012).

- Conservation in mounds (butte in french)

The fully mature tubers are kept in the mounds for 1 to 4 months depending on the variety, and the harvest is done as and when the needs are felt. This method is economical, but the tubers are exposed to nematodes, insects, rodents and thieves. There is also conservation in heaps covered with layers of dry lianas. The tubers are stored on the ground or on a carpet of dry vines of yam under an evergreen tree and are covered with a layer of lianas. This method is economical but the tubers lack aeration. Contact with the soil contributes to pest attack and contamination from one tuber to another.

- Conservation under straw roof shelters

The height is between 1.80m and 2m. The higher the hangar, the more ventilated it is and the more fresh it is. Wood is used for the support of these shelters. If it is well built, it can keep the harvest for

three consecutive years and at the same time serves as shelter for the farmers during the period of field work.

- Storage in pits

Pits of variable size, depending on the quantity of yam to be stored, are dug to conserve the yams after the first harvest. This storage method reduces tuber weight loss through respiration and sweating. The disadvantages are: bad aeration, attack of the parasites and contamination of other tubers, and higher temperatures which accelerate rot.

Most of yams are being cultivated after slash and burn woody savannahs. These areas are being turned into cultivated areas. In areas with low availability of land, yam production has decreased but still exists, in part of the fields cultivated using crop rotation or after livestock penning. Lowland cultivation and crop-livestock integration constitutes alternative forms of intensification for producers. In terms of rotation and associations with yam, there are various types. If we take the "old field" route, a rather strict alternation between legume and cereal or tuber seems to be maintained. Yams can be grown every three years after soybeans, groundnuts, cowpeas, or groundnuts, or every four years on a one-year grass-fallow followed by maize or sorghum, followed by peanuts, groundnuts or cassava. Sometimes mqia3 is associated with yam to protect it. In the lowlands, alternating rice-yam and their association for four years followed by fallow. On the less hydromorphic lower slopes, rotations and associations are similar to those of flooded soils, all often grown on large mounds. In sum, yam-cotton-maize rotation, those of the yam-yam, yam-sweet potato, yam-maize, yam-okra associations are most commonly observed (Baco, 2007). As for the "cattle yard", it is carried out for two to three years in order to regenerate the exhausted fields, which are then often left to rest for a year. Often, these fields are difficult to re-cultivate because the soil is compacted by the trampling of animals but is enriched by the feces and rich in nutrients; they will house several successive crop cycles where the yam will be at the head of rotation (Floquet et al., 2012).

In the same way, these technologies concern both the "Improved Production System" (SAP in French) for sustainable agriculture, the practices based on herbaceous legumes and cover crops (*Mucuna pruriens var utilis*, *Cajanus cajan* and *Aeschynomene histrix*) and agroforestry systems (sedentarisation of yam with *Gliricidia sepium*, fallow planted with Acacia *auriculiformis*, culture between perennial bands, alley culture with *Leucaena leucocephala*) and a combination of the two principles of cover plants and agroforestry elements. Cover crops such as Pueraria phaseolides, Mucuna utilis or Aeschynomene histrix, combined with some leguminous shrubs such as Gliricidia sepium, are incorporated into rotations to replace natural fallow and to be positioned as a precedent for yams. Most smallholder farmers did appreciate the ability of Mucuna spp. to increase productivity, maintain soil moisture, weed control (I. cylindrica in particular), and restore soil fertility. For instance, Mucuna pruriens with maize-yam rotation and intercropped Aeschynomene histrix with maize-yam rotation can meet their fertility (Maliki et al., 2012). Thus, care for yam is limited to protection against sunlight and attack of rodents and termites, rats, staking and weeding.

Two harvesting methods are practiced: a harvest for late varieties about 8 to 9 months after planting, and two harvests for early varieties. Nominative producers usually plant from November to January, and producers plant in July for early varieties and from September to January for late varieties. The name often comes at the head of rotation because of its soil requirements. More and more, especially for late varieties, a significant proportion of yam fields are grown after cereals (maize, millet and sorghum) (PDRT, 2002). With the information received from the KII and the literature review, the following tables present the innovative practices developed by farmers in yam farming and the main research operations and development programs concerning yam over the last decades in Benin.

Table 6: Innovative practices developed by farmers in yam farming (Adegola et al., 2003 and Dossou et al., 2010)

Endogenous technologies and organizational innovations	Previous practice replaced	Cause of change	Advantages
Making mounds with burying plants	Deep plowing of the soil and clearing	Hard work and willingness to plant larger areas	Easy practice, time saving - Limit manpower requirements - Maintains survival of microorganisms important for crop growth
Yam cultivation on old fields associated with sorghum and maize	Yam cultivation in the forest (burning of trees and adaptation as yam tutors)	Yam cultivation in the forest (burning of trees and adaptation as yam tutors) Increase in the area planted Depletion of forest lands that harbored yam crops and destruction of forests	Easy ground preparation - Cultivation of maize and sorghum, the stalks of which serve as yam protectors.
Use of herbicides for clearing and weeding	Clearing and frequent manual tapping	Insufficient manpower and low financial capacity to hire labor Difficulty of the weeding (difficulty to clear the big grasses)	Easy to clear large tufts of herbs - Limits the workforce size for the activity - Reduces the completion time and the number of weeding
Yam cultivation in the lowlands		Insufficient fertile forest land	Rich land High efficiency Large tubers
Yam cultivation in old cashew fields		Insufficient fertile land	Renewal of the cashew plantation, - fertile soil with large tubers. - Staking with burning cashew plants

Endogenous technologies and organizational innovations	Previous practice replaced	Cause of change	Advantages
Domestication of wild yam		Diversification of cultivated varieties, search for new varieties adaptable to the production environment	Maintaining the diversity of cultivated yam - Creation of new cultivars

Table 7: Main research operations and development programs concerning yam over the last decades in Benin

Research Institutions / Research Program	Research operation / techniques production Introduced	Actions / contributions to improve yam	Period from which the technology was ready to be popularized
UNIHOG5, PDRT, CRA center of INRAB	Introduction of leguminous shrubs in yam culture	Enrich the soil, Fight against erosion	1997-2005
	The technique of creeping plants and blankets plants or mulch	Improvement of soil fertility	1997-2005
CIRAD	Direct seeding techniques on vegetal cover: Yam plantation without ridging on Pueraria phaseoloides mulch	Restoration of soil fertility	2007
IITA, PDRT, CRA	Production of yam seed from mini-fragment (minisetts)	Increase yam multiplication rate and produce seed Good sanitary quality	2005
IITA, INRAB	Introduction of "Florido"	Good aptitude for poor soils, Seeds easy to obtain	1970-2000
Projet BEN/87/017	Straw hut (raised)	Storage of yam in fresh	1993
PADSA	Sifted ash Yam	conservation, pest control	1993

Reference: ADEGBOLA and *al.* (2003), Romuald DOSSOU and *al.* (2010)

2.2.2. Factors influencing innovations

The technological innovations introduced by Research and Development (R&D) in yam production are seldom used or not at all in certain communes. The main results show that the changes made in yam production as a result of endogenous or exogenous technological responses to curb the constraints on production are still not very determined. Reasons given by producers include minimal contact with extension agents, lack of information on technologies and low yam area cultivate. These reasons show the importance of farmer support and contact between research agents and farmers in the process of adopting innovations. In addition to these reasons, it should be noted that the low capacity of producers to finance yam production remains a major constraint that stunts the adoption of innovations. Other constraints on the adoption of innovations are low literacy, poor land availability and small areas of yam cultivated, migration and the perception of the cost. The adoption of technology is therefore determined by socio-economic factors and factors related to the perceptions of the producer. An analysis of the effects of adoption factors, has identified literacy as a particularly important determining factor in the adoption process (Calixte, 2013).

Therefore, any project or program aimed at adoption by family farms in Benin and West Africa, such as the RTB foods project, must take into account socio-economic and institutional factors, particularly those which related to producer perceptions.

2.2.3. Different uses of yam crop and resources access and gender aspects

Yam has many different uses, including the aforementioned ritualistic and spiritual purposes. In terms of food, yams are eaten in crushed, roasted, fried, local couscous called "wassa-wassa" or yam chopped into flour.

The most important form of processed yam is is pounded yam. The other yam derivatives are: (i) the cossette (sun dried chips) or sun-dried chips which after milling gives a flour for the preparation of "amala" (yam dough flour paste), (ii) the wassa-wassa which is a couscous made from dried yam chips flour, (iii) instant yam flour which is not yet popular in the domestic market, as its promoter has not yet achieved the conditions necessary for its sale at large public, (iv) toubani. To these elements must be added fried yams and boiled yams (Golf Expertise, 2011). About the various forms we can add: Stew, cooked under the hot ashes. (CELCOR /PADYP, 2012)

It is also used in traditional pharmacopoeia, specifically the prevention and treatment of hypercholesterolemia and diabetes. The crop is also used in traditional ceremonies lead by men and as an offering to ancestors and vodoun. Indeed, on August 15th of each year, it is the yam festival in Benin. This festival attracts thousands of Beninese and tourists to Savalou, the city of Gbaguidi. The commune of Savalou is known as the excellent geocultural place where the yam is celebrated. This festival is the belonging of socio-cultural groups such as Mahi, Nagot, Bariba, Dendi and other ethnic groups. Yam is rooted in the dietary habits of these populations and is a marker of their identity. Yams retain this advantage over competition from other less culturally marked starch products. Unlike yams, maize or rice, yam is a native product of these regions and is thus deeply rooted in the culture of their people. In many ethnic groups, its consumption is strongly ritualized, governed, at each new harvest, by ceremonies maintaining the cohesion of social groups and activating their identity: the yam festivals. The ceremony which dedicates the release of the new yam is placed under the sign of a recognition to the divinities. Which deities favored the abundance of crops. To celebrate, three days are devoted to secret and public rites. During the first two of the animal sacrifices are made to the convent to prepare the ceremony and the verdict of the Fâ and manna ancestors.

The main one, which is the last step after three days, is the consultation of the Fâ by a geomancer priest. This last session begins with dances adepts of Fâ before its introduction and that of the king in the royal court. Thus, in the center of this court, the priests make the consultation of the oracles. The yam haloed with religious songs undergoes a cut to the head (peduncle) and the tail (ritual made with

the variety Laboko preferably). Then, the consultation of the Fâ with wild apples nuts poured on the ground in the presence of the religious dignitaries, the king and the population.

Good prophecies (good next harvest for example) or bad (yield loss for instance) are made later on next season. It is according to these prophecies that sacrifices will be made at the beginning of the season next year. Then it is the presentation of the pounded yam from the yam of the past season to the Fâ who consequently gives the positive verdict of eating. If it is negative, sacrifices are made until to have a positive opinion. If the Fâ therefore authorizes, it is up to the king to give his blessing and the order to his people to consume the new yam. The yam festival in Savalou drains the world. In this case the many tourists who come to discover cultural realities. If sport is useful for human health, the pilling of the yam mortar could validly replace a sport. The ritual around the yam is to preserve not only the cultural and religious values of the MAHI people, but it also represents an opportunity for Beninese's reunion (MONTCHO, 2017; KINHOU, 2017)

It is mainly men who involved in the production of yam. In processing, women are the majority, but in selling and consumption of the crop, men and women are both present (FIDA, 2010). All varieties are intended for human consumption, but not all are preferred by women because the varieties have different levels of physical strength required in processing. Indeend, the yam varieties having good ability to be pound (example of Laboko) are the most preferred because they are also good to make boiled yam. So Varieties difficult to be pound such (Kinkerekou, Sounoudourou .....) are separated from the good ones. Men's preferences tend to be with regard to the yield and the quantity of seed that varieties can provide (Baco et al., 2007). The varieties of yam planted do not always include the preferences of women and thus may risk poor performance.

Exceptionally, KOUDANDE et. *al.,* (2010)'s survey results on yam cultivation in the department of Couffo showed that 52% of sampled farmers cultivate yam. Interestingly, in Couffo, women are more involved in production then men. The area under cultivation varies between 0.33 and 3.2 ha as a whole, and there are also some growers who cultivate only a few yam hills. Yam producers include all age categories; young people, adults and elderly people. In summary, men are heavily involved in yam production and women are more involved in all post-harvest phases of yam such as transportation, marketing, monitoring and management and processing. Thus, the production and celebration of ritual ceremonies, the use in the traditional pharmacopoeia are under the control of men. In addition, some men store yam for sale during the dry season. Women take control of yam processing (boiled yam, pounded yam, yam chip flour, fried yam) and marketing. With regard to the different beneficiaries of the different uses of the culture and trading of the raw material (yam tubers), the men are those who profit from the production, while women profit from processing, sale and the consumption. Hence, all the layers of society are beneficiaries but women are the greater beneficiaries for they are the ones who use it more than the others, especially in urban areas. Similarly, large urban areas are greater buyers of production in rural areas.

In relation to the resources for yam cultivation, there are multiple: yam seed, land, labor for farming operations, financial capital, cultivation and maintenance materials. Concerning the crop uses that are primarily under men's control (Onzo, 2014), only men can inherit yam fields from their parents and women are producers in central Benin. It's the opposite in the Couffo. The consumption of yam donuts appears as a more regular practice among men and inhabitants of neighborhoods. They take care of crop production and like pounded yam. Processors (mainly women) are heavily dependent on men (producers, owners of processing equipment, or carriers / traders who impose the price of derivatives). In summary, the major beneficiaries in each link of the chain are: men in production, women and men in selling and in consumption.

Concerning the resources required for yam cultivation, the producers need mainly the financial aid to get a plot, well decomposed organic manure (organic residues, poultry droppings), seeds and seeds yams, as well as fertilizer. Men are the majority in this domain according to the culture of most of the regions. In regard to harvest and selling: sticks, dibbles, machetes or hoes, basins, cars are the main needs of the different actors (producers to transport from fields to home or market, processors to

collect from producers to their processing units or selling places, traders to collect from producers to urban areas etc.) of the value chain require.

Indeed, about the norms, beliefs and perceptions within yam production, Benin ranks fourth after Nigeria, Côte d'Ivoire and Ghana with an estimated annual production of 4% of the total production of the yam belt (Baco et al., 2007). At the national level, yam is the second food product and remains the staple food of the populations of the Center and the North of the country (Auriole and Aboudou, 2006). Indeed, the yam benefits from an image of prestigious products with high nutritional and dietary values that allows it to withstand competition from other starchy foods such as cereals and cassava (Bricas and Vernier, 2000). According to Baco et *al.* (2004), the production of yam now entirely part of the mores and people's traditions to the point that we can talk about a yam civilization.

More than a subsistence crop, yam has become part of a commercial culture and plays important economic and socio-cultural roles (Ondo et al. 2009). It has traditionally occupied an important place in the consumption, cropping systems and local rituals and norms of many cultural groups. Its consumption is highly ritualized and determined at each new crop by ceremonies and festivals maintaining the cohesion of social groups and activating their identity through yam festivals in some African societies (Bricas and Attaie 1998, Hahn et al., 1987). It is gradually entering the family economy of rural households who tend to earn less in traditional markets such as the Sahel cities (Baco et al., 2007; Bricas and Vernier,2000).
Studies reveal that in central Benin, several ethnic groups are involved in the cultivation of yams (Table 3 and 4). Very few women grow yams. This can be explained by the fact that they are not landowners. Indeed, in most of regions, only men can inherit yam fields from their parents (Yolou and *al*., 2015).

The four seasons of yam and their role in household food security (Zannou et *al*., 2006)

From late June to July, when the first harvest of the early-maturing yams, e.g., Laboko, occurs. Farmers preferring pounded yam and unable to satisfy their needs during the period of shortage (February–June) are again able to eat their favourite food (Figure 1). From August to September when food is relatively abundant, as the tubers of most yam varieties, and certainly early-maturing ones, which are harvested twice, reach physiological maturity and become ready for consumption or sale. This period is marked by a drop in the price of yam on the market.

From October to January, when late-maturing varieties are harvested, as soon as the plant senesces. Some early-maturing varieties may be either harvested once or twice: e.g., Gnidou is harvested once in Kpakpaza, but twice in Yagbo. Towards the end of this third period, edible or marketable tubers of early-maturing yam become scarce, and the price increases. From February to the beginning of June, there is a period of food shortage when yam and other crops are not available. Only Gnidou and Florido − considered to be of low socio-cultural and market values − remain with some farmers. Farmers usually consider these varieties as the ones that “support the households during the shortage period”.

The figures represent the proportions of farmers (in %; n=100) who harvest and use a specific variety in a specific period

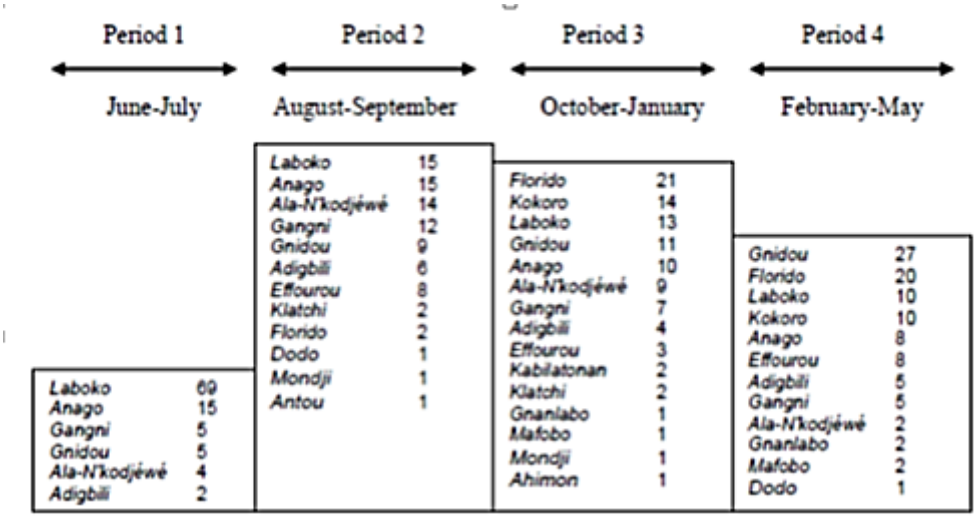

Figure 6 : Yam harvesting and use periods, guaranteeing household food security

2.2.4. Yam Marketing

With regard to the marketing of yam, the fall of the yam trade towards Nigeria in the late 1980s, following the economic difficulties of this country, had led to the decline of Beninese yam traders in the domestic markets. The more densely populated southern part of the country has become an excellent outlet for domestic production. The main characteristic of this sector is its structuring in commercial channels. There are three main ones: the Fon circuit, animated by the traders of the Fon ethnic group, manages the production of the North of the departments of Zou and Ouémé. It supplies the market with fresh yam; the bariba-chabè circuit, run by traders from the Bariba and Tchabè ethnic groups, manages the production of the Tchaourou region, northern Savé and eastern Ouessè. It supplies the market especially in yam chips but also in fresh yam. Then there is the dendi-tanéka tour, run by traders from the Dendi and Tanéka ethnic groups. It manages the production of the regions of Djougou and Copargo and supplies the market mainly with fresh yam. The main players in these different channels focus most of their activities on the city of Cotonou, which is also the largest consumer center in the country. Two categories of actors intervene in the distribution of yams in Cotonou: wholesalers and retailers. Wholesalers are mostly men. Women are poorly represented. The peculiarity of this circuit is that not all wholesalers are based in Cotonou. Part of these reside in Bohicon (including the largest wholesaler) and some in Djidja.

Most of retailers belong to the Fon ethnic group. Those belonging to the Bariba and Tchabe ethnic groups seldom re-stock with the wholesalers of this circuit. At retailers Bariba and Tchabè, the clientele, mostly made up of women who specialize in cooked dishes and from the north, is mainly interested in yam from their own region, except Laboko variety which is more suited to pounding and french fries. The aim of the various actors is the conquest of the gain in productivity. This conquest largely depends on the weight of each player in the market. The main marketing issues are access to transportation, access to the marketplace and access to customers. For the wholesalers of this circuit, access to the transport trucks is necessary for success in the profession, because the purchase of the goods is mainly done on the farm. Controlling transport is a source of power for traders. Most wholesalers on this tour own a truck. Those who do not rent vehicles, where the goods are unloaded in the stores and then gradually sold out. The development in recent years of direct sales from trucks, while penalizing wholesalers who do not own trucks, is an excellent remedy for wholesalers who do not have shops in Cotonou, mainly those who are based in Bohicon or Djidja. Each wholesaler has a clientele to whom he distributes his goods as soon as he arrives in Cotonou. This clientele consists mainly of Fon retailers. Wholesalers who have parents in the profession deliver a good portion of their merchandise to them. The sale is made on refundable credit after the sale of the product by the customer.

In conclusion of this part, we will say that the degree of control of the means of marketing (transport, market place and customers), is important for having a significant of the market share. As for the organization of wholesale sales at the Bariba- Tchabè circuit, three categories of actors intervene in wholesale sales in Cotonou: wholesalers, storekeepers and retailers. Wholesalers are mainly women, not based in Cotonou but rather in their regions of origin (Tchaourou, Toui in Savè, Kilibo and PK in Ouessè). Most of these traders only arrive in Cotonou during the yam marketing campaign in their respective regions. Unlike Fon traders specializing in the trade of fresh yams, these regions traders (Idaacha, Mahi, Tchabè etc.) selling in this circuit sell both fresh yams and yam chips and sometimes even corn. The sale of fresh yams is done during the rainy season and a good part of the dry season (Kokoro variety). On the other hand, the sale of yam chips occurs mainly during the dry season. That's why a lot of these women are active in the profession (sale of yam and its derivatives) all year long.

The majority of retailers belong to the Bariba and Tchabe ethnic groups. Some Fon retailers restock at the wholesalers in this circuit when their basket price is less expensive than those of the ethnicities mentioned above. The wholesalers' sales method of this circuit varies according to the size of the tubers. The sale of early yams at this circuit became important starting in 1994. Wholesalers sell a pile of four tubers to retailers because they are big tubers that do not lend themselves to bag sales. Even in the production areas, the purchase is done by the heap, the sale of late yams, mainly of the kokoro variety, whose marketing starts in December, is done per bag. Unlike Fon wholesalers, whose sales are made directly from the trucks parked on the fleet, the wholesalers of this circuit entrust their goods to the storekeepers who sell them.

As for the organization of wholesale sales at the level of the dendi-tanéka circuit, we will distinguish here also three categories of actors: wholesalers, occasional half-wholesalers, and retailers. Wholesalers are mainly women from Djougou and Copargo. They are mostly based in their regions of origin. The sale of fresh yams is the main activity of these women. Numerically, those of Djougou are more numerous, because they were the first ones to begin the trade of the yam towards Cotonou. The number of Copargo traders trading yam in Cotonou has increased in recent years. The occasional semi-wholesalers are mostly Dendi from the region of Djougou. Some, and this is also the minority, come from other regions of the Atacora Department such as Kouandé, Alédjo and Sèmèrè. Unlike wholesalers, they are based in Cotonou and work as food sellers at the Dantokpa market (sale of dried yam chips, peanuts, etc.).

The retailers of the bariba-chabè circuit belong to the Tchabe and Bariba ethnic groups. They refuel with occasional half-wholesalers. A few retailers Fon are also refueling with these half-wholesalers. The wholesalers' activity in Cotonou runs for about 10 months, from September to June. The importance of this varies depending on whether it is large or small tubers, the two products arriving on the market at different times. Yams are harvested during the rainy season and are marketed in September, October and November. They do not keep long. They are sought on the border market of Malanville which is mainly frequented by the Nigerian traders. Most of the Copargo traders give up long-distance trade to Cotonou during this period and simply dedicate themselves to collecting work in their locality. The collected product is resold to the women of Djougou who trade towards Malanville. The few traders on this circuit who trade yam in the direction of Cotonou during this period are those from Djougou. Late yams are harvested during the dry season and are marketed from December to May-June. The trade in late yams in the direction of Cotonou becomes intensive from February, until the release of the new yams. The wholesalers' practice of this circuit differs from that of the previous circuits in that it does not involve the direct sale of the goods to the retailers or the sale through the storekeeper; each wholesaler has its clientele of half-wholesalers to whom it delivers its goods once arrived in Cotonou (Jean Adanguidi, 2000).

2.2.5. Laws, policy, institutes, constraints and opportunities in the yam sector

Laws, policy

The social-cultural role of yams is particularly important in Central West of Benin. The demand for yam for use as a ritual object in cultural rites of passage, thanksgiving, petition and appeasement practiced in major producing and consuming centres is significant enough to produce significant effect on yam consumption. Additionally, the cultural rites have a long history of institutionalization in individual and group culture. For instance, it is noted that yam is also used as ritual object in the Savalou regions.

Indeed, information from the KIIs found that no law governs the use of yam cultivation in Benin. Only in certain cultures, such as among the Idaatcha ethnic group, some restrictions are found. For example it is believed that woman in menses should not enter a yam field because it brings bad luck to the producer and therefore will reduce the yield at harvest.

In terms of government policy, yam contributes significantly to the growth of the national economy. Although the agricultural sector in Benin certainly enjoys substantial food self-sufficiency for certain crops such as yam, agricultural productivity is still insufficient to make the most of the national potential. This sector is one of the locomotive sectors for the Agricultural Development Sites (ADP : Pôles Agricoles de Développement in French), which indicates the most developed and are potential sources of growth for rural communities (PSDSA, 2017).

Institutes

According to (KOUDANDE and *al*., 2010), there is considerable research on yam benefits by many institutions. Researchers from Benin's research institutions (INRAB, NGO, CeRPA, UAC, UP) in collaboration, have acquired significant experience in teamwork. They have mastered the analysis of constraints and the improvement of the different segments of the yam sector in West Africa for several years now. They have teams that have a long experience of joint partnership in the field of yam, both in terms of agronomy and on the evaluation and improvement of food technologies (INCO-DEV project, IFAD, CORAF, CORUS and FAO). They consider that the development of technologies for sustainable yam production with a goal of product quality is a major challenge for the yam sector and the protection of natural resources in West Africa. Their commitment to this research is long term.

For example, from a research facility's point of view, INRAB has had a collection at the National Institute of Agriculture (INA) since 1976. This collection has been enriched over the years with several surveys and collections and now contains 243 cultivars at INA. It is duplicated in the laboratory of genetics and biotechnology of FAST / UAC in Abomey-Calavi in the form of vitrothec (bank of vitro plants) and IITA-Ibadan. The Research and Development Institute on Biodiversity of Aromatic and Medicinal Plants (IRDCAM) has a collection of 1,017 accessions in its Dendougou (Djougou) farm as part of its activities with the FAO. The collection was carried out throughout Benin. The last collection was completed in December, 2009. This collection has doubled at IITA Ibadan. Another approach adopted by the FAST Genetics Laboratory in collaboration with the IRDCAM consists in the exchange of varieties between the communities of 15 villages in northern and southern Benin in order to widen the geographical area of cultivation of several varieties of yam. Farms / nurseries are available in Ina, Savè and the Laboratory of Genetics and Biotechnology (FAST / UAC) which also has a greenhouse and a conservation barn at the UAC in Abomey-Calavi. INRAB also has a conservation barn in Ina and Savè. Also in Benin, are there three laboratories that support yam research:

- Laboratories of the Department of Nutrition and Food Sciences of FSA / UAC;
- Pre and post-harvest laboratory of the Agricultural, and

- Food Technology Program (PTAA) of INRAB based in Porto-Novo.

In addition to these laboratories, there are other laboratories and programs that can also support yam research, which are:

- Laboratory of Soils Science, Water and Environment (LSSEE) of INRAB.
- Laboratory of genetics and biotechnology of FAST / UAC
- The Laboratory of genetics and biotechnology of FAST / UAC conducts research on the genetic improvement of yams for example in terms of:
- Resistance to abiotic stresses (eg drought and nutrients of drought and lowlands);
- Plant morphology for reduced working conditions (eg culture without guardian);
- Physiological attributes of tuber (eg resting) for long life.

These laboratories have experienced teacher-researchers and doctoral students who are aware that in vitro culture appears to be the only way to obtain the healthy plants needed for the production and exchange of genetic resources in yams. Similarly, the involvement of UMRs AMAP and CIRAD has made it possible to adapt yam to certain techniques for studying the root system (rhizotron method, modelling with a map MOD) already well developed on perennial plants (palm, rubber, etc.). In this context, internships have already been organized and a four-day training course was held from 1 to 4 December 2009 as part of the CORUS project. This training brought together researchers from several institutes (INRAB, CIRAD, AfricaRice, IITA and UAC). In the same time, Groups and associations exist in the yam sector but mainly at the level of the production.

Constraints and Opportunities

In regard to the gender-based constraints and opportunities, that women, men and other social groups experience with yam and boiled yam in Benin, it varies and depends on the norms established by the culture of the different areas. For instance, Women are more marginalized in Center and North region for they are few landowners and it is men who lead the ceremonies. Moreover, yam require an important workforce, so most of women are reluctant to cultivate it.The main constraints identified in this study, which have or have not been the subject of research topics in Benin during the last thirty years, remain those identified at the beginning of the PDRT program (IFAD, 2000), confirmed by Akoroda et al. (2003) and through different workshops with end-users of research achievements. They can be summarized as follows:

- **Agronomy and production**

Nematodes, wilt diseases, Ban (undetermined), termites and mealybugs were considered the most important pests and diseases in the study zone. To sustainably control pests and diseases for better yam production in Benin, it will be important to improve farmers' pests and disease management abilities by providing them with field diagnostic tools and educational materials through farmer field schools. Indeed, yam production constraints and their importance in northern Benin are: climate change, low soil fertility, disease and pest attacks, lack of performing yam cultivars, difficult post-harvest storage, lack of seed yam and lack of organised markets. As examples of farmer's description of damage, we have the fact that the tuber becomes dry, cracked and rotten by Yam nematode (*Scutellonemabradys*), the Rot of the tuber only at the level of the epidermis by lesion nematodes(*Pratylenchus* spp.), the fact that the tuber is covered with galls; Root knot nematodes (*Meloidogyne* spp.) which profuse growth of fine roots, Mealybugs *(Planococcuscitri)* Scale insects *(Aspidiellahartii) which d*amaged tubers are dehydrated, become more flexible and eventually dry; the dig tunnels in tuber roots caused by Tuber beetles (*Heteroligusmeles*), *the* defoliation of yam plant by leaf feeders *(Criocerislivida) etc. (*Loko *et al*.2013)

Moreover, destruction of yam (Dioscorea spp.) tubers by termites is a major constraint to yam production in Central Benin. Termites (Isoptera) have been reported as one of the most important causes of damage to yam tubers in Benin, specifically in Central Benin (Loko et al. 2013). As a matter

of fact, we have a lot a species which attack yam farms like : Amitermes evuncifer, Macrotermes bellicosus ,Trinevitermes oeconomus, Macrotermes ivorensis and Macrotermes subhyalinus. Therefore, the participatory evaluation of the existing yam landraces is recommended by some specialists for resistance to termite attack with the aim to identify more resistant landraces to termites that could be exploited in breeding programmes or directly through landrace exchanges.

About decreased soil fertility which is one of the major constraints for yam, we notice needs of rich nutrient land to express its potential; non-availability of specific mineral fertilizers, absence of formulas and doses of specific mineral fertilizers adapted to each agroecological zone, low availability of high performance and specific yam varieties. New specific varieties (high-yielding, drought- and moisture-tolerant varieties adapted to poor soils, tolerant to certain diseases and pests) are lacking in peasant environments. We have also the high prevalence of diseases and pests, converting large quantities of the crop into seed, non-availability of healthy seeds for planting, non-mechanization of production (hilling, fractionation of mother seeds for preparation of mini-fragments, planting, maintenance, harvest, etc.), negative impact of yam production on the ecological environment (destruction of vegetation cover, occupation of shallows, etc.), genetic erosion. Regardless of the yam area, financing and labor mobilization capacities, is the first factor differentiating yam producer categories. (Tossou 2012)

Men, engaged in production most often, face constraints such as: limited access to plant material, declining soil fertility, high labor costs, pests, the high cost of seed, competition of weeds, limited quantity of seed, the difficulty of conservation of the stock where the storage can be only made in the fields. On the other hand, for women, we can talk about the problems of access to land, given the cultural requirements in certain regions. In the same way, the difficulty of conservation of the yam and its derivatives are facets of these value chain actors. The continued demand for this product constitutes an opportunity for improvements. However, the constraints to the adoption of alternative systems of herbaceous legume cultivation are diverse (technical, financial, natural, etc.) according to the opinions of smallholders: difficulty of incorporation of biomass, crop competition for nutrients and Difficulties of access to the field (with Mucuna), land use by legumes during the second season, distribution of animals and legumes cause damage to crops, high cost of fertilizers, constraint of seed consumption (Mucuna cereals), difficulties in harvesting cereals and legumes including Aeschynomene (smaller seeds) exacerbated by highly variable and unpredictable rainfall affecting yam-based agricultural production. (Sinsin et al., 2012)

Some specialists like Mongbo et *al.(*2017*)* showed that improving soil fertility in yam based systems in West Africa faces three challenges that need to be addressed simultaneously if research is to deliver soil management innovations that are sustainable, feasible, and acceptable. These challenges are: (i) improving our understanding of the relations between soil properties, management, and tuber yield, (ii) analyzing the social and economic impacts of these innovations, and (iii) assessing their acceptance and implementation by stakeholders where innovation platforms can be a tool to develop collaboration between actors for designing innovations in yam-based systems.

- **Post- harvest**

There is a low diversification of yam derivatives. In fact, we find at the yam level, few derivatives being the subject of commercial transactions. Thus, the most common derivatives are the chips followed by yam-based couscous (wassa-wassa). We have no valuation of by-products. It is related to the lack of knowledge by producers of the physicochemical characteristics of processing by-products and processing techniques. Difficulties of storage and conservation due to their high water content are listed by producers. The losses suffered by these products due to rot are enormous (bacteria, fungi, germination, nematodes, mealybugs, etc.), Insufficient knowledge of the suitability of yam varieties and species for processing (bread making, flake, quality chips, starch, alcohol, etc.), Insufficient knowledge of quality criteria for yam products lack of knowledge on the effect of cultural and storage practices on the quality of yams and derived products, Physical, biological and chemical health risks due to products derived from yam (aflatoxin, prohibited pesticides, bacterial infections, etc.), Difficulty operations of processing of the yam (equipment of peeling, slicing, pounding, etc.). After the

production, at the level of the primary marketing of fresh yam, the major constraint identified is the low bargaining power of producers towards buyers. The unit selling price of the yam (heap, basin, bag, butte, truck) is not uniform at all farms. The producer sets his price first and the buyer debates the price by lowering it to a lower level according to his constraints. This discussion is puzzling producers who, because of not losing the customer and end up selling their product at very low price. Nevertheless, one of biggest opportunity to Beninese relating to yam, it is its big varieties diversity.

- **Institutional**

They are related to access to credit, land tenure, the availability of adequate infrastructure, the availability and quality of information on technology, and the development of para and non-agricultural activities. It is a fact that the construction of improved yam storage structures requires significant costs such as a very high labor force. Construction costs are added to those of handling (storage and retrieval of yams) and transport of tubers. The result is therefore for the producer a relatively high cost which in the absence of accompanying credit would be difficult to mobilize. The new technologies, the acquisition of which requires large financial means, meet more difficulties in the peasant world. Indeed, in most adoption studies, contact with technical support organizations is generally considered to be a determining factor in the adoption of a technology (Adégbola et al., 2010, Maboudou, 2003). The lack of sustainable funding for yam research activities, low link between research and extension structures on dissemination of yam research knowledge, low supervision of yam producers by extension structures are one of main constraints encountered in the intuitional level regarding yam (CeRPA, NGOs, ...).

According to a report from Niger state, in Nigeria, common constraints for women in yam production, which may be applicable in Benin, are as follows (in order of significance of the constraint): time spent on household chores, pest and disease, transportation and inadequate credit . The result indicated that both male and female yam farms reported similar problems except that time spent on household chores other than farming was the most limiting problem among female managers, while transportation was male managers greatest problem. Transportation was considered a problem because yam is heavy, bulky and fragile (can easily break) so transporting it can be difficult and costly. It is often transported manually using head pans and calabashes. Difficulty in transporting yam output to market could result in low income and losses resulting from breakages and spoilage. Pest and disease are also constraints to the yam farmers, both on the field and when in storage. Those attacked by pest and disease result in losses reflected by fall in the price of the yam due to reduction in quality. Even home consumption may suffer as a result of losses from pests and diseases. The male respondents considered storage as a major problem. Because of its bulk and perishability, yam requires special space for storage and this is not always available to farmers. The result is that most farmers sell their produce at low prices shortly after harvest. Both male and female respondents considered inadequate access to credit a major constraint. This is so because credit is important to enhance access to inputs and marketing costs like storage and transportation. Time spent on household chores was a minor problem to male respondents, who were not responsible for household chores. According to the gender roles in the study area, household chores like cooking and child care were women's work. It constrains the labour input of female farm managers due to limitations in time spent in laboring in the farm. These problems tend to limit the size of land cultivated, as the more the farm size and subsequent harvest, the more the problems. The problem of inadequate credit results in problem of accessing inputs like fertilizer, herbicide, insecticides, seed yams, and staking materials. Asinobi et al (2005) worked on cassava and Okoye et al (2008a) worked on cocoyam and also observed similar constraints among men and women farmers. (Ojo, Bulama, Mohammed, Greener, 2012).

2.3. Conclusion

Achieving food and income security in Benin and more broadly in sub-Saharan Africa requires increasing agricultural production through the revitalization of the various agricultural sectors, and specifically the yam sector. However, yam is one of the crops that receives less attention compared to other crops in agricultural development policies in Benin. Finally, the research for this report on Yam in Benin was an interesting not only for as baseline study for RTB Foods Projects but also for contributing to the enhancement of the sector. So, we thank all of yam specialists and all those researchers that we met and who helped us to have the information about this crop and its derived products.

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3. SoK Boiled Yam – Demand for Yam and Boiled Yam in Benin

CONTENTS

List of Figures

List of Tables

List of Acronyms

FAO: Food and Agriculture Organization of the United Nations

FAST: Faculty of Science and Technology

IFAD: International Fund for Agricultural Development

FSA: Faculty of Agricultural Sciences

IITA: International Institute of Tropical Agriculture

INRAB: National Institute of Agricultural Research of Benin

MAEP: Ministry of Agriculture and Fisheries

ONASA: National Office for Food Security

Key findings

Yam is of primary importance in West and Central Africa. Benin is part of the yam belt which extends from central Côte d'Ivoire to the mountain ranges of Cameroon. This zone produces about 90% of the world yam crop. Benin ranks fourth among producers on the African continent behind Nigeria, Ghana and Côte d'Ivoire. There are twelve departments in the country and the yam considered formerly as supplementary food for the populations of Southern Benin has gradually entered the consumption habits of the populations all over the country.

In Benin, yam production remains in surplus, as does its food balance even when considering a high consumption assumption, despite the disparities observed from one department to another. The crop serves to satisfy vital needs in households and in communities, but also plays an essential role in the rituals and ceremonies of the agrarian civilizations of Benin. The diversity of rituals, food habits, technological traits and food security strategies for the crop contributes to the maintenance of varietal diversity. It is not possible for one or even a few varieties to meet all needs. The more a variety is culturally and socially embedded, the greater the chance that it will meet acceptance on the local and regional market.

Regarding the quality criteria of boiled yam, texture, colour, taste, smell and digestibility are the major drivers of the preferences of Beninese consumers. There are two categories of varieties: good varieties to make crushed or pounded yam, which make up the majority of the varieties and belong to the Dioscorea rotundata cayenenis complex. These varieties are also good for other forms of consumption (boiled, fried, stew….). Varieties that are not good for crushed or pounded yam and most of which belong to the species Dioscorea alata are just good to eat in boiled or stew form. Perceived values allow a categorization of yam varieties into two major groups: one group with varieties characterized by high socio-cultural and economic values and another characterized by low socio-cultural and market values, but high food security value. Between them, the two groups provide farmers and consumers with a range of technological and agronomic aptitudes and provide food at different periods of the year.

The main foods analyzed were pounded yam, yam paste, fried yam and boiled yam. When yam is eaten boiled, the values highlighted by producers/consumers relate to taste, flesh color, friability and smell. Especially the characteristic smell of a variety is considered a determinant of quality in boiled yam.

Yam is a major source of cash income for millions of producing households because it has high market demand and it is easily exchanged for cash in rural and urban markets. In West Africa, yam is a source of foreign trade because its consumption is more widely dispersed than its production. It has multiple values including food and cash income generation.

An important finding on gender is that female farmers had a greater positive effect on the maintenance of diversity of both types of yam than male farmers, as the former valued food security, long storage and technological and culinary traits more than the latter. They cultivated varieties of different duration to minimize the risk of harvest failure, to meet multiple needs, and to ensure household food security.

In terms of demand segments of boiled yam, adult males provide the highest demand, followed by older men, women and children. It should be noted that in urban areas, some foreigners, such as Nigerians living in some Beninese cities, consume a great deal because of their original diet.

In general, men are involved in the production of yam and women in the processing and trading. A survey in the department of Couffo showed that women are more involved in production than men. Both men and women consume boiled yam at home. The aptitude for a good pounded yam, yield, market value and aptitude to be consumed as boiled yam are the main criteria that yam producers

are looking for when choosing any yam varieties. According to a study, aptitude for a good pounded yam remains the only criterion not met by the TDRS varieties promoted.

Introduction

In Benin, yam is an important element in the food culture of local communities in the Transitional Guinea-Sudan Zone of Benin. It is essential to the vital needs of households and communities, but also plays an essential role in the rituals and ceremonies of the agrarian civilizations of Benin. Benin is the fourth largest producer in the world, behind Nigeria, Ghana and Côte d'Ivoire, with production exceeding 3 million tonnes in 2013. Yam is grown in Benin from latitude 7 ° N to above 11 ° N and is an essential staple for the people of this region. The departments of North and Central Benin are the areas conducive to its production. More than 70% of the national production is supplied by the departments of Atacora (19%), Borgou (30%), the Hills (24%), to which are added the department of Zou to satisfy domestic demand and exports, and the deficient Mono and Ouémé departments, which only cover a small proportion of their yam requirements (MAEP, 2013).

It is indeed the second food product and remains the staple food of the populations of the Center and the North of the country (Aboudou and Auriole, 2006). In addition to its importance in food security, yam is an important source of income for producers and is also culturally important (Koudande and Houedjissin, 2010). This staple food for people in both the Center and the Northern region, remains also a product of choice for the people of Southern Benin. Nevertheless, although it occupies the first place, its prime importance in the Beninese diet and in terms of tonnage in the Republic of Benin, it has been a low priority in Benin's agricultural policy and it is subject to numerous constraints such as the lack of organization of its actors and very little work has been done on it (Adanguidi,2000; Agbandou, 2013). Even if less research has been done on boiled yam in Benin, it is one of various forms eaten (CELCOR /PADYP, 2012).

Thus, it is for enhancing the capacity of farmers and researchers in the development of tubers like yam, that the RTB foods project breeding programs is to implement, define demand-led and gender responsive breeding priorities, integrating traits to meet multi-user demands and needs, and adding value. However, producing new knowledge on user characteristics and preferences, socio-cultural and gender issues in broader food systems for RTB crop products to inform demand-led RTB breeding programs can't occur without understanding the state of knowledge (SoK) already available. So, this present state of knowledge (Sok) report, a baseline study, aims to reveal the findings from a literature review and key informant interviews related to the demand of yam and boiled yam particularly in Benin. The focus of this SoK is the demand of yam and boiled yam specifically related to the following research questions:

1. What is the food balance, supply and demand of yam in Benin?
2. What is the scale of production of the crop associated with the product? Are there different variants of the product?
3. Where are the segments of demand associated with the boiled yam (geographic, agro-ecological, age, sex, marital status) for the product and its variations?
4. How do the segments of the demand correspond to the preferred characteristics of the product?
5. What are the gender dimensions in the production chain, how is the product processed, transported, stored and sold by whom? What is the profitability of the product by demand segment?

The findings from the key information interviews and document review related to these questions are summarized in this report.

3.1. Methodology

3.1.1. Sampling for Key Informant Interviews (KII)

The key informants (8 yam specialists) were randomly selected from our universities and institutes of research like University of Abomey-Calavi in some of its scientific faculties (FAST, FSA), IITA, National Institute of Agricultural Research in Benin. Firstly, we list those we know as specialists. Theses specialists have been contacted in advance to be informed about the objective of the study. After a detailed presentation of the research objectives, for some of them who are present in the country, they gave us time to meet while we mailed those who travelled or were too busy to discuss with us. Data were collected between May and August 2018. In each research institute or university, interviews were conducted with the specialists by one of the members of the RTB foods-IITA team. Some specialists were identified and met with the help of the leaders of the team involved in the study to facilitate the organization of the meetings and the collection of information. Thus, some templates were received by e-mail from yam specialists. Also, we asked them to send (mail) us the other information (articles, books, films, journals, websites related to yam in Benin) which will help us to prepare the state of knowledge (SoK report or our baseline study. So, through a literature review and the data collected from the templates filled by these specialists, we have written this report. This upstream exercise and the exchanges with these various people made it possible to compile the report. This exchange was based on certain criteria in order of importance:

- Key informants' availability
- Their experience in yam study
- Gender aspects (presence of men and female specialists in the list)

Eight (08) key informants from different disciplines were identified at the three main institutes (UAC, IITA, and INRAB) of Benin to participate in interviews (Table 1).

Table 8: Sample of KII

Name	University/Institution	Faculty	Disciplines	Gender
AFFOKPON Antoine	Abomey-Calavi	Agronomic science (FSA)	Entomologist	Male
KOUDANDE Delphin	Abomey-Calavi	Agronomic science (FSA)	Genetic specialist	Male
FLOQUET Anne	Abomey-Calavi	Agronomic science (FSA)	Agro economic	Female
LOKO Laura	DASSA	Technical Science (FAST)	Entomologist	Female
MESSAH Serge	Cotonou (INRAB)	Agronomic science (FSA)	AGRIFAM Promoter	Male
MIGNOUNA DJANA	Cotonou (IITA)	Agronomic science	Agro-economist	Male
COFFI Nevrile Elodie	Abomey-Calavi	Agronomic science (FSA)	Entomologist	Female
ATCHADE Christian	Abomey-Calavi	Agronomic science (FSA)	Entomologist	Male

3.1.2. Document review

Indeed, two types of documents were gathered: 'grey' and peer-reviewed literature.

The 'grey' literature was selected from unpublished documents including thesis of MSc degree, project reports (existing in our library), and studies by national or international research institutions.

The peer-reviewed literature is related to others from international literature through google and journals' web sites, i.e. articles. The document citation and the countries and regions where the work was undertaken are summarized in the Table 2.

Table 9: Citations sources

CITATION LOG		COUNTRY AND REGION FOCUS
Adanguidi J. (2000)	Réseaux, marchés et courtage : la filière igname au Bénin	Benin
Adegbola, P.Y. et S.A. Adekambi, (2010).	Taux et déterminants de l'adoption des technologies agricoles: cas des variétés améliorées d'igname TDRS au Bénin	Benin
H. Chair and J. L. Pham (2008)	. Study & preserve of the diversity of yams grown in Africa	Africa
M.N Baco et *al.* (2007).	Igname, plante alimentaire commerciale et culturelle au Nord BENIN. INRAB. Annales des Sciences agronomiques du Bénin	Benin
Koudande et *al.(2010)*	Projet de renforcement de capacités de recherche pour le développement de l'igname en Afrique de l'Ouest et du centre : Etat des lieux de la recherche sur l'igame au Bénin	Benin
Coursey (1967)	Coursey D.F., (1967). *Yam; an account of the nature, origins, cultivation and utilization of the useful members of the dioscoreacae*.	
Adanguidi, 2000	Réseaux, Marchés et courtage : la filière igname au Bénin	Benin
FAO statistics, 2010	Crop Prospects and Food Situation,	
Golf Expertise, 2010	*Etude économique et financière des chaînes de valeurs ajoutées de la filière igname au Bénin*, Rapport final,	Benin
Naziha, 2002	La consommation et les critères de qualité des ignames au Bénin et au Nigeria	Benin, south and north Benin
Zannou et al. 2007	Socio-cultural factors influencing and maintaining yam and cowpea diversity in Benin	Benin, center Benin
MAEP, 2013	*Annuaire statistique,* campagne agricole 2009-2012, Cotonou, Bénin.	
CELCOR / PADYP (2012)	Module Production végétale Fiche 2 : La culture d'igname	Benin

3.2. Synthesis Report

3.2.1. Yam production, food balance sheet, supply and demand of yam in Benin

Yam production in Benin

Yam is of primary importance in West and Central Africa. Benin is part of the yam belt defined by Coursey (1967) and extends from central Côte d'Ivoire to the mountain ranges of Cameroon. This zone produces nearly 90% of the world yam crop (Adanguidi, 2000). Benin ranks fourth among producers on the African continent behind Nigeria, Ghana and Côte d'Ivoire (FAO statistics, 2010). Figure 1 shows the world production of yams in tonnes per country in 2011.

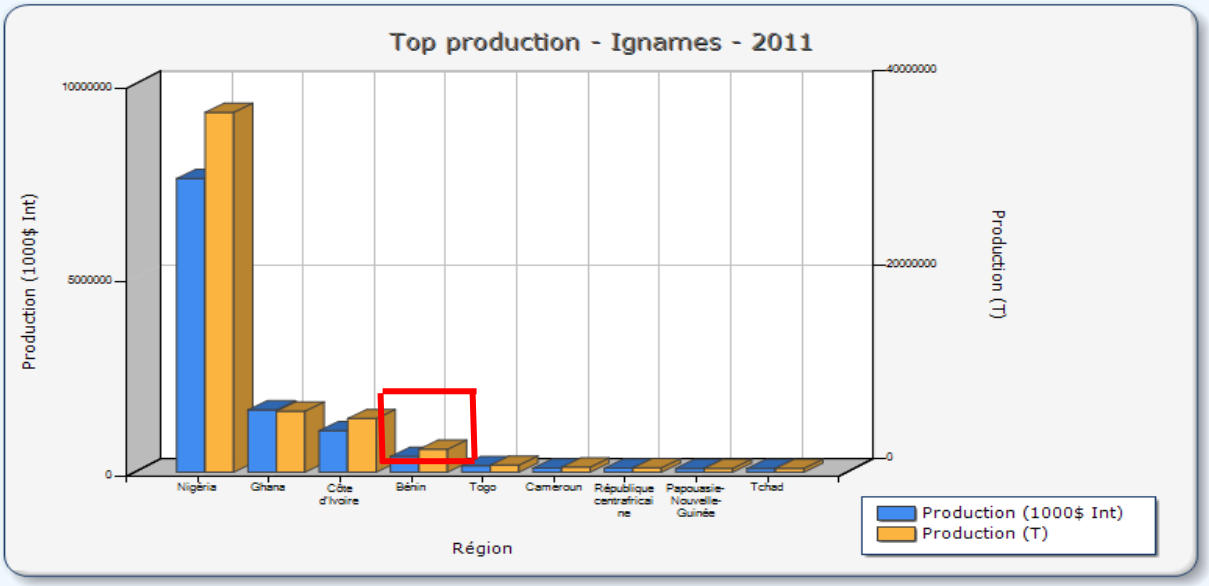

Figure 7 : World yam production by country in 2011 (Source: FAOSTAT)

Figure 2 below shows the evolution of yam production in Benin from 2010 to 2016

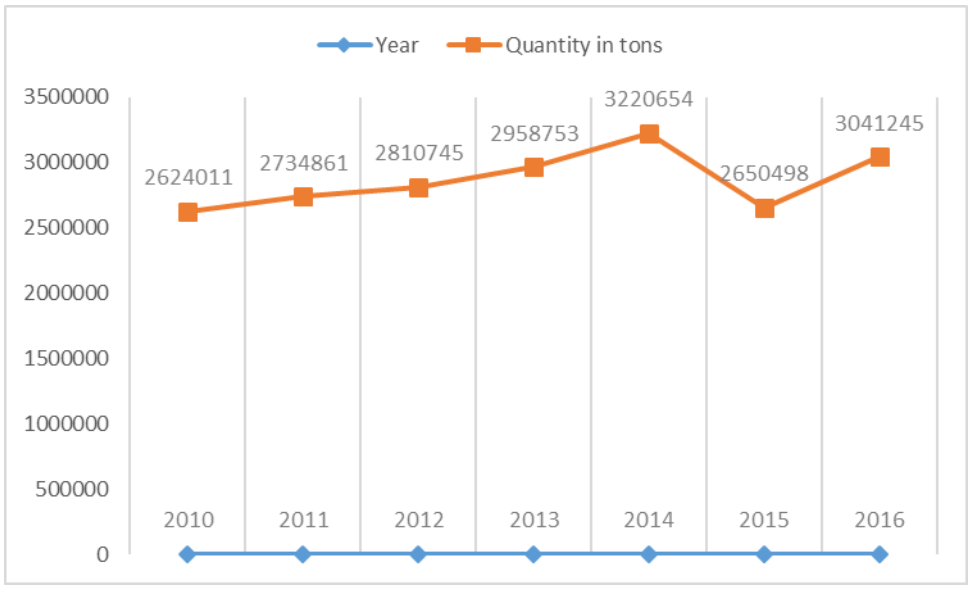

Figure 8: Yam production trends in Benin from 2010 to 2016 (Source: FAOSTAT)

Figure 3 below shows yam production as a percentage by department.

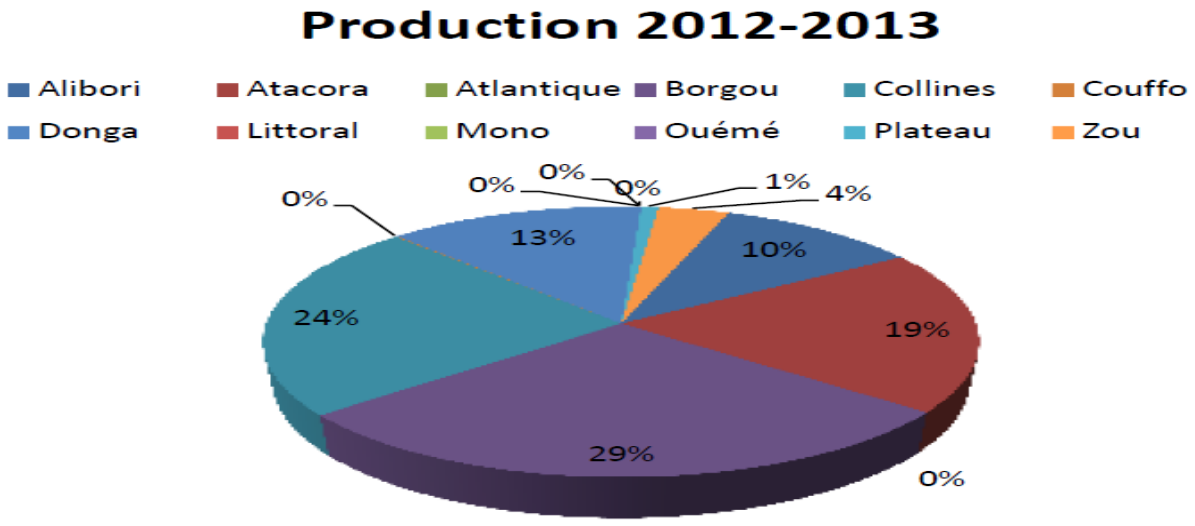

Figure 9: Percentage of yam production by department in Benin (Source: MAEP, 2013)

Food balance sheet, supply and yam demand in Benin

In Benin, there are twelve (12) departments and the yam considered formerly as supplementary food for the populations of Southern Benin has gradually entered the consumption habits of the populations all over the country. Yam production remains in surplus, as does its food balance even when considering a high consumption assumption, despite the disparities observed from one department to another (Golf Expertise, 2010). Figure 3 below shows the food balance of yam in 2010.

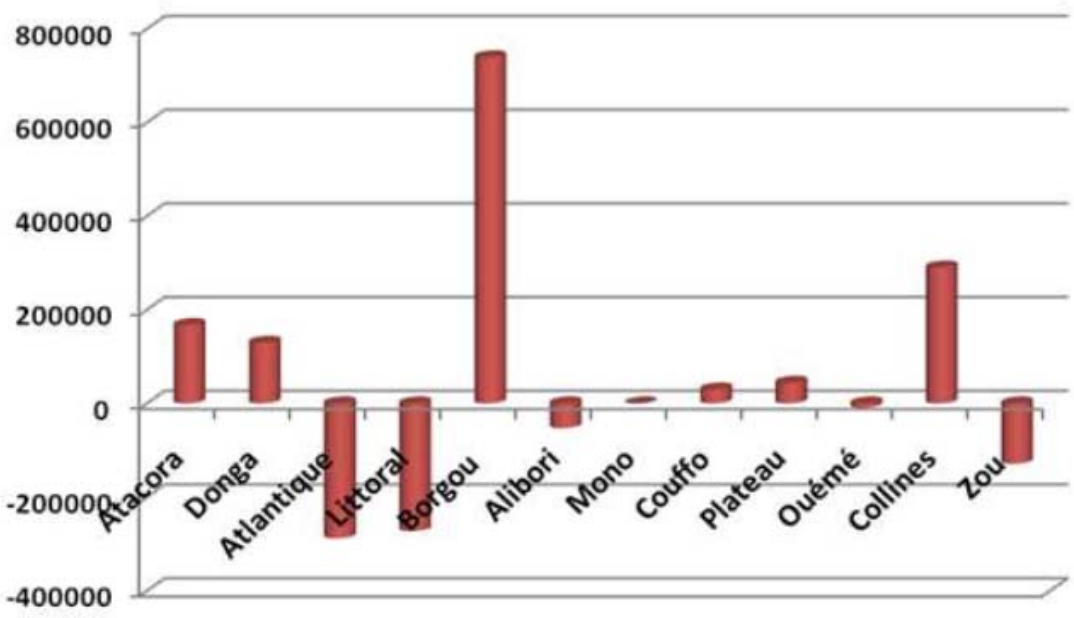

Figure 10: Yam consumption balance by department in Benin in 2010 (in tonnes) (Source: Golf Expertise, 2010)

This report shows as departments with good performance under average consumption hypothesis, the departments of Atacora, Donga, Couffo, Plateau, Collines (hills), and Borgou, which releases significant marketable surpluses of yams (i.e. more than 600 000 tons). The departments of Zou, Alibori, Atlantique and Littoral are deficient in yam in Benin (Golf Expertise, 2010).

The following graph (Figure 5) shows the evolution of the food balance in Benin from 2006 to 2010. There is a positive food balance with an average tonnage of 385,166 tonnes.

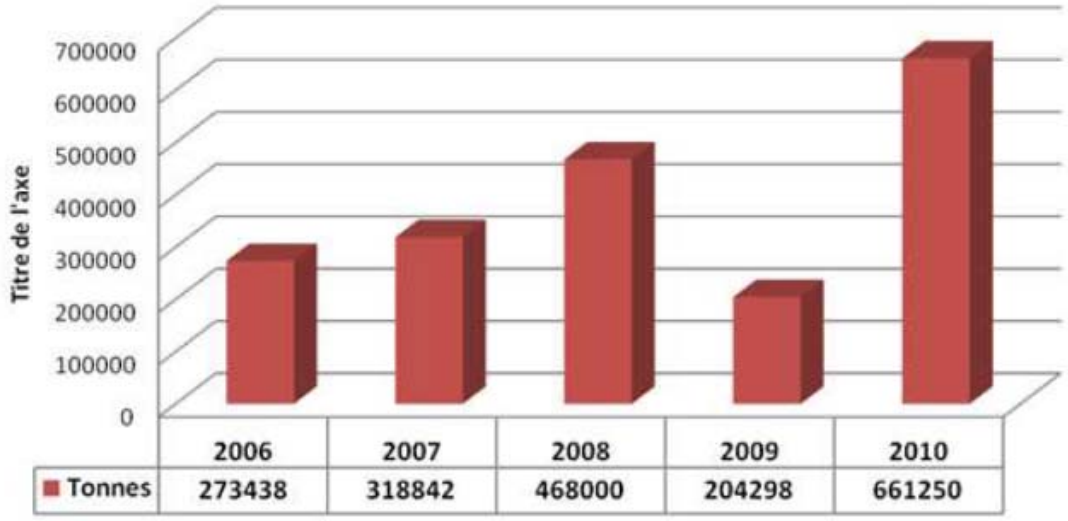

Figure 11: Yam food balance trends in Benin from 2006 to 2010 (in tonnes) (Source: Gold expertise, 2010)

The following table (Table 3) presents the supply of local yam by department in 2010.

Table 10: Supply of local yam by department

Departments	Consumption in tonnes	Production available	Useful production		Food balance	Positive balance : Supply	Negative balance : Demand
			%	Tonnes			
Atacora	186 169	505 247	70	353 673	353 673	167504	
Donga	118 618	354 468	70	248 128	129 510	129510	
Atlantique	287 754	0	70	0	-287 754		-287 754
Littoral	272 579	0	70	0	- 272 579		- 272 579
Borgou	121 237	1 228 929	70	860 250	739 013	739 013	
Alibori	48 156	49 700	70	6 772	- 41 384		- 41 384
Couffo	146 138	195 567	70	176 010	29 872	29 872	
Mono	0	0	70	0	0	0	
Plateau	4 907	70102	70	49 072	44 164	44 164	
Ouémé	8 809	0	70	0	-8 809		-8 809
Collines	180 879	673 249	70	471 275	290 396	290 396	
Zou	202 490	105 438	70	73 807	-128 683		-128 683
Total	**1 577 736**	**3 182 700**		**2 238 987**	**661 250**	**1 400 459**	**-739 209**

Source: Golf Expertise, 2010 from data of ONASA

The supply and gross demand of fresh yam and its derived products representing the total useful production and that consumed by the whole population of Benin are estimated at 2,238,987 tons and 1,577,736 tonnes respectively. The exportable supply of yams, estimated at 661,250 tons, represents the yam food balance (Golf Expertise, 2010). The departments of Borgou, Collines, Atacora and Donga alone account for the bulk of the total supply of fresh yam, or 1,326,423 tons during the 2010-2011 season.

3.2.2. Boiled yam Processing and Criteria of Boiled yam

Now, how do they cook boiled yam in Benin? The frequent ingredients are: salt, fresh yam and water. About the steps of cooking, we have:

1- Firstly, washing of fresh roots to remove the dirt,
2- Cut into pieces of identical size (preferably in slices),
3- Wash again, put the slices in a pot and fill it with water to just cover the pieces, salt the water with 1 g of salt per 100g of yam.
4- After boiling, take 15 to 30 minutes depending on the heat source. Yams are cooked as soon as you can push a knife tip fully or slightly but easily into the tuber. Once cooked, discard the cooking water of the boiled yam. It can be accompanied by peanut oil, palm oil, omelettes

(fried eggs), chilli or another meal (beans ...) etc. There are no variants of the product: Boiled yam is boiled yam.

The following table 4 presents the characteristics or quality criteria of boiled yam

Table 11: Quality criteria of boiled yam

Complex quality characteristics	Detailed criteria
Texture	Soft
	Mealy / friable
	No black spots
Taste	Slightly sugared / sweet
Colour	Very white
	White / cream
	Yellow
Digestibility	Satiating
	Easy to digest
	No distending
	No constipation

Source: adapted from Naziha (2002)

Regarding the quality criteria of boiled yam, texture, colour, taste, smell and digestibility are the major drivers of the preferences of Beninese consumers (Naziha, 2002; Zannou et al., 2007).

3.2.3. Segments of the demand and preference details, gender dimensions, the profitability of the product by demand segment

Yam production in West Africa accounts for more than 90% of world production (Pham, 2008). It is a subsistence food crop that plays a pivotal role for food security. It is marketed in villages, countries and regions. It is also a socio-cultural crop that occupies an important place in ceremonies (e.g. dowries). While considering the context of Benin, yam occupies 8% of cultivated area and comes in fifth position after maize, sorghum, cotton and cassava. Demanding in terms of soil fertility, most of the time it is grown on burnt soil. In regard to varieties of the crop in the country yams grown in Benin belong to the species *Dioscorea rotundata*, *D. cayenensis and D. alata.*

Sometimes some varieties may have different names depending on the localities. There are two categories of varieties: Good varieties to make crushed or pounded yam. These varieties make up the majority of the varieties and belong to the *Dioscorea rotundata cayenenis* complex. These varieties are also good for other forms of consumption (boiled, fried, stew….). Varieties that are not good for crushed or pounded yam and most of which belong to the species *Dioscorea alata* (winged yam: Guiwa, Sakata, Ogbo, Sankounore, etc.). These latter varieties are just good to eat in boiled or stew form (CELCOR / PADYP, 2012).

Yam is a major source of cash income for millions of producing households because it has high market demand and it is easily exchanged for cash in rural and urban markets. In West Africa, yam is a source of foreign trade because its consumption is more widely dispersed than its production. It has multiple values including food and cash income generation.

In Benin, yam is an important element in the food culture of local communities in the Transitional Guinea-Sudan Zone of Benin. It serves to satisfy vital needs in households and in communities, but also plays an essential role in the rituals and ceremonies of the agrarian civilizations of Benin. The diversity of rituals, food habits, technological traits and food security strategies for the crop contributes

to the maintenance of varietal diversity. It is not possible for one or even a few varieties to meet all needs. The more a variety is culturally and socially embedded, the greater the chance that it will meet acceptance on the local and regional market. Farmers' ambition to meet market demands in order to satisfy socio-economic needs also sustains and increases varietal diversity. Especially, female farmers growing yam showed positive diversity maintenance behavior. According to Houedjissin *et al*. (2010), the most common varieties are *Gangni, Gnidou, Laboko, Morukorou, Orukonai* (early varieties), *Kokoro and Florido-Dioscoreaalata* (late varieties) in the major production areas of Zou, Central and Northern Benin.

From our interviews with the yam key informants, the main foods analyzed were pounded yam, yam paste, fried yam and boiled yam. Their availability varies over the year. During this period, yam can be consumed after being boiled or after being pounded. When yam is eaten boiled, the values highlighted by producers/consumers relate to taste, flesh color, friability and smell. Especially the characteristic smell of a variety is considered a determinant of quality in boiled yam. Boiling yam is also an intermediate step in converting it to pounded yam. The differential traits mentioned by producers/consumers when boiling and pounding are the elasticity of the pounded product. All varieties (*Laboko, Gnanlabo, Effourou, Ala-N'kodje´, Gangni* and *Anago/Moroko*) suitable for pounded yam are also suitable for production of boiled and fried yam. Florido is commonly eaten boiled or fried. Fried yam is a snack food. The taste and friability are the main traits. Fried yam is made both during the period when yam is pounded and the period when yam paste is consumed (BACO *et al.*, 2007). Early varieties are more popular in boiled form during field preparation, whereas late varieties are sought after for roasting. To eat at dinner these three forms (fried, boiled, grilled) of preparation is dishonorable for some people. The Batonnu ethnic group, for example, refrain from eating these products and sleep on an empty stomach, when faced with this situation.

Among other ethnicities such as Fon and other ethnic groups mainly from the South, consuming fried yams or boiled yams at dinner is no problem knowing that the boiled form is the culinary preparation best suited to fast cooking. Moreover, it should be noted that the Northerners (Dendi, Lokpa, Bariba etc.) and some ethnic groups in the Center (Mahi and Idatcha) are known for their great affinity with pounded yams rather than its boiled form. Indeed, these ethnic groups in the North and in the Center find no difficulty in pounding yam and it is nationally recognized as their flagship meal, and therefore that of choice. But in the center, in addition to the natives settled in these areas, Idatcha and Mahi, Fon also like the consumption of pounded yam. On the other hand, unlike these ethnic groups mentioned above, it is not anchored in their eating habits, they prefer boiled yam because it does not require much physical effort. Paradoxically, in the South, in the urban areas (Calavi, Cotonou) where we observe the presence of all ethnic groups although the Fon are the majority, this urban population consumes both the boiled and pounded yam form which is by far the most beloved because these large areas are those where most civil servants and wealthy people live and work and are also the ones where the largest political, social, legal, cultural and administrative infrastructures are located. In addition, the plethora of restaurants and kiosks of sale favors the big consumption of the boiled yam but especially that of the pounded yam for which an electro-mechanical maker has been invented.

Exceptionally, Koudande et *al's* (2010) survey results on yam cultivation in the department of Couffo showed that 52% of sampled farmers cultivate yam. Interestingly, in Couffo, women are more involved in production than men. The area under cultivation varies between 0.33 and 3.2 ha as a whole, and there are also some growers who cultivate only a few mounds of yam .

Yam producers include all age categories; young people, adults and old people. Despite yam production declining in Couffo from 130,000 kg in 2000 to 115,000 kg in 2003, several local (late or early) varieties continue to be grown. They are: *"Gbota, Kanlin, Laboko, Lité, Gbobo, Namayi, Plasedjun, Awla, Gbomina, Fonté, Troukpa"*. These different varieties are consumed in several forms: pounded, boiled, fried, stewed and chopped. The problems that limit the development of yam cultivation in the Couffo are essentially: related to the transport of production, the absence of a market for the sale of products, the lack of appropriate technologies, conservation, high price of yam cultivation and finally soil poverty. Farmers' perceptions vary by farm type. Perceptions (cost of technology, speed of restoration of soil fertility or reduction of erosion, mobilization of land)

determined the adoption of all the technologies studied. Access to credit, level of formal education, and gender have a positive effect on the adoption of soil fertility restoration technologies. The study suggests the development and popularization of technologies according to the types of exploitation. It is noted that for the same price, the weight of the tubers varies according to the varieties and the size of the tubers. Variations are 15 to 25% for early varieties and 7% for late varieties. This shows that selling by weight is the best alternative to selling heaps, mounds, basins or carts. Finally, it has been shown that producers in some areas are already imposing the switch as a means of selling yam.

Further south, Adja of Couffo, Goun are not affiliated with the consumption of yam although the minority consumes boiled yams and fried yams. Moreover, as its production is not important, those population groups are more attached to the consumption of maize and its derived products.

As far as boiled yam is concerned, the scale of production of the crop that is used is low. From our meetings with specialists, several variants are attached to this product. We have the morphotype white, yellow, light, dark yellow. Regarding the consumption of boiled yams, there are several segments of demand namely: men, women, youth and children. Men (carpenter, blacksmith, craftsmen, painter, moving street sellers, motorcycle taxi drivers etc., most of them illiterate) are more profitable (big boiled yam demand segments) for the boiled yam sellers than the civil servants who are less beneficial for they usually eat it at home and rarely buy it. However, in Benin the product is more used and therefore consumed at home rather than in the market except in a few regions in Central Benin (DJIDJA, DASSA, Porto Novo etc.). In the Northern regions (like Djougou and Kopargo) and a few of the South (like Porto-Novo and Sèmè), boiled yam is consumed more at home and hardly found at the market, because they prefer selling pounded yam. Large cities have a strong demand for boiled yam. In rural areas, especially women of childbearing age are found selling this product. Compared with the preferred features of the household demand segment, market consumers tend to focus on whiteness and the taste of boiled yams. At home, the tenderness of the yam is the most preferred feature. This supports the fact that the variety *Laboko* is the preferred one both in households and markets not only for its tenderness but also for its ease of cooking its speed to be boiled (short time on fire and its poundability) and its quality to make pounded yam. With regard to the mechanisms of operation of the boiled yam chain, after yam production and its sale both in the field and in the market (by means of a pick-up truck or basin depending on the means of transportation and the distance from the destination), it is transported to the house where it will be processed and therefore boiled either for domestic and family consumption or for the market. In the latter case, it will be put in large bags from the basins and accompanied with peppers, salt, oil or their mixture, and will be sold in the market. It is very profitable for these sellers in the case where the product is sold at the market with many customers. Nevertheless, in terms of demand segments of boiled yam, adult males provide the highest demand, followed by older men, women and children. It should be noted that in urban areas, some foreigners, such as Nigerians living in some Beninese cities, consume a great deal because of their original diet. The following table 5 shows the regions of Benin, the varieties of yam they produce and the forms of yam they prefer in order of importance.

Table 12 : Varieties of yam produced and forms of yam preferred by region in Benin

Benin key regions	Early varieties (6months before harvesting)	Late varieties (9-10 months)	Forms of yams preferred
Mahi region (Central Benin)	Dodo, Gangnin, Gnidou, Klatchi, Laboko, Mondji	Alougan, Gnalabo, Hounbonon Kokoro, Kokowonde	Pounded yam (1) Dried yam flour (2) Fried yam (3)
Fon region (Central Benin)	Dodo, Gangnin, Gnidou, Klatchi, Laboko, Mondji	Alougan, Gnalabo, Hounbonon Kokoro, Kokowonde	Boiled yam (1) Pounded yam (2) Fried yam (3)
Bariba region (North Benin)	Adam, Agogo, Ahimon, Angbawobe Bakinissourou, Danwari, Douroubayessirou, Guirissi, Kéé Kokouma, Kpakara, Kpanhoura, Kpouna, Morokoro, Olodo, Orouhingou, Soagona, Soussou Soussounou, Tankouando, Terkokonou, Wossou	Assourouwoguiri, Banioure, Baniyakpa, Dourou, Gambarougninou, Gourossa, Kagourou, Kinkérékou, Konto, Kourakouro gouroko, Kpiroukpita, Nadéba, Omonya ,Oroubinsi, Singo, Singou, Tabane Wonmaaka, Yakarango, Yassousika, Yonbouanri	Pounded yam (1) Fried yam (2) Dried yam flour (3) Boiled yam (4)
Nago region (Central Benin)	Anago, Dodo, Gangnin, Gnidou, Klatchi Kodjéwé, Laboko, Mafobo, Mondji, Ofègui	Aguida, Gnalabo, Kokoroowo, Kpadjibakokpo	Pounded yam (1) Dried yam flour (2) Fried yam (3)
Lokpa region (North Benin)	Aloupa, Ankploman, Ekpétile, Hê-abalo Walassi, Wotanam	Alassola, Ewotolo, Kologo, Kpassa, Wolouchahabim	Pounded yam (2) Fried yam (2)
Wama region (North Benin)	Fakoni, Chanwounbaafa, Morokourou, Koumassi kpeina, Nondapéchi, Soussouka ,Tartimanin ,Wokorou	Banioure, Biwokou, Komopéina, Kpatchiri, Kpérékpéré, Tabane, Tchététchérékou, Tchiguita, Wourouwona	Pounded yam (1) Fried yam (2) Dried yam flour (3) Boiled yam (4)

Benin key regions	Early varieties (6months before harvesting)	Late varieties (9-10 months)	Forms of yams preferred
Yom region (North Benin)	Gorei Idolo, Noolasse, Nounin Sossorasse, Tarasse; Assinabaro, Assinapeina, Bakaroume, Brizi, Djersine, Kadjokraoun, Kokone	Kpakagnina, Sossohanhan Tanwounbiaha, Tanwounma, Wmai	Pounded yam (1) Fried yam (2) Dried yam flour (3) Boiled yam (4)
South of Benin (Cotonou, Calavi)	Buy from other ethnic groups in the North and Center	Buy from other ethnic groups in the North and Center	Pounded yam (1) Boiled yam (2) Dried yam (3) Fried yam (4)
South of Benin (Goun, Adja, Mina)	Gbota, Kanlin, Laboko, Lité, Gbobo, Namayi, Plasedjun, Awla, Gbomina, Fonté, Troukpa But buy the major part from other ethnic groups in the North and Center	Gbota, Kanlin, Laboko, Lité, Gbobo, Namayi, Plasedjun, Awla, Gbomina, Fonté, Troukpa But buy the major part from other ethnic groups in the North and Center	Boiled yam(1) Fried yam (2) Stew (3)

Source: Dansi et *al.* (2003) and key informants (2018)

The following table 6 presents the segments of boiled yam demand per region

Table 13 : Regions and segments of boiled yam demand in Benin

Regions	Segments
Urban area	- The young (workers, carpenters, blacksmiths, craftsmen, painters, moving street sellers, traders, motorcycle taxi drivers etc., most of them illiterate) - Some foreigners especially Nigerians
Rural area	- Adult males (maneuvers/producers) provide the highest demand, followed by older men, women of the market and - Children who go to school or left it.

Source: key informant interviews (2018)

3.3. Conclusions

The State Of Knowledge (SOK) report on the demand of boiled yam has demonstrated that yam remains an important component of the culture and religious beliefs of sampled rural groups in the Guinea Sudan zone of Benin. The findings show a relationship between diversity of yam varieties and cultural diversity. The yam varieties preferred for cultural reasons also happen to be of high economic value as reflected in market preferences. However, the cultural and economic preferences cannot alone explain all of the diversity found in yam. The farmers' desire to guarantee food security all year round is a third important factor enhancing the diversity of cultivated varieties. This factor selects for varieties that perform well when others preferred for cultural and economic reasons become scarce. All these varieties offered to farmers and consumers various food, technological, and agronomic traits. Perceived values allow a categorization of yam varieties into two major groups: one group with varieties characterized by high socio-cultural and economic values and another characterized by low socio-cultural and market values, but high food security value. Between them, the two groups provide farmers and consumers with a range of technological and agronomic aptitudes and provide food at different periods of the year.

The priority farmers give to food security in households is an important factor in varietal diversity maintenance. Food security provides the frame within which yam varieties with low socio-cultural and market values survive. Indeed, it is so important to cope with hunger in this way that these kinds of varieties have come to dominate in terms of area planted and percent of farmers cultivating them.

Socio-cultural factors and market demand are inter-linked, and not independent, dimensions. Put simply, where tradition lives (as in Central Benin), tradition sells. But it also contributes to stability of local production systems.

An important finding on gender is that female farmers had a greater positive effect on the maintenance of diversity of both types of yam than male farmers, as the former valued food security, long storage and technological and culinary traits more than the latter. They cultivated varieties of different duration to minimize the risk of harvest failure, to meet multiple needs, and to ensure household food security. In Central Benin, boiled yam is more sold in the rural market and also consumed by the family because it provides food for many workers during the periods of work. In general, men are involved in the production of yam and women in the processing and trading. But men and women consume the boiled yam at home. The aptitude for a good pounded yam, yield, markets value and aptitude to be consumed as boiled yam are the main criteria that yam producers

are looking for when choosing any yam varieties. Aptitude to a good pounded yam remains the only criterion not met by the TDRS varieties promoted (Adegbola et al., 2010).

3.4. References

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