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Konan Evrard Brice Dibi*, Brice Sidoine Essis, Boni N'zué, Amani Michel Kouakou, Goli Pierre Zohouri, Amon Brice Assouan, Tom Van Mourik

Participatory selection of orange-fleshed sweetpotato varieties in north and north-east Côte d'Ivoire

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Abstract: Sweetpotato is cultivated in all the regions of Côte d'Ivoire for consumption and as a source of income. Only varieties with white or yellow flesh are grown. Production of nutritious orange-fleshed sweetpotato (OFSP) is hampered by the lack of genetic resources and planting material. To evaluate and release OFSP varieties, on-farm demonstration tests were conducted with women farmer groups in Bondoukou, Nassian, Korhogo and Bondiali in the north and northeast Côte d'Ivoire. Six varieties- 'Kabode', 'Kakamega' ('Irene'), 'Tacha', 'Bela Bela', 'Vita' and TIB-440060-were evaluated in comparison with locally grown varieties. The on-farm demonstration was laid out in a randomised complete block design with replicated three times per location. Assessments were made on yield, disease and pests; and consumer preference on attractiveness of skin color and flesh of the root (fresh and boiled), taste, texture and starchiness. Results showed that introduced varieties have generally recorded higher yields than the local varieties: Yields of about 25 t/ha have been recorded on the sites. The best average yield of about 15 t/ha, was recorded for TIB-440060 and 'Irene' varieties. Farmers' acceptance of OFSP varieties based on the attraction of their color, the dry matter content and taste was more than 90%. At the end of the sensory tests, 'Irene', which achieved the best compromise between all observed

and measured parameters, was most appreciated and was the farmers' first choice, followed by varieties TIB-440060 and 'Bela bela'.

Keywords: Orange-fleshed sweetpotato, on-farm Demonstration, participatory varietal selection, sweetpotato

1 Introduction

Sweetpotato is cultivated in all the regions of Côte d'Ivoire for consumption and also as a source of income. It is a dicotyledonous plant called *Ipomoea batatas* (Lam.) that belongs to the family Convolvulaceae, and a tuberous root crop important for food security (Ermias *et al.* 2013). Globally it is among the important food crops in the world, after wheat, rice, maize, Irish potato, and barley and it ranks second following Irish potato in the world's root and tuber crops production and third after Irish potato and cassava in consumption in several parts of tropical Africa (Teshome *et al.* 2012). Sweetpotato is also a good source of calcium, ascorbic acid (vitamin C) and beta carotene (provitamin A). Varieties with orange flesh contain particularly high levels of beta carotene which is converted to vitamin A in the human body (Sakamoto *et al.* 1987); while there is moderate amount of beta carotene in yellow-fleshed and none in white-fleshed varieties (ACIAR, 2010 and Stathers *et al.* 2013). Vitamin A is involved in building the body's immune system to defend against disease and blindness (WHO, 2014). According to the World Health Organization (WHO), vitamin A deficiency (VAD), which is associated with low consumption of products rich in vitamin A is common and is a serious health problem in many developing countries (including Côte d'Ivoire). According to FAO (2009) about 218 million Africans suffer from chronic hunger and malnutrition. In 2013, about 45% of all child deaths were

*Corresponding author: Konan Evrard Brice Dibi, Centre National de Recherche Agronomique (CNRA), BP 633 Bouaké, Côte d'Ivoire, E-mail: dibikonan@yahoo.fr

Boni N'zué, Amani Michel Kouakou, Goli Pierre Zohouri, Brice Sidoine Essis, Centre National de Recherche Agronomique (CNRA), BP 633 Bouaké, Côte d'Ivoire

Amon Brice Assouan, Helen Keller International (HKI), Country office of Abidjan, Côte d'Ivoire

Tom Van Mourik, Helen Keller International (HKI), Regional office of Dakar, Sénégal

linked to malnutrition (WHO 2014). One of the reasons for the malnutrition is the narrow range of foods eaten by households in the region. Farmers produce a limited number of food crops and many households consume only staple foods like maize or wheat. However, these foods do not provide enough micronutrients including vitamins and minerals that are needed in small amounts for good health. Vitamin A deficiency affects over 40% of pre-school children in Sub-Saharan Africa and is responsible for about a quarter of child deaths. Each year, VAD leads to the blindness of 500,000 children and the death of 670,000 (Stathers *et al.* 2013). The main reason for the deficiency is that most people have poor diets that contain inadequate amounts of vitamin A.

Nutritional deficiency is a serious problem in Côte d'Ivoire where about 12.6% of households face food insecurity (EASA, 2009; IPC, 2009 and FSMS, 2010). One third of children under 5 years of age are affected by chronic malnutrition and 5% by acute malnutrition. The nutrition situation is worse in the north and northeast of the country where more than 30% of children are in chronic malnutrition, close to the critical threshold of 40%. More than 10% of children are in severe malnutrition in the northeast of Côte d'Ivoire.

Currently, orange flesh sweetpotato (OFSP) is the crop where most evidence has been established on its role in reducing VAD. Promoting OFSP as a food based approach to address VAD is based on sound scientific evidence. OFSP is effective in providing vitamin A to consumers (Hotz *et al.* 2012a; Hotz *et al.* 2012b). Consumption of OFSP among children aged below 5 years led to a 15% reduction in the prevalence of VAD (Low *et al.* 2006).

In Côte d'Ivoire, only varieties with white or yellow flesh are grown. Production of nutritious orange flesh sweetpotato (OFSP) is hampered by the lack of genetic resources and planting material. The availability of orange-fleshed sweetpotato within the household provides women with a productive, low cost source of provitamin A as a base for preparing weaning foods of higher nutritional value. This new approach for combating hidden hunger is seen as more sustainable than taking food supplements (Julius *et al.* 2014).

To overcome the lack of orange flesh sweetpotato genotypes, 18 OFSP varieties were introduced from Burkina (INERA), Kenya and Uganda through CIP and KEPHYS (Dibi *et al.* 2013). Those varieties were evaluated at a research station. Some were preselected for on-farm demonstration based on their yield, susceptibility to virus, dry matter content, cooking abilities and taste. The process of conducting on-farm demonstrations can be divided into the following five steps; diagnosis,

planning, establishment and management, evaluation, recommendation and diffusion (John 1997). Participatory Varietal Selection (PVS) is a cost effective way to assess and select potential varieties which can rapidly provide farmers with improved germplasm (Abidin 2004; Laurie and Magoro 2008).

Farmer participation in the advanced stages of sweet potato varietal selection has been reported to be successful in Ethiopia, Kenya and Uganda (Shamebo and Belehu 2000; Ndolo *et al.* 2001; Abidin 2004).

The general objective of this study is to contribute towards enhancing household food security and alleviating malnutrition. Its specific objectives are: to select adapted OFSP for targeted regions; to enhance farmers' access to OFSP varieties; to create farmer awareness on the benefits of OFSP consumption and to train farmers in improved cultivation practices.

2 Materials and Methods

2.1 Description of the study site

The on-farm demonstration tests were conducted with women farmer groups in Korhogo and Bondiali in the north and Bondoukou and Nassian in northeast Côte d'Ivoire (Figure 1 : Beadou 1980, modified). In these four locations, evaluated varieties were introduced in 42 villages with women farmer groups (Table 1). Agronomic data were collected in 8 fields (2 fields per localities). Trials were conducted over two years (2014 and 2015) with one growing season per annum at each site.

The north's climate is of type Aw according to the Köppen Classification: it is very hot and dry (Sudan climate). The vegetation is woodland savannah or west Sudan savannah. The average annual rainfall is 1243 mm, with the rainiest months being May to October. Its average year-round temperature is 26.6 °C, and the hottest months are February to April (Beadou 1980; Climatedata.eu 2016).

The northeast's climate is of type Aw according to the Köppen Classification. The vegetation consists of forest in the southern part and woodland savannah in the northern part. The region is characterized by a great rainy season (May-July) and a large dry season (November-April). The average annual temperature is 26.1 °C and the average annual precipitation reaches 1129 mm. The driest month is January (8 mm) the highest rainfall is recorded in September (175 mm) (Adjanoh 1964; Tiebre *et al.* 2016, Climate-data 2016).

All the sites are characterized with well-drained and loam soil texture, gentle slopes and dominated by Dystric

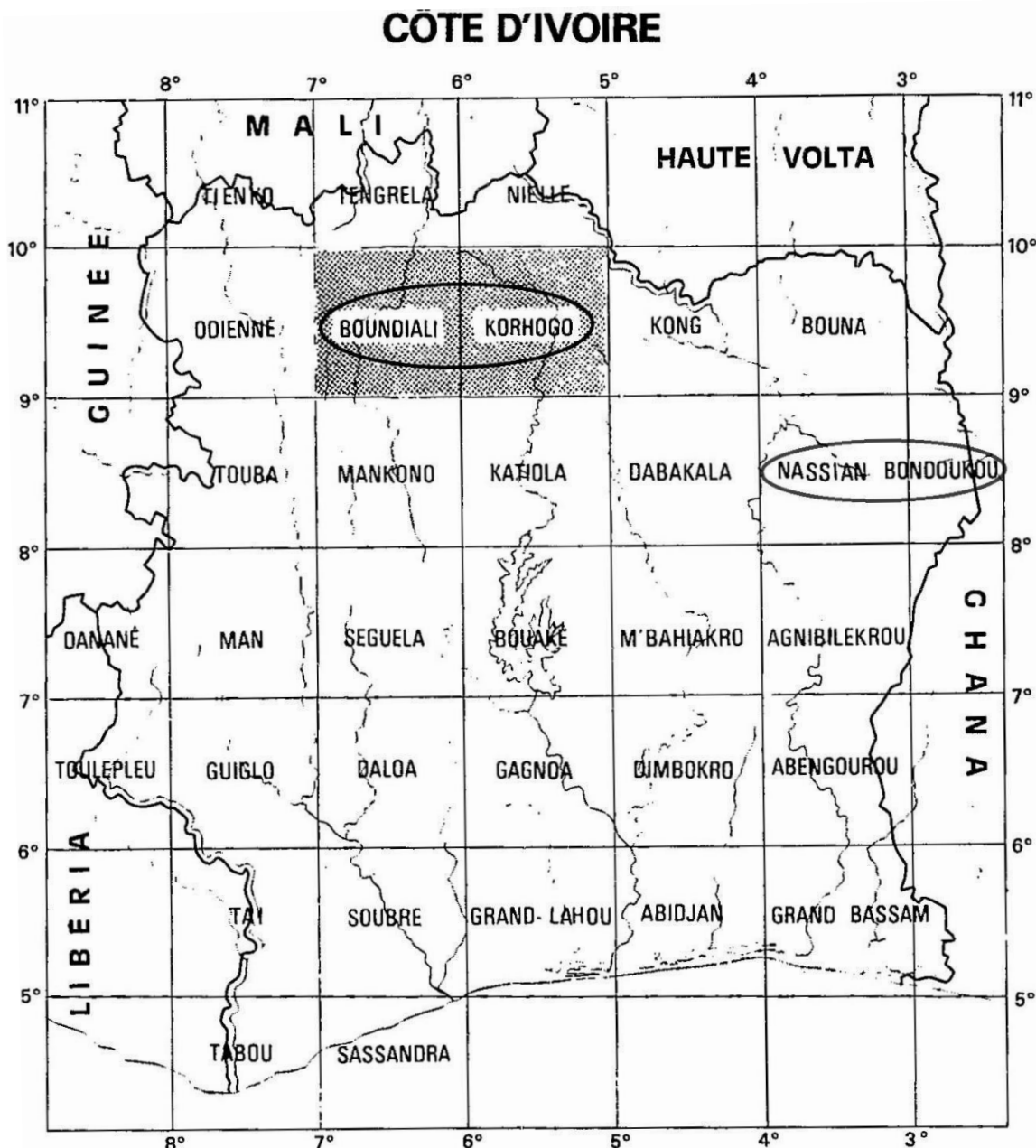


Figure 1: Côte d'Ivoire's map showing the North and Northeast regions (Beaudou (1980), modified)

Table 1 : Number of women farmer groups engaged in OFSP on-farm demonstration per localities

Region	Locality	Women farmer groups	Number of women
North	Korhogo	12	748
	Boundiali	10	694
Northeast	Bondoukou	10	690
	Nassian	10	637
	Total	42	2 769

Agronomic data were collected only in 8 fields (2 fields per location)

Ferralsols soil type (World Reference Base 2015).

2.2 Experimental treatments and design

The 6 varieties Kabode, Kakamega7, Tacha, Bela Bela, Vita and TIB-440060 were used as treatments in this on-farm demonstration in comparison to locally grown varieties (Table 2). The on-farm demonstration was laid out in a randomised complete block design (RCBD) with 5 treatments replicated three times per location.

2.3 Experimental procedures

The Implementation works (clearing, ridging or mounding, hole digging and planting) were carried out by farmers. Vine cuttings of 20 cm length with 4 to 5 nodes were prepared from the healthy stem of each OFSP variety. Cuttings were planted, on mounds or ridges according to cultural habit of populations, with about 2 to 3 nodes buried in the soil.

In the northeast (Bondoukou and Nassian), planting was done on mounds. In each block, each of the varieties occupied a 5x3 m plot on which 4 lines of 6 mounds (24 mounds in total) were made, with spacing of 1 m / 1 m. Each mound contained 3 cuttings planted close to the top equidistantly in a triangle. A total of 72 cuttings were planted per plot.

In the north (Korhogo and Boundiali), planting was done on ridges at a spacing of 100 cm between rows and 30 cm between plants. Plots size were 5x3 m containing 4 rows and 17 plants per row resulting in 68 plants per plot.

Weeding was conducted twice, manually by farmers. Earthing up and other cultural practices were done according to the standard recommendation.

2.4 Data collection and analysis

To evaluate adaptability, disease resistance, yields and farmers' preferences of OFSP varieties, data were recorded. Assessments were made on yields, diseases, pests and consumer preference on attractiveness of the color of the skin and the flesh of the root (fresh and boiled), taste, texture and starchiness.

Sensory evaluation was carried out. Boiled roots were placed in bowls and passed round for each woman to pick and taste. Voting was done by women raising their hands.

Finally, data were analyzed using the Genstat statistical software and treatment means were also compared using LSD value at the 5% significance level.

3 Results

3.1 Sanitary status of OFSP fields:

Generally, the plots showed a good sanitary status. Attacks of rodents, locusts and caterpillars (white grub larvae) were observed on all plots, however, their impact was not significant (7%). On average, low levels of virus-infected plants were also recorded. However, high viral incidences were observed in Tacha and in local varieties and TIB-440060, with data presented in Table 3. Two varieties Vita and Kabode did not show symptoms of viruses and seemed to be resistant to viruses.

3.2 Yields

Tuberous roots harvested for each variety were sorted, piled on the corresponding plots and weighed. Yields of about 25 and 19 t/ha were recorded in some localities with TIB-440060 and Irene respectively. Table 4 shows the average yields of sweetpotato varieties in different localities. The overall mean yield of sweetpotato varieties

Table 2 : Genotypes main characteristics (recorded in research station)

Varieties	Yield (t/ha)	Dry matter content (%)	Resistance to virus	Flesh Color
TIB-440060	22,22	28	Medium	Medium Orange
Tacha-2 Ininda	14,51	25	Medium	Medium Orange
Kakamega 7 Irène	21,67	27	High	Orange with Yellow
Spk004 6 6 Kabode	25,11	23	High	Deep Orange
SDKOD 4 6 Vita	18,11	27	High	Medium Orange
UWII906-79 Bela Bela	19,33	31	High	Yellow with Orange

was 9.65 t/ha across locations.

Kakamega7 Irene showed the most stable yields across localities (between 10 and 19 t/ha). Vita and Kabode presented difficulties producing tuberous roots on some sites and yield data could not be recorded with Vita.

TIB-440060 and Irene recorded the best average yield of about 13.3 and 15.2 t/ha. They were followed by local varieties (9.9 t/ha) and Tacha (9.2 t/ha). Bela Bela and Kabode showed the smallest yields (6 and 4.3 t/ha).

3.3 Farmer preferences and choice:

The analysis of the sensory evaluation data showed that the main characteristics determining the choice of producers were the yield, dry texture, good taste and attractiveness of boiled roots (Figure 2). Thus, according to the producers, the predominant qualities of the Bela Bela variety were in order of importance; its dry texture (28.55%), attractiveness (26.70%) and good taste (26.08%). However, its yield was relatively low, and recorded only 18.67% of the scores. The main asset of Kabode was

attractiveness (31.6%) followed by taste (28.1%), however yield (13.5%) was not appreciated by the producers. Irene variety recorded similar scores (24 to 25.6%) for the four characters identified. Scores were also not too varied for TIB-440060 (22,87 to 26,92%) with the dry texture as main quality. Tacha variety scored similarly to Bela Bela.

Acceptance of OFSP varieties by women was over 90% (Figure 3). At the end of the on-farm demonstration, variety Kakamega7 Irene, was the first choice of farmers. It was followed by varieties TIB-440060 and Bela Bela (Figure 3).

4 Discussion

Orange Fleshed Sweetpotato varieties tested in this study showed good behavior in farmers' fields. They generally recorded a good sanitary status and a good level of yield. The overall mean yield of 9.65 t/ha across locations in this on-farm demonstration is promising. This first result obtained through two years of on-farm study indicates that OFSP may well grow in Côte d'Ivoire with satisfactory

Table 3 : Incidence of virus observed with varieties in different localities

Varieties	Bondoukou	Nassian	Korhogo	Boundiali	Means
Kakamega 7 Irène	1%	0%	0%	2%	1%
UWII906-79 Bela Bela	0%	0%	0%	0%	0%
Spk004 6 6 Kabode	0%	0%	0%	0%	0%
Tacha-2 Ininda	12%	9%	27%	23%	18%
Local varieties*	30%	17%	15%	10%	18%
TIB-440060	13%	9%	10%	10%	11%
SDKOD 4 6 Vita	0%	0%	0%	0%	0%

*Recorded average of all local varieties at different localities

Table 4 : Yields (t/ha) recorded with varieties in different localities

Varieties	Nassian	Bondoukou	Korhogo	Boundiali	Means (lsd = 3.12)
Kakamega7 Irene	10	16.8	19.3	14.6	15.2
Local varieties*	7.3	5.1	24.7	2.8	9.9
Tacha-2 Ininda	12.2	7	8.5		9.2
UWII906-79 Bela Bela	5.4	3.3	8.3	7.1	6.0
Spk004 6 6 Kabode	1.6	9.6	4.9	1.2	4.3
TIB-440060	-	25	8.6	7	13.3
SDKOD 4 6 Vita	-	-	-	-	-
				Overall mean	9.65

*Recorded average of all local varieties at different localities

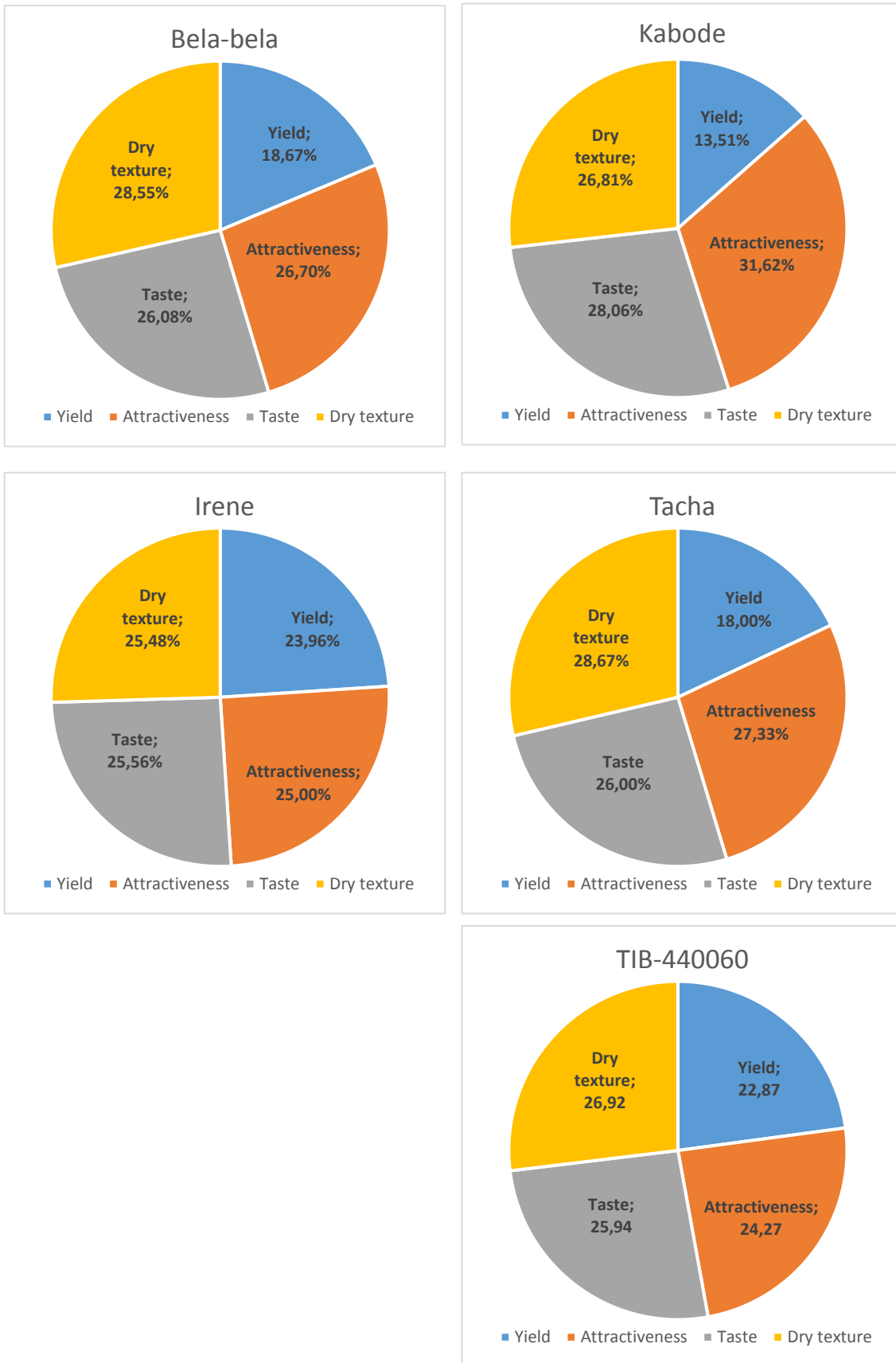


Figure 2: Characteristics of varieties according to farmer's votes

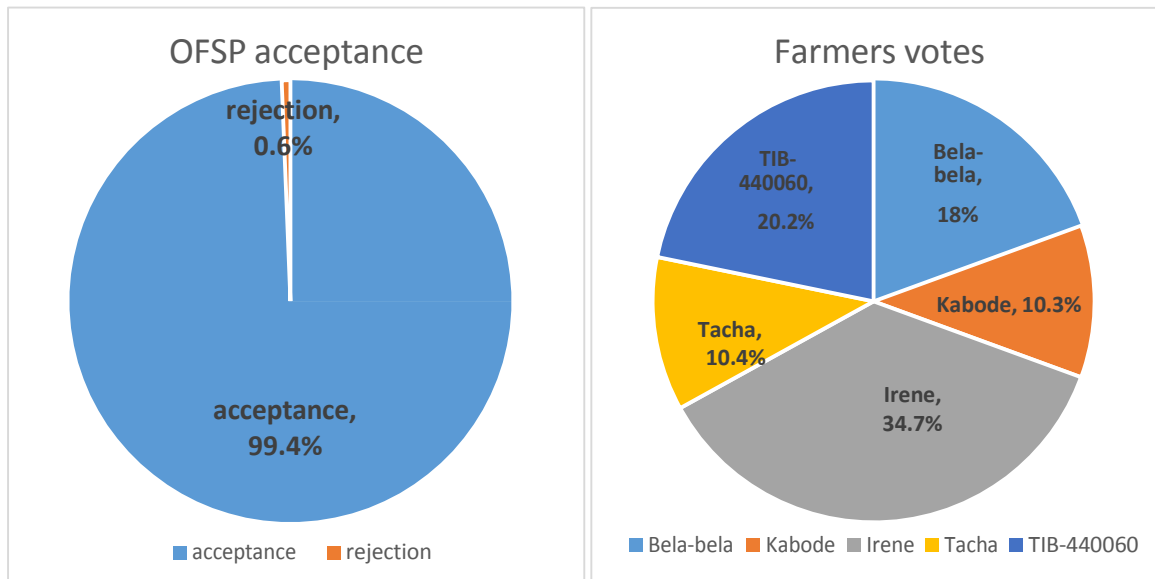


Figure 3: OFSP acceptance and choice of varieties by farmers

yields.

On-farm demonstrations also raised awareness among farmers with the advantages of varieties with colored flesh. They learned not only to apply improved cultivation methods to produce sweetpotato, but also to make dishes (e.g. mashed or pounded sweetpotato). In Côte d'Ivoire, where the production of nutritious OFSP is hampered by the lack of genetic resources and planting material, on-farm demonstration is likely to be the best way to rapidly provide farmers with improved germplasm (Abidin 2004; Laurie and Magoro 2008).

This process also allowed a good knowledge of the OFSP by the farmers and a high acceptance of the varieties of more than 90%. This study showed that the most important traits used by farmers to select sweet potato varieties were not only a sweet taste, dry texture and good yield (Domola 2003). Here the attractiveness of the boiled roots was a determining factor for the choice of varieties. Variety Irene was most appreciated and was the first choice of farmers because it achieved the best compromise between all observed and measured parameters (good yield, taste and dry texture and very attractive). TIB-440060 was selected by the farmers because of its good yield (13 t/ha), dry texture and taste. Bela Bela was selected, despite its lower yield, because of its dry texture and attractiveness. This variety was preferred to Tacha because of its high dry matter content (Dibi *et al.* 2013) and susceptibility to viruses of the latter.

According to John (1997), the process of conducting on-farm demonstrations can be divided into the following five steps, namely diagnosis, planning, establishment and

management, evaluation, recommendation and diffusion. At the end of this study the three OFSP varieties Irene, TIB-440060 and Bela Bela selected in a participatory manner with farmers can be recommended. These initial OFSP varieties selected in and suitable for Cote d'Ivoire will need to be disseminated to producers in order to overcome the current lack of genetic resources.

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