



FARMERS TRAIT PREFERENCES FOR DESIRABLE CULTIVARS: IMPLICATIONS FOR DEMAND-LED SWEETPOTATO [*IPOMOEA BATATAS* (L.) LAM] VARIETAL DEVELOPMENT

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Abstract

In a bid to identify trait preferences that influence the adoption of cultivars by farmers in diverse agro-ecologies, a study was conducted in the Rain Forest (Abia State) and the humid Guinea Savannah (Benue State) using structured questionnaires. The socio-economic characteristics of the respondents revealed that more females were involved in sweetpotato production in both States. However, there exists marked differences in age (more Benue sweetpotato farmers were older), educational background (Abia farmers more and better educated), and farming experience (Benue farmers more experienced). Majority of the farmers in both States shared similarities in their farm size (majority having <3.0ha) and number of cultivars planted on a farm (>1.0). However, the farmers from both agro-ecologies differed in their preferences for cultivar maturity time (99% of Benue farmers preferred early maturing, while as high as 43% preferred late maturing cultivars). For root shape, most Benue respondents preferred cylindrical root shape, while Abia farmers wanted the round shaped roots. Farmers in both States preferred the big to very big root sizes. For preference for taste and mouth-feel of boiled roots, sweet and hard roots were preferred by farmers in both agro-ecologies. Majority of Abia farmers (64%) practiced sole cropping as against 14% for Benue farmers. For those engaged in mixed cropping across both agro-ecologies, up to 5 crop-mix were practiced. Above 70% of farmers in both States also had knowledge of the sweetpotato virus disease. The study also shows the need to mainstream gender into sweetpotato breeding, especially traits such as long in-ground storability which is key for household piecemeal harvesting, and as such is more important to the female than the cash crop-focused male farmers.

Keywords: Sweetpotato, trait preferences, cultivar characteristics, Abia and Benue States

Introduction

The development of new crop varieties is a continuous process due to diverse or changing end-uses. Trait preferences of crop end users are never constant but change in the long run due to many factors, mainly changing food preferences and new food forms, cultural dynamics, industrial application, new information that impact utilization among others. For a breeder to develop acceptable new varieties that can be a commercial success, the prevailing end-user preferences must be understood. This is important in the design of the product profile of the new varieties to be developed. In Nigeria, a new sweetpotato variety must fulfill both producers' (farmers) and consumers' trait preferences to be acceptable. A variety that does not satisfy farmers' agronomic preferences will not be adopted for production. So also any variety that falls below consumers' expectations in key traits, even if produced, will not enjoy market access. Therefore, farmers choose specific cultivars to plant based on a complex mix of preferences that enhance appreciable household food security, market access and good

income. The utilization of sweetpotato depends on the food culture of the end-users. In northern Nigeria, the roots are used in the production of *kunnu* (fermented non-alcoholic, sweet drink) and *kambar* (sliced, blanched and sun-dried sweetpotato roots), while it is largely boiled and eaten with egg or tomato sauce, or prepared as porridge, or fried and eaten with fried egg in the southern part of the country (Bergh *et al.*, 2012; Afuape, 2014). In the middle belt, sweetpotato is often pounded along with starchier root crops for eating (Afuape, 2014), and according to Bergh *et al.* (2012), it is often roasted, and fresh roots peeled, sun-dried and converted to flour. Sweetpotato fries are also popular in this area. All these food forms and utilization ends require different root quality traits. While varieties with low dry matter (soft roots with dry matter < 30%) could be amenable to food products such as porridge, *kambar* and puree production, others such as *kunnu*, root fries, pounded roots and flour require high dry matter (Afuape, 2014). Other root factors and food quality attributes also affect farmers' preference (Egeonu and Akoroda, 2010; Sugri *et al.*, 2012; David and Madu,

2013). This study, therefore, was carried out to identify farmers' current important trait preferences in different agro-ecologies. This will enable identification of common and divergent preferences to aid in the selection of critical traits that can be used to develop acceptable sweetpotato varieties for varied end users.

Materials and Methods

Study area

The study was conducted in two States (Abia and Benue) located in two different agro-ecologies. Abia is located in the Rain Forest belt of the South-eastern Nigeria with mean annual rainfall of 2,000mm and above. The State lies within latitude 4°40' N and 6°14' N; and longitude 7°10' E and 8°00' E. The soil is predominantly an ultisol. Other food crops of great importance in Abia State are cassava, rice, maize, yam and cocoyam. Benue State is located in North Central Nigeria in the southern Guinea Savannah. The location is humid grassland with moderate to high mean annual rainfall of 1,200-1,500mm. The State spreads between latitude 6°25' N and 8°8' N, and longitude 7°47' E and 10°00' E. Main soil types are oxisols and ultisols. The top layers are generally loose. Some of the other important crops widely cultivated in Benue State include; yam, maize, rice, cassava, soybean, groundnut and sesame.

Data collection

Structured questionnaires were designed and used to collect information on sweetpotato farmers' and consumers' traits preferences in the two States. Sixty (60) questionnaires were administered on identified sweetpotato farmers in Abia State, while 100 sweetpotato farmers were interviewed in Benue State. The difference in the number of respondents interviewed in the two States was because Benue had more active sweetpotato farmers than Abia in the sweetpotato farmer groups targeted for questionnaire administration. The surveys were conducted in the three Agricultural Development Program (ADP) agro-zones in each of the two States. The questionnaire covered the following areas: socio-economic attributes of the respondents (sex, education status, age, marital status, etc.), sweetpotato production attributes of the farmers, sweetpotato culinary attributes, sources of vines, knowledge about orange-fleshed sweetpotato – its production and consumption, and knowledge about sweetpotato diseases, especially the sweetpotato virus disease.

Data analyses

The data collected were analysed using descriptive statistics through the Summary Statistics procedure of SAS (Statistical Analyses System) version 9.2. Data were analysed for each variable on State basis, and the results presented as frequencies and percentages. Bar charts were used to graphically display results.

Results and Discussion

Farmers socio-economic characteristics

Gender distribution, marital status, age distribution and the educational status of the sweetpotato farmer respondents involved in the study are presented in Figure 1, 2, 3, and 4 respectively. In both Abia and Benue States, more females (62% in Benue and 55% in Abia) were involved in sweetpotato production than males. Also, most of the respondents were married (71% in Benue; and 77% in Abia) (Figure 2). Both males and females are involved in sweetpotato production. The involvement of more married females in sweetpotato production as observed in this study could be due to the role of sweetpotato as a food security crop. Female farmers are often more concerned about family food security. Understanding the roles gender plays in sweetpotato production will help in mainstreaming gender into the development of new varieties. Such mainstreaming may involve targeting the development of varieties that tuberize early with long in-ground storability for piecemeal harvesting for family food to the female farmers; while targeting very early maturing varieties to the male farmers who are concerned more with improving family income, thereby cultivating sweetpotato more as a cash crop.

In terms of their age distribution, most of the Benue respondents (81%) were between the ages of 31-60 years, with majority of them (33%) being between 41-50 years. In contrast, more than half of the respondents in Abia (52%) were 30 years old or less, while 80% and above in Abia were between 20 and 40 years of age, depicting a younger generation compared to Benue respondents which seemed older (Figure 4). The age distribution of 20-60 years for over 90% of the respondents observed across the two states showed that sweetpotato farmers were still in their active years of production. The age range was similar to the 30-59 years reported by Mbanaso *et al.* (2012).

The educational status of the sweetpotato producers interviewed is presented in Figure 5. In Abia State, none of the farmers was without some form of formal education with more than one-third (39%) having some form of tertiary education. In Benue State, only 85% of the farmers had any form of education with 33% some form of tertiary education. As education plays a positive role in technology adoption (Oduro, 2013), the 82% of Abia farmers having at least secondary education as against 54% of farmers in Benue with similar level of education may partly explain why more Abia farmers (68%) adopted the use of chemical fertilizers compared to Benue farmers where 85% of farmers reported no fertilizer use.

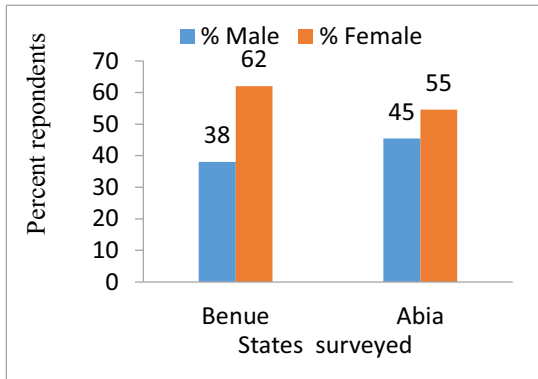


Figure 1: Gender distribution of sweetpotato farmers in Benue and Abia States

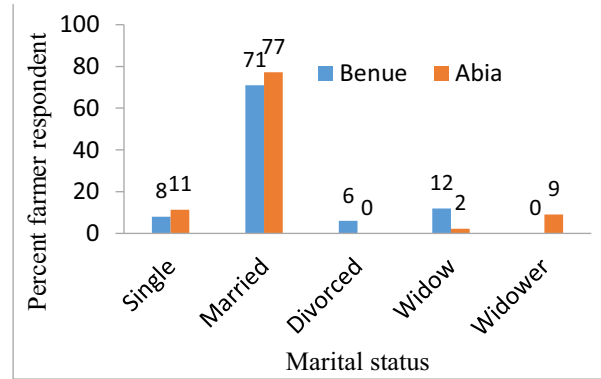


Figure 2: Marital status of respondents in Benue and Abia States

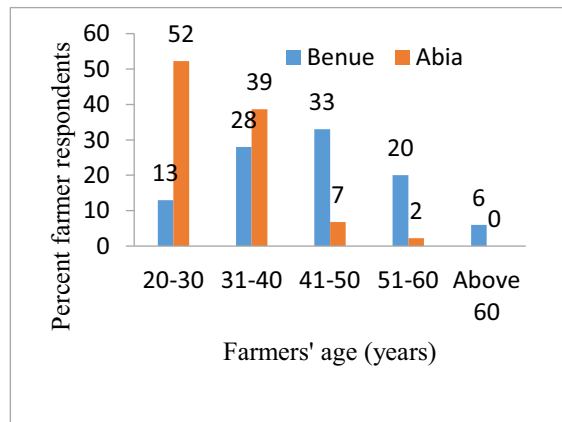


Figure 3: Age distribution (years) of sweetpotato farmer respondents in Benue and Abia States

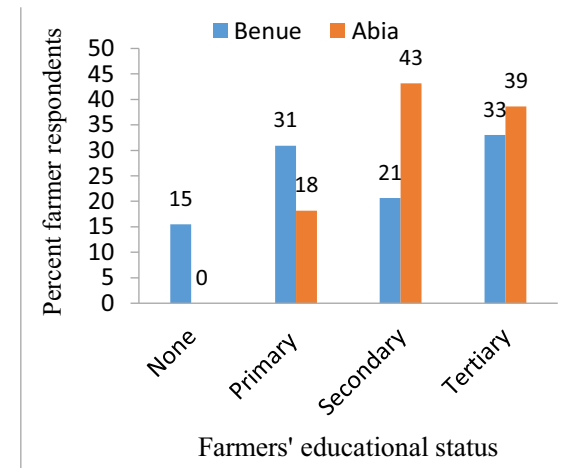


Figure 4: Educational status of sweetpotato farmers in Benue and Abia States

The number of years of cropping sweetpotato gives an insight into the experience of a farmer in sweetpotato production and other related issues that surround the sweetpotato crop enterprise. About 50% of the Benue State sweetpotato producers had over 15 years of experience cropping sweetpotato (Figure 5), while about 30% of the Benue farmers had at least 11 years and above. This is in total contrast to the observed farming experience of sweetpotato producers in Abia State where 59% had about 5 years of experience, and a combined 84% had less than 10 years of experience on the crop. Respondents from both States shared similar trend in size of land under sweetpotato cultivation. For both States, more than half of the sweetpotato farmers produce sweetpotato roots on 0.0 – 1.0 hectares of land (Figure 6). In Benue State, 59% of the farmers produce on small farm holdings of < 1.0 hectare, while 64% produce sweetpotato on same land hectareage. Above one-third (40% in Benue and 36% in Abia States) produced on > 1.0 hectare is a pointer to the growing status of sweetpotato as a cash crop. While most sweetpotato farmers across sub-Saharan Africa generally cultivate less than one hectare of land for sweetpotato production (Baafi *et al.*, 2015; Kivuva *et al.*, 2014), majority of the smallholder farmers still plant more than two cultivars on the same piece of land (Odoro, 2013).

The emergence of commercial production of sweetpotato as cash crop is beginning to influence the emergence of large hectareage of sweetpotato farms of up to 5 hectares as observed in this study. Commercial crop production often involves the use of a single, highly productive cultivar targeted at a specific market. Such sweetpotato cultivar, however, should be one with high resistance to the sweetpotato virus disease (SPVD) to prevent vine growth suppression and huge yield depression.

The use of fertilizer in sweetpotato production is a highly recommended practice, especially in highly weathered poor soils. The sweetpotato producers interviewed in both States showed contrasting attitude towards the use of fertilizer in their sweetpotato production activities. In Benue State, only 15% of the farmers apply fertilizer to their sweetpotato farms, while the rest 85% don't usually apply fertilizer (Figure 7). However in Abia, 68% of sweetpotato root producers use fertilizer, while, 32% do not. Across the two States, the number of sweetpotato cultivars farmers plant on a piece of land ranged between 1 – 6. The Abia farmers' use of fertilizer must have influenced the expectation of up to 10 tons/ha of sweetpotato root yield from a good cultivar compared to approximately 3 tons/ha

expectation by Benue farmers. The selection of high yielding sweetpotato genotypes under low or no fertilizer condition will benefit such environments as Benue state, while input-using farmers like those in Abia state will benefit from the development of genotypes that respond well to fertilization.

Majority of the farmers in both states plant either two (Benue State) or three (Abia State) cultivars on one farm land (Figure 8). While no farmer plants only one cultivar on a farm in Benue State, up to 10% of the farmers in Abia State do plant just one (1) cultivar. Interesting to note is the fact that some farmers do plant up to six (6) cultivars in both States. Growing more than two cultivars is a food and income security strategy that aims at limiting crop failure which farming households

depend on for food and income. The planting of early maturing cultivars guarantees farming households' quick food availability and income early in the new farming season. However, the preference for medium to late maturing cultivars by sizable number of Abia farmers was for the farmers to be able to harvest the roots in piecemeal for household food security and to take advantage of high market price when sweetpotato roots would be scarce after the initial harvest glut. Ddumba *et al.* (2014) noted that most subsistence sweetpotato farming households practice piecemeal harvest and so prefer early-bulking cultivars that can remain in the soil for long time without spoiling. As such, breeding for early maturing cultivars with long shelf life will be a good breeding objective in many sweetpotato breeding programs in Africa.

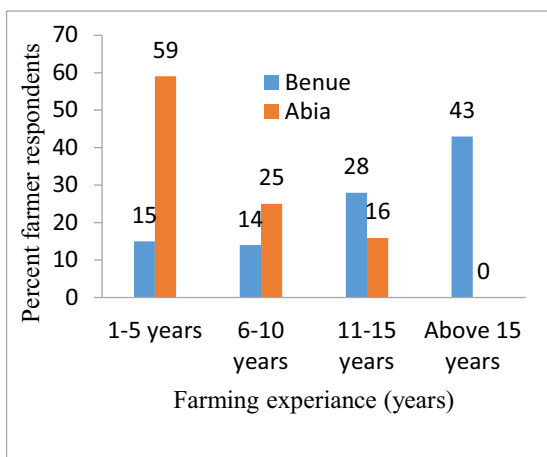


Figure 5: Farming experience (years) among farmers in Benue and Abia States

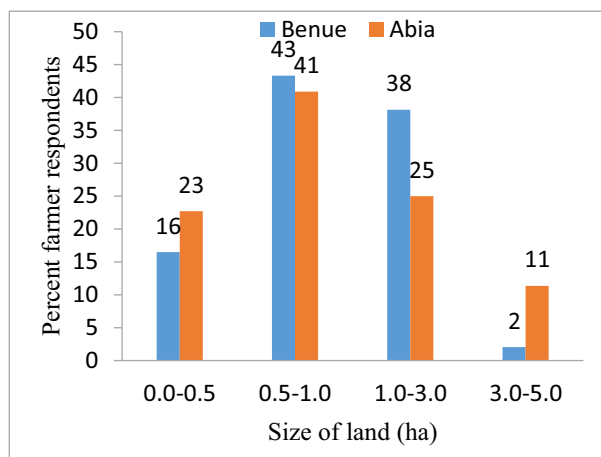


Figure 6: Size of land under sweetpotato cultivation by sweetpotato farmers in Benue and Abia States

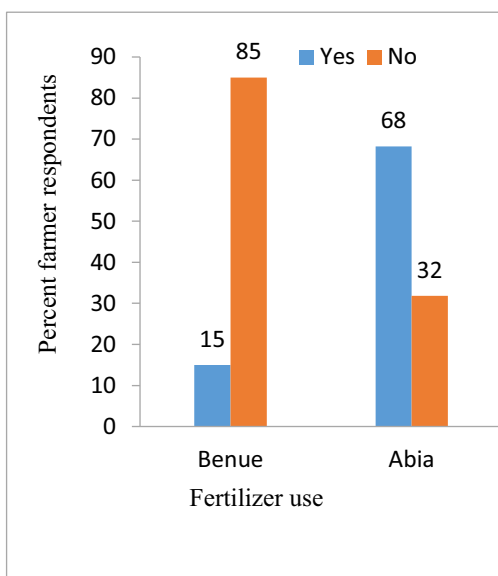


Figure 7: Percent of sweetpotato farmers in Benue and Abia States that apply fertilizer for sweetpotato production

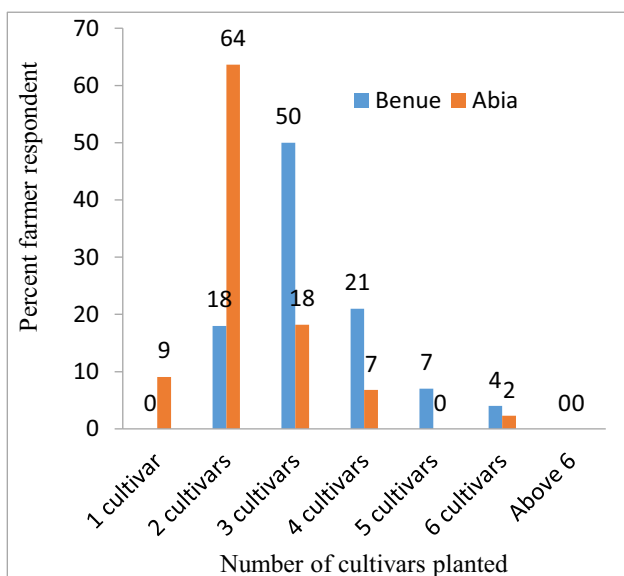


Figure 8: Proportion of Benue and Abia States' farmers' response to number sweetpotato cultivars planted on the same field

Preference for sweetpotato root characteristics

Expected sweetpotato root yield (tons/ha): Yield is an important trait that exerts strong influence on variety adoption. A variety meeting the yield expectations of farmers will go a long way in increasing the adoption of such new variety. For expected root yield, most farmers in Benue and Abia States (88% and 50%, respectively) had expectation of average yield level of about 3 tons/ha (Figure 9). Most of these farmers with low yield expectation usually grow many crops such as cassava and maize on the same land simultaneously, a practice which Akoroda (2009) noted would lead to sweetpotato yield depression due to lower plant density and more competition from the other component crops. However,

33% of Abia respondents still had high root yield expectations of at least 10 tons/ha. These were mostly sole cropping sweetpotato farmers. High root yield is one of the most important traits that influence variety adoption and cultivar choice by farmers (Akoroda, 2009; Ddumba *et al.*, 2014). Most of the farmers interviewed reported yield of about 3 tons/ha which they thought was good enough, especially in Benue. This could be because most sweetpotato farmers interviewed in Benue practice mixed cropping which Akoroda (2009) had noted often leads to yield depression. Breeding for high root yield is a common breeding objective in many sweetpotato breeding programs.

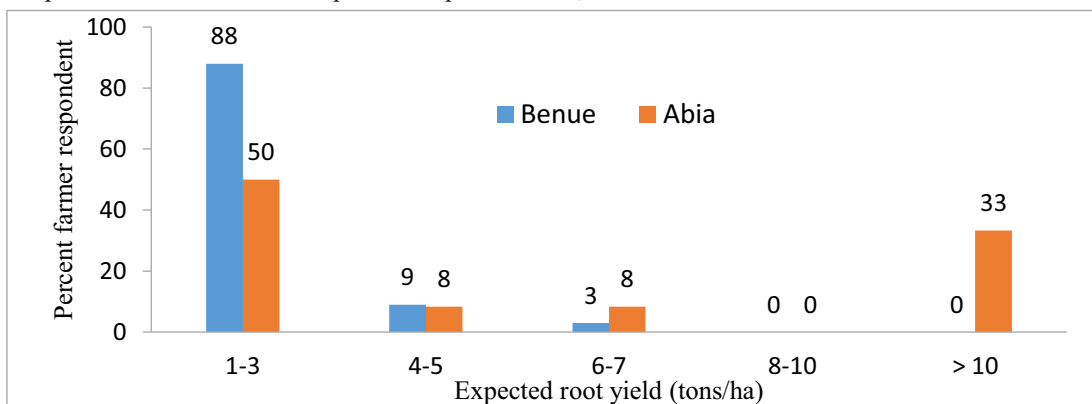


Figure 9: Proportion of Benue and Abia states' farmers' response to expected sweetpotato root yield (tons/ha)

Prevailing and preferred sweetpotato root maturity time: Farmers' responses on how long it takes their current popular cultivars to mature are presented in Figure 10. Many sweetpotato producing farmers in Benue State (90%) had preference for early maturing cultivars that mature at three months after planting (MAP). Almost all the sweetpotato producers in the State (99%) plant cultivars with maximum maturity of 4 MAP. In contrast, only 57% (7% for 3 MAP and 50% for 4 MAP) of farmer respondents in Abia State plant cultivars that mature at most by 4 MAP with 27% and 16% of the farmers preferring medium (5 MAP) and late maturing (6-7 MAP) cultivars, respectively. However, while there is a slight shift in willingness to adopt early maturing cultivars in Abia State with 82% respondents preferring 3-4 months cultivar (Figure 11), Benue farmers still exhibited same trend of high preference for early maturing cultivars.

Preference for sweetpotato root shape and size: Root shape is an important trait that appeals to farmers greatly because of its market influence. Fifty-nine percent (59%) of sweetpotato producers in Abia State preferred the roundish shape, with 2% caring less about any particular root shape (Figure 12). In Benue State, 98% of the farmer-respondents preferred roots with the cylindrical shape. For root size, most of the sweetpotato producers in both States prefer big roots, though as high as 45% of the respondents in Benue preferred medium roots as well (Figure 13). In Abia, 36% prefer big roots with 50% very big roots (As used in this study, Small roots = < 100g; Medium roots = 100 – 500g; Large/big

roots = 500 – 1,000g; while Very large/big roots = > 1,000g).

Farmers' preference for root flesh and skin colour: Common sweetpotato root flesh colours are white/cream, shades of orange and yellow. Most farmers in both States (62% in Benue; 45% in Abia) showed strong preference for white fleshed roots (Figure 14). Both locations also showed good preference for orange-fleshed roots with 38% in Benue and 23% in Abia States showing preference for the pro-vitamin A-rich orange-fleshed sweetpotato. As for skin colour, majority of the respondents in Benue and Abia States (83% and 60% respectively) also showed same strong preferences for cream-skinned roots (Figure 15). While purple root skin colour ranked second in preference in Benue State (15% respondents), brown-skinned roots also ranked same in Abia State (13%).

Preference for taste and mouth-feel of boiled sweetpotato roots: The preferences for taste and mouth-feel of boiled sweetpotato roots are presented in Figures 16 and 17, respectively. Majority of the respondents in Benue State (94%), and 71% in Abia State preferred sweet boiled sweetpotato. For the mouth-feel of boiled roots, more than half of the respondents in both States (70% in Benue; 52% in Abia) preferred hard boiled sweetpotato roots (roots with boiled white yam texture) (Figure 17). Quite a number of the respondents (30%) in Benue and (18%) in Abia still preferred the soft boiled roots (roots with boiled potato texture). However, 30% of the respondents in Abia had no special preference for texture of boiled sweetpotato roots.

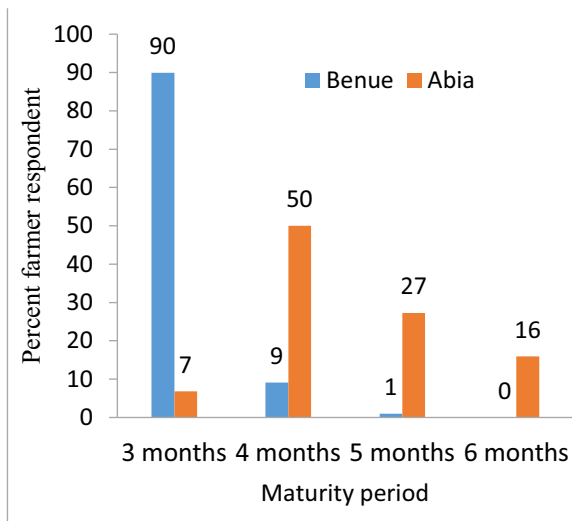


Figure 10: Proportion of Benue and Abia farmers' response to cultivar root maturity time

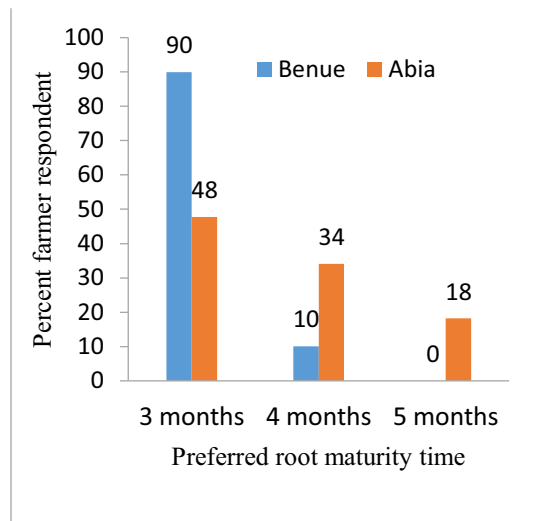


Figure 11: Proportion of Benue and Abia farmers' response to preferred sweetpotato root maturity time

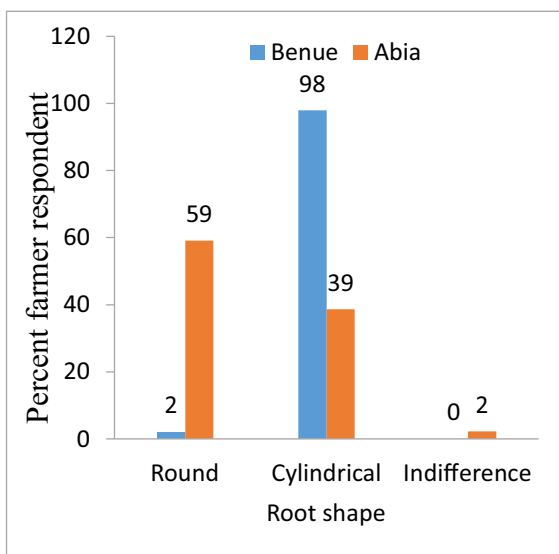


Figure 12: Proportion of Benue and Abia farmers' response to preferred sweetpotato root shape

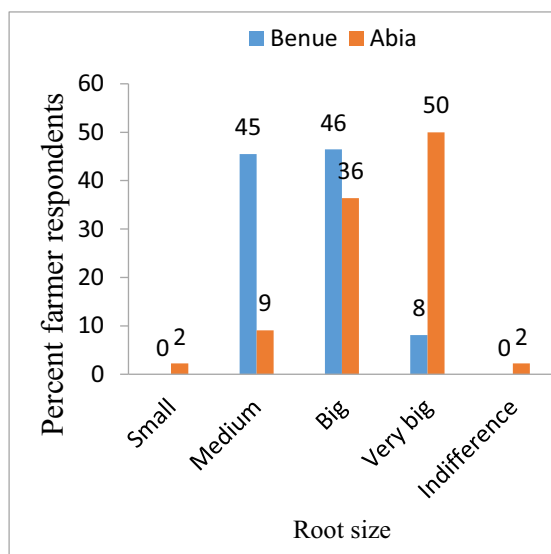


Figure 13: Proportion of Benue and Abia farmers' response to preferred sweetpotato root size

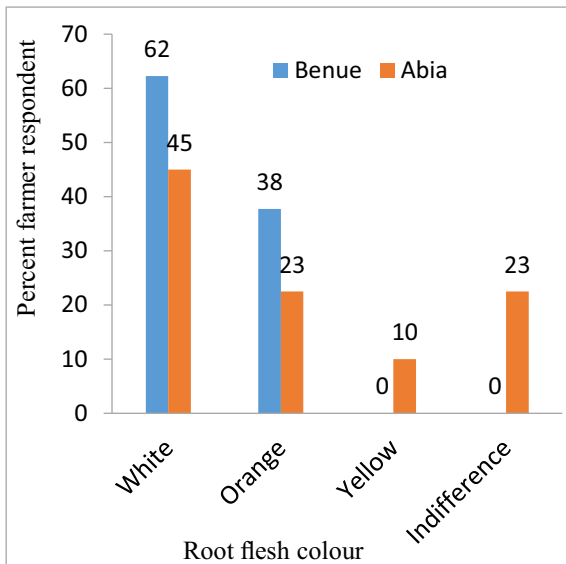


Figure 14: Proportion of Benue and Abia farmers' response to preferred sweetpotato root flesh colour

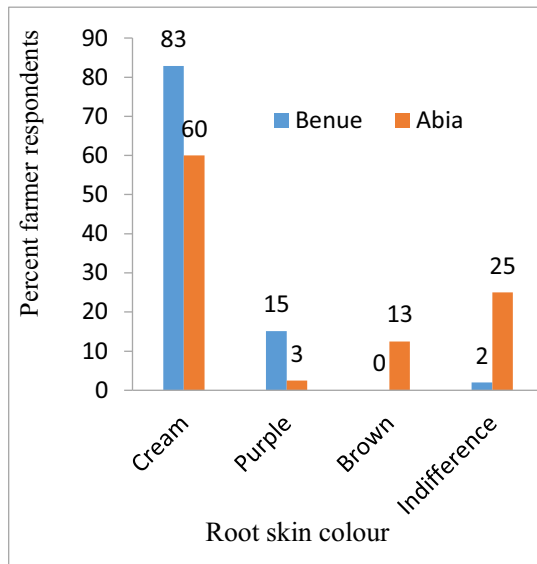


Figure 15: Proportion of Benue and Abia farmers' response to preferred sweetpotato root skin colour

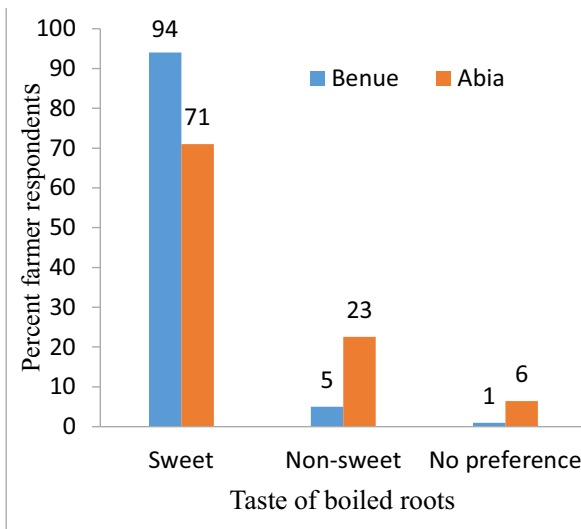


Figure 16: Proportion of Benue and Abia farmers' preference for taste of boiled sweetpotato roots

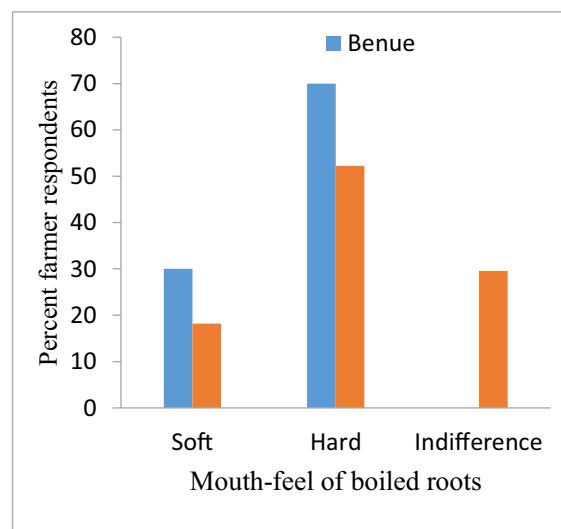


Figure 17: Proportion of Benue and Abia farmers' preference for hard texture (mouth-feel) of boiled sweetpotato roots

Cropping system and sweetpotato-based crop mixtures: Many subsistence farmers usually don't plant one crop on their farms. More than one crop is usually grown simultaneously to serve as food security and food diversity for the household. The survey in Benue showed that 86% of the sweetpotato producers interviewed were involved in mixed cropping with only 14% planting sole sweetpotato (Figure 18). In Abia, and to the contrary, most sweetpotato farmers (64%) plant sole sweetpotato, with 23% of the farmers engaging in mixed cropping. In Benue, 95% of the mixed cropping practicing farmers engaged in sweetpotato-cassava crop

mix (Figure 19a). Other crop mixtures that were observed were sweetpotato-cassava-beniseed mix, sweetpotato-yam-maize mix, sweetpotato-cassava-cowpea mix, and sweetpotato-cassava-maize mix. In Abia (Figure 19b), 15 different sweetpotato-based crop mixtures were observed among the respondents. The fairly dominant crop mix is the sweetpotato-maize-cassava-yam system with 23% of the respondent involved in it. The second and third most practiced crop mixtures are the sweetpotato-maize (13% respondents) and sweetpotato-cassava (10% respondents).

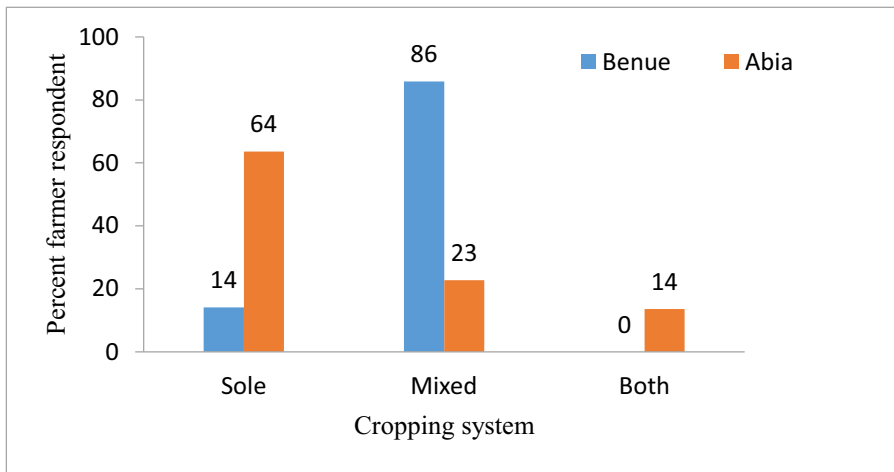


Figure 18: Proportion of Benue and Abia farmers' response to sweetpotato crop combination with other crops

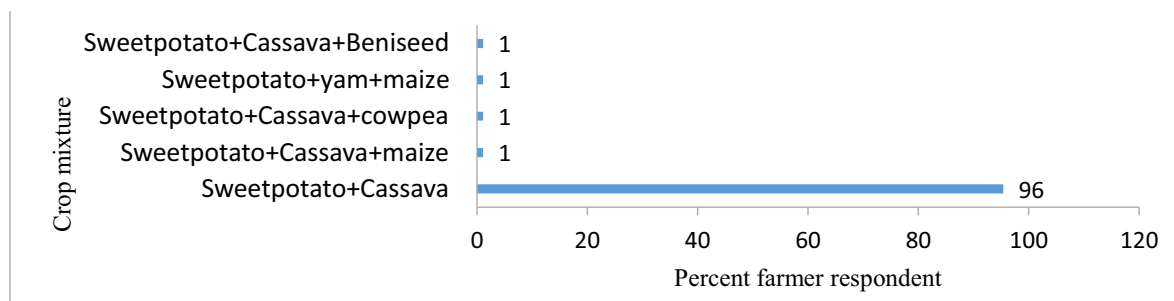


Figure 19a: Percent Benue farmers' response to sweetpotato-based crop mixture

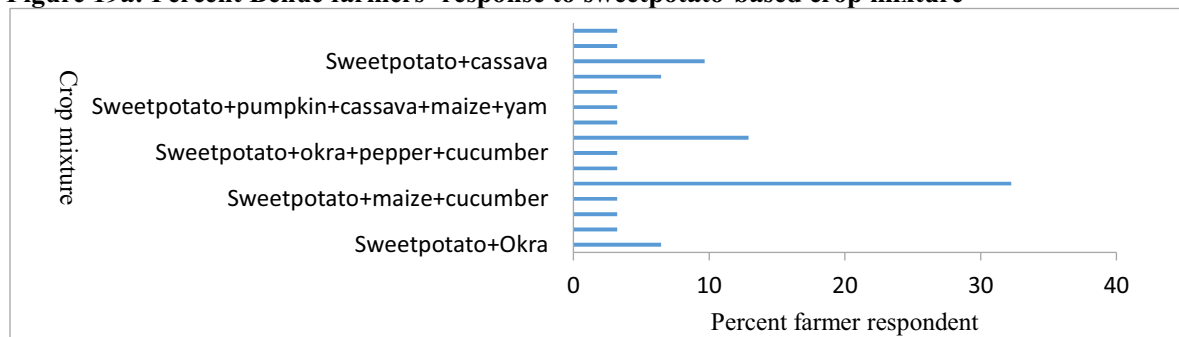


Figure 19b: Percent Abia farmers' response to sweetpotato-based crop mixture

Adequacy of farmers' current sweetpotato cultivars: On the need to know what farmers' thoughts were about the adequacy of the cultivars they currently plant, 57% and 96% of the sweetpotato farmer-respondents in Abia and Benue, respectively, adjudged the present cultivars

being used as either good or very good (Figure 20). While 32% in Abia and 3% in Benue categorized their present cultivars as 'fair', no respondent in both States indicated the present cultivars were bad.

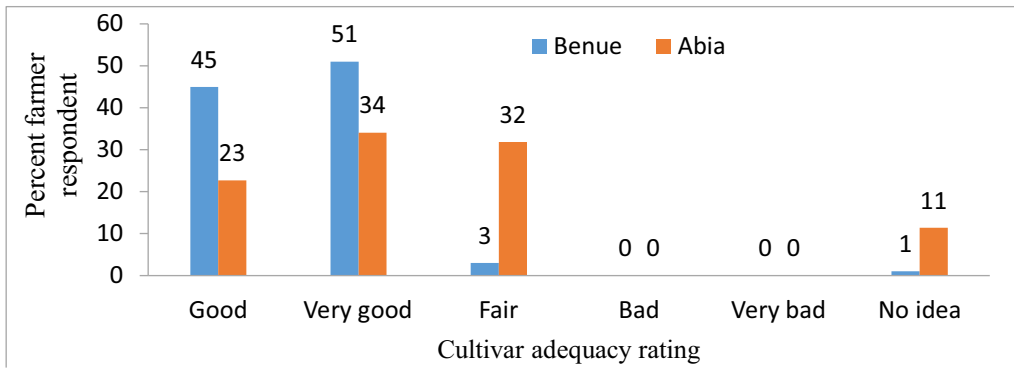


Figure 20: Proportion of Benue and Abia farmers' response to adequacy of present sweetpotato cultivars

Knowledge of Sweetpotato Virus Disease (SPVD): Large percentage of sweetpotato farmers have knowledge of the highly destructive Sweetpotato Virus Disease (SPVD), and can identify an infected plant on their farms. In Benue, 78% of the farmers can identify SPVD and reported to have seen the symptoms on their farms, while 20% reported that they had not seen SPVD

on their farms before (Figure 21). Only 2% of the farmers had no idea what SPVD is. In Abia, 48% of the sweetpotato farmers interviewed reported SPVD incidence on their farms, while 23% reported absence of the virus disease. A large number (30%) of those interviewed in Abia still had no knowledge of SPVD.

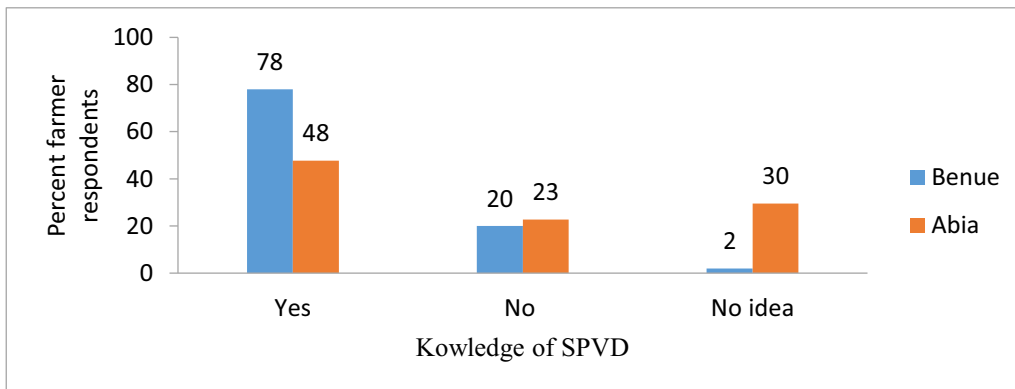


Figure 21: Proportion of Benue and Abia farmers' response to knowledge of sweetpotato virus disease presence in their fields

Farmer-identified important cultivar characteristics: Figure 22a and 22b present the trait characteristics identified by Benue and Abia farmers as important in their preferred cultivars, respectively. All the traits presented were mentioned as important by at least 50% of the farmers in both States except for round root

having 41% in Benue. In Benue, all the respondents (100%) identified high yield, early maturity, large roots and root storability as important traits, while same is true in Abia, except for early maturity which 50% of the farmers identified as important.

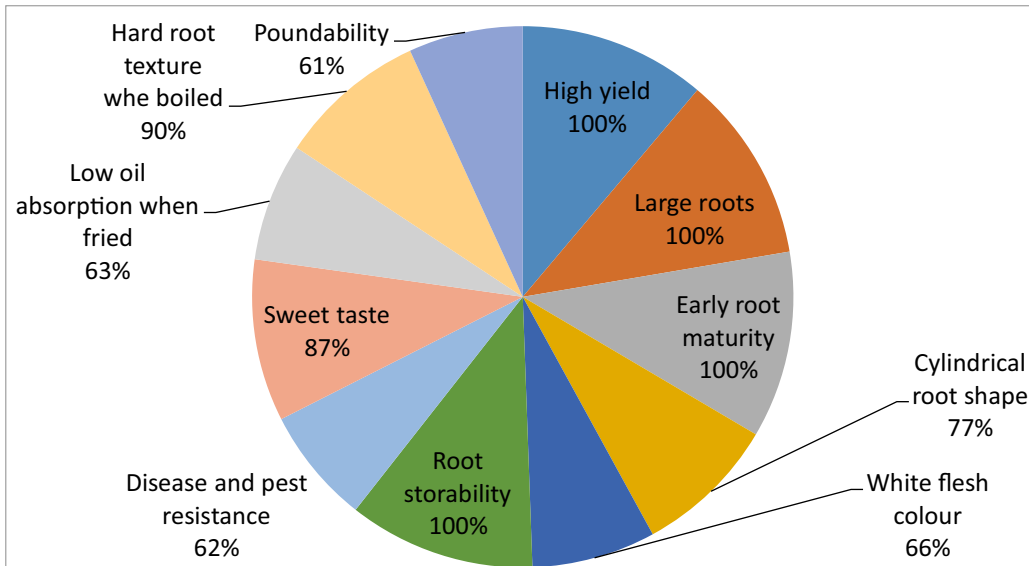


Figure 22a: Important sweetpotato cultivar characteristics identified, and the proportion (%) of Benue state sweetpotato farmers that identified with the trait

Note: When sliced and fried sweetpotato root is crispy, the oil absorption is termed low; when it is soggy after frying, the oil absorption is termed high.

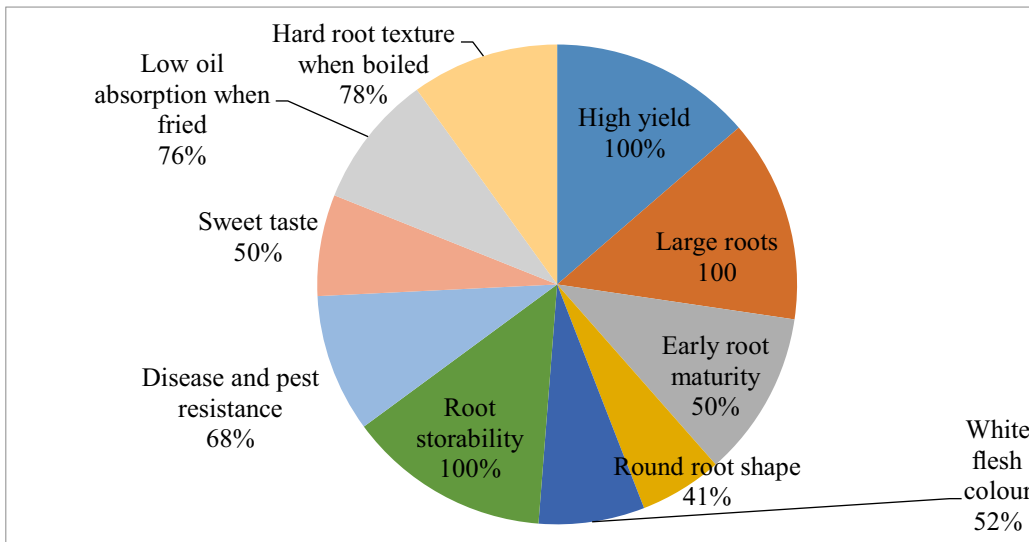


Figure 22b: Important sweetpotato cultivar characteristics identified, and the proportion (%) of Abia sweetpotato farmers that identified with the trait

Sweetpotato root characteristics such as shape, size, flesh and skin colours are very important in the choice of cultivars to plant by farmers and to process by the processors. Irregularly shaped sweetpotato roots often lead to high peel-loss and poor quality of final product due to presence of unpeeled skin. Peel-loss of up to 24% of the fresh root weight had been reported by Afuape *et al.* (2014). Most of the farmers preferring cylindrical or roundish root shape and medium to very big root size may be for ease of handling during manual peeling as big roots enhance ease of manual processing. Root size is mainly under environmental control with small genetic effect, and can be manipulated better using

cultural factors such as plant density and fertilization. According to Rees *et al.* (2001) and Omodamiro *et al.* (2013), colour characteristic of sweetpotato roots is an important consumer preference factor. With some of the farmers in Benue and Abia having preference for orange fleshed roots, and Omodamiro *et al.* (2013) reporting good consumer appeal for fried orange-fleshed sweetpotato (OFSP) products, the use of OFSP in ameliorating vitamin A deficiency is a huge possibility. Putting this trait in good genetic background will enhance the adoption of OFSP cultivars for consumption. The preference for white-flesh colour is probably from the long-held farmers' belief that white

root flesh is associated with high dry matter, a highly preferred trait. The two states showed contrasting cropping systems with sole cropping being dominant in Abia and mixed cropping dominant in Benue. Mixed cropping is often done to minimize harvest failure, for food diversification, food security and income generation. The number of crops often mixed with sweetpotato vary from one farmer to the other, and is usually influenced by household needs (food culture) and market value of other crops. While any high performing variety can be developed and used for sole cropping, the variety to be used for mixed cropping must consider the architecture of the other crop combinations in order to prevent shading and other performance-limiting interactions. One other factors that leads to great yield lose is the occurrence of sweetpotato virus disease (SPVD) on farmers' fields. In Nigeria, SPVD had been reported to reduce yield by 90-98% (Hahn, 1979). Majority of the interviewed sweetpotato farmers could identify its presence on their field, which they reported they have often seen. Their knowledge of SPVD will help minimize yield lose as diseased plants can quickly be removed. However, the development of resistant varieties and the use of virus-clean planting materials remain the most effective control methods (Kivuva *et al.*, 2014).

Conclusion

Among the eleven preferred root characteristics identified by the farmers, only high root yield, large root size and storability were mentioned by all the farmers in the two States. It means these traits are critical and should be in the genetic background of any new varieties to be extended to farmers, especially in these locations. Taste and hard mouth-feel (dry matter) of boiled roots were also mentioned by most farmers in both Sates, implying they are also key traits for consumption and should be part of the breeding objectives. However, the study also shows that gender roles should be mainstreamed into sweetpotato breeding, especially traits such as long in-ground storability which is key for household piecemeal harvesting, and as such is more important to the female than the cash crop-focused male farmer. While any high performing variety can be developed and used for sole cropping, the variety to be used for mixed cropping must consider the architecture of the other crop combinations in order to prevent shading and other performance-limiting interactions.

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