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Improving Food Security with Cocoyam Production by the Smallholder Female Farmers in Ebonyi State, Southeastern Nigeria

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Abstract
A survey was carried out to ascertain the cocoyam species found, grown and used as one of the underutilized food security resources for solving food supply problems in the developing regions of Ebonyi State, Southeastern Nigeria, which has provided good nutrition to south pacific Islanders for 100s of years. Ebonyi State is an agrarian economy rich in abundant food crops with a vegetation of mixed savanna and semi-tropical forests. Six local government areas out of 13 were randomly selected for the survey from which two female smallholder farmers each were interviewed. Taro (*Colocasia esculenta*) and Tannia (*Xanthosoma sagitifolium*) were found grown in all the communities and the index of each species' popularity and utility was shown by the percentage response of the farmers. The taro/dasheen species; 'ede bu ji' (100%), 'udugu' (75%), 'agbakara' (75%), 'okoroko' (41%) and 'ikponyini' (54%), whereas tannia species as 'nkashi ndonyu' (white fleshed) was 100% but 'nkashi manu' (pink fleshed) was only 25%. Basically, 'ede bu ji' of taro and 'nkashi ndonyu' of tannia were more popular, more widely grown and utilized in the area than other species. Storage is mainly underground pit lined with palm leaves and dusted with ash to prevent fungal growth or sorted and sold out-rightly for which 75% farmers agreed to. Cocoyam is rarely sole cropped but intercropped with maize, yam and cassava in a slash and burn system.
Keywords: Cocoyam species, food security resource, underutilized crop species, resource-constrained farmers

1. Introduction

The population of people living on the earth planet is galloping day by day causing the United Nations in 2010 predict a total population increase from 6.8 billion to about 9.1 billion by 2050. This projection also added that almost all that growth is expected to be in the developing countries with about nine in ten of all the worlds young people found there too (Spore, 2010). Already questions of demographic dimensions are rising from this scenario. Questions put forward by Sievers and Albrecht (2008) run on this tenet, "can enough food be produced to feed all these people on the dwindling land resources of the tropical world without escalating climate challenges and environmental disruption?" Or, "can the south 'hold the fort' against the backdrop of growing threats from climate change and an ever-increasing need for energy?" (Spore, 2010) Jaenicke and Pasiecznik (2009) suggested a cheering option when they stated that increasing the use of underutilized crops is one of the better buffers to help farmers diversify, and sustain nutritional, environmental and financial security in times of change, while spreading risks to reduce vulnerability of already vulnerable people.

Certain global initiatives such as 'Convention on Biological Diversity and Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture' resulting from the 2002 world food summit have been instituted in recognition of increasing human vulnerability to hunger and starvation as important vehicles for ensuring the maintenance of a safety net of diversified crops that can meet the material needs of future generations. This establishes the important role of biodiversity in food and livelihood security (Anon, 2004). Moreover, an international centre for underutilized crops (ICUC) has been established to address ways of increasing the use of underutilized crops for food, medicinal and industrial products and for environmental improvement. Padulosi and Hoeschle-Zeledon (2004) defined underutilized species as "those non-commodity crops which are part of a larger biodiversity portfolio, once more popular and today neglected by users' groups for a variety of agronomic, genetic, economic, social and cultural factors". In many cases these species are valuable sources of the micro-nutrients and vitamins needed (McClintock, 2004) to overcome the problem of lack of essential nutrients in diets consisting mainly of carbohydrate staples which often affect the young and the old, termed the 'hidden hunger' (Johns, 2004). And many of these species can make an important contribution to a better diet for local communities; like some Andean tuber plants providing much richer Vitamins A and C than potato, some such grain species containing far higher amount of certain essential amino acids than wheat and some local leaf vegetables providing appreciable amounts of minerals including calcium, iron and phosphorus, vitamins A and C, proteins and amino acids such as methionine which is commonly scarce in marketed vegetables.

Apart from their nutritional importance over the "improved species", or the "commodity crops," agro-biodiversity is basic to the survival of other farmers living in areas unsuitable for the cultivation of the improved

species. Gamarra-Rojas *et al*. (2004) indicated that the more diversified their farming systems, the greater the chance of self-sustainability and self-reliance, because they have been selected over time to withstand such stress as drought and floods (Mulaama, 2004, Oakley, 2004) and can be produced in a sustainable way using available low-cost input practices.

Man has overtime identified and learned to use nearly 8000 plant species for his food and well-being. However, the development of cultivation technology and agricultural intensification made the net food production easy thereby causing much research attention being focused on a limited number of species. Jaenicke and Pasiecznik (2009) indicated that over 50% of the carbohydrate and protein needs of the world's human population are met by only three plants (maize, rice and wheat) while over 95% of energy needs are from less than 30 plant species (Anon, 2004). This development has neglected the old sage: "Do not put all your eggs into one basket" which has led to over dependence on external inputs for the production of the improved species and consequently pest, disease and climate change issues.

The Asian root-crop plant (taro) or the West Indian root-crop plant (tannia), known as cocoyam in West Africa, taro in Asia and the Pacific, dasheen in Caribbean, is a gender polarized crop in favour of women in Cameroon, Nigeria, etc., except in Hawaii, where only men may grow it (Spore, 2003). It belongs to the aroid or calla lily family, Araceae, widely cultivated in developing countries in Africa, Asia and the Pacific and ranks 14th worldwide among the staple crops (Okwuowulu, 2000), yet listed among the world's most under-utilized food crops and on the under-utilized food brackets in Nigeria, regarded as poor people's food eaten just to ward off hunger (Thorp, 2014, Okwuowulu, 2000, Spore, 2003). It has two major identified species, *Colocasia esculenta* (L) Schott (taro), originated in Asia (small and round, perhaps one of the best known examples of the crop plant) or dasheen (a longer variety) in the Caribbean, from the French 'chou de chine', or Chinese cabbage whose tubers are known as 'eddo' or 'malanga', and *Xanthosoma sagittifolium* (L) Schott (tannia) or macabo, originated in West India which is extremely similar to the Asian root-crop. The underground storage portion is known as a corm – a short, swollen stem covered with fibrous leaf bases that form very important source of starch for people living in the wetter tropical regions, though rich in carbohydrates, is generally less rich in other food substances (Baker, 1965). Onwueme and Sinha (1991) reported that cocoyam was introduced into West Africa in the 16-17th century by Indian mercenaries, while the Polynesians carried taro to Hawaii (Baker, 1965).

Is the future of cocoyam precarious or promising? Cocoyam is grown in 30 countries either in flooded wetlands or in uplands, with the bulk of its production coming from Africa. Nigeria accounts for almost half of the world's production of 8.5 million tons, producing about 4 million metric tons of cocoyam per annum which accounts for 40% of the world production to become the largest producer in the world (Spore, 2003, Chukwu *et al*., 2008), while Papua New Guinea is currently ranked the fourth highest producer of taro in the world (Singh *et al.,* 2009). Other major producers in sub-Saharan Africa are Ghana, Cote d'Ivoire, Madagascar, and the Central African Republic. Africa is followed by Asia, where China is the main producer, followed by Japan, the Philippines and Thailand. FAO says 'no other part of the world can match Oceania (with 300,000 tons) in terms of the intensity of production, utilization and dependence on taro for food' (Spore, 2003). However, cocoyam can survive in marginal soils and under erratic rainfall pattern (GSC, 2009), with yields varying from 4 t/ha in Ghana, but with good management practices, yields of 25-37 t/ha have been recorded in the Pacific (Sar *et al*., 1998).

Cocoyam has a very high nutritional profile whose corms, cormels, stalks and inflorescence are all utilized in human nutrition in a variety of ways either, cooked and eaten alone or together with other dietary staples and vegetables or pound into flour (Ekwe *et al*., 2007). The nutritional profile of both the roots (R) and the leaves (L) of taro are stated as follows: energy-9%R, 1%L, protein-14%R, 7%L, vitamin A-0%R, 64%L, vitamin C-43%R, 107%L, vitamin B1-22%R, 6%L, vitamin B2-8%R, 15%L, calcium-9%R, 15%L, iron-17%R, 21%L, and niacin-12%R, 3%L (SPC, 1992), yet suffers serious image disorder. Okoye and Onyenweaku (2007) reported that cocoyam is recommended for diabetics, nursing mothers, the aged, children with allergy and people with intestinal disorders However, the starchy flesh is toxic to an irritating level, unless well cooked and the corms/cormels have very short shelf-life in the store. The leaves attain the worship-level of a national dish when cooked as greens and served as 'callaloo' in Trinidad or Jamaica. The tubers are mashed with cassava as 'fufu' in West Africa where it is a staple in Cameroon, Ghana, Guinea and Nigeria. FAO (1989) reported that taro starch grains are small and very digestible and therefore used for invalid foods while, Sar *et al*. (2001) indicated that it has a potential of being an important crop in the diversified food system. The tubers of taro represent a national intake of dietary calories in Tonga (40%), while about 10% of the people of Solomon Islands gain their dietary calories intake of 30% from taro tubers and it is in Samoa that the central role of taro is better expressed (one-fifth of all the population's dietary intake) prior to the taro leaf blight of 1993 (Spore, 2003). Cassava, white rice, maize and coco-yams were introduced from Brazil and Southeast Asia about 16th century which helped to augment the yams which was the major source of carbohydrate for the African people in the region (Orkwor, 2001). Taro chips, powders flours cakes, biscuits, ice-creams are banal products, but power foods for a people. In 2010, an estimated 9 million tons of various species of cocoyam was grown and consumed worldwide (Spore,

2014). The main goal of this study therefore, was to determine the importance of cocoyam species found, grown and utilized by the rural people of Ebonyi State and the role it plays in her food economy.

2. Materials and Methods

2.1 Study Area Characteristics:

Ebonyi State is geographically located in the southeastern agro-ecological zone with an agrarian economy on a land mass of approximately 5,932 square kilometers and lies approximately at latitude 07° 30'N and longitude 05° 40'E. Cocoyam species found in the traditional food habits of Ebonyi State have been described as varied and abundant in a rich vegetation of mixed savanna and semi-tropical forest. The species discovered and utilized in the area compared closely with the species found in the National Root Crop Research Institute (NRCRI), Umudike, situated in southeastern Nigeria. The mixed vegetation hosts various food crops like, yams, cocoyam, cassava, rice, maize, plantains and bananas, and many other cash/plantation and horticultural crops (EBSMI, 2001). The state has pseudo-bimodal rainfall pattern spread from April to November with annual rainfall rang between 1700mm-2060mm. Ebonyi state receives abundant insolation during the day. The maximum mean annual temperature is 27-36°C all through the year. Humidity is high with lowest levels during the dry season in April before the rainy season begins. The area generally has an isohyperthermic soil temperature regime. The most prevalent soil in the state is Ultisol. Although other soil orders of the USDA classification identified previously include Entisol, Alfisol and Inceptisol. The soils are generally strongly weathered but because of the varied nature of geological formations, the chemical and mineralogical properties (fertility status) of the soil vary greatly.

2.2 Methodology:

A reconnaissance survey was carried out on the study area, involving the thirteen (13) local government areas of Ebonyi State (Table 1) alphabetically listed with their local government headquarters, out of which six (6) local government areas (asterisked) were randomly selected through the use of numbered paper cards. It has been shown that the agrarian nature of the state conveys to every community the status of a cocoyam grower and user of the same in their traditional food habit (personal communications). Against this background and some economic considerations, six local government areas (representing 46.15%) were adjudged a fair statistical representation of the state. The brief information on Ebonyi state contained in the diary of the state published by the Ministry of Information in 2001 gave credence to the popularity of cocoyam in the traditional food culture of the people and mentioned as one of their food crops.

Table1. Alphabetical listing of the 13 Local Government Areas in Ebonyi State with their headquarters showing the randomly selected ones with asterisked

S/N	Local Government Area	Headquarter
1.	Abakaliki *	Nkaliki
2.	Afikpo North*	Afikpo
3.	Afikpo South	Nguzu Edda
4.	Ebonyi	Ugbodo
5.	Ezza North*	Ebiaji
6.	Ezza South	Onueke
7.	Ikwo*	Onuebonyi Echara
8.	Ishielu*	Ezillo
9.	Ivo	Isiaka
10.	Izzi	Iboko
11.	Ohaozara	Obiozara
12.	Ohaukwu	Ezzamgbo
13.	Onicha*	Isu

*Randomly selected local government areas
Source: Ministry of Information, Ebonyi State, 2001

The information gathering instrument was the questionnaire informed by a reconnaissance survey made to identify two towns from each selected local government areas during which two female-farmers were selected from each selected towns (which gave 24 female smallholder farmers) who were interviewed in their homes using an open ended questionnaire one on one by reading out the questions and explaining wherever confusion arises while the interviewer wrote down as much information from the farmer as possible. After the interview, the farmer was requested to release some of their species (at a token) with their local names which was used along with the English (common) names of those obtained from NRCRI, Umudike.

Table2. List of randomly selected Local Government Areas, Towns and Farmers in Ebonyi State, Nigeria

Local Govt. Area	Headquarter	Town	No. of Farmers
Abakaliki	Nkaliki	Nkwegu, Nkaliki	2 2
Afikpo South	Afikpo	Afikpo Owutu	2 2
Ezza North	Ebiaji	Ekeimoha, Oriuzor	2 2
Ikwo	Onuebonyiechara	Idembia, Achara	2 2
Ishielu	Ezillo	Ezillo Nkalagu	2 2
Onicha	Isu	Isu Umudomi	2 2
6	6	12	24

2.3 Research Questions:

The following survey questions were posed to elicit needed information from the smallholder female farmers: (a) Do you grow cocoyam? (b) What type of cocoyam do you grow? (c) In what forms do you utilize the crop? (d) What time do you plant, harvest and the cultural practices you carry out in your farm? (e) What storage methods do you adopt?

Prior to this, visit was made to NRCRI, Umudike to interview some scientists and observe available species in their collection in order to acquaint ourselves with the cocoyam species available to ensure that relevant information are gathered during the conduct of the survey of the selected study area. Table 3 shows the species obtained from the research institute having cocoyam as one of her mandate crops. Eight improved cocoyam species were recognized, of which three tannia species were identified namely, the pink fleshed, white fleshed and the yellow fleshed also known as Ghana, while five taro/dasheen types were identified two of which are differentiated into the green petiole and the purple petiole types. These were invariably the types eventually identified among the farmers in the survey area which helped greatly to carry out a smooth survey exercise.

Table3. Some improved breeds of cocoyam species from National Root Crop Research Institute, Umudike, Umuahia, Nigeria

Scientific name	English name	Genetic name	Igbo name
X. sagittifolium var. caraca	Tannia	NCY 001 (white fleshed)	Ede ocha
X. sagittifolium var. violaceum	Tannia	NCY 002 (pink fleshed)	Ede uhie
X. sagittifolium var. atrovirens	Tannia	NCY 008 (yellow fleshed)	Ede odo (Ghana)
C. esculenta	Taro (Dasheen)	NCY 003	Okorokoro
C. esculenta	Taro (Dasheen)	NCY 004 (Cocoindia)	Ede buji
✓	✓	NCY 005A (green petiole)	Ede ofe
✓	✓	NCY 005B (purple petiole)	Ede ofe
✓	✓	NCY 006	Ukpong
✓	✓	NCY 007 (giant)	Ede ofe

All the information gathered from the questionnaire was described accordingly, while the data collected were converted to percentages. The percentage response was computed by dividing the frequency (F) by the number of respondents (N) to an item and the quotient multiplied by 100. An item must score 50% to be significantly different.

3. Results and Discussion

Sustainable food security in developing nations of the world has become an enigma defying almost all the diverse food security policies of the United Nations, but food aids. What has kept the deluge of famine in check among most of the resource-constrained rural poor going all these days of raging hunger is the identification and concerted utilization of numerous underutilized food crop resources (security food crops) like cocoyam by the rural populace. Survey of these security food crops has become very necessary now that the threat to biodiversity by climate change is on rampage and taming of hunger pangs almost elusive.

Table 4: The identified cocoyam species of taro and tannia grown in the survey area and the percentage of female smallholder farmers involved in the cultivation of each type

Species		Dialectical name	Common name	Scientific name	Farmers involved	
					No.	%
Tannia	1.	Nkashi mmanu	Tannia (pink flehed)	*X. sagittifolium*	6	25
✓	**2.**	Nkashi ndonyu	Tannia (white fleshed)	*X. sagittifolium*	24	100
Taro	1.	Ede buji	Taro /dasheen	*C. esculenta*	24	100
✓	**2.**	Udugu	Taro /dasheen	*C. esculenta*	18	75
✓	**3.**	Agbakara	Taro /dasheen	*C. esculenta*	18	75
✓	**4.**	Okoroko	Taro /dasheen	*C. esculenta*	10	41
✓	**5.**	Ikponyini	Taro /dasheen	*C. esculenta*	13	54

Table 4 indicates that the white fleshed tannia (Nkashi ndonyu) is commonly grown in Ebonyi state by the female smallholder farmers and all the 24 farmers are involved in its production, whereas only six farmers indicated being involved in the production of the pink fleshed tannia (Nkashi mmanu). There is a very high involvement by the farmers in the production of the five taro species, though only ten farmers indicated involvement in the production of okoroko subspecies of taro. One hundred percent of the farmers are involved in the production of Ede buji, seventy five percent each of Udugu and Agbakara subspecies of taro while, thirteen farmers or 54% are involved in the cultivation of Ikponyini taro or dasheen.

Table 5: Land preparation activities and cultural practices adopted by the female smallholder farmers in the study area

S/N	Activity	Percentage involved
i.	Slash with cutlass, allow to dry and burn	79%
ii.	Slash with cutlass, gather to corners and allow to decompose	62%
iii.	Sole cropping on small to medium mounds	29%
iv.	Mixed cropping with yams, cassava and maize on large mounds	100%
v.	Hoe weeding 4 WAP once (sole plots) before leaves form canopies	37%
vi.	Hoe weeding 4 WAP repeated 2-3 times (mixed plots) before harvest	100%
vii.	No fertilizer application (sole or mixed)	90%
viii.	Fertilizers applied at 14 WAP (sole or mixed)	45%

Key: WAP = Weeks after planting

In Table 5, different land preparation activities and cultural practices carried out by the female smallholder farmers in the survey area are displayed, which showed that all the farmers interviewed adopt mixed cropping of cocoyams with yams, cassava and maize, and carry out hoe weeding 2-3 times before harvest (100%). This observation agrees with Onwueme and Sinha (1991) who stated that cocoyams are shade tolerant which can adapt to lower canopies of staked yams, cassava and maize intercrops. Rarely (29%) is cocoyam grown alone as a sole crop. Rather, it is mostly planted in mixtures of yams, cassava and maize plants or planted under plantation crops. Few farmers (45%) apply fertilizers to cocoyam plants either in mixtures or sole stands. Generally, most farmers do not apply fertilizers (90%), but practice slash and burn (79%) and moderately slash and allow the debris to decompose on the farm (62%).

Table 6: Storage methods cocoyams by the smallholder female farmers in the survey area

S/N	Storage methods	Percentage users
i.	Leave in the soil after maturity and harvest piecemeal	41%
ii.	Harvest, sort, store in underground pit lined with ashes and palm leaves	75%
iii.	Harvest, sort and pill up in prepared cocoyam barns	45%
iv.	Harvest, sort and pill up in open rafters with overhead shade	62%
v.	Harvest, sort and sell off leaving some for planting and for food	75%

Loss of cocoyam harvests is enormous and of great consequence to the female smallholder farmers who have used several storage methods out of which item numbers (ii) and (v) methods are used by greater number of farmers (75%), followed by item number (iv) method (62%), then item number (iii) (45%) and the least used method is item number (i) (41%) displayed in Table 6. The use of underground pits lined up with palm leaves and sprinkled with ashes is the usual common method as the ash is claimed to have fungicidal effect that slows down the incidence of white rot in cocoyam (Personal communication).

Table 7: Forms of utilization of cocoyams by the smallholder female farmers in the survey area

Species	Dialectical name	Utilization forms
Tannia	Nkashi mmanu	Consumed boiled/roasted with vegetables and palm oil
Tannia	Nkashi ndonyu	-do-
Taro	Ede buji	Consumed boiled/roasted/fried slices, ideal as soup thickener
Taro	Udugu	Ideal bitter leaf soup thickener; Preserved as 'achicha' dry chips
Taro	Agbakara	Ideally boiled and pounded into foofoo; also as 'achicha' dry chips
Taro	Okoroko	Boiled and pounded into foofoo, eaten with vegetables and oil
Taro	Ikponyini	-do-

Table 7 showed that taro 'udugu' is used to prepare 'achicha' a traditional local food delicacy which is the preserved dry form of cocoyam obtained after boiling, slicing and drying cocoyam, commonly eaten during periods of lean food supply. The dry chips 'achicha' is prepared as a meal by beating it with pestle in a mortar into tiny particles, soaked in water, sieved, parceled in plantain leaves and water heated to soften which can be eaten with vegetables, dry/fresh pulses and freshly prepared palm oil (in some quarters children savour it as 'Igbo rice'). Igbo rice is used here as the final tiny particles resemble the common rice (*Oryza spp*). Okoli *et al*. (2000) showed that cocoyam can be processed into high quality instant cocoyam *fufu* and had earlier processed instant cocoyam flour enriched with melon flour of a very promising quality (Okoli *et al*., 1999) to fight the issue of hidden hunger usually experienced in consuming staples like cocoyam.

4. Conclusion

Conclusion is made on the basis of the findings that cocoyam species similar to those found in the research institute are found grown and used in the study area and are playing vital role in the traditional food habits of the people. Florence Egal of the Nutrition Division (Food and Agriculture Organization), commented that at a time when fortification is widely promoted as the most effective solution to address micro-nutrient deficiencies, nature provides an almost infinite variety of food species which are disregarded and pushed into oblivion and extinction by the prevailing food production system (Biodiversity International, 2013), which this survey underscores. Cocoyam, despite its importance as an 'underutilized crop species', a term that refers to those species whose potential to improve people's livelihoods as well as food security and sovereignty, is not being fully realized because of their limited competitiveness with commodity crops in mainstream agriculture, is now receiving more recognition in the dominant smallholder form of agriculture (Padulosi *et al*., 2011, IAASTD, 2009). The Via Campesina has long argued that small farmers are of central importance for communities to be able to meet growing food demands and believes that in order to protect livelihoods, jobs, people's food security and health as well as the environment, food production has to remain in the hands of small-scale sustainable farmers and cannot be left under the control of large agribusiness companies or supermarket chains (Altieri, 2008).

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