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Survey of diversity and production of yams in four communities in Southern Ghana

Aboagye L. M.[1,2]*, Nyadanu D.[3], Opoku-Agyeman M. O.[1,4], Owusu S. K.[1] and Asiedu-Darko E.[1]

[1]Council for Scientific and Industrial Research, Plant Genetic Resources Research Institute, P. O. Box 7, Bunso (ER), Ghana.
[2]Department of Crop and Soil Sciences, College of Agriculture Education, University of Education, P. O. Box 40, Mampong Ashanti, Ghana.
[3]Department of Crop and Soil Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.
[4]Cocoa Research Institute of Ghana, P. O. Box 8, Akim Tafo, Ghana.

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A survey was conducted in four yam growing communities in southern Ghana, with the objectives of analyzing the diversity of yam species being cultivated, extent of production, yams preferred and identification of challenges confronting yam production. A total of 264 farmers were involved in the survey, 200 men and 64 women. Six yam species were encountered and 136 varieties were characterized according to the number of households cultivating the varieties, area under cultivation, frequency of harvesting and the preferred yams. Invariably in the four communities, most of the varieties were cultivated in small areas by few households, depicting serious genetic erosion of yams in the communities. Preference of yams cultivated depended mostly on the maturity period, ability to withstand biotic and abiotic stresses and multiple utilization as food sources. Eleven constraints were enumerated which needs to be addressed to ensure sustainable yam production. The inter-relations of the species with respect to the characteristics surveyed are presented.

Key words: Yam diversity, genetic erosion, productivity, Ghana.

INTRODUCTION

Yams are economically important starchy staple in West Africa, which is eaten as boiled, pounded, roasted or fried and can be dried to produce yam flour (Ayedoji et al., 2012; Oluwole et al., 2013). It is a staple food for over 300 million people (Mignouna et al., 2003). The yam belt of West Africa produces 95% of the annual global production of yams which is close to 51 million metric tonnes (Demuyakor et al., 2013; Fu et al., 2011). Ghana produces 25% of yam traded on the international market (Bancroft et al., 2005; SRID, 2011) and ranks third after Nigeria and Ivory Coast and contributes 17% of Agricultural Gross Domestic Product (AGDP) (FAO,

*Corresponding author. E-mail: aboagyelawrencemisa@yahoo.com

2009). Yam contributes substantially to household food security (Akromah, 1993; Kenyon and Fowler, 2000). In Ghana yam occupies 11.6% of the total cropped area and annual production is estimated to be 5.8 million metric tonnes in 2009 (FAO, 2009). Income generation from yam improves the livelih ood of resource poor farmers especially women (Bennett-Lartey and Akromah (1996). Intensive cultivation of improved yam cultivars as a cash crop reduces the number of cultivars grown in a specific area, resulting in genetic erosion (Park et al., 2005; Akromah and Bennett-Lartey, 1993). Usually farmers do not have full access to local varieties due to limitations in financial resources, facilities and the available diversity (Cooper et al., 1992; Dansi et al., 2000). Unpredictable climate extremes manifesting in loss of vegetative cover, flooding, drought and declining soil fertility are all factors militating against the loss of yam diversity. Ghana falls within the West and Central African yam belt and abounds in yam diversity especially the Guinea yam complex (*Dioscorea rotundata* and *Dioscorea cayenensis*). Other species such as *Dioscorea alata* are introduced species that have adapted well with lots of diversity. In Ghana, a number of surveys related to varietal identification (Demuyakor, et al., 2013), diseases and pests debilitating the crop (Asante et al., 2007; Tanzubil and Yakubu, 1997; Osei et al., 2004) have been carried out. In the West Africa sub-region, a number of studies have been carried out relating to production (Sesay et al., 2013; Dansi et al., 2013). Traditional breeding of yam is relatively difficult and production systems have for a long time relied on the spontaneous hybridization in the wild. There is also the need for innovations in the management of yam genetic resources in the face of current threats to germplasm loss (Mignouna et al., 2003). On-farm conservation in farmers' fields, germplasm exchange of cultivars with wider adaptation across geographical locations are some of the few interventions that need attention (Arunachalam, 2000; Akromah, 1993; Park et al., 2005). There is therefore the need to assess the existing diversity of yams, farmers' needs and preferences and to make the resulting information and diversity more available to all stakeholders in the yam value chain (Witcombe et al., 2001; Kenyon and Fowler, 2000). The decentralization of conservation activities on-farm will allow a more efficient regeneration of materials adapted to the various agro-ecological zones and an increased access to diversity of yams by farmers and other users. The knowledge of existing diversity and farmers' preferences are also a prerequisite for managing the decentralization process in a rational and efficient manner (Almekinders and Elings, 2001; Howard, 2003). The objectives of the study were to survey the diversity of yam in four communities in Southern Ghana in terms of the number of species cultivated per household, assessment of endangered species, identification of challenges facing yam farmers, preferred yam cultivars by farmers and to develop strategies for sustainable production of yams for food security, income generation and sustainable livelihood.

MATERIALS AND METHODS

Site selection

The study was conducted in four yam growing communities: Dinkro community in the Afram Plains district of the Eastern Region; Agou-fie in the Nkwanta District of the Volta region; Mfadwen in the Ewutu-Senya district of the Central region and Nyankumase in the Upper Manya district of the Eastern region. Data were collected through observation, group and individual discussions and interviews using structured questionnaire (Adoukonou-Sagbadja et al., 2006; Dansi et al., 2008a, b). The farmers were selected taking into consideration their gender, with the assistance of the Agricultural Extension Agents of the Ministry of Food and Agriculture. The discussion on yam diversity was always preceded with an enumeration of various challenges of yam cultivation and their performance.

Diversity inventory and distribution

At each village, information were taken on: name of variety, species, maturity (early or late), extent of distribution (that is, number of households and cultivated area) which were recorded using four square analysis approach (Brush, 2000; Dansi et al., 2008a, b). All the accessions were taken, evaluated and placed in the appropriate quadrant. Discussions were also held to understand the reasons of cultivation, ranking of preferred varieties and challenges encountered in each community.

Data analyses

Data was analyzed using SAS 9.2 software and using the simple matching coefficient of similarity, a dendrogram was created by Unweighted Pair-Group Method with Arithmetic Average (Rohlf, 2000).

RESULTS

Demographic information

Table 1 shows the demographic characteristic of the areas surveyed. A total of 246 farmers were involved, 200 males (81%) and 46 females (19%). The percentage of male participants ranged from 76.6% in Mfadwen to 91.4% in Dinkro. Female participants were highest in Mfadwen (23.4%) and least in Dinkro (8.6%). Of the 15 ethnic groups, the Krakyes, Dagombas, Kusasis, Ewes and Akans were the dominant growers of yams as they were encountered in more than one community.

Households and extent of cultivation in the four communities

Table 2 shows the variability in terms of cultivation and the number of households of the yams surveyed. The

Table 1. Demographic information of the communities surveyed.

Community	No. of participants	Sex		Ethnicity of group
		Male	Female	
Dinkro	47	43(91.4%)	4(8.6%)	Sissala, Konkomba, Krakye, Akan, Kusasi Dagarti, Gruma, Kabra
Mfadwen	30	23(76.6%)	7(23.4%)	Ewutu, Fante
Agou-fie	80	65(81.2%)	15(18.8%)	Krakye, Konkomba, Akan, Ewe
Nyankumase	89	69(77.5%)	20(22.5%)	Krobo, Ewe
Total	246	200	46	15

Table 2. Variability in households and area under cultivation in the 4 communities

Communities	++	+-	-+	- -	Total
Dinkro	6(4.4%*)	3(2.2%)	3(2.2%)	34(25.0%)	46
Mfadwen/Bontrase	2(1.4%)	3(2.2%)	1(0.7%)	14(10.3%)	20
Agou-fie	8(5.9%)	0	4(2.9%)	33(24.3%)	45
Nyankumase	1(0.7%)	0	0	24(17.6%)	25
Total	17(12.4%)	6(4.4%)	8(5.9)	105(77.2%)	136

++: Many households and large areas; **+-:** Many households and small; areas **-+:** Few households and large areas; **--:** Few households and small areas; *: Figures in brackets are percent of overall total (136).

Table 3. Evaluation of maturity of the yam germplasm in the four communities.

Species	Communities							
	Double harvesting				Single harvesting			
	Dinkro	Mfadwen	Agoufie	Nyankumase	Dinkro	Mfadwen	Agoufie	Nyankumase
D. rotundata	17	5	23	2 (47*)	11	6	13	0 (30*){77#}
D. alata	0	0	0	9 (9)	18	7	9	0 (34){43}
D. esculenta	0	0	0	0 (0)	0	1	0	0 (1){1}
D. cayenensis	0	0	0	6 (6)	0	1	0	0 (1){7}
D. dumetorom	0	0	0	1(1)	0	0	0	0 (0){1}
D. praehensilis	0	0	0	7(7)	0	0	0	0 (0) {7}

*: Figures in brackets are total for either double or single harvesting of the four communities; #: Figures in brackets are total for double or single harvesting of the four communities.

greatest numbers of yam varieties were recorded at Dinkro (46) with the least at Mfadwen (20). In general, the number of accessions cultivated by few households on small areas constitutes 77.2% of the total. To a lesser extent 12.4% of the yams were cultivated by many households over large areas. In terms of the communities, Dinkro and Agou-fie had the greatest number of yams being cultivated by many households as well as the greatest number of few households on small areas.

Maturity period of the accessions

Table 3 shows the maturity period early (double harvesting) and late (single harvesting) in the four communities. Forty-seven accessions of *D. rotundata* were double harvested and thirty accessions were single harvested. Dinkro and Agoufie had the greatest number of double and single harvested *D. rotundata* respectively. In *D. alata*, nine accessions were double harvested in only one community and 34 accessions were single harvested in three communities. In the other three species, Nyankumase recorded a total number of double harvested of 14: *D. cayenensis* (6), *D. dumetorom* (1) and *D. praehensilis* (7). Of the six species enumerated, *D. roundata* had the greatest number of accessions of 77 followed by 43 in *D. alata*, with *D. esculenta*, *D. dumetorom* having one accession each.

Preference for yams

Figure 1 shows the preference of the yams in the

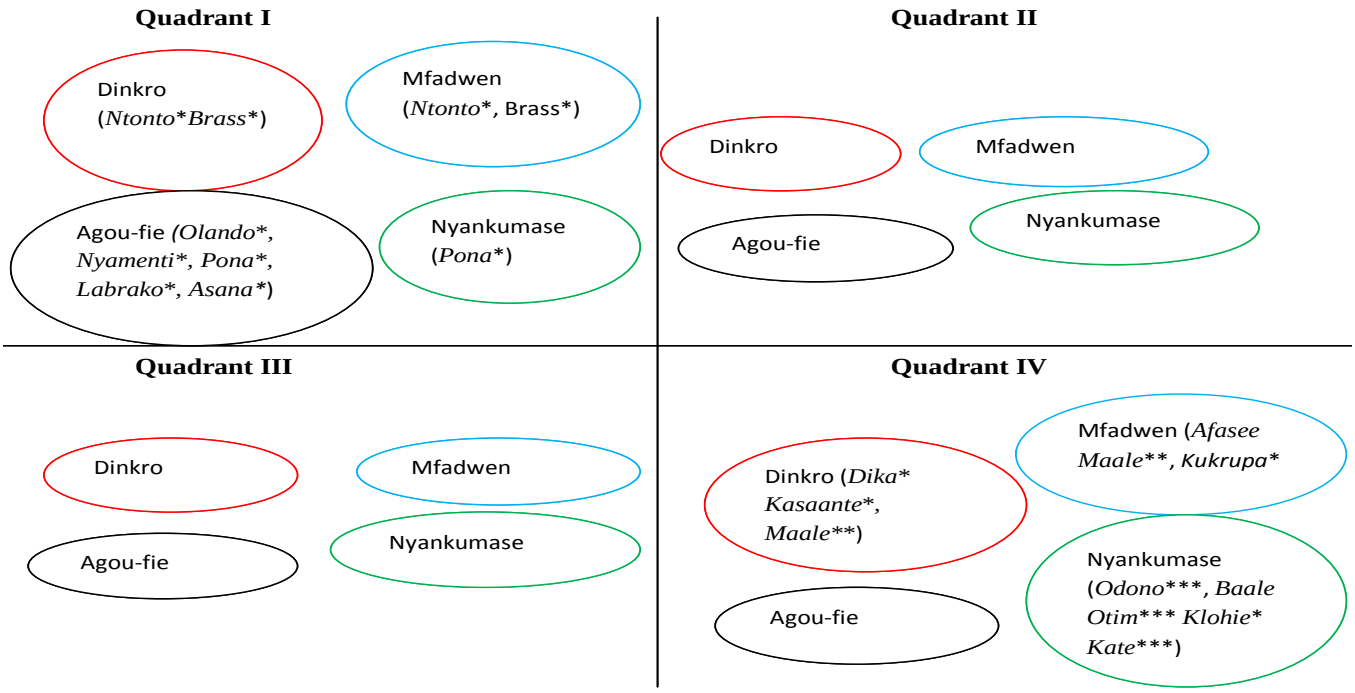

Figure 1. Preferred yams and extent of cultivation. **D. rotundata*; ** *D. alata*; *** *D. praehensilis*.

localities and the extent of cultivation in terms of households and area under production. Six varieties were listed, all *D. rotundatas*, three of which were listed in three communities. The varieties: *Ntonto*, *Brass* and *Pona* were planted by many households on large areas and double harvested (Quadrant one). Other most preferred yams cultivated by few household on small areas were: four *D. rotundatas* (*Dika*, *Kasaante*, *Kukrupa* and *Klohie*) and three *D. praehensilis* (*Odono*, *Baale Otim* and *Kate*) which are double harvested. In terms of the communities, at Mfadwen, the preferred *D. rotundata* varieties were: *Ntonto, Krukrupa* and *Brass* and that of *D. alata* were *Matches* and *Afasee Maale*. *Ntonto* and *Brass* were cultivated by many households in large areas and practice double harvesting. At Agou-fie, the preferred varieties were *Labrako, Pona, Nyamenti and Olando*. All the preferred yams were *D. rotundata* which were double harvested and cultivated by many households over large areas. At Nyankumase, the preferred *D. rotundata* varieties were *Pona* and *Klohie* and that of *D. praehensilis* were *Odono, Kate* and *Baale Otim*. Both *D. rotundata* and *D. praehensilis* were double harvested and cultivated in few areas. At Dinkro, the preferred varieties were *Ntonto* and *Brass* and cultivated by many people over large areas. Others are *Kasaante*, *Dika* and *Baale* which are cultivated by few people over small areas.

Constraints identified

Table 4 shows the constraints enumerated during the survey. In all, 11 constraints were recorded. Diseases and pests were recorded as the major constraints in all the four communities. Planting materials constraints were recorded in Nyankumasi and Mfadwen; storage/shelf life and credit were recorded at Mfadwen and Agoufie. Mfadwen recorded constraints of land availability, poor soil, labour and drought. Weed control and transportation were recorded at Agoufie. In all, Mfadwen recorded the highest number of constraints (8) and Dinkro had the least (1).

Figure 2 shows the dendogram of the species based on the characteristic of the yams surveyed. At a similarity index of 10.42, there were two major clusters. Cluster one consists of only *D. rotundata* and cluster 2 consists of two sub-clusters: *D. alata* and that of *D. esculenta*, *D. cayenensis*, *D. dumetorom* and *D. praehensilis* together. These two sub-clusters had a similarity index of 40.28. At the similarity index of 85, there were two sub-clusters grouping *D. esculenta* and *D. cayenensis* together with *D. dumetorom* and *D. praehensilis*.

DISCUSSION

Within the four communities surveyed, a total of 136 accessions of yams and six out of the seven known species of yams in Ghana were encountered: *D. alata* - 43; *D. rotundata* - 77; *D. praehensilis* – 7; *D. cayenensis* – 7; *D. esculenta* -1 and *D. dumetorom* - 1. A major challenge was the genetic erosion in the farmers' fields as depicted by the greater number of accessions in

Table 4. Constraints in the four communities.

Constraints	Dinkro	Mfadwen	Agoufie	Nyankumase	No. of communities
Diseases and pests	*	*	*	*	4
Planting Materials		*		*	2
Storage/shelf life		*	*		2
Credit		*	*		2
Marketing				*	1
Land		*			1
Soil		*			1
Drought		*			1
Labour		*			1
Weed			*		1
Transport			*		1
No. of constraints/community	1	8	5	3	17

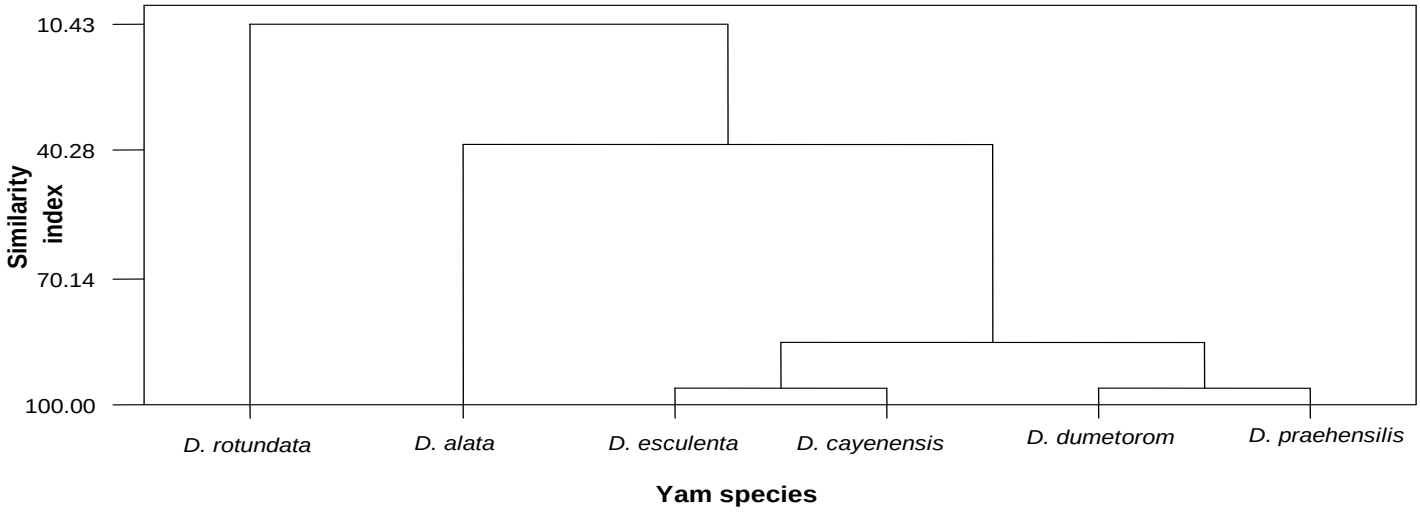

Figure 2. Inter-relations of the characteristics of the yam species surveyed.

quadrant IV (few households, in small areas), showing a value of 77.2%. Concerted efforts are being made in Ghana to multiply some of the germplasm under threat for re-distribution to farmers and also to place all available yam germplasm *in vitro*. Yam diversity fairs must be organized by stakeholders to afford farmers opportunity to know more about yam genetic resources and to exchange germplasm, a way of broadening the genetic base of yams on farmers' fields (Witcombe et al., 2001). The genetic erosion on-farm are due to the introduction of new varieties, loss of farms, changes in farmers' practice and market demand (Kenyon and Fowler, 2000). Climate change, biotic and abiotic stresses are the other causes of genetic erosion and cultivation of few accessions in small areas. On the other hand as many as 103 accessions were cultivated by farmers under small areas. The number of accessions being cultivated may have peculiar characteristics to mitigate stresses for sustainable food security. In this study, some accessions were identified as tolerant to drought or excessive moisture and these materials give ample room for further research and development of varieties to mitigate stresses. *D. praehensilis* was identified in only one community and it was double harvested and the others were found in all the four localities. Conspicuously absent was *D. bulbifera* which was not encountered in any of the communities, a situation giving cause to underutilization, genetic erosion and extinction and suggest urgent need to salvage this endangered variety. In the localities, preference was given to some accessions in terms of maturity (double - early or single - late harvested), tolerant to abiotic and biotic stresses and utilization. Of particular mention was the identification of some yams with special traits resilient

to climate change. They are: *D. rotundata*: '*Nyamenti*' – which can tolerate excess moisture conditions; *Pklinjo, Benin* and *Ofunkudja* which are also *D. rotundata* varieties that tolerate moisture stress conditions. Other attributes need further investigation so as to develop a full agronomic package to boost their productivity. Over the years, participatory characterization and evaluation were done by scientists without the involvement of the farmers and other stakeholders (Kamara et al., 1996; Kitch et al., 1998; Witcombe et al., 1996). Concerted efforts must be made to involve all stakeholders in the yam value chain for better utilization by knowing the culinary and storage properties of the materials of which gender role especially that of women is very crucial (Defoer et al., 1997; Ogato et al., 2009). Out of the seventeen yam accessions preferred by the farmers, 14 were *D. rotundata*, out of which 10 were double harvested and 10 were cultivated by many households in large areas (Table 4). Such varieties should be candidate materials for any yam improvement strategy to boost production. Two major groups of white yams in terms of maturity were encountered: early yielding and late yielding. Early yielding in white yams is defined as the ability to conveniently give a double harvest at one planting season when the yam is milked. Late yielding ones were those that might not give ware-tubers if harvested early, in an attempt to obtain double harvest. Generally the preferred yams were early maturing i.e. double harvesting, good quality, good market price, excellent storability and can be used as *fufu*, a delicacy in Ghana. Other food preparations include *Ampesi*, *Koliko*, *Wasawasa*, *Konkonte*, *Tubani* and roasted yam (Owusu et al., 1994). At Nyankumase, all the yams were double harvested and planted by few households. It was the only location that had *D. praehensilis* among the six species recorded. At Agou-fie, 23 of the yam varieties were double harvested and 13 single harvested, showing the balance between production of ware yams and planting materials (Bennett-Lartey et al., 1997). These materials should be developed as food security crops as well as planting materials production.

Diseases and pests issues are often neglected in conservation approaches despite their negative effects on collected samples and further use of the germplasm. Diseases and pest were prevalent in all the 4 areas surveyed. Yam tubers are known to carry and accumulate many pests and diseases: viruses, fungi, nematodes, insects and bacteria (Coyne et al., 2006; Coyne et al., 2012; Morse et al., 2000).

As a result, while maintained in the field by farmers–, they presents reservoir of pests and diseases with damaging consequences on future germplasm production and pathogen dispersion and the surest way to obtain disease free materials, is through *in-vitro* conservation. On the other hand materials identified to be resistant to diseases and pests need to be developed, promoted and used by farmers (Ettien et al., 2013; Jarvis and Campilan, 2006).

CONCLUSION AND RECOMMENDATIONS

The survey has revealed a number of challenges facing yam production in southern Ghana. Among them was the number of accessions cultivated by few household in small areas, giving cause to tackle genetic erosion of the species to prevent their total extinction. The gender imbalance as reflected in the involvement of women needs to be looked at, since apart from the mounds making (normally done by men), women are the key stakeholders in the marketing, transportation and processing (as food and food products) of yam. Particular attention must be paid to yams preferred such as the following *D. rotundatas*: *Ntonto*, *Brass*, *Olando*, *Nyamenti*, *Pona*, *Klohie*, *Asana*, *Kukrupa*, *Labrako*, *Dika* and *Kasaante*. The preferred *D. alata* are the *Afasee Maale* and *Maale* and that of *D. praehensilis* include *Odono*, *Otim* and *Kate*. These materials should be improved and production technologies transferred to farmers to enhance productivity of yams. Finally, farmers' access to conserved germplasm should be improved through the multiplication, distribution and exchange of yam genetic resources.

Conflict of Interest

The authors have not declared any conflict of interest.

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