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Increasing farmers and breeders access to yam (*Dioscorea* spp) diversity: The case of Forest-Savannah Transition Agroecology

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A study was conducted in five yam-growing communities in the Forest Transition Agroecological Zone of Ghana to identify cultivated yam varieties, their distribution and intensity of cultivation and to document the rate and causes of landrace germplasm loss. Generally, the cultivated varieties ranged from 9 to 16 with a mean of 12. The most diversity was found in Sankore (Asunafo South District), followed by Sampa in the Jaman North District, Asantekwa in the Kintampo District, Ejura in the Ejura-Sekyedumase and Mim in the Atebubu/Amantin Districts with 16, 15, 12, 11 and 9 cultivated varieties respectively. *Dioscorea rotundata* is most widely cultivated species of yam followed by *Dioscorea alata*, *Dioscorea cayenensis*, *Dioscorea praehensilis* and *Dioscorea bulbifera* respectively. Factors such as good culinary characteristics, high yield, seed generation capacity, good storage characteristics and resistance to biotic and abiotic stresses were important criteria for selection of variety. The market and utilization were major determinants of continual cultivation of a variety or its neglect.

Key words: Agro-morphological, cultural, environmental, Ghana, technological.

INTRODUCTION

Yam (*Dioscorea* spp. of family Dioscoreaceae) is multi-species, polyploid in nature and vegetatively propagated crop. It is cultivated for its starchy tubers (both cultivated and wild) (Obidiegwu et al., 2009). The major edible yam species are *Dioscorea rotundata* P., *Dioscorea cayenensis* Lam., *Dioscorea dumetorum* (Kunth) Pax, *Dioscorea alata* L., *Dioscorea bulbifera* L., *Dioscorea esculenta* (Lour.) Burk, *Dioscorea trifida* L. and *Dioscorea nummularia* Lam (Alieu and Asiedu, 2011).

Yam is a staple food crop of over 300 million people in tropics and subtropics (Mignouna et al., 2003). Ghana is one of the most important yam producing countries in the world; it is the third (9%) behind Nigeria (66%) and Cote d'Ivoire (13%) in terms of production (FAO, 2009). It is an elite crop, preferred over other root and tuber crops in West Africa and it is the food of choice at

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festive occasions, and the only crop that is celebrated wherever it is cultivated (Coursey, 1967; Hahn et al., 1987). Resource poor people, especially women, derive a good income from its production, processing, and marketing (Dufie, 2009). It also constitutes a cheap source of carbohydrate in the diets of millions of people worldwide and in tropical West Africa it provides some 18 metric tonnes of food for people in the yam zones. Yam also constitutes 53% of total root and tuber consumption in West Africa (Asiedu and Otoo, 2009).

Yam, therefore, is not only an important stable crop in West Africa but also an important cash crop. It contributes 12% of dietary energy supply and of the major agricultural food items in Ghana traded in 2010; yams were among the most important crops (top exports) with the net trade (export) of 7030 tonnes valued $4245000 (FAO, 2010). The importance of yams to the Ghanaian economy can therefore not be over-emphasized.

Yam shows considerable diversity both at inter- and intraspecific levels (Okoli, 1991). The diversity under cultivation is further enhanced by the ongoing domestication of wild yam in various countries (Mignouna and Dansi, 2003; Scarcelli et al., 2006a). The diversity of yams in Ghana is poorly determined. Yam species generally, however, have adapted to different zones where they are often more abundant. *D. rotundata,* for instance, thrives well and is grown in the Guinea Savannah zone even though it can also be grown in the forest and Sudan Savannah zones. *D. alata*, *D. cayenensis*, *D. dumentorum* and *Dioscorea praehensilis* are mostly grown in the forest zone. In terms of utilization as food, *D. rotundata* is the most popular yam in Ghana followed by *D. alata*, *D. cayenensis*, *D. dumetorom*, *D. esculenta* and *D. praehensilis.*

Yam (*Dioscorea* spp.) belongs to the genus *Dioscorea*, representing more than 600 species worldwide (Coursey, 1967). The Dioscoreales are believed to be amongst the earliest angiosperms that originated in Southeast Asia, but followed a divergent evolution in three continents separated by the formation of the Atlantic Ocean and desiccation of the Middle East (Hahn, 1995). As a result, the major food species occur in three isolated centers: West Africa, Southeast Asia and tropical America (Alexander and Coursey, 1969).

Ghana however, is the leading exporter of the crop. It contributes about 17% of agricultural gross domestic product (GDP) and also plays a key role in guaranteeing household food security (Kenyon and Fowler, 2000). The crop occupies 11.6% of the total cropped area of Ghana and annual production is estimated to be 5.8 million metric tonnes in 2009 (FAO, 2009).

There are numerous yam species in Ghana including the *D. cayenensis and D. rotundata* as well as some wild species such as *D*. *praehensilis*. The relative importance of these species has not been determined hence the extent of their usage is not known resulting in loss of some landraces over time. For vegetative propagated crop such as yam, and being indigenous to the sub-region such an approach will greatly enhance the improvement of the crop. Germplasm of vegetatively propagated species generally often contains accessions which, although morphologically similar have different genetic origins and vice versa (Lebot et al., 1998). The first step in this direction is knowing the status of the gene base of the crop in the country especially at the Forest Savannah Transition where it is mostly cultivated, documenting the rate of loss and initiating action to conserve relevant germplasm.

The aim of the study therefore was to identify the cultivated varieties of yam and their distribution in different zones in the Forest-Savannah Transition Agroecology in Ghana, the extent of landraces loss, causes and farmers' variety preference criteria.

MATERIALS AND METHODS

Study area

The study was conducted in the forest-savannah transition zones in Ghana (Figure 1). Major yam growing communities were selected from each of the districts for the study. The study area covers all the tiers of yam production in the country. It included for instance, Mim in the Atebubu/Amantin District (average production per year of 250001-459860t), Asante Kwa in the Kintampo District, Sampa in the Jaman North District, Ejura in the Ejura-Sekyedumasi District (average production per year 100001-250000t) and Sankore in the Asunafu South District (average production per year 10001-25000t). Yam production is very important in these districts especially Ejura-Sekyedumasi, Kintampo and Atebubu/Amantin (Figure 1). The other districts were added in order to obtain as much biodiversity as possible. Selection of these districts was targeted at capturing as much diversity as possible.

To assess the diversity of yams at each location, a Participatory Rural Appraisal approach was used to obtain relevant information from the farmers. It also included focus group discussions and key informant interviews.

In each of the zones, a group of at least about 30 farmers were organized and taken through a discussion based on the checklist prepared (Appendix I). The information obtained was organized in a form that it could be well communicated. Gender and ethnic zones to effectively capture relevant data on parameters such as cooking quality and preferences disaggregated the participants.

The distribution and intensity of cultivation of cultivated varieties were documented. The rate of variety loss was assessed using 4×4 matrix system (Appendix II).

The study also carried out the following activities: an inventory of the cultivated varieties in the different yam production zones and assessment of their distribution and extent of cultivation; determination of the rate of landraces loss and its variation across villages; documentation of the reasons that underlie the landraces loss and its variation across diversity zones, identification of the different yam diversity zones in the country for development actions, identification and prioritization of the farmers' variety preference criteria across zones, and documentation of the cultivated varieties for the construction of national yam database.

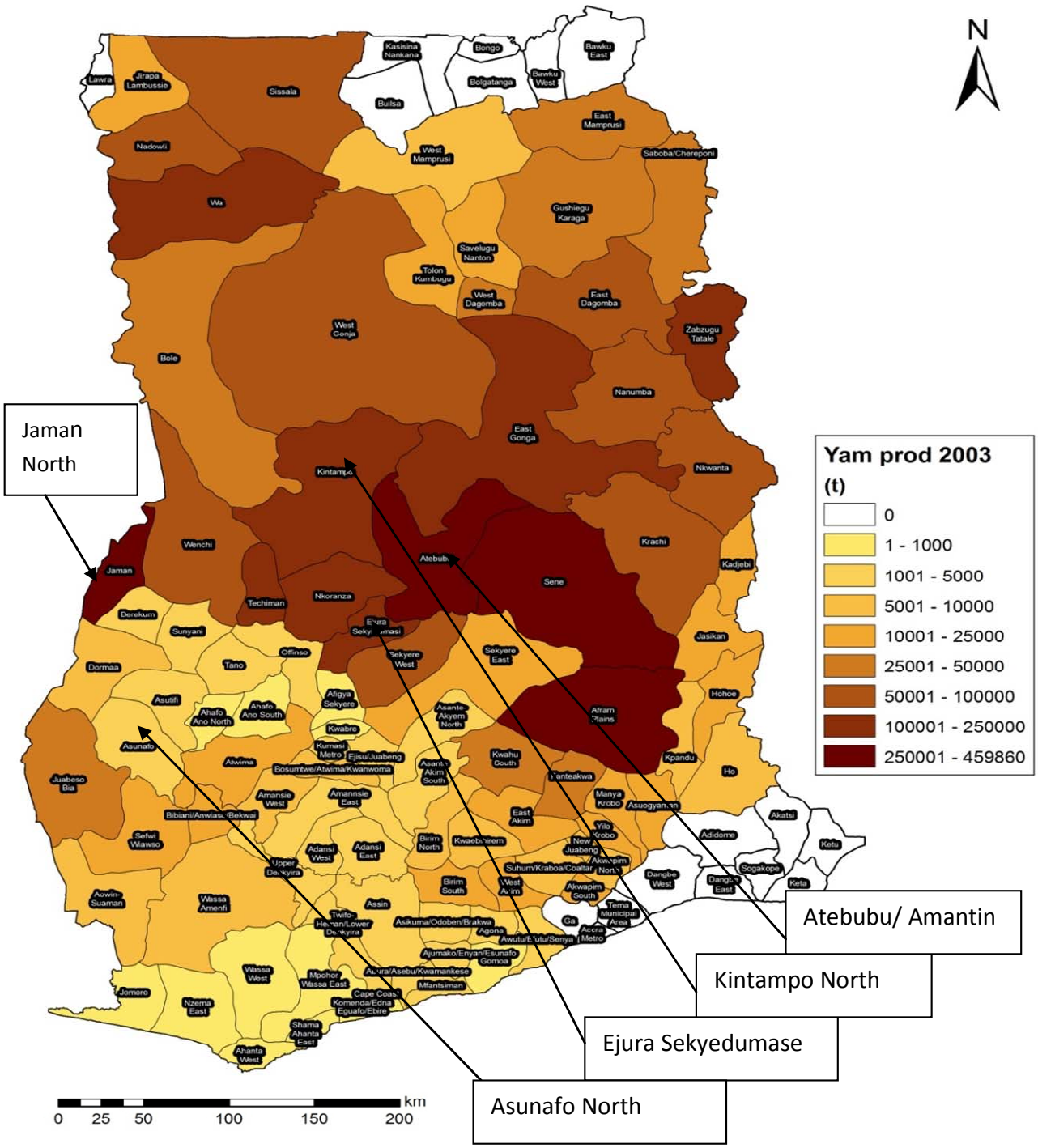

Figure 1. Study area.

RESULTS

Results of the comparison of the distribution and intensity of cultivation are shown in Table 1. In the Mim community in Atebubu-Amantin District, *D. alata* cv Matches and *D. rotundata* cv *Muchumudu* are widely cultivated by many households and in large acreages. *D. rotundata* cvs *Pona, and Serwaa* are however in danger of extinction, due to the few number of households cultivating it and on the small acreage of cultivation.

Similar trends were observed at Kintampo North District, where *Dioscorea alata* cv Matches and *D. rotundata* cv momnyowa are cultivated by many

Table 1. Distribution and intensity of yam varieties at various locations.

S/No.	Variety name	Species	Harvesting type	Distribution and extent	
				Household	Cultivated area
		Mim (Atebubu/Amantin District)			
1	Akaba	*D. alata*	Single	+	-
2	Matches	*D. alata*	Single	+	+
3	Labreko	*D. rotundata*	Double	-	+
4	Dente	*D. rotundata*	Single	+	-
5	Yesu mogya	*D. rotundata*	Double	+	-
6	Serwaa	*D. rotundata*	Single	-	-
7	Didi	*D. rotundata*	Double	+	-
8	Pona	*D. rotundata*	Double	-	-
9	Muchumudu	*D. rotundata*	Double	+	+
		Asante Kwa (Kintampo District)			
1	Afebetua	*D. rotundata*	Double	-	-
2	Akaba	*D. alata*	Single	-	-
3	Dansi	*D. alata*	Single	-	-
4	Dente	*D. rotundata*	Single	-	-
5	Dobare	*D. rotundata*	Double	-	-
6	Fuseni	*D. rotundata*	Double	-	-
7	Karangba	*D. cayenensis*	Single	-	-
8	Lele	*D. rotundata*	Double	+	-
9	Matches/Seiduble	*D. alata*	Single	+	+
10	Mmonyowa	*D. rotundata*	Double	+	+
11	Pona	*D. rotundata*	Double	+	-
12	Tela	*D. rotundata*	Double	-	-
		Sampa (Jaman North District)			
1	Afun/Kamba	*D. cayenensis*	Single	-	-
2	Akaba	*D. alata*	Single	+	-
3	Apoka/nkontina	*D. alata*	Single	-	-
4	Asamoah	*D. alata*	Single	-	-
5	Asobayere	*D. rotundata*	Single	-	-
6	Dente	*D. rotundata*	Single	-	-
7	Dobre	*D. rotundata*	Double	-	-
8	Enoti	*D. alata*	Single	-	-
9	Lele/nkasebayere	*D. rotundata*	Double	-	-
10	Lobi bayere	*D. rotundata*	Double	-	-
11	Matches	*D. alata*	Single	+	+
12	Pona	*D. rotundata*	Double	-	-
13	Teacher Takyie	*D. rotundata*	Double	-	-
14	Tempi	*D. rotundata*	Single	-	-
15	Tila	*D. rotundata*	Double	-	-
		Sankore (Asunafo South District)			
1	Afase pona	*D. alata*	Single	-	-
2	Afun	*D. cayenensis*	Single	+	-
3	Apoka	*D. alata*	Single	-	-
4	Asobayere	*D. rotundata*	Double	-	-
5	Dente	*D. rotundata*	Single	-	-
6	Entrentre	*D. alata*	Single	-	-
7	Esom ne hyen	*D. alata*	Single	-	-

Table 1. Contd.

8	Gonglogon	*D. alata*	Single	-	-
9	Guawa	*D. alata*	Single	-	-
10	Matches	*D. alata*	Single	+	+
11	Mensa	*D. rotundata*	Single	-	-
12	Muchumudu	*D. rotundata*	Double	-	-
13	Nnokoben	*D. rotundata*	Double	-	-
14	Pona	*D. rotundata*	Double	-	-
15	Serwaa	*D. rotundata*	Single	-	-
16	Soaba	*ariel yam*	Single	-	-
		Ejura (Ejura –Sekyedumasi district)			
1	Afebetua	*D. rotundata*	Single	-	-
2	Akaba	*D. alata*	Single	-	-
3	Ama Serwaa	*D. rotundata*	Single	+	+
4	Dente	*D. rotundata*	Single	+	+
5	Labreko	*D. rotundata*	Double	+	-
6	Lele	*D. rotundata*	Double	+	+
7	Matches	*D. alata*	Single	+	+
8	Nananto	*D. rotundata*	Single	-	-
9	Nentipo	*D. rotundata*	Single	-	-
10	Pona	*D. rotundata*	Double	+	-
11	Saate	*D. rotundata*	Double	-	-
12	Yesu Mogya	*D. rotundata*	Single	-	-

+: under household means lot of household, and under extent means cultivated in large acreages (greater than 2 acres), and –: under household is few household, and under extent is small acreages (less than 2 acres).

households and also in larger acreages; all other varieties are cultivated by few households and in small acreages. This trend was consistent for almost all locations.

In the Ejura Sekyedumase district, however, *D. alata* cv Matches, and *D. rotundata* cvs Dente, Lilee and Ama Serwaa are all cultivated by many household on large acreages. Varieties such as Akaba, Nananto, Nentipo, Yesu mogya *and* Afebetua have the potential of disappearing. *D. rotundata* cvs *Yesu mogya* and *Afebetua* are almost at the brink of extinction.

In the Mim community in Atebubu District, *D. rotundata* cvs *Pona, Serwaa and muchumudu* are also in danger of extinction, due to the low number of households cultivating it and the small acreage of cultivation. *D. alata* cv Matches is cultivated by many households and in large acreages.

At Sampa in the Jaman North district, there is no one variety that is cultivated by many households and on large acreage. Most of the yams varieties cultivated in the area are by few households and on small acreages. All other varieties except *D. rotundata* cv *Larebako* are cultivated in small acreages. *D. rotundata* cvs *Pona, Tila, Tempi, Teacher Takyi* and *Lobare* are gradually getting extinct. Some farmers also indicated their preference to *D. praehensilis.*

Similarly at Sankore, all the varieties are cultivated in small acreages with an exception of *D. cayenensis* cv *Afun;* all others are cultivated by a few households. Although this is not a major yam producing area, there are several yam germplasms in this area. *D. alata* cv Apoka, and *D. rotundata* cvs Dente, Nnokoben and Pona were listed as varieties on the brink of extinction.

A wide diversity of *D. rotundata* yam species was documented in the study areas; 78% in Mim, 58% in Asantekwa, 60% in Sampa, 44% in Sankore and 82% in Ejura. *D. alata* varieties were 22% in Mim, 33% in Asantekwa, 33% in Sampa, 44% in Sankore, 18% in Ejura. Only one variety of *D. cayenensis* (*D. cayenensis* cv Afun) was found at Sampa and Sankore. It was only at Sankore that *D. bulbifera* cv was documented as a cultivated species. The maturity period also correlated positively to the harvesting type (r=1), with all *D. rotundata* varieties except for *D. rotundata* cvs Dente, Serwa and Tempi, being early maturing and thus double harvested. *D. alata*, *D. cayenensis* and *D. bulbifera* were late maturing and thus singly harvested. Income and food security were major determinants of distribution and intensity of cultivation of a particular variety across all locations, gender and ethnic groupings.

The Table 2 shows the rate of variety loss in the studied communities. Results from Table 2 show that the

Table 2. Analysis of rate of yam variety loss at various locations.

Villages	Total number of varieties	Number of DHV varieties	Number of SHV varieties	Number of varieties in Q1	Number of varieties in Q2	Number of varieties in Q3	Number of varieties in Q4	Number of NIV	Rate of variety loss (RVL)
Mim	9	5	4	1	4	1	3	2	1
Asante Kwa	12	8	5	2	2	0	6	0	6
Sampa	15	9	6	0	3	0	12	5	7
Sankore	16	6	10	0	1	0	10	4	6
Ejura	12	4	6	4	3	0	5	2	3

DHV: Double harvest variety, SHV: single harvest variety, NIV: newly introduced variety, Q: quadrant, RVL = (Q4 – NIV)/Total number of varieties.

Table 3. Preference criteria of farmers in the selected localities.

Criteria	Ejura	Kintampo	Atebubu	Sankore	Sampa
Good culinary characteristics	x	xxx	x	x	x
Good yield	xxxx	xxxxx	xxx	xxx	xxx
High seed production capacity	xxxx	xxx	xxx	xxx	xxxxx
Low staking demand	xx	xxxx	xxxx	x	
Good post harvest storage characteristic of the tuber	xxxx	xx	xxx	xxx	xxxxx
Good quality of the cossettes					
Resistance of the cossettes to storage insects				xx	
Good storage characteristic of the fresh tuber	xxxx	xxxxx	xx	xxxx	xxx
Tolerance to high soil moisture	xxxx	xxx	x	xxxxx	x
Resistance to drought	xxxxx	xxx	xxxxx	xxx	xxx
Tolerance to poor soils	xxx	xxx	xxxxx	xxxxx	xxxxx
Resistance to pest and diseases	xxx	xxxxx	xxxx	xxx	xxxxx
Tolerance to weed	xx	xxx	xxxxx	x	xxx
Adaptability to all type of soil	xx	xx	x	x	xxx

x: indicates the level of importance, with x- least important and xxxxx- most important.

diversity is lower at Mim than the other locations. Although the number of newly introduced varieties is more at Sampa than the other locations, the rate of variety loss is also greater than all the other locations. This means that yam cultivation is expanding in the area than the other locations hence new varieties are being explored and those not satisfactory enough are quickly lost. There were however, no newly introduced varieties at Asante Kwa in the Kintampo district. The rate of variety loss is therefore the least at Mim in the Atebubu District.

To ascertain the reasons for preference of one variety to the other, assessment was done on farmer preference criteria ranking them in the order of importance (Table 3). From Table 3 above, it can be seen that good productivity, high seed production capacity, good post harvest storage characteristic of the tuber, tolerance to high soil moisture and resistance to drought are the most important criteria farmers look out for in selecting yam varieties in the Ejura area. In the Kintampo area, however, good culinary characteristics, good productivity, low staking demand, good storage characteristic of the fresh tuber and resistance to pest and diseases are the most prominent criteria. There is not much difference between criteria for Atebubu, Sankore and Sampa. Among these three locations, resistance to drought, resistance to pest and diseases, tolerance to weed, high seed production capacity and good post harvest storage characteristic of the tuber dominated.

From Table 4, the importance of agro-morphological and environmental (biotic and abiotic) factors to the farmers was more than all the other factors. Agro-morphological alone accounted for about 50% in terms of importance in about all locations except Kintampo where environmental factors dominated. Cultural factors however accounted for about 4.51% in the Kintampo district, 1.17 in the Ejura and 0.82% in the Atebubu districts.

DISCUSSION

Local yam classification systems exist in all yam-growing

Table 4. Percentage importance of technological, agromorphological, environmental and cultural factors to yam production.

Type of factors	Importance per zone (% of responses)				
	Ejura	Atebubu	Kintampo	Sampa	Asunafu South
Technological factors					
Poor quality of pounded yam	4.57	0.41	1.50	0.47	1.24
Difficulty in pounding of the boiled tuber	4.57	4.49	4.51	0.93	1.86
Low expansion capacity of the pounded yam	2.86	6.94	9.77	2.33	1.24
Frequent presence of lumps in the pounded yam	3.43	6.12	9.77	2.79	4.97
Total	**15.43**	**17.96**	**25.56**	**6.51**	**9.32**
Agromorphological factors					
Profuse branching of the tuber	8.57	6.94	1.50	8.37	6.21
Profuse thorniness of the tuber	8.00	0.82	1.50	8.37	11.18
Presence of red spots in the tuber flesh	6.86	6.94	2.26	8.37	11.18
Low productivity	5.71	6.94	3.76	7.44	7.45
Low seed tuber production capacity	8.00	6.53	1.50	5.58	11.18
High staking demand	6.86	6.94	3.01	8.37	1.24
Poor post-harvest storage characteristic of ware tubers	1.14	6.94	3.01	6.51	3.11
Poor post-harvest storage characteristic of seed tubers	0.57	6.94	3.76	5.58	0.62
Total	**45.71**	**48.98**	**20.30**	**58.60**	**52.17**
Environmental (biotic and abiotic) factors					
Poor adaptation to climate change	5.71	6.94	15.04	7.44	8.70
Susceptibility to poor soils	6.86	6.94	4.51	5.58	6.21
Soil selectivity	7.43	6.53	0.00	7.44	1.24
Susceptibility to pests and diseases	5.71	4.90	15.04	7.44	11.18
Susceptibility to weeds	11.43	6.94	15.04	6.98	11.18
Total	**37.14**	**32.24**	**49.62**	**34.88**	**38.51**

areas, and are often based on relevance or the characteristics of the individual yam variety. Previous studies revealed an intricate naming system where the most important or recognizable feature of the yam is used in naming it. These names are often descriptive. Farmers often preserve varieties they think is important and neglect unimportant varieties, leading to the loss of such varieties. The continuous existence of a particular variety, therefore, is an indication of its relevance in one way or the other to a particular individual or community.

D. rotundata cv Pona, for instance, is an early maturing variety, and therefore amenable to double harvesting. Many households cultivate it albeit in small areas. This was attributed to the poor storability of this variety and the high cost of its seed yam. Even though it is the yam that attracts the premium price, its poor storability means that it is often depleted very quickly after harvesting. The seed yam is also often not available making it very expensive and increasingly putting it out of reach for the resource-poor farmer.

D. rotundata cvs *Afebetua, Tela, Dobare, Fuseini* and *Dente* are cultivated by few households on small acreages. This was attributed to the relative low market value of these varieties compared pona, for instance, thus placing these varieties in danger of extinction if no serious measures are taken to collect and conserve.

The high patronage of *D. alata* cv *Matches* and *D. rotundata* cv *Mmonyiwa* in these locations could be attributable to the good storability of these two varieties. Farmers therefore can rely on these varieties for both home consumption and marketing during the hunger period. The former variety for instance, is known to have being introduced to Ghana from Cote D'ivoire. Due to its high propensity to establish, it was distributed using matchbox as the standard multiplication size. This, coupled with its late maturity and ability to be used for several food forms has enhanced its spread in the country.

To enhance germplasm preservation therefore, local agro-biodiveristy, decentralized participatory breeding could be the preferred approach to breeding (Kirsten vom Brocke et al., 2010).

In choosing varieties, it was clear that agro-morphological characteristics such as good culinary characteristics, good productivity, low staking demand, good storage characteristic of the fresh tuber and resistance to pest and diseases are the most prominent criteria. Hence any variety improvement programme that fails to take cognisance of these facts is bound to fail. It was therefore in agreement with Tamiru et al. (2007) assertion that often, overall structure of morphological diversity may be consistent with the local yam classification system.

Conclusions

A wide diversity of yams exists in the study area, however more and more of these diversity is getting extinct. There is the urgent need to collect and conserve these varieties. *D. rotundata* is most widely cultivated species of yam followed by *D. alata, D. cayenensis* and *D. bulbifera* respectively.

Conflict of Interest

The authors have not declared any conflict of interests.

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APPENDIX

APPENDIX I: VARIETY DOCUMENTATION (GUIDE OF DISCUSSION)

Generalities

- Vernacular name and naming language
- Other names and corresponding language of naming
- Meaning of the vernacular name
- Origin of variety (domestication, introduction from other country)
- Species

Agronomic characteristics

- Earliness (single harvest / double harvest)
- Relative Productivity (farmers' perception)
- Number of tubers per mound (indicate range when necessary)
- Relative length and size
- Adaptability to pour soil (put score)
- Preferred type of soil (clayey, sandy, chipping, etc.)
- Staking demand
- Adaptability to lowland (put score)
- Resistance to drought (behaviour in the following situations)
  - In case of delay of the rain
  - Regular but insufficient quantity of rain
  - Stop of the rain during vegetative growth
- Storage aptitude of fresh tuber (put score / duration of storage
  - Post harvest
  - In the mounds
- Storage aptitude of the cossettes (resistance to storage insects / put score)
- Susceptibility to weeds (put score)
- Resistance to yam nematodes
- Susceptibility to other biotic factors (scale insects, virus, termites, Mealybugs, Tuber beetles)
- Multiplication rate / Tuber seed production capacity

Culinary characteristics

- Coloration after peeling
- Poundability (discuss the following)
  - Easy to pound? If not why?
  - Quality (taste, elasticity, expansion, presence of eventual lumps)
- Quality of chips (taste, softness)
- Quality of boiled yam (taste, softness, become hard when cool?)
- Quality of the cossettes (flour, quality of the pate, etc.)

Particular utilisations and information

- Any particular use? (Cultural? Medicinal?)
- Market value
- History? Taboo and proscriptions? Etc.

APPENDIX II. ASSESSMENT OF YAM DIVERSITY AT COMMUNITY LEVEL

Objectives of the study

1. Carry out an inventory of the cultivated varieties in the different yam production zones and assess their distribution and extent.
2. Determine the rate of landraces loss and its variation across villages.
3. Understand the reasons that underlie the landraces loss and its variation across diversity zones.
4. Identify the different yam diversity zones in the country for development actions.
5. Identify and prioritize the farmers' variety preference criteria across zones.
6. Document the cultivated varieties for the construction of national yam database

Selection of the villages for the study

This is very important and the success of the study depends on that.

- Avoid selecting villages only along major roads.
  Take into account the necessity to have a very good geographical distribution of the selected sites: *country/ yam production zone* should be well *covered.*
- Consider the ethnic zones: *Preference criteria vary most of the time with the ethnic groups.*
- Do not forget agroecological zones (*humid zones; arid and semi arid zones*).

Diversity inventory and distribution and extent analysis

- This is done at community/village level and in group
- The group should be made of 30 to 40 farmers. Here, gender issue (sex and age) is important. *Women will give the best information on the cooking qualities; rare or old varieties are mainly produced by old farmers; newly introduced varieties are most often well known by young producers*, etc.
- Record the local generic name of: early maturing yam (double harvest), late maturing yam (single harvest), *D. alata, D. dumetorum, D. esculenta, D. bulbifera.* This is important as ignorance of this name create a lot of confusion leading to an underestimation of the real diversity. For example at Djougou region of northern Benin, all the early maturing varieties are called ***Noudouossé***. In a given village of this region, you may therefore by ignorance record the existence of only one variety named Noudossé while this village has really 12 early maturing landraces of different names.
- Based on our experiences, the expressions "**double harvest"** and "**single harvest"** should be used at the place of *early maturing* and *late maturing* respectively. In fact within the early maturing yams, farmers recognize some that are early and some that are late. This sometime lead to serious confusion when documenting the earliness of the varieties.
- Record now (*per category of yam*) the list of all the varieties cultivated in the village. Fill the three four columns of the following table:

N°	***Variety name***	***Species***	***Earliness***	***Distribution and extent***	
				Household	***Cultivated area***

- In the process of the four square analysis, take the parameter frequency *(relative frequency of the households cultivating the variety)* and assess the varieties with that. Farmers know the situation of all the varieties. Let them tell you in group (*and sometime after discussion between them*) if the variety **X** is cultivated by "*many households"* or just by "*few households"*. Use the symbols **+** and – **to fill column 5**
- Repeat this exercise with the parameter *"cultivated area".* Use the symbols **+** and – **to fill column 6.** *Never combine the two parameters together in a single exercise*

  Summarize and restore the results to the farmers (*use paper of big size: 1m x1m for example*) for comments as follow:

QUADRANTS CLASSIFICATION METHOD FOR DETERMINING VARIETY LOSS

Quadrant 1: Many households, large area (++)	**Quadrant 2**: Many households, small area (+-)
Quadrant 3: Few households, large area (-+)	**Quadrant 4**: Few households, small area (--)

Varieties in quadrant 4 are those that are disappearing. Note however, that in this same quadrant are also found varieties that were newly introduced in the village.

Start filling this table (use Excel when back to office for your statistical analysis):

Villages	Total number of varieties	Number of DHV varieties	Number of SHV varieties	Number of varieties in Q1	Number of varieties in Q2	Number of varieties in Q3	Number of varieties in Q4	Number of NIV	Rate of variety loss (RVL)
Village 1									
Village 2									
.....									
Village n									

DHV: Double harvest variety, SHV: single harvest variety, NIV: newly introduced variety, Q: quadrant.

RVL = (Q4 – NIV)/Total number of varieties.

Reasons of variety loss

- Take one by one the varieties in quadrant 4 and ask farmer to give the reasons why they are being abandoned. Generally the reasons vary from variety to variety.
- Carry out individual survey with 20 farmers from the group. Let them tell you individually (isolate them) why, according to them, varieties are being disappeared.

Farmer preference criteria

- Carry out individual survey in each village.
- You can also use the matrices comparison method.