INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

www.ijabpt.com Volume-4, Issue-2, April-June-2013 Coden : IJABPT Copyrights@2013

ISSN : 0976-4550

Received: 17th Mar-2013 *Revised: 27th Mar-2013* *Accepted: 28th Mar-2013*

Research article

PRODUCTION CONSTRAINTS AND FARMERS' CULTIVAR PREFERENCE CRITERIA OF CULTIVATED YAMS (*DIOSCOREA CAYENENSIS - D. ROTUNDATA* COMPLEX) IN TOGO

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ABSTRACT: Fifty (50) villages randomly selected throughout agroecological zones in Togo were surveyed, using participatory approach, to identify and prioritize factors that affect production and farmers' varietal preference criteria of Guinea yam (*Dioscorea cayenensis-D. rotundata* complex). A total of nineteen (19) constraints of varying importance across agro-ecological zones were identified among which the most important were insects' damages on both leaves and tubers, nematodes attack on tubers, drought, soil poverty and wilting. For the majority (78.94%) of the constraints, the use of tolerant cultivars remains the most sustainable, economically profitable and environment preservative solution. Farmers' cultivar preference criteria identified are many (24 in total). Among them, high productivity, good quality of pounded yam, resistance to drought and adaptability to all types of soils are the most important. A perfect match is noted between enumerated constraints and identified preference criteria. The knowledge of farmers' selection criteria is of capital importance for breeders and also extension services for eventual yam cultivar exchange between agroecological zones in Togo.

Key words: Constraint, preference criteria, production, yam, Togo

INTRODUCTION

Root and tuber crops play an important role among edible plants worldwide. They rank third after cereals and grain legumes and are the staple food for over 20% of the world population (FAOSTAT, 2010). Among root and tuber crops, yam is one of the most important, particularly in the so-called yam belt of West Africa (Asiedu et *al*. 1997, Babajide et *al*. 2010, Norman et *al*. 2011). Due to its significant contribution to food security in the sub-region, yam is considered as an important target for breeding and cultivars development programs (Dumont *et al*. 2005, Babajide et *al*. 2010).

Yam, of the genus Dioscorea, has over 600 species (Coursey 1967). Despite the diversity of the species, only ten of them are cultivated. These are: *D. alata* L., *D. esculenta* Lour, *D. batatas* Decne or *D. opposite* Thumb. originating from Asia, *D. bulbifera* L., *D. cayenensis – rotundata* complex, *D.dumetorum* Kenth originating from Africa, *D. trifida* L. originating from America, *D.nummularia* Lam. and *D. pentaphylla* L. from Asia and Oceania (Miège, 1952; Degras, 1986). Among these species, only *Dioscorea alata* and the *D. cayenensis – D. rotundata* complex are cultivated widely and have a real economic significance especially in West Africa (Asiedu et *al*. 1997; Baco et *al*., 2004, Babajide et *al*. 2010). Nutritively, yam tuber is rich in starch, carbohydrates, proteins, vitamins and mineral salts (Degras, 1986, Auriole and Ramanou 2006).

In the sub-region, Togo is one of most important yam-producing countries and ranks fifth after Nigeria, Cote d'Ivoire, Ghana and Benin (FAOSTAT, 2010). Unfortunately, yam production in this country is facing serious constraints, which, according to the producers, account for significant yield losses and genetic erosion (Dansi et *al*. 2012). These constraints need to be identified and prioritized for sustainable solutions to be proposed. Moreover, national agricultural research structures are planning to establish a cultivar improvement and development program in order to provide producers with performing varieties that meet their requirements and needs (ITRA, 2001). For high adoption of the cultivars to be developed, it is important to take into account the farmers' cultivar preference or selection criteria (Mulumbaa et *al* 2012; Frison et *al* 2011). In Togo, these criteria and their variation across agro-ecological zones are still unknown.

The objective of this study was to identify and prioritize yam production constraints and farmers' cultivars preference criteria throughout production zones and across agroecological regions in Togo

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MATERIAL AND METHODS

The study area and site selection

Republic of Togo is located in West Africa between Burkina Faso (in the North), Ghana (in the West), Benin (in the East) and the Atlantic Ocean (in the South). It covers a total land area of 56,600 Km² with a population estimated at about 6 million (Afidégnon, 1999). The country is partitioned from North to South into five administrative regions (Savannah region, Kara region, the Central region, the Hills region and the Maritime region) inhabited by 21 principal ethnic groups (Adja, Akposso, Akébou, Ana, Anii, Atchè, Bassar, Ewé, Gam-Gam, Gourma, Ifè, Kabyè, Konkomba, Kotokoli, Lamba, Moba, Para, Tchokossi, Tém, Temmari, Yaka). Togo has two climatic regions (MERF, 2005): the Southern and the central regions characterized by a subequatorial climate with two rainy seasons and two dry seasons and the Northern region with Sudanian climate type characterized by only two seasons (a rainy season and a dry season). The average rainfall varies from 800 to 1400 mm of water per year (DGSCN, 2006) according to the agroecological zones. The north is situated in arid and semi arid agro-ecological zones characterized by unpredictable and irregular rainfall oscillating between 800 and 950 mm/year. The country's mean annual temperatures range from 26 to 28°C and may exceptionally reach 35 - 40°C in the far northern localities (Afidégnon, 1999). The vegetation is mainly Savannah type with some strips of dry dense forests, open forests and gallery forests (Ern, 1979, Brunel 1981, Brunel et *al*. 1984, Seddoh 1981, Akpagana 1992, Batawila 1997, Kokou 1998, Afidégnon 1999).

For the country to be sufficiently covered and for an exhaustive biodiversity inventory, 50 villages located in diverse agro-ecological (humid, semi-arid, arid) and ethnic zones were randomly selected (Table 1; Fig. 1) following Dansi (2011) and distributed as follow: Kara region (14 villages), Plateau region (14 villages), Savannah region (4 villages), Central region (14 villages), and Maritime region (4 villages). The administrative (regions and prefectures) localisations and the geographical coordinates (longitudes, latitudes, altitudes) of the explored villages are compiled in Table 1 while their geographical locations are indicated in Figure 1.

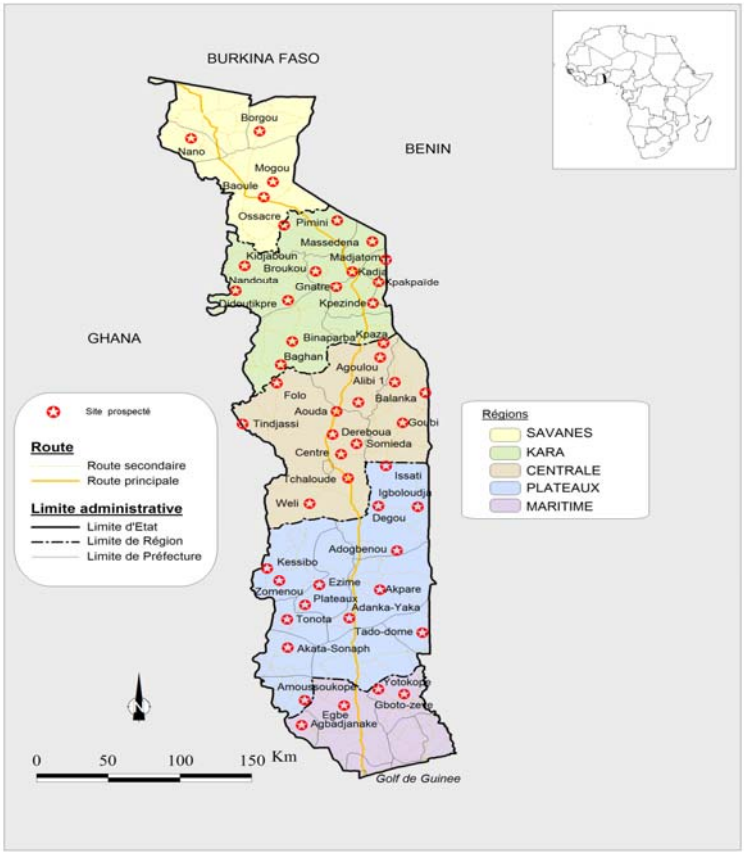

Figure 1: Map of Togo showing the geographical locations of the villages surveyed

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Table 1: List, administrative localisations and geographical coordinates of the villages surveyed

No	Villages	Region	Districts	Longitude	Latitude	Altitude
1	Adanka-Yaka	Plateau	Ogou	E 001.12854°	N 07.25043°	209m
2	Adogbenou	Plateau	Lanié	E 001.43232°	N 07.73715°	245m
3	Agbadjanakè	Maritime	Ave	E 000.82656°	N 06.48226°	124m
4	Agoulou	Centrale	Tchaoudjo	E 001.32577°	N 09.12030°	397m
5	Akata-Sonaph	Plateau	Kpele	E 000.73876°	N 07.03908°	240m
6	Akparé	Plateau	Ogou	E 001.32308°	N 07.45326°	192m
7	Alibi 1	Centrale	Tchamba	E 001.41877°	N 08.94293°	337m
8	Amoussoukopé	Plateau	Agou	E 000.84646°	N 06.66239°	147m
9	Aouda	Centrale	Sotouboua	E 001.04829°	N 08.73353°	385m
10	Baghan	Kara	Bassar	E 000.69402°	N 09.06979°	241m
11	Balanka	Centrale	Tchamba	E 001.61330°	N 08.86813°	363m
12	Baoulé	Savanes	Oti	E 000.58550°	N 10.27421°	152 m
13	Bgoto-zevé	Maritime	Yoto	E 001.47752°	N 06.70553°	102m
14	Binaparba	Kara	Bassar	E 000.76643°	N 09.23450°	367 m
15	Borgou	Savanes	Kpendjal	E 000.55951°	N 10.74806°	165m
16	Broukou	Kara	Doufelgou	E 000.91533°	N 09.74173°	228 m
17	Dégou	Plateau	Est-mono	E 001.31339	N 08.05655°	264m
18	Déréboua	Centrale	Sotouboua	E 001.02382°	N 08.56922°	420m
19	Didoutikprè	Kara	Bassar	E 000.73965°	N 09.52914°	269 m
20	Egbé	Maritime	Zio	E 001.09671°	N 06.62369°	125m
21	Ezimé	Plateau	Amou	E 000.93774°	N 07.48824°	279m
22	Folo	Centrale	Sotouboua	E 000.66974°	N 08.93627°	197m
23	Gnatre	Kara	Kozah	E 001.04715°	N 09.62724°	271 m
24	Goubi	Centrale	Tchamba	E 001.46782°	N 08.65236°	294m
25	Igboloudja	Plateau	Est-mono	E 001.56382°	N 08.05046°	276m
26	Issati	Plateau	Est-mono	E 001.36214°	N 08.34395°	296m
27	Kadja	Kara	Pagouda	E 001.14850°	N 09.73830°	260m
28	Kazaboua	Centrale	Sotouboua	E 001.07694°	N 08.42838°	315m
29	Kessibo	Plateau	Wawa	E 000.60837°	N 07.60947°	353m
30	Kidjaboun	Kara	Dankpen	E 000.46535°	N 09.78134°	152 m
31	Kpakpaïdè	Kara	Binah	E 001.31655°	N 09.66033°	376 m
32	Kpaza	Centrale	Tchaoudjo	E 001.34585°	N 09.22342°	406m
33	Kpézindé	Kara	Kozah	E 001.27942°	N 09.50965°	340 m
34	Madjatom	Kara	Pagouda	E 001.36231°	N 09.82532°	398 m
35	Massédéna	Kara	Niamtougou	E 001.27534°	N 09.95576°	329 m
36	Mogou	Savanes	Oti	E 000.64333°	N 10.38382°	163 m
37	Nakpéli	Savanes	Tandjouaré	E 000.12516°	N 10.69733°	252 m
38	Nandouta	Kara	Dankpen	E 000.40699°	N 09.59836°	147 m
39	Ossacré	Kara	Kéran	E 000.71515°	N 10.07210°	235m
40	Patatoukou	Plateau	Amou	E 000.84864°	N 07.34533°	390m
41	Pimini	Kara	Kantè	E 001.05221°	N 10.10650°	212 m
42	Somiéda	Centrale	Sotouboua	E 001.17443°	N 08.50178°	296m
43	Tado-domè	Plateau	Tohoun	E 001.59268	N 07.14550°	205m
44	Taworèda	Centrale	Tchaoudjo	E 001.18638°	N 08.79837°	370m
45	Tchaloudè	Centrale	Blitta	E 001.12076°	N 08.25568°	322m
46	Tindjassi	Centrale	Sotouboua	E 000.45160°	N 08.64421°	191m
47	Tonota	Plateau	Danyi	E 000.73452°	N 07.24082°	873m
48	Wèli	Centrale	Blitta	E 000.87780°	N 08.07477°	345m
49	Yotokopé	Maritime	Yoto	E 001.31484°	N 06.73875	92m
50	Zoménou	Plateau	Wawa	E 000.68448°	N 07.51878°	695m

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Data collection and analysis

Data were collected during expeditions from the different sites through the application of participatory research appraisal tools and techniques, such as direct observation, group discussions, individual interviews, and field visits using a questionnaire following Dansi et al. (2010), Kombo et *al*. (2012). In each village, interviews were conducted with the help of a local translator and groups surveyed were made of 20 to 40 yam producers of both sexes and of different ages identified and assembled with the assistance of the local farmers' associations and the chiefs of the village involved in the study to facilitate the organization of the meetings and the collection of data following Dansi (2012). According to the literature, several biotic and abiotic constraints are related to yam cultivation. If generally farmers have a very good knowledge of abiotic constraints it is not the case with biotic factors, especially diseases and pests (Kombo et *al.* 2012). To help producers to easily identify the different types of yam pests and diseases, selected pictures were used. In each selected site information on the location (name of district, name of village, ethnic group) was first collected after a detailed presentation of the research objectives to the farmers. After this, farmers were asked to list (vernacular names) per category (abiotic and biotic) all the constraints related to yam production in their area. Using pictures, the specific types of pests and diseases listed were identified. The identified constraints were prioritized in groups by identifying and gradually eliminating the most severe constraint. In a first step, producers were asked to identify, among the constraints they have listed, the most critical one and for which an urgent solution must be found. The constraint thus identified is ranked first and is eliminated from the list. The same procedure was repeated until the last constraint was ranked and the results were given immediately to producers for approval.

Two methods are generally used to identify and prioritize farmers' varietal preference criteria. These were group survey (Kamara et *al*. 1996) and individual survey using the matrix comparison method (Gueye and Freudenberger 1991; Adoukonou-Sagbadja et *al*. 2006; Dansi et *al*. 2008, Dansi et *al*. 2010) or spontaneous reactions (Defoer et *al*. 1997). In this study, the group method is employed. In each village, producers were asked (in group) to list the characteristics that a yam variety must have to be widely adopted in the context of their village. Using the same approach described above (gradual elimination of the most important factor) the identified criteria were then prioritized by producers.

Data obtained were analysed using descriptive statistics (average, percentage, etc.) and the results were presented in the form of tables or figures. At the regional and national levels, the constraints were prioritized based on the average of the following three parameters:

- The total number of villages (TNV) in which the constraint is cited
- The number of villages in which the constraint was classified among the principal constraints (PCO) i.e. among the first five
- The number of villages where the constraint is the major one or ranked first (MAC).

For these three parameters, the higher the number is, the more important is the constraint.

The importance of a constraint (IMC) was determined by the formula IMC = (TNV + PCO + MAC)/3**.** The same approach was used to rank farmers' cultivar preference criteria.

RESULTS AND DISCUSSION

Constraints related to yam cultivation in Togo

Nineteen (19) constraints have been identified throughout the different zones explored (Table 2). Their prioritisation based on the three above-mentioned parameters ranks first damages caused by insects on leaves and tubers, followed (by order of importance) by the by nematodes attacks, drought, soil poverty, leaf blight and early leaf fall (Table 2). Surprisingly the low productivity of the cultivars ranked last. This could be explained by the fact that low productivity is determined the direct consequence of the negative effects of the other constraints.

As expected, the nature and the severity of the constraints vary from one region to another. For example, tubers attack by nematodes is not a concern in the Savannah region while it ranks first in the Central region and second in the other regions (Kara, Plateau, and Maritime). In the Central region, soil poverty is not yet a concern. This result is expected since in this humid forest zone, cultivable lands are available for the moment and fertile soils required for yam cultivation are easily obtained by destroying old fallows or portions of the forests (Maliki et *al*. 2012). Drought, results of climate changes ranks third at the national level as well as in the different regions except in Kara region where it ranks fifth. Its rank in the southern humid region shows that its effects are already being felt. Therefore it is necessary to define and implement some integrated strategies to preserve agriculture. Among these strategies, the sedentarisation of yam cultivation (Bricas and Vernier, 2000) that will stop or considerably reduce the devastating effects of yam production on the vegetation.

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2: List and importance of yam production constraints agroecological zones in Togo

Constraints	Number of villages			Mean	Rank	Rank per region			
	TNV	PCO	MAC			Savane	Kara	Centrale	Plateau-Maritime
Insect damages on leaves and tubers	46	16	33	31,66	1	1	1	5	1
Nematodes attacks	46	5	27	26	2	-	2	1	2
Drought	42	6	15	21	3	3	5	3	3
Soil poverty	37	6	19	20,66	4	2	4	-	5
Leaf blight and early leaf fall	35	5	17	19	5	6	3	2	6
Rot of tubers in the mounds	36	4	16	18,66	6	11	-	16	12
Staking demanding of some cultivars	31	5	16	17,33	7	5	-	11	4
Difficult post-harvest storage	36	1	8	15	8	7	6	4	7
Susceptibility to weeds	29	3	9	13,66	9	-	9	17	14
Inadaptability to high soil	22	1	15	12,66	10	8	7	-	15
Inadaptability to all types of soil	27	1	5	11	11	10	12	10	10
Foliar diseases (Anthracnose; virus)	23	1	8	10,66	12	-	-	12	9
Malformation of the tubers	21	0	3	8	13	4	13	7	8
Lack of seed yam	14	0	2	5,33	14	-	-	13	13
Lack of organised markets	10	0	4	4,66	15	-	11	14	-
Low germination rate of seed yam	10	0	2	4	16	-	14	6	11
Rodent attack of the tubers	7	0	2	3	17	9	8	15	17
Damages by birds of young leaves and stems	6	0	0	2	18	-	-	8	16
Low productivity	4	0	2	2	19	-	10	9	18

NB: *TNV: Total Number of Villages; PCO: Principal Constraint; MAC: Major Constraints*

If in the south drought already ranks third, in the northern region which is dry, it should normally rank first or second. In this respect, the importance that producers have given drought in the regions of Kara and Savannah is relatively low in our point of view. Producers explained this by the fact that many people hesitated to cite drought as the major constraint even if it is severely felt since for them, rain is totally beyond human control and drought as constraint can never be solved. Leaf blight followed by early leaf fall in full rainy season and during the active growth stage is nothing more than the effects (root rot) of the pathogenic soil-borne fungi such as *Fusarium sp.* and *sclerotium* sp. (Nwankiti and Arene, 1978; Okpala and Eziakor, 1989). As it was the case in Benin (Loko et *al*. 2013), producers ignoring the existence of these soil fungi, attribute leaf blight to Striga, a devastating weed of cereal crops known worldwide (Isah and Lagoke, 2013). With regard to producers' statements according to which entire fields are sometime affected and the phenomenon is significantly expanding, a particular attention should be paid to the preservation of the yam (through research and intervention actions) in the fields against pathogenic soil-borne fungi.

All the identified constraints but four (lack of organized markets for selling, low germination rate of seeds, damages of the tubers by rodents, damages by birds of young leaves and stems) can be addressed by the use of tolerant or adapted yam cultivars. Such cultivars already exist and where found (may be in insufficient number for some agronomic traits) in the Togolese traditional agriculture and also in Benin (Dansi et *al*. 2013, Loko et *al*. 2013). To address the recorded agronomic, biotic and abiotic constraints, Research and Development programs in Togo should therefore act at two levels:

- Improvement of the cultural practices and their popularisation. This includes treatment of seeds, rotation with fertilizing and nematodes trap crops, etc.
- Promotion of the identified tolerant or adapted yam cultivars

Producers have not mentioned cultural constraints maybe because they consider them as of minor effects. In Togo, like in many African countries, yam production and consumption follow many traditional or cultural rules (Degras, 1986; Goody, 1984; Baco et *al*. 2008) that have even become prohibitions or taboos hence affecting yam production. For example, it is forbidden to consume red oil in a yam field, to peel roosted yam close to the yam granary, to have sexual relations on the eve of the planting date. According to producers, not abiding by these rules will lead to tubers rot in the mounds, to a decrease in seed germination rate, to young plants drying up, to yellowing followed by early leaf fall and to yam rot in the granary. Similar cultural practices are mentioned in Oceania regions (Bricas, 1997).

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Framers' preference criteria

Twenty-four preference or cultivar selection criteria have been identified throughout the surveyed villages (Table 3). Out of these criteria, 01 (market value) is economical, 4 (quality of the pounded yam; quality of the boiled yam; quality of the fried yam; quality of the dried yam) are culinary and technological and 19 are agronomic. Among the identified criteria, the most important at the national level were (by order of importance), productivity, quality of the pounded yam, resistance to drought, adaptability to all types of soils, resistance to termites, resistance to mealybugs, resistance to nematodes, multiplication rate, post-harvest conservation and earliness (Table 3). High productivity as major criterion is not surprising since it is for any producer and any crop the most desired criterion (Zannou et *al*. 2006; Ojulong et *al*. 2010; Kombo et *al*. 2012). In case of yam and according to producers, high productivity includes high number of tubers and a size of tuber which is wanted big and long. Good quality of pounded yam ranks second and can be explained by the fact that pounded yam is the major mode of yam consumption in all the surveyed villages and the adoption of a new variety mainly depends on the quality of the pounded yam assessed through the ease of pounding, the absence of lumps in the pounded yam, its elasticity and taste and its dilatation capacity (water uptake). Resistance to drought in the third position is a strong indication that it is very determinant criterion for producers. Ability to all types of soils is important in the sense that many cultivars are soil selective and a producer may be constrained to do not cultivate a cultivar that he would yet have liked to produce because he does not have the type of appropriate soil to do so. Producers attach particular importance to pests which attack mainly tubers. These are mealybugs, termites and especially nematodes. The other criteria as well as their relative importance are in conformity with the identified constraints and their prioritization throughout the study zone.

Table 3: farmers' preference criteria of yam cultivars and their importance across agroecological zones

Criteria	Number of villages			Mean	Rank	Rank per region			
	NTV	PCr	MCr			Savane	Kara	Centrale	Plateau-Maritime
High productivity	48	10	35	31	1	3	4	4	1
Good quality of pounded yam	44	3	34	27	2	4	5	3	2
Tolerance to drought	39	8	27	24,66	3	2	6	1	4
Adaptability to all type of soil	32	7	28	22,33	4	9	7	2	3
Resistance to termites	38	6	22	22	5	6	3	5	9
Resistance to weevils and scale insects	36	8	18	20,66	6	5	1	6	12
Resistance to nematodes	32	6	17	18,33	7	7	2	10	11
High multiplication rate	26	1	19	15,33	8	8	9	8	8
Good post-harvest storage aptitude	31	1	13	15	9	12	8	7	7
Earliness	21	5	18	14,66	10	1	10	11	5
High market value	23	1	11	11,66	11	11	11	9	13
Resistance to diseases	14	1	6	7	12	-	-	17	6
Good quality of boiled yam	16	0	2	6	13	10	13	13	14
No staking requirement	9	2	5	5,33	14	-	-	18	10
Resistance to coleoptera attacking tuber	8	1	3	4	15	-	-	-	17
Tolerance to weeds	9	0	2	3,66	16	-	16	12	16
Adaptability to poor soils	5	1	3	3	17	-	12	-	19
Adaptability to production in lowlands	5	0	2	2,33	18	-	14	-	15
Good quality of dry yam chips	5	0	0	1,66	19	13	-	14	21
Good quality of fried chips	5	0	0	1,66	20	-	-	15	20
High germination capacity of the seed yam	4	0	0	1,33	21	-	-	19	18
Resistance to the early leaves fall	2	0	0	0,66	22	-	-	16	22

NB : TNV : Total number of villages ; PCr : Principal criteria ; MCr : Major Criteria

Like the constraints, preference criteria also vary throughout the explored regions. In the arid Savannah region, earliness and resistance to drought that are all related to the same cause rank first followed by high productivity and the quality of pounded yam. In Kara region, producers attach a particular importance to resistance to mealybugs, nematodes and to termites that are all pests causing severe damages on tubers (Korada et *al*. 2010; Wood et al. 2011). In the central humid region, resistance to drought appears surprisingly as the most important criteria since it ranks first. No region of the country seems to be spared from the effects of drought, with varying levels depending on the zones.

According to producers and contrary to the northern region where lateness, early stops, insufficiencies and bad distributions of rains act together, the Central humid region records for the moment only lateness of rains that, for many cultivars, significantly affect seed germination rate in the mounds and thereby productivity since these cultivars rot, most often, due to heat (Zannou et *al*. 2006). Except the constraints relative to damages caused by birds and rodents on the different organs of the plant, all the other identified constraints have equivalences among farmers' preference criteria but with, sometimes, highly different levels of importance. The criteria thus identified and prioritized in this study will be used in yam breeding and cultivars exchange.

CONCLUSION

This study allowed the identification of several constraints that hamper yam production in Togo and to address them recommended the use of tolerant and/or resistant cultivar. The introduction of performing cultivars will strengthen the existing diversity but also improve the productivity. The adoption of these varieties by producers depends on a good knowledge of their preference criteria that were found of agronomic, culinary, technological and economical nature. Both constraints and selection criteria vary among villages, regions and ethnic groups. The results of this study will allow national extension services and NGOs to better guide their cultivar exchange programs between regions in the same country. Likewise, they will help national and international research institutes in defining their breeding strategies of performing yam varieties.

ACKNOWLEDGEMENTS

This study has been funded by the Global Crop Diversity Trust and jointly carried out by ITRA (*Institut Togolais des Recherches Agricoles*) and the *Laboratoire d'Agrobiodiversité et Amélioration des Plantes Tropicales* (LAAPT) of the University of Abomey-Calavi (UAC). We would like to thank the Director General (Dr Agbobli Comlan Atsu) and the Scientific Director (Dr Labare Kodjo) from ITRA for the technical facilitation. We also thank Dr Dao Balabadi (ITRA) and Mr Edéa Emile (UAC) for designing the maps and Mr Tsatsu Domenyo (ITRA) for his technical assistance. We express our deep gratitude to all producers, village Chiefs, Leaders of farmers' groups and agricultural technicians met for their contribution to the success of the missions.

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