

Studies on yam domestication and farmers' practices in Benin and Nigeria

P. Vernier, G.C. Orkwor and A.R. Dossou

Abstract: This paper combines the results of surveys carried out between 1995 and 2001 in Benin and Nigeria on farmers' practices in connection with the domestication of yams (*Dioscorea rotundata*), which is still an active process in West Africa. In Benin more than 500 yam producers belonging to four major yam-producing ethnic groups (Bariba, Mahi-Fon, Nago and Yom) and nearly 300 farmers in six different states of Nigeria were interviewed. The knowledge of wild yams is still alive even among farmers who have never domesticated yam. In the two countries the techniques described are very similar and the domesticated wild yams belong either to *D. abyssinica* in the northern part of the studied area (drier savanna zone) or to *D. praehensilis* in the southern part (humid savanna). The percentage of farmers who are domesticating or have recently domesticated yams varies from 3–14%. The domestication process mainly leads to early maturing cultivars, which are produced in double-harvest systems. The practice of domestication is decreasing, especially in the regions where commercial yam production is well developed.

Keywords: domestication; farmers' practices; *Dioscorea*; Benin; Nigeria

P. Vernier is with CIRAD T70/16, 34398 Montpellier Cedex 05, France. E-mail: philippe.vernier@cirad.fr. G.C. Orkwor is with NRCRI, PMB 7006, Umuahia, Nigeria. E-mail: ncri@infoweb.abs.net. A.R. Dossou is with Station de Ina, INRAB, BP 03, N'Dali, Benin. E-mail: cilcom@intnet.bj.

Most of the cultivated yams in West Africa, a region producing about 95% of the world's yam output (FAO, 2000), belong to the botanical group (or species complex) *Dioscorea cayenensis* Lam.–*D. rotundata* Poir, known as Guinea yams. They have frequently been described as originating from a process of domestication of wild yams of the Enantiophyllum group, initially by Burkill (1939) and by Miège (1952), and later, in a more elaborate way, by Hamon (1987) and Terauchi *et al* (1992). It is only recently that research institutions have realized that the domestication of wild yam is still an active process. The first attempt to clarify the techniques of domestication used by African farmers in West Africa was conducted in 1995 in northern Benin within the Bariba ethnic group, known to have great skills in yam cultivation (Dumont and Vernier, 2000). In order to obtain a more global vision of the importance and features of yam domestication, the same study was extended to other yam-growing ethnic

groups in Benin. In a second phase the work was also carried out in Nigeria, the world's largest yam producing country, which accounts for about 70% of the total annual output of this crop.

The objective of this paper is to present information gathered in the different regions of Benin and Nigeria in order to give an overview of the techniques of domestication of yam in this region, considered to be the centre of dissemination of Guinea yams.

This study focuses only on the savanna zones or degraded forest zones and the domestication process that leads to *D. rotundata* cultivars, the white Guinea yams. It does not consider *D. cayenensis*, known as the yellow Guinea yam, which is mainly grown in humid forest areas and is now thought of as an interspecific hybrid between *D. burkilliana* Miège and *D. praehensilis* or *D. abyssinica* (Terauchi *et al*, 1992; Ramser *et al*, 1997).

In the savanna zone, the wild species involved in the

process of domestication belong, with respect to the present taxonomy of yams, either to *D. abyssinica* Hochst ex Kunth or to *D. praehensilis* Benth, according to the ecological status of the area from where they are collected. The former is generally found in the northern part of the yam belt in West Africa where the vegetation is annually affected by periodic bush fires. The latter can only be seen in forest areas, such as gallery forests close to savannas or forest pockets in degraded forest zones, as long as these places escape the rampant bush fires during the dry season.

Methodology

The study was based on a survey conducted to assess farmers' knowledge of wild yams and their use in agriculture and other fields (eg medicine). It was directed only at yam producers. In Benin, four ethnic groups, known to have wide genetic diversity in yams (Vernier and Dansi, 2000), and which have continued to domesticate yams, were selected. The Bariba zone was covered in 1995 with the survey being carried out in two distinct areas (northern and southern areas). The results of this work have already been published (Dumont and Vernier, 2000).

In 1998 similar work was carried out in the department of Atacora with the Yom farmers in the north-western part of the Republic of Benin. In 1999 the study in Benin was completed with Fon and Nago yam producers, both in the department of Zou, the southern part of the yam belt of the country.

In Nigeria, the research work was conducted in the year 2000. A preliminary survey had previously been carried out in the whole yam-producing area of the country in order to determine the regions where farmers used wild yams. This study was made possible by the collaboration of the Centre Suisse de Recherche Scientifique (CSRS), based in Abidjan, Côte d'Ivoire during a research activity on yam post-harvest issues. Based on the results of this previous work, six states were selected, two in the western part of the country (Kwara and Oyo) and four in the central and eastern region (Nasarawa, Benue, Taraba and Cross River states) for the present study.

The areas covered by the surveys in both countries are shown in Figure 1. A similar questionnaire was used in all

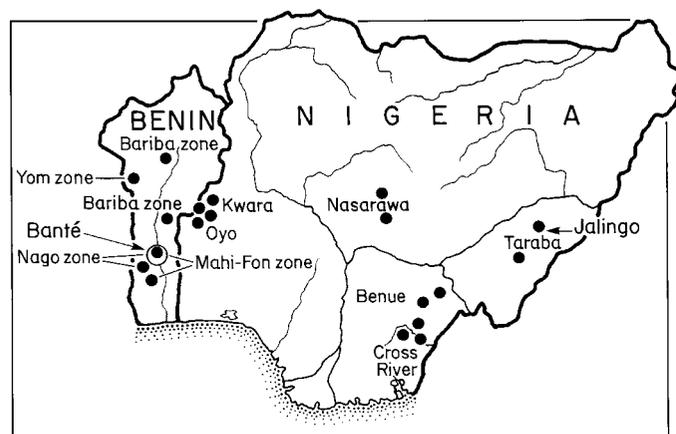


Figure 1. Location of study area.

the surveyed regions. The questions concerned:

- the knowledge of wild yams, ie the identification of the different types of wild yams, their uses according to circumstances (hunting, 'hungry gap' before harvest);
- the knowledge of domestication techniques used with appropriate wild yams and the description of the different operations needed;
- the product of domestication: cultivars currently known to be the result of domestication; and
- the practice of domestication: to identify the farmers who are presently domesticating or have done so in the recent past.

For the entire study, 614 farmers in 67 villages in Benin, and 296 farmers from seven major ethnic groups in 56 villages of Nigeria were interviewed. They were generally male farmers, yam cultivation being the domain of men in West Africa.

Results and discussion

Knowledge of wild yams and domestication

Wild yams and their uses still seem to be well known among yam producers in both countries. In Benin, between 42 and 99% of yam growers know about the diversity of wild yams, and an important percentage (46 to 92%) consume them (Table 1) mainly while hunting. In Nigeria, knowledge and consumption of wild yam seem to be even more widespread (Table 2).

The use of wild yam as medicine concerns a minority of people, according to the statements of farmers. In Benin, between 2 and 18% use wild yam for medicinal purposes (data are not available for the Baribas). This use seems to be related to the availability of close forest area, where wild yams can be collected easily. In the Fon zone, forests or long-duration fallow areas are more scarce and the opportunity to find wild yams is more rare.

In Nigeria, the use of wild yams varies from 39% (Cross River) to only 2% in Oyo state, where the forest areas are few. In Taraba state (north-eastern part of Nigeria) all farmers interviewed said that they had never used wild yam as a medicine. This seems to be a little surprising because the consumption and domestication of wild yams here is widely prevalent. One can only suppose that this kind of information is not easily given to strangers by suspicious farmers who are not sure if the information will be used in their best interests.

With respect to the actual domestication, a distinction has been made in the survey between 'just to know' that wild yams can become cultivated yams by domestication and the 'ability to detail the techniques' needed to attain morphotypes appropriate for agricultural use.

A simple knowledge of domestication is shared by 74 to 91% of the farmers in Benin (not recorded within the Bariba people) and from 37% (Cross River) to 88% (Kwara) in Nigeria.

A close examination of the results of the surveys shows that the proportion of people capable of describing the techniques ranges from 22% (Yoms) to 47% (Baribas) in Benin, and from only 10% in Cross River state to 77% in Kwara state in Nigeria, where the farmers interviewed were mostly Bariba. This information shows that the

Table 1. Knowledge of wild yams and their domestication among ethnic groups in Benin.

	Bariba (S) 1995/96	Bariba (N) 1995/96	Yom 1998	Nago 1999	Fon 1999
Date of survey					
Number of farmers interviewed	50	100	101	208	155
Number of villages	3	3	20	22	13
Question (answers as % of respondents)					
Know the diversity of wild yams	42%	84%	99%	93%	66%
Consume wild yams as food	46%	92%	55%	56%	70%
Use wild yams for medicine	na	na	18%	10%	2%
Know techniques of domestication	44%	47%	78%	91%	74%
Can describe the technique of domestication	na	na	22%	39%	31%
Practise techniques of domestication (currently or recently)	8%	3%	9%	16%	13%

Table 2. Knowledge of wild yams and their domestication in west and east Nigeria, 2000 (by state).

	Benue	Cross River	Nasarawa	Taraba	Oyo	Kwara
Number of farmers interviewed	45	50	50	51	50	50
Number of villages	23	7	10	6	5	5
Question (answers as % of respondents)						
Know the diversity of wild yams	100%	96%	94%	100%	100%	100%
Consume wild yams as food	95%	54%	94%	86%	75%	84%
Use wild yams for medicine	27%	39%	10%	0%	2%	35%
Know techniques of domestication	41%	37%	48%	67%	83%	88%
Can describe the technique of domestication	16%	10%	18%	53%	62%	77%
Practise techniques of domestication	15%	6%	16%	43%	0%	20%

domestication of wild yams is still widely known among people of the rural areas in these two countries.

Statements of actual practice of domestication (present or recent) suggest it to be much rarer. In Benin, it varies from 3% (northern Bariba) to 16% for Nago farmers. In Nigeria, the practice is stated to be used by 6% (Cross River) to 43% (Taraba state), with the exception of Oyo state where all farmers confirmed that they had given up the practice some time ago.

In Nigeria, this overestimation seems to be more particularly confined to Nasarawa and Benue states, but we were not able to find other data on domestication in order to assess these figures. In Taraba state, 43% of yam producers interviewed said that they were currently domesticating or had done it recently, which appears excessive. A more precise study may be necessary to assess these data, but discussions with farmers and extension officers in Yoro LGA, close to Jalingo, confirmed that the practice was indeed very common in the state.

In Benin, data on domestication practice are available from other recent sources. Baco (2000) found 3.7% of domesticators in his study carried out in the same region of northern Bariba, very close to our own figures (3%). In the Nago zone, Okry (2000) estimated the percentage of domesticators as 9.2% in the region of Banté (Nago area), as opposed to the higher rate of 16%, which we observed in this study. In the Yom and Fon zones, no other studies are available, but actual domestication is likely to be less important than the rates of 9 and 13% indicated in Table 1.

Even if the actual rate of domestication is lower than the collected data indicated, if we consider that all yam producers in both countries reach several million indi-

viduals, this means that several thousand new genotypes are probably incorporated into agriculture every year. In terms of biodiversity, this is a sizeable number and should be taken into consideration by breeders and geneticists.

The objectives of domestication

Most African farmers do not speak spontaneously on yam domestication and this may be the reason why the phenomenon has been ignored for so long by agronomic research. In the first place, many people fear that speaking about their use of wild yam in agriculture may be interpreted as a failure on their part to produce enough yams to feed their families. Thus among the Bariba, where the head of a family is usually proud to produce an excess of yam every year, it would appear shameful for someone to declare himself as a cultivator of wild stocks.

The motivation of farmers to practise domestication is not easy to clarify. Many of them speak of curiosity or tradition. Others put forward the lack of seed yams to explain their recourse to domestication. Others still invoke the fact that wild yam placed in a field protects the other yams from the influence of people of evil intention. The same protective effect is also attributed to *D. alata* yams. In many areas of West Africa, two or three stands of these species are often planted at each end of Guinea yam lines all around the plots for that purpose.

Last but not least, and the most interesting for a geneticist, some farmers explain that their interest in domestication lies in the fact that seed tubers that descended from wild yams alleviate the impact of diseases by bringing in 'new blood'. In this case, farmers claim to domesticate when their cultivars appear to be losing vigour. This explanation is acceptable if we consider the

polyclonal status of cultivars currently fed by new domestications. The new germplasm's contribution with less virus- or pest-contaminated seed tubers can give strength to the seed material.

As a corollary, the reason given by many farmers for not domesticating or for having given up, is essentially related to the availability of sufficient yam seed outside their vicinities, as opposed to scarcity at domestic level. With the increase of commercial exchanges and transport, it seems easier for farmers to purchase seed yam from markets rather than spend energy in an unpredictable and long-term venture such as domestication. The difficulty of finding wild yams to domesticate is also reported in some locations where land pressure is high and few forest areas remain available.

The decline in domestication practices seems especially high in regions where commercial production of yams is well developed, as in Oyo state, where there are no farmers who still domesticate yam, or in Nasarawa state, where many of them declare that they stopped 40 years ago.

The techniques of domestication

The farmers who claimed to know the techniques of domestication were asked to describe, as precisely as possible, the different stages of the process. Generally these techniques, when used, are applied in the first year, that is to say on the tuber collected from the wild. Eventually they are repeated the following year. The next year they are generally cultivated as ordinary yams, even if it takes several years to achieve the process of 'tuber ennoblement', the term used by Coursey (1967) to qualify the transformation of the wild-type tuber (generally long, thin and more or less thorny) into a cultivated shape, which is shorter and larger in diameter.

The different techniques used for domestication can be summarized and grouped into three or four operations. The answers of different groups of domesticators are given in Tables 3 and 4.

Planting only the head of the wild yam tuber. In the first year of the study, the Bariba farmers of Benin and the farmers from Benue state, Nigeria seemed to place great importance on this technique, with between 98% and 86% of positive answers respectively. The other groups placed less emphasis on it, and seem to plant the other parts of the collected tubers too. In all cases this implies that the tuber is cut, which is different from the practice of regrowth from a whole tuber, as occurs in the wild.

Interruption of tuberization. Another practice mentioned by domesticators is the interruption of tuberization during the vegetative growth. This practice is known by the name of 'milking' or 'double-harvest' and is usual with early maturing cultivated varieties. The first-harvest tubers are consumed while still immature between August and September. Those of the second harvest are picked three months later and usually used as seed.

In Benin, milking in the first year of domestication is regarded as essential by a minority of farmers (Bariba: 34%, Yom: 36% or much less). In Nigeria, farmers generally see milking as something optional, the exception being the farmers in Taraba state, where 74% of them think it is necessary to milk yams. (This kind of question is not always well understood and the difference between compulsory and optional is not always clear to farmers.) More accurate discussions have shown that domesticators carry out the double harvest as early as the first year, whenever it is possible: that is to say, when tuber growth is estimated to be sufficient by them at the usual milking

Table 3. Techniques considered necessary in the first year of the domestication process according to declaration of domesticators (percentage of respondents) in Benin (by zone).

	Bariba		Yom	Nago	Fon
	North	South			
Number of respondents			11	58	34
Planting only the head of the tuber	96%	100%	36%	0%	3%
Introduction of an obstacle under seed tubers	65%	82%	55%	36%	0%
Double-harvesting/milking	34%	18%	36%	11%	0%
Minimum duration for ennoblement (in 3 years)			2.88	2.93	2.85

Table 4. Techniques used for the process of domestication according to declaration of domesticators (percentage of respondents) in Nigeria (by state — ethnic groups in parentheses).

	Benue (Tiv)		Cross River (Mbube, Bette)		Nasarawa (Eggon, Koro)		Taraba (Mumye)		Kwara (Bariba)	
	N	Op	N	Op	N	Op	N	Op	N	Op
Number of respondents	8		8		9		27		39	
Planting only the head of the tuber	86%	14%	29%	57%	11%	33%	22%	78%	0%	100%
Introduction of an obstacle under the seed tuber	0%	0%	0%	0%	0%	11%	7%	7%	42%	47%
Double-harvesting/milking	0%	100%	0%	14%	11%	44%	74%	7%	8%	70%

Note: N = Necessary; Op = Optional.

time, roughly three or four months before the foreseeable senescence of yam plants. When the size of tubers is estimated to be too small, milking is not done.

Introduction of an obstacle. The third technique used in the domestication process is the introduction of an obstacle under seed tubers at planting time. For this, farmers use flat stones, pieces of gourd or pottery. The purpose, according to them, is to limit the growth in depth of the yam tuber since wild yams go very deep into the soil during growth. Not every group uses this method. In Benin, it is common within the Baribas and Yoms, but much less so (36%) among the Nagos, while the Fon farmers never mentioned it.

This could lead one to imagine a relationship between the wild yam species involved in the domestication (*D. praehensilis* or *D. abyssinica*) and the placement of obstacles, used with the latter species but not with the former. But this hypothesis could not be confirmed in Nigeria. The situation is somewhat comparable between the Bariba regions of Benin and in Nigeria (Kwara state) where the domestication concerns *D. abyssinica* in particular. In Taraba and Nasarawa states, few people put obstacles under the seed tubers, although they use the same species. But the effectiveness of obstacles is not obvious. On many occasions we observed tubers that had avoided the piece of pottery and kept growing downwards. It is, however, difficult to generalize on the domestication processes since the importance of each technique varies from one place to another

The most evident constraint that occurs to a wild yam tuber when domesticated, in addition to the fact that it is always cut, is the shift of environmental conditions. In natural conditions young plants grow in the shade, and the stem is forced to grow far above the canopy to reach direct sunlight. The tuber develops generally in confined surroundings. In contrast, when yams are placed under normal agricultural conditions there is direct access to sunlight without necessarily the need to develop a substantial foliar system. For tubers, mounds offer a medium for growing without any physical resistance.

The shortest length of time needed to obtain ennoblement of the tuber is generally three years in all zones studied, and no difference was observed according to the kind of yam species utilized.

The selection criteria used by farmers during the process of domestication are difficult to assess. Few people state that they make tuber selection according to size or shape before the next planting. On the contrary, they generally claim to replant every tuber harvested the previous season. Natural selection seems rather restrictive. In a domestication trial done under controlled conditions in farmers' fields in northern Benin, we obtained a survival rate after four years of less than 10% due to different causes such as viruses, rotting and drying.

Yam domestication, as well as normal yam cultivation, are the prerogatives of men in western Africa. The influence of women in this process is very difficult to establish, although it probably exists, in particular

Table 5. Local names of wild yams used for domestication in Benin and Nigeria.

Ethnic group (department, state or country)	Wild yams that can be domesticated into <i>D. rotundata</i>	Remarks	Other domesticated wild yams	Remarks
Bariba (Borgou, Benin; Kwara state, Nigeria)	Dika: Dika guéa (true d.); Dika wonka (black dika); d. Kpika (white)	(General name for wild yam) = <i>D. abyssinica</i>	Momon (wild form) = <i>D. dumetorum</i>	Yansourerou (frog yam = cultivated form)
Fon & Mahi (Zou, Benin)	Gbété (bush yam), (zounté)	= <i>D. abyssinica</i>	Léfé gbéton = <i>D. dumetorum</i>	
	Zounté: forest yam Ha-tevi (in Mahi)	= <i>D. praehensilis</i> Both		
Nago, Idatcha (Zou, Benin);	Ishu igbo (bush yam)	No thorn = <i>D. abyssinica</i>		
Yoruba (Oyo state, Nigeria)	Atchou, Ishu kô in Benin	Thorny = <i>D. praehensilis</i>	Gbégbé, Eréfé Gudugudu (Nigeria)	Erefé, Esuru (cultivated form)
Yom (Atacora, Benin)	Frogoun Bongounu, Bondi, Bounoui	Black/red types = <i>D. abyssinica</i>	Yerenga, Hiléna, Iloho hile (Devil's yam) = <i>D. dumetorum</i>	
Mbube (Cross River, Nigeria)	Ekporo	= <i>D. praehensilis</i>	Kegue = <i>D. dumetorum</i> Batal = <i>D. bulbifera</i>	Emunu (cultivated)
Bette (Cross River, Nigeria)	Kipam Uto	= <i>D. praehensilis</i>	Kinim = <i>D. dumetorum</i>	
Bekwara* (Cross River, Nigeria)	Ipam utu Achum unim	= <i>D. praehensilis</i>		
Ekajuk (Cross River, Nigeria)	Ekpire	= <i>D. praehensilis</i>	Npoko = <i>D. dumetorum</i>	
Tiv (Benue state, Nigeria), Kwandé, South zone	Mzemba Atakpa	= <i>D. abyssinica</i> = <i>D. praehensilis</i>		
Tiv, Zaki Biam, North zone	Gbangu, Gbage Alakpa	= <i>D. abyssinica</i> <i>D. praehensilis</i> ?		
Mumuye (Taraba state, Nigeria)	Lokojinte	= <i>D. abyssinica</i>	Jamoko = <i>D. dumetorum</i>	Shitigoro (cultivated)
Eggon, Koro (Nasarawa state)	Afga Igetru	= <i>D. abyssinica</i> <i>D. praehensilis</i> ?	Izuma = <i>D. dumetorum</i>	
Alogo (Nasarawa state)	Ishakyo	= <i>D. abyssinica</i>		

when the tubers arrive at the kitchen where the characteristics of the tubers for peeling, cooking and pounding can be assessed. It is also known that in African villages female farmers are very reluctant to express themselves about yam in front of men.

The material used for domestication

Two wild yam species, *D. abyssinica* and *D. praehensilis* are domesticated to obtain *D. rotundata* cultivars. They are generally found in different ecological zones, although in some areas they can grow in very close proximity. In addition several other wild yam species are present in the environment and are considered as yams by farmers. Two other species of wild yams, *D. dumetorum* (bitter yam) and *D. bulbifera* (aerial yam) are also said by farmers to be occasionally domesticated. The wild forms are toxic, but once domesticated they become edible. Others, such as *D. sansibarensis* or *D. togoensis*, are never consumed but can be collected for use in traditional medicine.

Not all farmers are able to make distinctions between all these wild yams or give them precise names. Table 5 gathers together some of the most frequent designations used to identify wild yams in the zones surveyed. This list is probably not exhaustive and if the survey had been extended to other regions additional names could have been discovered, as is usually the case with cultivars. Nevertheless, within the same ethnic group (Bariba, Yoruba) names are very similar on both sides of the border between Benin and Nigeria.

The products of domestication

When the process of domestication is considered concluded by farmers they generally mix the tubers obtained through domestication with those cultivated varieties that they resemble. In this case there is no creation of a new variety *per se*, and the cultivars stated as coming from current domestication should be polyclonal. It is only when the shape of newly domesticated yams does not conform to existing germplasm that a new designation is given. In the Bariba zone, only one new name was found out of 27 identified as coming from current domestication (Dumont and Vernier, 2000).

The majority of domesticated varieties belong to the early maturing varieties (or double-harvested variety),

especially in Benin where 80% (104 out of 129) of the cultivars are classified as early yams (Table 6). In Nigeria, the bias towards early types is smaller (50%), but here, especially in the eastern states, the distinction between single- and double-harvested cultivars is not always clear. Indeed, in the case of a market-oriented production, many farmers manage the same cultivar under both systems (single/double harvest) in order to spread yields over a longer period. Whatever the reason for this, it is difficult to understand and needs more investigation.

Conclusion

The domestication of yam has remained an active process in many regions of Benin and Nigeria. Knowledge of the possible uses of wild yams and the techniques needed to transform them into cultivated forms of *D. rotundata* are still very common among yam producers in both countries.

Understanding of the domestication process by the scientific community is still very limited and much more research is necessary to clarify it. Several studies using biotechnological techniques are in progress and should soon bring greater insights into what happens during the ennoblement of yams. It is also clear that the taxonomy of wild yams related to *D. rotundata* should be reviewed. Irrespective of this, domestication represents a unique and remarkable case of a farmer-driven process of plant breeding with a vegetatively propagated crop. It appears to be an ingenious way, discovered by African farmers, to take advantage of the huge reservoir of biodiversity preserved in wild yam populations. As cultivated varieties represent a rather limited range of genetic diversity for varietal improvement due to the vegetative propagation of yams, this opportunity to increase the germplasm suitable for breeding should be given serious consideration by breeders.

Unfortunately the study also showed that actual practices of domestication are tending to decline, in particular where yam production is mostly market-oriented, and this endangers the future of *D. rotundata*, a species representing about 90% of the cultivated yams in the world, and which is a major component of food security in western Africa.

There is therefore a danger of rapidly losing this

Table 6. Cultivated varieties of yam (*D. rotundata*) coming from current domestications of wild yams in Benin and Nigeria.

Country	Zone/state	Total number of varieties	Early maturing type	Late maturing type	Intermediate type	Undetermined
Benin	Nago	63	51	7	0	5
	Fon	8	6	1	1	0
	Yom	32	24	4	2	2
	Bariba	27	24	3	0	0
	Total Benin	130	105	15	3	7
West Nigeria	Oyo	5	5	0	0	0
	Kwara	15	6	2	3	4
East Nigeria	Cross River	5	0	3	2	0
	Nasarawa	13	11	1	0	1
	Taraba	4	1	2	1	0
	Benue	16	6	6	0	4
	Total Nigeria	58	29	14	6	9
Total		188	134	29	9	16

valuable indigenous knowledge if action is not taken to encourage, and even revive the practice of yam domestication. It could also be an opportunity for agronomic researchers to undertake balanced collaboration with farmers on a crop about which the indigenous knowledge is often greater than that of the researchers.

References

- Baco, M. N. (2000), 'La "Domestication" des ignames sauvages dans la Sous-préfecture de Sinende: savoirs locaux et pratiques endogènes d'amélioration génétique des *Dioscorea abyssinica* Hochst', thèse Ing Agro, UNB-FSA, Cotonou.
- Burkill, I. H. (1939), 'Notes on the genus *Dioscorea* in the Belgian Congo', *Bulletin du Jardin Botanique de l'Etat*, Vol 15, No 4, pp 345–392.
- Coursey, D. G. (1967), *Yams. An Account of the Nature, Origins, Cultivation and Utilisation of the Useful Members of the Dioscoreaceae*, Longmans, Green and Co Ltd, London.
- Dumont, R., and Vernier, P. (2000), 'Domestication of yams (*D. cayenensis-rotundata*) within the Bariba ethnic group in Benin', *Outlook on Agriculture*, Vol 29, No 2, pp 137–142.
- FAO (2000), FAOSTAT Agriculture data Website: <http://apps.fao.org>.
- Hamon, P. (1987), 'Structure, origine génétique des ignames cultivées du Complexe *D. cayenensis-D. rotundata* et domestication des ignames en Afrique de l'Ouest', Thèse de Doctorat ès-Sciences, Université Paris XI, Orsay.
- Miège, J. (1952), 'Contribution à l'étude systématique des *Dioscorea* d'Afrique Occidentale', Thèse de Doctorat ès-Sciences, Paris.
- Okry, K. F. (2000), 'L'Igname dans le système de production agricole de Bantè et la domestication de quelques unes de ses formes sauvages: savoirs locaux et pratiques endogènes de culture et d'amélioration génétique', thèse Ing Agro, UNB-FSA, Cotonou.
- Ramser, J., Weising, K., Lopez Peralta, C., Terhalle, W., Terauchi, R., and Kahl, G. (1997), 'Molecules marker based taxonomy and phylogeny of Guinea yam (*Dioscorea rotundata* D. Cayenensis)', *Genome*, Vol 40, No 6.
- Terauchi, R., Chikaleke, V. A., Thottappilly, G., and Hahn, S. K. (1992), 'Origin and phylogeny of Guinea yams as revealed by RFLP analysis of chloroplast DNA and nuclear ribosomal DNA', *Theoretical and Applied Genetics*, Vol 83, No 6–7.
- Vernier, P., and Dansi, A. (2000), 'Participatory assessment and farmers' knowledge on yam varieties (*D. rotundata*) in Benin', in M. Nakatani and K. Komaki, eds, *Proceedings of the 12th Symposium of ISTRC, Tsukuba, Japan, ISTRC 2000 – Potential of Root Crops for Food and Industrial Resources*, pp 360–365.