

Knowledge on yam variety development: insights from farmers' and researchers' practices

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Introduction

With the growing dissatisfaction of governments and donors on the limited impact of agricultural research given the substantial investment made, researchers are being pressured to be more client-, impact- and results-oriented (Stroud 2003). To respond to these challenges, participatory innovation processes are being designed to find more effective models for agricultural development, not only at local level, but also across hierarchical levels and scales, and to bridge the knowledge divides between scientists and farmers, as for crop diversity management (Röling *et al.* 2004; Zannou *et al.* 2004; Zannou 2006). The needs still exist to explore new domains as for crop variety development by scientists and farmers. Studies showed that farmer knowledge adds an important element to scientific research (Richards 1989).

Farmers and researchers belong to two different institutional frameworks: informal and formal ones. In each of these constituencies, the main issue is to know what the institution is about, how it works (Eckert and Wenger 1994). As this knowledge is acquired and enacted in day-to-day practice, it becomes part of one's institutional identity. This day-to-day practice of living within an institution is configured within the local communities of practice:

A community of practice is an aggregate of people who come together around some enterprise. United by this common enterprise, these people come to develop and share ways of doing things, ways of talking, beliefs, values.
(Eckert and Wenger 1994)

Communities of Practice are 'groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis' (Wenger *et al.* 2002). These communities can be defined by disciplines, by problems, or by situations (Wenger 2004).

In this case study, although farmers and researchers come from different communities of practice, they share the objective of developing new varieties which satisfy both farmers' and consumers' needs and provide notoriety to researchers' professional work. The objective of this paper is to establish that farmers have an experimental science of their own and then describes why national and international agro-science needs to establish an effective link with farmer experimentation in order to develop appropriate varieties meeting preferences of farmers and consumers.

Farmer yam variety development

This section analyzes the domestication process, mainly the choice of the wild yam, the criteria to evaluate the results of the domestication process, the time needed to complete a domestication cycle, and the farmers' knowledge on wild yam and its uses.

Research area

This research has been conducted in the district of Glazoué in the central part of Benin. This district lies between 7 and 10° northern latitude in the Guinea Sudan transition zone of Benin. The annual rainfall varies between 1100 and 1200 mm, and the average monthly temperature between 22°C and 32.8°C. The natural vegetation is mainly tree savannah.

Data collection

This research was conducted in August 2005. Interviews were held with 38 farmers active in domesticating yam in this district, in 13 villages where yam farmers have knowledge and experiences in yam domestication. Farmers who have knowledge on yam domestication represented 1-5% of yam farmers in these villages. Questions asked focused on the cultivated varieties; sources of seed / planting materials; knowledge and uses of wild yams; description of processes, techniques and results of domestication; time needed to complete a cycle of yam domestication; the reasons for failure of some domestication practices; and the farmers' perception on the social and economic value of yam domestication.

Socioeconomic characteristics of the farmers

Yam domesticators interviewed had different ethnic backgrounds: 55% were Idatcha, 42% were Mahi and 3% were Peuhl. Idatcha and Mahi are dominant in central Benin. The age of the farmers varied from 25-82 years, with an average of 48 years. An analysis of poverty in Benin revealed that farmers in this district belong to the category of poor farmers in Benin (Aho *et al.* 1997). Among farmers, yam domesticators are often perceived as the poorest of yam farmers.

Farmers' experiences and knowledge involved in domestication

Farmers' experiences were diverse and included both successes and failures. Farmers showed a certain risk aversion, i.e., they tried to avoid the risk of becoming ill by eating the wild plant material when it was not yet domesticated. Box 1 presents some narratives on farmers' experiences. One of the first effects of domestication was a lower risk. The statement 'we got nothing' means in the local language 'we were safe'. The number of years to get eatable yam was another aspect considered by farmers. Farmers often tried to change the taste, size, the tuber thickness, etc. Some farmers tasted the wild material before the domestication process began.

Box 1: Farmers' experiences: successes and failures

Successes

- The first, second and third harvests have been replanted, it is the fourth result that we ate and we got nothing.
- We harvested the tubers from forest during the dry season and planted the tubers in big mounds during three successive years. After the third year, we realised that it is mixed with the cultivated varieties and we can not distinguish it from the others.
- We cultivated it for 3 years before eating; it was in the 3rd year that we tasted it. In that year, we could not distinguish it from the others.
- After 2 years of production, I gave a small bit of its tubers to chickens, and the chickens got nothing. From there, I began eating it myself.
- We find wild yam whose vegetative parts resemble a little bit the one of variety Mondji. We harvested it and cultivated it for 2 years. The tuber was like Mondji in the 3rd year.
- The first harvest has not been eaten, the second harvest was given to animals who got nothing; it is from there I began eating.

Failures

- After the first year of cropping, I saw that it was no use continuing as it was not eatable.
- I cultivated it for 2 years and the shape did not change and I abandoned it.

Some aspects of farmers' knowledge and practices are considered in more detail. The types of mounds built for yam to be domesticated are important. Change in taste is progressive and results from a consecutive planting for several years. Most of the farmers stated that by dint of consecutive cultivation of the wild-type over 2-5 years, good results were obtained. The shape of the tuber was also progressively transformed (Box 2). Some farmers managed the process of changing the form only by adjusting the type of the mounds, but others introduced flat stones in the mounds to reduce the long size and to blow up the thin shape.

Box 2: Knowledge and practices involved to change its forms and taste or structure

- By dint of cultivating it several times, everything changed.
- Cultivating in mounds several times changed the taste and the shape.
- After the first harvest, I tasted it and it was still bitter, but in the following years the taste became better.
- We changed the taste progressively over several years.
- I introduced flat stones in the mounds.
- We dug a hole before making the mounds in order to make the harvest easier.

Knowledge on wild types

Most farmers considered the wild types as food but others as planting materials used for domestication. When the wild types were considered mainly as a source of food, they were collected during the period of hunger during the dry season. Some wild types were tasty and edible, while other ones were bitter and non-edible (Table 1). The colour of the wild types varied: the middle part can be white, whitish, and the head red, reddish or yellow. The shape also varied: fringed, long, snaking or sometimes forked. Some farmers compared the flower of the wild-types with those of their varieties.

Table 1: Tuber colour and shape of the wild materials used for domestication
 (total n=38)

Wild tuber colour	% of farmers	Wild tuber shape	% of farmers
White / whitish head and middle part	37	Fringed	55
Red head – white middle part	30	Long	37
Yellow entire tuber	18	Sinusoidal	9
Yellow head-white tuber	9	Long and fringed	6
Reddish/ Brown	6	Forked	3

The empirical evidence of farmer variety development

In the course of evaluation, the yield appeared to be one of the main criteria that farmers considered after the first year of domestication. Evaluating the taste was postponed by most of farmers until the third year. Most of the traits (including taste, edibility, colour, tuber length, tuber shape and size, spine absence) were evaluated during the third year of domestication by most farmers (Table 2). The third year appeared then as a year of reference for evaluating the result of yam domestication for most of the criteria.

Among the factors that influenced the duration of the domestication process were taste, tuber size and tuber length. The types of mounds and the care provided to the plant, as well as the soil quality influenced the duration of the domestication process. Some farmers considered it risky to humans to eat the product first if they were not sure that the yam under domestication was already eatable. For tuber length, the moderate type was preferred because when the tubers become too long, they may break during harvesting and in that case often an important part remains in the soil. The preferred tuber size was the relatively big or very big one. When the tuber is big, it becomes economically interesting for farmers. The tuber at the end of the domestication process can have different shapes: conic, fringed, egg-shaped. Sometimes when the results from the domestication appeared to be very successful for farmers, the tuber remained somehow sinusoidal. Mostly, the whole tuber flesh became white. After successful domestication, the spines and bristles were absent from the tuber surface or were considerably reduced. The new variety may phenotypically resemble already known varieties but this does not mean they are the same.

Table 2: Criteria for evaluation and numbers of farmers who considered the criteria each year (total n=38)

Process	Year 1	Year 2	Year 3	Year 4	Year 5
Yield	24	7	3		
Taste	9	9	15	3	3
Edibility		7	27		2
Colour	4	4	26	2	
Size	3	9	22	5	1
Length	5	9	18	3	
Small bristles on tuber		9	21	1	
Spines	4	11	18		2
Shape	1	6	25		

Farmers' motivations

Farmers' motivation to domesticate may start from their culture, i.e. what they inherit from their ancestors and parents. But dominantly, it was their curiosity and their willingness to research and try the origins of cultivated varieties that stimulated them to domesticate. Some narratives showed also that the motivations were grounded on their food needs: 'to have planting materials', 'to have more varieties', 'to find yam for consumption'.

Yam improvement: insights from researchers' work

We hereafter review and analyze the past 35 years of research to improve yam conducted by researchers in Benin and in Africa.

Yam variety innovations by researchers in Benin

Like farmers, researchers have been involved in yam research but, in contrast, they have approached the needs for developing new cultivars that would meet the requirements of the desirable variety traits for farmers and consumers in a different way. There was no breeding programme on yam. The lack of knowledge on existing plant materials and their agronomic characteristics, as well on farmers' and consumers' preferences prevent scientists from developing appropriate methods to increase yield, to reduce post-harvest losses, and to select desirable variety-types for the market (INRAB 1996).

Research activities were mainly based on multi-location trials of 'improved varieties' selected by the International Institute of Tropical Agriculture (IITA). The current dominant characteristic of the national elite crop science system for varietal innovation was limited to receiving new introductions from elsewhere. At the national

level, it has been mentioned that:

the demand for agricultural services included the identification of varieties, cropping technologies, and post-harvest technologies which have been developed elsewhere, then to test them in the most appropriate zones and systems of the country. (INRAB 1995)

These technologies are supposed to satisfy farmers' needs by increasing agricultural productivity.

Scientists' motivations and research on yam breeding at international level

The improvement of specific characteristics of yam varieties has been a concern for plant breeding at international public research level in the past (IITA 1971, 1974; Akoroda 1983). At the very beginning of scientific research on yam in Africa, scientists were concerned with yam breeding and its reproductive biology. Their main argument was that:

a sustained high capability for sexual reproduction is desirable in a breeding programme, since the continued use of elite clones as parents in yam hybridization programmes depends to a large extent on whether such clones are seed producing. (Akoroda et al. 1984)

The controlled production of hybrid seeds required for genetic improvement of food yams has not been possible because of insufficient understanding of flowering in relation to practical techniques for artificial pollination. The success of yam cultivar inter-crossing depends on some conditions: synchronous flowering of male and female plants, stigma receptivity of female plants and pollen viability of male plants, and the genetic compatibility between cultivars (Zoundjihékpon et al. 1997).

The knowledge developed by scientists on the crop has been mainly technical and limited, whereas farmer knowledge is both technical and socio-economically rooted.

Bridging the knowledge divides between farmers and scientists

Lessons from farmers' own experimentation and scientists' practices

As revealed by farmers in this study, domestication remains the method these farmers use to transform the taste, shape, the colour, the size, and the thickness of the wild variety types into desired new cultivar traits. Domestication led to variety types that were either similar to known landraces or to completely new cultivars (Mignouna and Dansi 2003; Dumont et al. 2005). For many reasons, farmers lack tubers for planting and this justifies their return to domestication to reconstitute their stock of planting materials which is a cheap source of planting materials and a way to cope with hunger, or to deal with the loss of productivity experienced in existing cultivated varieties.

From the analysis of yam improvement, the way the formal research provided farmers with supposed useful variety types suggests that there have been pre-established needs for farmers. At the national level, most of the new improved varieties did not increase

productivity.

The second dimension of crop variety innovations is the lack of an effective breeding programme on which participatory crop improvement can be developed with farmers at the national level. At the international level, the results of developing hybrid yam varieties remained mitigated. This highlights the fact that the reproductive biology of yams and the genetics of their wild and cultivated varieties need further research.

The knowledge divides between scientists and farmers

It appeared that, in both theory and practice, the farmer crop improvement system and the formal crop breeding system remained two isolated communities of practice. Hardon and de Boef (1993) revealed that past experiences of modern plant breeding failed to elicit farmers' crop requirements and involve them in setting breeding objectives, and these past conflicts would be based on lack of appreciation of the inherent characteristics and limitations of both systems of crop improvement. Plant breeders would have assumed that modern varieties bred for improved yield potential would have more general relevance over, in their view, more primitive landraces. It has also been claimed that farmers reject modern varieties because they do not meet their requirements, and farmers give considered preference to local landraces.

In general, the traditional convention has been to view scientists as the source of new agricultural knowledge, with this knowledge being delivered to farmers via a separate extension service (Hall et al. 2003). Most of the time, the research programmes do not take heed of the different layers of social reality which make up and surround programmes. Current crop variety development systems also lack contextual thinking to address the issues of 'for whom' and 'in what circumstances' a programme will work. It is acknowledged that agricultural research systems tend to be relatively weak in the area of technological contextualization (Hall and Clark 1995).

The technologies of fertilizer-responsive varieties developed by international agricultural systems and introduced into poorer and complex areas are not easily replicated. This has led to the realisation that solutions to complex problems cannot be solved on-station but need to be built up in situ in farmers' fields, taking full advantage of a farmer's knowledge and innovative abilities. All of these cases illustrate the discrepancies between farmer knowledge and scientists' knowledge in national and international research systems.

Bridging the knowledge divides between farmers and scientists

As revealed by Synder et al. (2004), the complexity of today's challenges and associated performance expectations requires a commensurate capacity for learning, innovation, and collaboration across diverse constituencies. They suggested that one way to integrate efforts across these boundaries is to cultivate communities of practice that promote cross-boundary action learning to address national priorities. The communities could operate as social learning systems where practitioners connect to solve problems, share ideas, set standards, build tools, and develop relationships with peers and stakeholders.

Farmer variety development is a culturally and socially rooted knowledge and practice. As end-users of new materials or technologies from scientists and

researchers, farmers need to internalize the new innovations that often do not meet their needs. The convergence of the two different domains of knowledge and practice requires trans-disciplinary skills (Max-Neef 2004; Roux et al. 2006; Zannou 2006). Crop variety development in Africa needs what is called communities of practice where a new domain of knowledge needs to be explored and developed. This domain will provide a common focus that gives the community or the group its identity and defines the key issues that members need to address. The practice of crop variety development requires that all practitioners (farmers and scientists) and end-users are involved in variety development to more closely align new technological solutions to real farmer needs or problems.

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Abstract

This paper analyzed three different types of actors (farmers, researchers at national and level and researchers at international level) having different approaches and practices to improve yam in Benin. Farmers' own experimentation on yam variety development resulted in insight into yam domestication. With a thorough process of domestication, a new variety can be developed in three years. Farmers evaluated new material based on yield, taste, suitability for food, size, colour, shape, and length of the tubers, and presence of spines and bristles on the tubers. In the national, formal system, the lack of knowledge on existing plant materials and their agronomic characteristics, and on farmers' and consumers' preferences, prevent scientists from developing appropriate methods to increase yield and to reduce post-harvest losses. In an international context, researchers have worked on yam for 35 years but still fail to fully understand the reproduction biology and genetics of wild and cultivated yams. The study revealed that farmers have their own experimental science and suggests that there is a need for the elite formal crop science to establish an effective link with farmer experimentation and to cultivate communities of practice that promote cross-boundary action learning to address farmer needs and national priorities.

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