Participatory Research in Cassava Breeding with Farmers in Northeastern Brazil

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Contents

List of Acronyms

BNB	Northeastern Bank of Brazil
CGIAR	Consultative Group of International Agricultural Research
CIAT	International Center for Tropical Agriculture
CNPMF	National Center for Research on Cassava and Fruits, Brazil
CORPOICA	Colombian Agricultural and Livestock Research Corporation
CPATSA	Agricultural and Livestock Research Center for the Semiarid Regions
EBDA	State Rural Extension Agency, Bahia, Brazil
EMBRAPA	Brazilian Agricultural and Livestock Research Agency
EPACE	Ceará Agricultural Research Agency (Brazil)
IFAD	International Fund for Agricultural Development
IPMY	Participatory Research for Cassava Breeding
PPB	Participatory Plant Breeding
PRGA	CGIAR Systemwide Program for Participatory Research and Gender Analysis, convened by CIAT (Colombia)
PRODETAB	Program for Supporting the Development of Agricultural and Livestock Technology for Brazil
PRONAF	Family Farming Program
PRÓ-SERTÃO	Project for Supporting Low-Income Families, Brazil

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Abstract

Participatory research with farmers is gaining acceptance in institutions and programs that seek to develop technologies for sustainable development in rural areas. Among these institutions are the breeding programs in several Latin American and Caribbean countries. The Participatory Research in Cassava Breeding (IPMY) procedure—initially developed by the International Center for Tropical Agriculture (CIAT) in collaboration with the Colombian Agricultural and Livestock Research Corporation (CORPOICA) in the Caribbean coastal region of Colombia—has been adopted and/or adapted and applied in several countries. This document presents a participatory cassava breeding experience with farmers from northeastern Brazil, implemented by the Brazilian Agricultural and Livestock Research Agency-National Center for Research on Cassava and Fruits (EMBRAPA-CNPMF) in collaboration with the regional rural extension services, NGOs, farmers' associations and individual farmers. The experience began with a pilot project in nine communities of a municipality in the Northeast; today, seven years later, the initiative has supported a total of 305 participatory trials in 70 communities of 4 states in the region. Eight varieties have been released, and another dozen clones with a high probability of acceptance have been identified. Many farmers are already growing these clones and testing others and there has been a constant demand from farmers and institutions in the region to continue this work. The expansion phases of the Project, what was learned during the process and the results obtained thus far are described. The strengths and weaknesses of the work are also analyzed, and some of the challenges and possible directions in the immediate future are highlighted.

Introduction

Participatory plant breeding (PPB) is a research approach that facilitates the close interaction among farmers, researchers and other actors in the genetic improvement of crops[1]. With this approach researchers are able to respond more precisely and efficiently to the needs and preferences of resource-poor farmers and their markets—clients that are not always reached by the public agricultural research system. The varieties resulting from this process are developed more rapidly and have higher adoption rates than varieties produced by means of conventional breeding. By the end of a PPB process it is expected that farmers and other participants have refined their capacities and are able to continue working more independently and to apply the principles of research to solving problems in other fields of rural development. In the longer term this will be translated into a greater and more accelerated impact on the reduction of food insecurity, poverty and deterioration of the natural resources in rural zones (Weltzien/Smith et al., 2000).

To date, PPB has been used to evaluate and improve crop potential in various countries of the world. Work has been done with both seed- and vegetatively propagated crops, with both

[1] PPB comprises all breeding activities—from the establishment of priorities, the generation of variability, the selection and testing of experimental varieties to the release of a new variety or diffusion of planting material..

stable and segregating materials. Although the majority of the cases studied are located in subsistence agriculture systems in biophysically and socioeconomically marginal areas, this approach is also being used in areas suitable for commercial production (PBG/PRGA Program, 2000). For many breeders, PPB represents a change not only in their way of working with farmers but also in the organization of their work as it involves more people (and different actors). Work is done at a greater number of sites, and more and different types of information are managed.

In the mid-80s CIAT and CORPOICA researchers developed the IPMY procedure[2] (Hernández, 1992). This procedure, which was originally developed, tested and validated in the Atlantic Coast region of Colombia, was first disseminated in 1993 when technicians and breeders participating in the Symposium of Latin American Breeders in Havana (Cuba) were trained. In subsequent years this procedure was tested in Brazil, Cuba, Ecuador and other countries of the region; and as a result some modifications and adaptations were made in accordance with the local conditions. Among the factors that most motivated the national research programs to adopt and adapt the procedure, two stand out: the possibility of improving the adoption rate of new varieties, which had traditionally been low, and the stimulus of funding available from several international donors who were also concerned by the low indices of impact of the breeding programs.

At present the most important cassava breeding programs in Latin America and the Caribbean are using adaptations of this procedure (Iglesias and Hernández, 2000). In addition to the cassava crop, are also participatory approaches being applied to the improvement of common beans, maize, potatoes and other Andean roots and tubers, plantains, wheat, rice, forages, squash and vegetables, among others (PRGA Program, 2000).

Participatory Plant Breeding in the Semiarid Region of Northeast Brazil

This document explaing and analyzes the experience of a cassava breeding project, implemented in collaboration with farmers from the semiarid region of northeastern Brazil. This case is particularly interesting given the geographical extended area covered, the number of communities and cassava clones with which it is working, the emergence of a group of farmers who are multiplying and disseminating the varieties that they have selected, and the

[2] Participatory methods had already been used in parts of Latin America but under the generic name of participatory research without a specific methodology for crop improvement..

rapid adoption of these materials by other farmers in the region. Moreover, this experience highlights some of the more important challenges and issues in implementing PPB.

Application of the IPMY procedure in Brazil began in the semiarid Northeast at the end of 1993. It was promoted by EMBRAPA-CNPMF and CIAT with technical support from the State Rural Extension Agency in Bahia (EBDA) and funding from the International Fund for Agricultural Development (IFAD). Later on, entities such as the northeastern Bank of Brazil (BNB), the Program of Support for the Development of Agricultural and Livestock Technology in Brazil (PRODETAB), the Project of Support for Low-Income Families (PRÓ-SERTÃO), the Family Farming Program (PRONAF) and the CGIAR Systemwide Program for Participatory Research and Gender Analysis (PRGA), convened by CIAT (Colombia), began to finance this work,[3] which made it possible to expand it to several other ecosystems in northeastern Brazil.

Initially the work was done with farmers from nine communities in one municipality; and in the following years it was gradually expanded to other states in the Northeast. At the same time, the number of institutions that joined and financed the Project was expanded. To date, the initiative has facilitated 305 participatory trials, in which some 1500 families, distributed in four states of the region, have participated. From the onset of the Project, varietal evaluations have been carried out with the participation (with varying forms or levels of participation of men, women and children); and hundreds of cassava varieties in the final phases of research and thousands of clones in early phases of the breeding program have been included.

Among the preliminary results of this work, the following can be highlighted: the adoption of new cassava varieties and their multiplication by farmers with the subsequent increase in genetic diversity at the farm level; the training of researchers, technicians, extension agents and farmers in participatory research methodologies and raising their consciousness with respect to the importance of participating in the generation and selection of new technologies; and the establishment of a feedback system between the farmers and the breeding program.

This document is organized as follows:

- The knowledge and management of local and improved cassava varieties by farmers in

[3] It is considered that these donors became interested in the Project because participatory research had already begun to give results in other projects and crops in different parts of the world. At that point the research and extension institutions in Brazil had not worked closely with the cassava producers, and it was thought that it was a

northeastern Brazil, as well as the physical and socioeconomic context in which the work was carried out

- Conventional cassava breeding in Brazil prior to the implementation of PPB
- The development of PPB in Brazil, explaining the researchers' reflections in each expansion phase
- Results obtained thus far
- Challenges and future directions for the cassava PPB project in the region
- Conclusions

The specific objectives of this document are to illustrate, analyze and disseminate the experience acquired with the IPMY procedure in Brazil so that other practitioners can reflect upon the case and learn from it. It is not a manual and therefore does not explain how to repeat the experience per se because the IPMY procedure is explained in a series of other publications (Hernández, 1992; 1993; 2000). Moreover, there is extensive literature on participatory research and the different tools that can be used in their application (Quirós et al, 1992; Guerrero et al., 1996).

It should be noted that this document was prepared before several of the subprojects that make up the experience ended[4]; therefore, specific data as to their final impact are not included. Nevertheless, the results of the ongoing research and the process itself can be of great interest and usefulness.

Farmers' Knowledge and Management of Local Cassava Varieties in the Semiarid Region of Northeast Brazil

Northeast Brazil is characterized by low-fertility soils and adverse climatic conditions. There are long periods of drought that can last up to 8 months. The annual rainfall ranges from 400 to 750 mm, distributed over a 3- to 4-month period.

The level of poverty in the region is extreme. The farming is done mainly by small producers, many of whom do not own their own land, splitting their harvests with the landowner. In this region, cassava has great social importance and constitutes the main subsistence crop, which is used principally for on-farm consumption in the forms of *farinha* (a

good opportunity for achieving impact in the poorest areas of the country.

[4] The experience that is described in this document consists of several subprojects implemented in different municipipalities over the last 7 years. The Project as such refers to the participatory research experience as a whole.

form of roasted flour) and starch. It is also used on a smaller scale for fresh consumption and for preparing diverse breads and desserts. In periods of extreme water stress—very common in the region—cassava is the only crop that survives and produces, the roots being an excellent source of carbohydrates and the aerial part, proteins. The aerial part is also used for domestic animal feed in some communities.

Attacks by pests such as cassava mites and diseases including root rot and bacterial blight can be very intense. Recently it was estimated that production losses caused by these two diseases can reach from 50-100%, respectively, in some zones (Fukuda et al., 2000).

On occasions the fresh cassava roots and the by-products from processing are sold on the local markets. In general the women extract and commercialize the starch, in which case they handle the money; whereas the commercialization of the *farinha* and the fresh roots are generally the men's activities. It should be noted, however, that commercial-scale production is not a systematic activity and that both the access to the markets and the purchase prices are not assured. Consequently, the income from this activity is not significant if compared to its potential and in relation to the income generated by other crops in the region.

The small farmers of this region do not use inputs in cassava cultivation; and when they do, it is in minimal amounts. They do not use other improved technologies either. Different varieties are planted in mixtures and in nonlinear fashion; therefore, only the farmer who plants them can identify them. Although this may seem like a random act, it has also been observed on the Caribbean Coast of Colombia and in other parts of Latin America, and is probably a practice developed historically in order to ensure a harvest in the case of either a drought or excessive rains, to protect the crops against pests and diseases and to maintain some ground coverage as some varieties mature and are harvested earlier than others. In northeastern Brazil, cassava is commonly planted in association with other crops, especially with a succulent used for animal feed.

The local varieties are those that are most cultivated in this region, where improved varieties are not common. The varieties are usually passed on to the farmers by their fathers and often their origins are not known. In fact in some zones there are varieties that have been planted for more than 100 years. This constitutes a barrier for the adoption of new varieties because the farmers do not believe that there is anything better that is capable of competing with or replacing their traditional varieties. Thus far the intervention of governmental

institutions in this process has been limited. Thus the farmers acquire and select their materials without support from the formal research sector.

Many times local varieties are obtained through farmers from neighboring regions or other parts of the country.[5] Despite having introduced and tested many varieties on their farms, the farmers are exigent selectors, only adopting and multiplying a few of them after several years of observation. For this reason they affirm that many of the varieties that they used to cultivate were discarded or even disappeared for lack of adaptation to the environment or the breakdown of resistance[6] to a given pest or disease.

In general the farmers of this region are not interested in the plants that originate from true seed as they produce only one taproot with vertical growth. Many farmers do not know that this condition changes when the plant is multiplied vegetatively. Nevertheless, it has been observed that some of them multiply the segregants from true seed that appear among the adult plants in their plots. Sometimes these plants produce normal and better roots than the local varieties, so the farmers select and conserve them. When farmers introduce a variety to their farms, they often give it a name, which can refer to the site where it was collected, the farmer who collected it, or some outstanding trait. It has been observed that although there is enormous genetic diversity of cassava in Brazil, sometimes one variety has several names.

Once the quality and adaptation of a variety—whether it be from true seed or vegetative material—is confirmed, the process of multiplication and diffusion among farmers and communities is quick and spontaneous although not systematic. Despite the fact that the farmers have proven to be active in the evaluation and continued selection of their local varieties, in the initial diagnoses conducted for the project, it was not possible to identify anyone who was doing this work systematically and for the community.

Although the farmers generally maintain broad genetic diversity of cassava on their farms, it has been observed that they have a few preferred varieties that occupy most (80%) of their land and that are used to produce *farinha* and sometimes starch. The remaining varieties are planted in lower numbers, possibly to secure against pests or diseases, or for use on a smaller scale for domestic consumption or animal feed. Even when this is taken into account, the loss of genetic diversity in the fields of this region is common and of concern. This loss is caused on the one hand by the long periods of drought in consecutive years during which the

[5] Sometimes these are improved varieties, but generally their true origin is unknown as the farmers have been planting them for many years. It is possible that they are varieties generated by farmeres, but thus far there are no studies to confirm this.

[6] In reality the varieties do not lose resistance as they are usually propagated vegetatively; rather the pests and

materials are used for feeding animals and on the other hand, by diseases and pest attacks in less resistant varieties (W. Fukuda, pers. com.). This loss of genetic diversity leaves the crops and the farmers more vulnerable to losses during periods of stress.

In summary, it can be said that the conditions in the Project work area are extreme, characterized by little rainfall and a high incidence of pests and diseases. The producers are very poor and practice subsistence agriculture in which cassava plays a central role. They grow local varieties that are passed on from one generation to another and among neighboring farmers and friends. Despite this constant introduction of new germplasm, the cultivated varieties have low production potential and are susceptible to pests and diseases in the region—a situation that is further aggravated by the loss of genetic variability in the fields. The farmers are active selectors of the germplasm, which in one form or another appears on their farms, but they do not consciously generate new varieties and know very little about the results of formal agricultural research.

Conventional Breeding of Cassava in Brazil Prior to the Implementation of Participatory Research

Conventional cassava breeding in Brazil begins with the definition of problems and objectives based on the research institution's policies and priorities and with input from the plant breeders.

After the objectives are defined, the plant breeder selects the progenitors and makes crosses or begins evaluating and selecting materials available from the germplasm bank. These materials are submitted to an average of three evaluation cycles, after which the best varieties are evaluated in regional experiment stations (regional trials) and sometimes on the lands of farmers who loan their plots for a period of two cycles. The elite varieties that result from this process are ready to be recommended for release and difusion. Outstanding varieties can be used in recombinations for generating progenies, which are incorporated in the same evaluation and selection scheme (Fig. 1).

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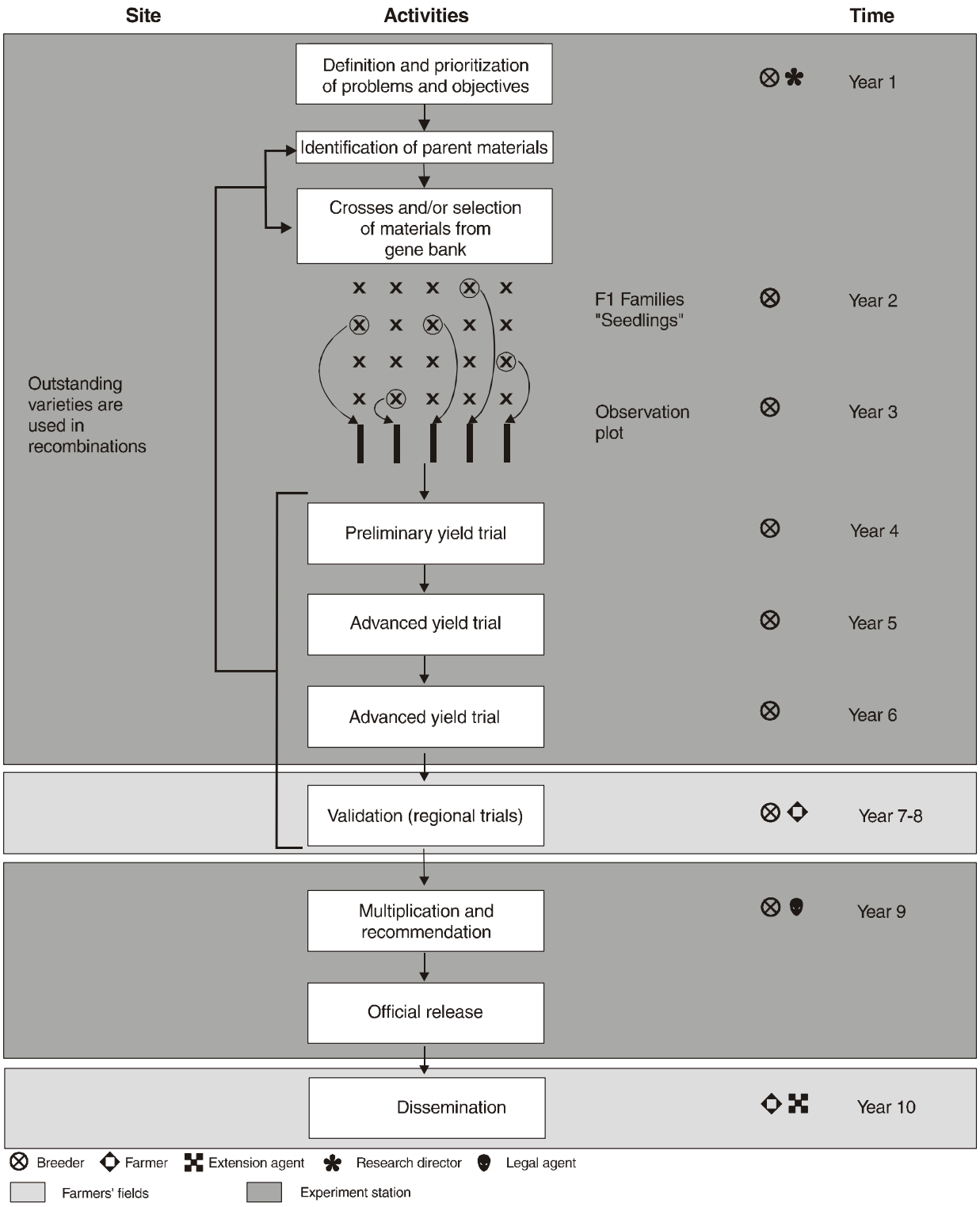
pathogens evolve.

Figure 1. Traditional Breeding Scheme in Northeast Brazil



Prior to the diffusion phase, demonstration plots are established, generally on the farmers' land. Although there is some interaction between the farmers and plant breeders in this phase, the farmers do not participate much in the establishment of priorities, the experimental design or the decision-making; and their criteria and preferences are not necessarily considered in the breeding program. The purpose of these plots is basically to demonstrate the final result of the breeders' work and to recommend the varieties through field days, where the farmers are brought together, the planting materials of the recommended varieties are distributed, and the work is considered finished. This conventional scheme takes an average of 10 years to produce a variety.

This breeding scheme has several limitations:

1. Almost all the work is carried out at experiment stations under controlled conditions that are optimal for the crop. Thus varieties with high production potential, but adapted to ideal crop conditions are generated and selected. These conditions are quite different from those found in the small farmers' production systems in Northeast Brazil, where the edaphoclimatic conditions are adverse, little or no external technology is used, and cassava is grown together with other crops.
2. The varieties generated in this scheme are released at the end of a selection process based almost exclusively on the plant breeders' criteria. Farmers are offered few alternatives (in some cases <1% of the clones generated in the crosses) from which to choose (Hernández and Iglesias, 1994; cited in Iglesias, 1994); and many times these are not ideal for meeting their needs.
3. Farmers play a passive role in this process. Even though their lands are sometimes used for the regional trials, their opinions and needs are not incorporated in the process. With this focus the risk is run of excluding promising varieties from the farmers' standpoint and selecting something not desired by them although it may seem promising from the breeder's point of view.

Within the conventional method of cassava breeding in Brazil, the generation and diffusion of varieties is unidirectional; that is, researcher to extension agent to farmer. The plant breeder develops and selects the clones at the experiment stations and after a series of yield trials distributes them to other social or scientific institutions located in other ecosystems for proceeding with the regional trials. These institutions organize field days to demonstrate and recommend the best varieties. Then the extension agents are in charge of disseminating them and promoting them among the farmers. Thus there is insufficient feedback and communication among the actors involved in the generation, trial, diffusion and adoption of

new cassava varieties.

Upon analyzing this process and the results in Northeast Brazil, it was clearly observed that many recommendations have failed. Adoption of new varieties has not occurred, and the farmers continue to plant their traditional varieties, which—despite their being less productive—are more reliable from their standpoint given that they themselves selected them under their own conditions over a period of many years. Many of the varieties selected by farmers have traits that are not considered significant from the plant breeder's standpoint but that are very important and at times essential for the farmers.

Development of Participatory Plant Breeding

The availability of a procedure developed specifically for the cassava crop[7] and the success in its application on the Caribbean Coast of Colombia motivated researchers to try participatory breeding in Northeast Brazil.

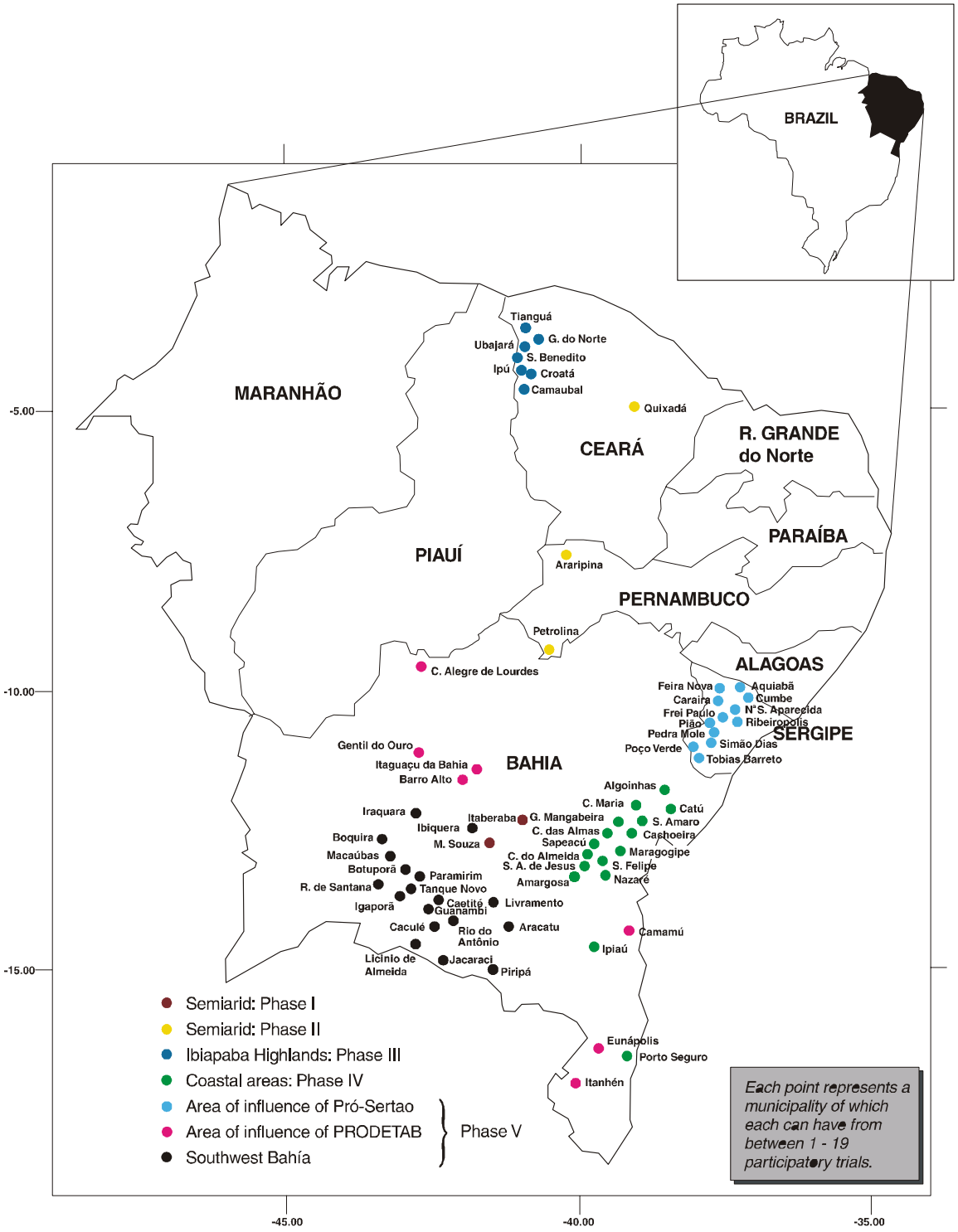
The use of a participatory approach was initially proposed by IFAD and CIAT, who suggested it as a way of reversing the low adoption rates of the clones generated in the cassava breeding project that they financed. At the same time, some plant breeders from EMBRAPA-CNPMF and other institutions in Latin America, who were seeking the possible causes of the low levels of adoption and the lack of impact of improved cassava varieties, had the same idea. At the end of 1993 a series of visits by CIAT researchers to Brazil were organized to adapt the IPMY procedure, and to train and provide follow-up to the pilot project established by EMBRAPA-CNPMF and the collaborating entities. In 1994 the first training on IPMY was held for researchers and extension agents from EMBRAPA-CNPMF, EMBRAPA-CPATSA (Agricultural and Livestock Research Center for the Semiarid Regions), EPACE and EBDA (state research and extension agencies in Ceará and Bahia, respectively), which had been participating in a cassava development project for the semiarid conditions of northeastern Brazil.

IFAD financed this training, the principal objective of which was to introduce the new concepts of participatory research with cassava varieties, involving researchers, extension agents and farmers from that region and using as inputs the clones generated by that project. In 1997 CIAT held several training events that included workshops on the information analysis tool, which now also forms part of the IPMY procedure (Hernández, 2000).

[7] For a more detailed description and discussion of the procedure, see Hernández, 1992; 1993.

The participatory research project comprised several expansion phases (Fig. 2).

Figure 2. Phases of Expansion of PPB in Northeast Brazil



First Phase

After the initial training in 1993, a participatory diagnosis was done, and the first pilot trials were implemented on farms that had been selected by extension agents in nine communities located in the municipalities of Itaberaba and Marcionílio Souza in the semiarid parts of the State of Bahia. On each farm one trial was conducted on plots with 50 plants/clone and no replications. For the duration of this work, these lands were nominally considered community areas, where all the farmers from the community could participate. In these trials the nine best varieties selected in advanced phases of the breeding program were used, plus one local variety known as Platina, and cultivated using the farmers' traditional cultural practices. From the onset of the work, a permanent dialogue was established among researchers, extension agents and farmers, which has permitted the constant exchange of information among the actors involved in the Project.

Role of the participants. A plant breeder, a research assistant, two rural extension technicians from EBDA and the nine farmers on whose properties the first pilot participatory trials were established participated in this first phase. Besides selecting the clones for evaluation in this phase of the Project, the plant breeder participated in the stages of evaluation at 60 and 180 days after planting and during the harvest and the processing of the product, evaluating the traits of the plants together with the farmers. In all the evaluations and following the IPMY procedure, the farmers' opinions and commentaries were recorded and complemented by the plant breeders' agronomic observations. This information made it possible to determine the state of the farmers' production systems, the traits of their preferred varieties and the principal criteria used in their selection. The research assistant was in charge of systematizing the farmers' commentaries in the field books.

Farmer Rosildo Viera dos Santos multiplies and distributes planting material of his preferred cassava clones

In the community of Cachá, municipality of Marcionílio Souza (a settlement of 400 families), in addition to evaluating and selecting, farmer Rosildo Vieira dos Santos, leader of this community, multiplies and distributes to six neighboring communities planting material of the four best cassava varieties that he selected on his property. Prior to the implementation of the project in this municipality, the farmers had one variety that predominated on their farms. Now the farmers are multiplying five new varieties they selected in the participatory trials.

Currently, the EMBRAPA researchers have, in conjunction with Mr. Dos Santos, planned a study with the farmers in these six communities to evaluate the level of adoption, the diffusion of these varieties in the region and then to measure the impacts resulting from the adoption.

The extension agents were the

link between the researchers and the farmers, participating in the planting and accompanying the farmers throughout the crop cycle. The first participant farmers were selected on the basis of the land they had available, their experience with the crop, interest in new varieties, ease of communication and influence in the community. The following factors were not considered relevant: the farms' representativeness of regional conditions and access to markets. This is because the characteristics of the land in the region are highly variable among plots and, as was mentioned, the farmers of semiarid Brazil are almost all characterized by subsistence agriculture.

The farmers played an active role in the planting of the crop and in all the evaluation phases. Together with the extension agents, they selected and prepared the areas for establishing the trials, indicated the local variety that should be used as the check, and assumed the management of the experiment based on their traditional practices. They also made known their criteria for selecting and ranking the clones based on their preferences. Only those clones preferred by the majority of the participating farmers were included in the following evaluation cycles. Although the researchers were the ones who decided that only those clones classified as good or fair would enter the next trial, the farmers were the ones who scored the clones and thus ultimately decided which of them should pass to the next stage of selection and which were to be discarded.

Observations. The farmers' experience helped the researchers understand better some of the reasons why many varieties that had been developed and recommended as part of the conventional breeding process had never been adopted and disseminated in the region. As mentioned, the small farmers of semiarid Brazil use little or no external agricultural technology, often planting several species in association with other crops. This means that when the varieties developed in the optimal environments of the experiment stations are submitted to the farmers' traditional cropping system, their performance is unstable and often inferior to that of the local variety. Another reason is the existence of traits such as the cortex color and the presence of a peduncle on the roots, which although of minor importance for the plant breeder, can be decisive factors in the farmers' adoption or rejection of new varieties.

In this first phase the plant breeder also realized that the contact between researchers and farmers had been, up to that point, minimal or nil. Many farmers were not aware of the existence of other cassava varieties with potential for raising the productivity and quality of their crop. Moreover, they had no knowledge of other technologies generated by the research institutions for the cassava crop, and in some communities they did not know the different end uses for cassava as food, animal feed or for industrial purposes. Probably the lack of contact

and flow of information between researchers and farmers was one of the mainreasons for the lack of adoption of improved varieties.

With the support of the extension agents and farmers, the work was consolidated in the region in this first phase, the possibility was seen of raising the adoption rate of new clones generated by the breeding program, and great interest was identified on the part of the farmers in learning about and testing new cassava clones on their land.

Second Phase

The following year (1994) the work was extended to another 17 communities in the municipalities of Quixadá (CE), Araripina (PE) and Petrolina (PE), located, respectively, at 1400, 850 and 580 km from the pilot site in Itaberaba and within the semiarid region of northeastern Brazil. As a result of a participatory diagnosis, it was decided that the objective should be to identify a clone with resistance to drought. In this phase a maximum of nine improved clones in advanced stages that had been previously selected in the municipal-level experiment stations plus a traditional variety, were used. The experimental design and the participants' roles were the same as in the first phase. As a result of this work, varieties BGM 260 (Rosa) and BGM 549 (Amansa Burro) were selected and recommended for the central semiarid region of the State of Ceará. These varieties are being multiplied by the local farmers and by EMBRAPA-CNPMF for distribution in the region. Although the trials were established in organized communities, in this phase as in the first, only the individual farmers on whose lands the trials were planted, their families and some neighbors who were selected by the participating farmers themselves participated. The researchers monitored the work closely and tried to explore, as much as possible, the farmers' opinions about the new varieties so that by the end of the second cycle of work the farmers' criteria would be confirmed, it would be possible to trace the profile of a variety with traits desired by the farmers in semiarid Brazil. Table 1 includes the principal selection criteria used by the farmers. The general criteria are those most frequently used by the farmers of northeastern Brazil and those that constitute the profile of the variety desired by the farmers. The specific criteria are those that occur in specific situations in the region.

Observations. In the two first phases, the breader decided to work with a small group of individual farmers rather than with large groups, associations or whole communities despite the fact that the majority of the communities with which the Project worked were socially and politically organized. The selected farmers were the leaders of their communities. At the end of these two phases, the breeder reflected on the advantages and disadvantages of working with individual farmers.

The work with individual farmers provided the opportunity for exchanging and exploring the knowledge that they have of the cassava crop in great depth; nevertheless, there are several constraints, among which is the slow diffusion of the results. Moreover, working with a reduced number of farmers excludes the opinions of other farmers who may have needs and priorities different from the majority of the community. In this way the possibility of obtaining new knowledge or criteria for feeding back into the breeding program is limited, and the varieties with traits of interest to these farmers may be discarded. It has been observed that often, the excluded or nonrepresented groups tend to be women and the poorest, most marginal farmers in the communities.

Table 1. Selection criteria of the farmers in northeastern Brazil.

General Criteria	**Traits**	**Justification for Their Use**
Germination	Rapid, high germination index	Good competition with weeds, takes advantage of the rains; high productivity of roots per area
Content and quality of starch and *farinha*	High	High starch and *farinha* yield
Number of thick roots	3-4	Reduced labor for grating the roots
Stake production	Short internodes	High yield of planting material and product for animal. feed
Specific Criteria	**Traits**	**Justification for Their Use**
Ease of harvest	High	Reduced time and labor for the harvest; few roots wasted
The cuticle of the root comes off	Easy	Ease of peeling; good quality of the *farinha*
Constrictions in the root	Absent	Ease of peeling
Root peduncle	Absent	Facilitates harvest
Color of the root cuticle	Clear	Good quality of the *farinha*
Color of the root flesh	Clear	Good quality of the *farinha* and starch
HCN content in the roots	Low	Apt for fresh consumption
Plant architecture	Erect/high branching; low to average	Facilitates management of the crop
No. of stalks per plant	2-3	Facilitates management of the crop, interferes with root yield.
Yield of the aerial part with good leaf retention	High	Alternative for animal feed.

Farmers in Ceará evaluate and multiply cassava clones on their own farms and establish a bank of planting materials

In addition to the nine cassava varieties that were evaluated in the trials, the farmers in the municipality of Quixadá took the initiative to test another six varieties on their own farms. They had selected these varieties previously from a group of clones in the preliminary stages of the breeding program at the experiment station of the extension service (EPACE). The farmers were testing these varieties without the participation of the researchers as EPACE, the institution directly responsible for the work in the region, was closed. EMBRAPA-CNPMF is monitoring the work with periodic visits to keep informed of what the farmers select and to evaluate the level of adoption and diffusion of these varieties in the region.

Meanwhile, some of the farmers who had participated in the first trials in Quixadá were moved to the Vale dos Sonhos settlement, 66 km away, where they are multiplying four of the new varieties (BGM 260, 549, 384 & 924) for different uses, which they selected for establishing a bank of planting materials.

Besides the aforementioned limitations, there is also an important risk when working with individual farmers given that one of the important criteria that the extension agents have in mind at the moment of selecting them is their leadership in order to ensure the diffusion of the results of the evaluations. Nevertheless, in an environment as politicized as the rural zones of northeastern Brazil, the popularity or acknowledgment of a leader can change within a relatively short time. This has occurred in one of the communities where the Project works; and although work has continued with the farmer, there is uncertainty as to whether this fact will affect the results of the evaluations and whether they will be accepted or not by the community.

At the end of the first two phases of the work, many farmers in the region began to request participatory trials on their farms. Many of them had heard of the work from extension agents, their neighbors, and from friends in nearby communities. Requests were received by the project from individual farmers, communities, farmers' associations, agrarian reform settlements, development projects, and NGOs. Some extension agents also expressed their interest in implementing this type of approach in their regions and, at the same time, use it as a tool for transferring and disseminating results.

Third, Fourth and Fifth Phases

The work was extended in three more phases in the Sierra of Ibiapaba (CE), the coastal Tabuleiro[8] and the Recôncavo[9] of the State of Bahia and Sergipe, and to the southeast of the State of Bahia, respectively. With the experience and the confidence that the work team

[8] Flatlands characterized by poor, compact soils.

acquired and with the change of context, some aspects of the work were modified.

Consequently, the types of actors involved were changed according to the state in which they worked; for example, in Sergipe work was done through PRÓ-SERTÃO, an integrated development project supported by the State government and international donors. In this case the researchers from EMBRAPA played a lesser role in the relations with the communities and the implementation of the trials given that the communities were already organized and mobilized for the work with PRÓ-SERTÃO. Nevertheless, the EMBRAPA team continued to supply clones for the evaluations and to record trial data.

In the State of Ceará, as established in the participatory diagnosis, the priority for the farmers, researchers and extension agents was to identify varieties with resistance to witches' broom, associated with root production. The farmers wanted a variety with good production because the common variety (Cruvela) was very susceptible and when it was attacked by the disease, production was nil. They were very interested in replacing the local variety for one with additional traits such as root thickness and cortex color.

Another change consisted in the evaluation in certain communities of clones in preliminary stages of the breeding program (instead of advanced stages). Some 500 clones were planted in two communities (Bonsucesso, municipality of Simão Dias; and in Muniz in the municipality of Aquidabã). The idea was to further reduce the time required to generate varieties and their adoption, and to offer farmers more options of materials. Farmers began to test on their own lands some of the experimental clones that they had previously selected from community areas. They began to multiply their favorite ones and this resulted in an increase in planting material and availability of the clones selected and in the broadening of genetic diversity of cassava in the area. This situation has concerned the plant breeders because of the possible loss of the identity of clones multiplied by the farmers and planted in mixtures with their varieties.

José Pequeno, a farmer-experimenter, plans to establish a germplasm bank on his farm

José Pequeno, a farmer-experimenter from the community of Muniz, Aquidabá, has on his own already multiplied a group of clones in advanzed stages of selection and a group of clones in preliminary stages of selection. Mr. Pequeno plans to establish a gene bank on his property.

[9] Very fertile region on the coast of the State of Bahia.

The number of participating farmers in each evaluation also increased in these last phases of the project expansion. While in the first trials only one farmer and one or two neighbors participated, in these last phases men, women and children, almost whole communities participated in the evaluations despite the fact that the IPMY procedure recommends working with a maximum of 10 farmers (Hernández, 1993). This difference may be due to the fact that in southwest Bahia and Sergipe the farmers that the project works with have more community spirit and experience in cooperating and working in groups, and their associations are very active; moreover, in the case of Sergipe, the communities have been prepared and motivated by the PRÓ-SERTÃO Project. These communities also receive more assistance from the rural extension services than those where the work was begun.

Summary of Phases Three to Five

Third phase:	1994, Ibiapaba-Ceará Distance from Itaberaba: 1500 km
Fourth phase:	1994, coastal tablelands & Recôncavo in Bahia Distance from Itaberaba: 160-250 km
Fifth phase:	1997, two sites in Sergipe & one in Bahia Distance Itaberaba: Sergipe 700-1000km : Southwestern Bahia 300 km

Community rather than individual participation could also be due to the fact that the cassava production losses from diseases are extremely high in this area. For example, in Ceará there were areas where most of the harvest was lost, and some 5000 families were threatened by the lack of production. These families grew only one or two varieties that were highly susceptible to witches' broom, and they were very concerned about the heavy losses of roots caused by this disease. It was observed that in those places where the problems are less serious or threatening, the farmers have less interest in participating and often prefer their own varieties. The participation of a greater number of farmers is also due to the fact that the Project team, which now had more experience and confidence using participatory approaches, integrated better with the technicians and farmers and explained the procedure and the work more clearly. Besides, the project wanted to experiment working with communities as opposed to with individuals.

Observations. In these last phases of the work in Sergipe, 14 farmer-experimenters were identified[10]. They expressed interest in evaluating on their own land, some of the clones that they had selected in preliminary stages on community plots. The researchers visited these trials

[10] The diference between these farmeres and those who were experimenting on their areas in Quixadá lies in the fact that they were evaluating clones that had been selected in preliminary stages (F_1C_1) in community areas; while the farmeres in Quixadá were testing the clones that had been selected in advanced stages at the EPACE experiment station.

once or twice a year to monitor the work and observe the performance of the clones in the different environments and their acceptance or rejection by the farmers. If one or more of these clones were selected, then the technicians investigated the reasons for the selection, they named it officially and obtained the planting material for multiplying and distributing it to other farmers.

There was an interesting case of a farmer who did not participate in the trials. On his own initiative, he planted the clones that were discarded in one of the participatory evaluations. Months afterwards, while the participating farmers were meeting for an evaluation on a neighboring farm, he was harvesting the discarded varieties and producing *farinha* with them.

The behavior of this farmer can be explained in several ways: It is possible that he decided to take advantage of the cuttings that were being discarded because he did not have much planting material that year, or he simply wanted to have a more abundant harvest even if they were not more productive, adapted or better quality varieties. It could also be that the discarded clones, although not the best among those that were being evaluated, were comparable with the varieties that he was growing and so he wished to test them. Or perhaps the participating farmers' discarded clones seemed better to him than the ones being tested and ranked among their top preferences.

It is important to learn the motives that led this farmer to plant discarded clones as these can help the project adjust its approach and its objectives. If the first supposition is correct, for some of the farmers in the region it is more important and urgent to obtain planting material than to improve the quality of the varieties that they plant on their plots. This is an important message for the Project as it could be one of the reasons for explaining the rapid diffusion of some of the experimental clones.

In the case of the second supposition, the implications would be somewhat different. The fact that a farmer did not participate in the trials and later evaluated the quality of the discarded varieties could indicate that there is a segment of the community that for one reason or another is not being represented in the evaluations and therefore that the participatory research is serving and responding to the needs and desires of only part of the community. It would be very useful to know which is the real explanation of this farmer's behavior, but this is not possible as the Project is designed in such a way that the discarded clones in the participatory trials are eliminated definitively, independent of what happens to them.

As a result of the work in these three last phases of the Project, clones 8709/02 (EMBRAPA 54), 8740/10 (EMBRAPA 55), 8911/16/ (EMBRAPA 56) and 8952/06 (EMBRAPA 57) were recommended and adopted. These varieties were disseminated more rapidly by the participating institutions and to more farmers than in the previous phases.

In these last phases it was also observed that working with a large number of clones is very difficult. The farmers sometimes confuse them in the evaluation and selection processes because some of the clones either do not have very marked differences among them or it is difficult for the farmers to identify and compare them. A similar situation was found in the joint CIAT-CORPOICA work during the development of the IPMY procedure when improved clones in different stages were supplied to the farmers. Because of these difficulties, the breeder decided to reduce the number of clones tested in preliminary stages from 500 to a maximum of 100.

The work with a larger number of farmers had several advantages, among which are:

1. There is greater integration of the farmers in the work and a faster diffusion of the results among the members of the community and to other communities within the region
2. Work in organized communities can be very efficient; e.g., the farmers knew how to work in groups and understood the need to share with all members of the community
3. The selection criteria derived from farmer's comments can be more accurate as they come from a large group of farmers
4. The farmers' knowledge and experience facilitated the development of a detailed profile of the farmers' crop production system, problems and demands.

Despite the aforementioned advantages, it was observed that involving a large number of farmers in the evaluations makes establishing selection criteria and ranking clones a difficult process for the researchers. This is due to the fact that the increase in the number of farmers also increases the number of opinions, making it difficult to at times reach a consensus. In these cases the opinions of the majority always prevail, and the farmers whose preferences do not coincide with the majority have to take the clones that they like and test and multiply them alone on their farms. This is good for broadening the genetic diversity on the farms, but it can be negative if the PPB program is only meeting the needs of the majority of the farmers or of those who have more voice, without taking into account the criteria of those who are not being represented.

Taking into account the foregoing points, it was decided that it was better to return to working with a smaller number of farmers, preferably leaders who disseminate and share the

information and the material for multiplying the varieties selected within their own and neighboring communities. In the preliminary contacts with the community leaders and with the other farmers, they are always reminded of this obligation.

From 1993 to 2000, a total of 305 participatory trials were established in several ecosystems in northeastern Brazil, which represented a 3000% increment in relation to the initial work. The scale of this Project has made it possible to identify a broad range of opinions that provide feedback to the breeding program and to reach numerous potential beneficiaries, which means that the latent impact is immense. Nevertheless, working with a large number of communities has its disadvantages, one of them being a reduction in the quality of the information obtained and used. This is due to the fact that there is insufficient time for detailed analyses and there is a certain degree of dispersion of the information. To compensate for this, it is important to have a well-trained and efficiently coordinated work team and a strategy for information management.

As the work area expanded, it was necessary to train a greater number of extension agents in participatory research methods and to delegate greater responsibilities to them with respect to the selection of farmers, implementation of the trials and their evaluation and, above all, in the recording of data. It was also necessary to expand the work team. Assistants were hired, and work was begun with other professionals such as specialists in soils and plant pathology. The latter worked on the integrated control of root rots, associating resistant varieties with soil management in Sergipe, and on the problem of bacterial blight in southwestern Bahia.

The considerable volume of work generated a similar quantity of information; and in order to manage it, it was necessary to create a special database. In addition the electronic worksheet Excel was used to analyze the logistical regression of the farmers' preference ranking of the clones (Hernández, 2000) this has been an important working tool for processing the information obtained in the farmers' fields. At present the plant breeder's work is supported by the use of matrixes and figures that reflect the degree of acceptance of the clones and by the discussion and statistical analyses of all the data from the trials. This is complemented by visits to participating communities and participation in harvests and planning meetings. The Project continues expanding and the plant breeder continues evaluating the performance of experimental clones and supporting the participatory trials with the most appropriate clones for the different systems and for the farmers' preferences. Table 2 summarizes the characteristics of the expansion phases of the Project.

Information Management and Feedback— Project Database

The management of information and feedback in the Project occurrs as follows:

Farmers group the varieties from the trials in advanced phases of selection and score them on the basis of the following ranges: good (1-4), fair (5–7) and poor (8-10). The poor varieties are discarded in the first cycle of evaluation. Some farmers and the extension and research institutions multiply the varieties from the intermediate group, so that they can be evaluated in the next phase. The good varieties, which have a high probability of being adopted and recommended for official release are also multiplied.

Feedback to the breeding program occurrs when the farmers explain why they sselect a group of clones and discard others. They identify the good and poor traits of the selected and discarded clones. The Project researchers analyse all the opinions and derive from them, the farmers' selection criteria (e.g., cortex color), the ratings of each criterion (e.g., white color), and the reasons why they are important (e.g., ease of grating). The scores (1-10) that the farmers assign to the clones are entered on a matrix where the cumulative frequencies of the preference ranking are calculated, and the probability of acceptance curves are generated[11].

Taking into account the information derived in the first selection at one or more sites, the plant breeder can re-test the fair and good clones to validate their acceptance and substitute the discarded clones with others that have traits closer to what the farmers seek and thus greater probability of acceptance. For example, it was observed that in the communities of Araripina, varieties with a peduncle are not selected or adopted even if they have good root and starch production because the peduncle makes the harvesting much more difficult. Therefore, this type of clone was not sent to this region for evaluation. The information also guides the plant breeder in choosing the parents for generating new varieties.

To manage the information, the plant breeder uses a database in Excel. This database can be consulted to guide decisions about which groups of clones should be taken to future trials in the same communities or for new trials in different areas. The plant breeder is also guided by the list of the farmers' criteria for each type of crop use and by analyzing preferences and regression curves. For example, in one community the Project team identified that a white cortex is a trait preferred by farmers who produce starch; thus the plant breeder is sending the clones selected at this site for participatory trials at other sites with similar edaphoclimatic

[11] The methodology for this procedure is documented in Hernández (2000).

conditions and where there are starch industries.

Table 2. Phases of the participatory research work with cassava in northeastern Brazil.

Phase /Year	States	Financed by	Ecosystem	Actors/ Organizations	Objectives	Breeding Stages	Outcomes	Challenges
I 1993	Bahia	IFAD	Semiarid	Researchers (EMBRAPA), extension agents (EBDA), farmers	Resistance to drought	Advanced	Selection criteria; varieties with high probability of acceptance; feedback to breeding program; adoption; multiplication of selected clones; farmer-experimenters; training of actors in participatory breeding.	Greater participation of extension agents; definition of other selection criteria; impact study
II 1994-	Pernambuco Ceará	IFAD PRGA Program	Semiarid	Researchers (EMBRAPA, IPA & EPACE), farmers	Resistance to drought	Advanced	Selection criteria; varieties with high probability of acceptance; feedback to breeding program; adoption; multiplication of selected clones; farmer-experimenters	Greater participation of extension agents; definition of other selection criteria; impact study
III 1994-	Ceará	UNDP	Transition semiarid	Researchers (EMBRAPA & EPACE), extension agents (EMATERCE), farmers	Resistance to witches' broom	Advanced	Varieties with high probability of acceptance; multiplication of selected clones	Monitoring of adoption of selected clones
IV 1994-	Bahia	EMBRAPA	Coastal tablelands of Bahia	Researchers (EMBRAPA), extension agents (EBDA), farmers	Increased productivity	Advanced	Varieties adopted	Monitoring of recommended varieties; impact study

Continues..

Table 2. cont.

Phase /Year	States	Financed by	Ecosystem	Actors/ Organizations	Objectives	Breeding Stages	Outcomes	Challenges
V 1997-	Sergipe	Dept. of Agriculture -Sergipe, PRGA Program, IFAD	Semiarid	Researchers (EMBRAPA), extension agents (EMDAGRO), development project (PRÓ-SERTÃO), communities of farmers	Resistance to root rot	Advanced, Preliminary	Probability of acceptance of varieties; increased genetic diversity of arable land; farmer-experimenters; extension agents trained in participatory methodologies; incorporation of management in trials; multiplication of planting materials; selection criteria; feedback to breeding program	Validation of selection criteria; multiplication and diffusion of selected clones; monitoring of varieties adopted; impact study; gender analysis; generation of new clones resistant to root rot and with traits of local variety
	Bahia	PRODETAB	Semiarid, coastal tablelands, Atlantic Mata[1]	Researchers (EMBRAPA), extension agents, NGOs Communities of farmers	Broadening genetic diversity of cassava fields; increased productivity	Advanced	Varieties selected with high probability of acceptance; multiplication of clones selected	Monitoring of work; training of NGO technicians in participatory approach; project continuity
	Bahia (Southeast)	PRGA Program, PRONAF, Dept. of Agriculture -Bahia	Transition zone, Cerrados, Semiarid	Researchers (EMBRAPA), extension agents (EBDA), communities of farmers.	Resistance to bacterial blight	Advanced, Preliminary	Multiplication of planting materials; training of extension agents; incorporation of other technologies; demands and expansion of the PPB work	Identification of new selection criteria; diffusion and multiplication of the selected clones; gender analysis; monitoring of adopted varieties; impact study; generation of new clones resistant to bacterial blight and with traits of the local varieties

[1] Zone between beach and barren area, characterized by great fertility and abundant vegetation.

At present the plant breeder is beginning to work with specialists in soils and geographic information systems (GIS) in order to conduct environmental homology studies and determine more precisely the places where it is possible to test the varieties selected in the participatory trials. The information on preferences and criteria will be added to the biophysical information contained in the GIS.

Results and Discussion

Although at this moment it is not possible to have conclusive results and measure the impact of the work with IPMY in northeastern Brazil, important intermediate results can be observed, including:

- Positive changes in the orientation of the conventional breeding program as a result of the participation of extension agents and farmers in the preliminary and advanced trial evaluations; trials in farmers' fields; and constant inclusion of the farmers' opinions, observations and criteria into the breeding program
- The opening of a communications channel between extension agents, farmers, breeders and other professionals from the sector
- Positive changes in the attitudes of the principal actors: the breeders and researchers toward the farmers due to their comprehension of their production systems and selection criteria; and the farmers due to their openness to new varieties and technologies offered by the researchers and extension agents
- Greater interest on the part of the farmers and their associations in the research with new varieties and other technologies in their fields, and the identification of several independent farmers who are complementing and following up on the evaluation work and selection of varieties on their own land
- Training and motivation of researchers, extension agents and producers in the use of the IPMY procedure through courses, follow-up and by means of the direct and active participation throughout the work cycle
- Identification of the selection criteria of the producers with whom the Project works in northeastern Brazil (see Table 2)
- Identification of a dozen clones with high probability of acceptance by farmers, and the adoption as well as multiplication of several of the selected clones
- Official release of 8 varieties: 4 for controlling witches' broom, 2 for the coastal

tableland region and 2 for the semiarid region

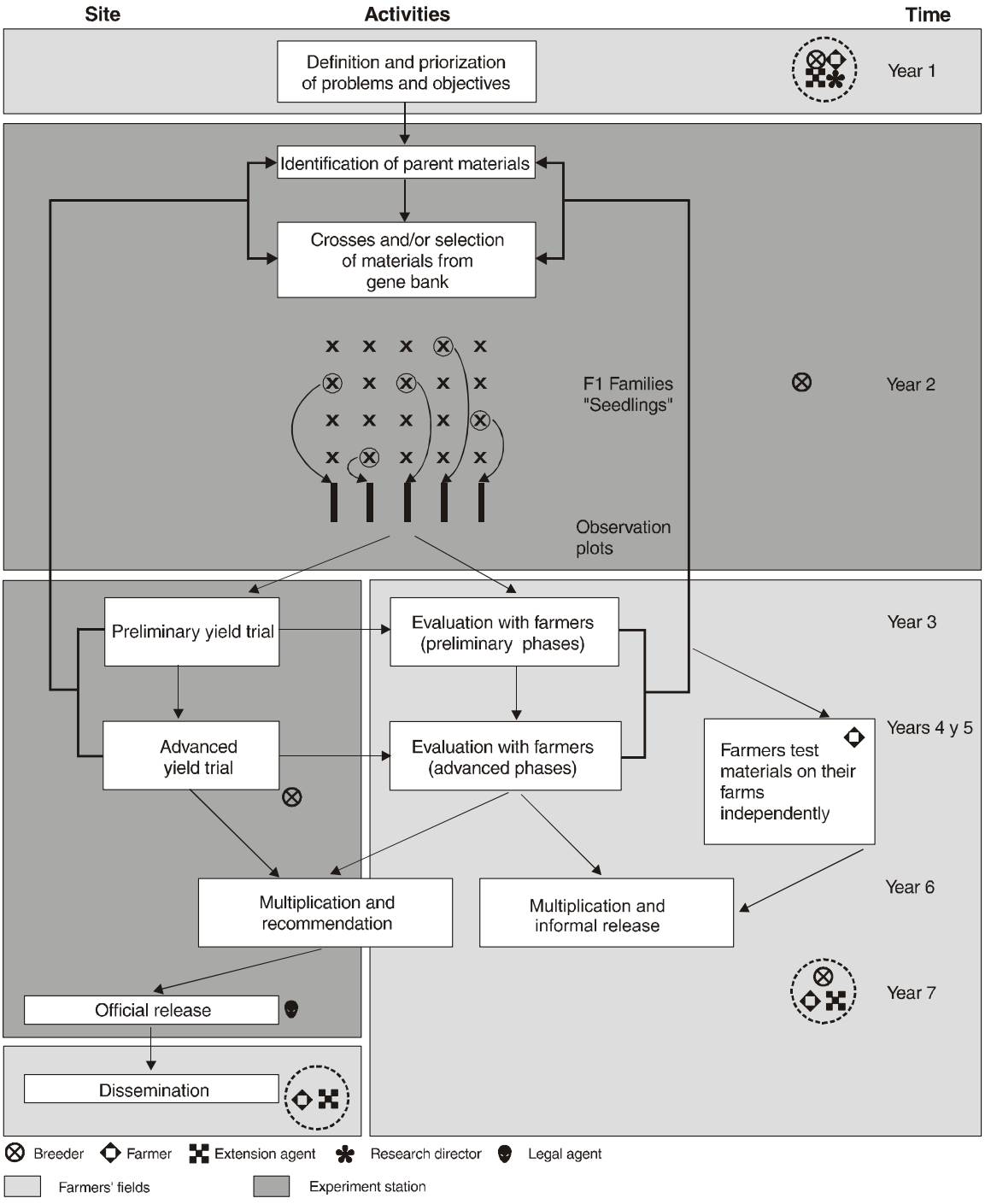
- Increased volume of cassava harvests in the areas more seriously affected by diseases. Although the actual increase in harvests has not yet been calculated, it is known that the varieties that have been tested and multiplied as a result of this work are yielding more than the susceptible materials.
- Increased genetic diversity in the farmers' plots in the region through the multiplication and planting of clones introduced for evaluation in the participatory trials
- Expansion of the participatory research work in northeastern Brazil as a result of the demand by extension agents, communities, associations and agrarian reform projects (settlements), as well as the financial support from new donors
- Recognition of EMBRAPA's work in the form of two national prizes: the Prize of Excellence in 1997 and the National Partnership Prize obtained in 2000
- Validation of the IPMY procedure

Changes in the Conventional Breeding of Cassava in Brazil

The general organization of the cassava breeding program for Northeast Brazil changed as a result of the adoption of a participatory approach. As can be seen in Figure 3 this change began with the inclusion of farmers and extension agents in the program. The sites and the criteria for selecting new cassava clones were expanded and diversified and the breeding program began to get constant feedback from field data and now uses it to select parents for crosses as well as new varieties for the participatory trials in farmers' areas. Thus it is possible to reduce the time that it takes to identify a clone or a group of clones that respond to the local needs and preferences.

Besides the farmers, the participatory procedure also includes the state extension and research institutions and professionals from other disciplines such as plant pathology, soils and information sciences. In contrast to the conventional breeding scheme, the interaction and cooperation among the three groups in the participatory scheme have been very close so that each one contributes fundamentally to the process. This alliance with regional institutions has enabled the program to have a broader scope with materials more specifically adapted to the local conditions and needs.

Figure 3. Participatory Breeding Scheme in Northeast Brazil



Another important change that occurred with the implementation of participatory methods was the rapid informal diffusion of new varieties. Although the Project has been implemented by professionals from a formal breeding program that normally promotes its new varieties by formal means and although some varieties resulting from this process have been recommended and formally released, in many cases, the farmers had begun to multiply and disseminate the promising materials among relatives, friends and neighbors, reaching an extensive coverage before they were officially released.

In absolute terms, the costs of the participatory breeding program are higher than those of a conventional program, which has motivated the plant breeders to seek new donors. Nevertheless, if the costs *and* the benefits of the two focuses are compared, it is clear that given the greater benefits for a larger number of farmers, the participatory procedure has more advantages than the conventional one.

Changes in the Actors

First of all the change in the plant breeders' position with respect to the farmers' demands should be mentioned. Their greater integration with the farmers and extension agents gives them the opportunity to learn firsthand about the production systems, the demands and, above all, the criteria for selecting cassava varieties. It is clear that the farmers' resistance to the new varieties recommended by researchers, which had previously been interpreted as an indication of little education or traditionalism, is directly related to the differences among some of the plant breeders' selection criteria and those of the farmers[12]. It was found that the cassava farmers have a lot to teach the researchers and that their experiences and opinions are fundamental for providing feedback into the research being done on the crop and for developing viable technologies adapted to their demands and to their cropping systems, respecting their local or regional traditions. Thus the plant breeder is aware that there are other important traits for the farmers that are not taken into account during the conventional selection processes on the experiment stations.

It is also important to highlight the change in the perception and the comprehension of the participatory focus by the researchers who implemented it. At the onset of the PPB work, the Brazilian researchers perceived this new procedure, which had been designed to develop agricultural technologies, as a technology transference tool. Thus the principal motive for establishing and expanding the work was, and for some continues to be, reversing the low

[12] It is assumed that being a region where the majority of farmers produce cassava for family consumption, the lack of adequate marketing oportunities is not a factor that limits the adoption of high-producing varieties as occurs in other regions.

adoption rates of the new cassava varieties. After several years of implementation, however, the researchers reached the conclusion that besides facilitating the transfer and diffusion of the new varieties generated, the procedure brought the plant breeders closer to the farmers in such a way that there was greater and better feedback between the breeding program and the farmers and a deeper knowledge of the farmers' cropping systems on the part of the researchers (Wania Fukuda, pers. com). This feedback, as mentioned previously, has been the basis on which the breeding program has begun to develop varieties that respond to the farmers' needs.

In the case of the farmers, a change of attitude was observed in which there was better and more detailed observation of the traits of their traditional varieties and interest in learning about new techniques developed for managing the crop. Before this work was done, the farmers did not value their own selection criteria sufficiently and were not familiar with the existence of other cassava varieties with a potential for increasing productivity and the quality of the product in the region. They also had no knowledge of other technologies generated by the research institutions for the cassava crop; in some communities, for example, they did not know about several forms of using the crop in human and animal foods/feeds and for industry.

With the implementation of participatory trials in their regions, many farmers were motivated to evaluate the new improved varieties offered by research. At the beginning they were motivated by the simple curiosity of trying new types of cassava and later on by the possibility of enriching the genetic diversity of their plots with more productive varieties, more resistant to pests and diseases, and suitable for forms of use other than the production of *farinha*.

The presence of the farmer-experimenters was also an important change, considering that the majority of the farmers with whom the work began were averse to the improved varieties. These farmers were initially interested in evaluating on their own land, the clones selected in preliminary stages of breeding in the community areas after testing and selecting their preferred varieties, several of them began to multiply and disseminate them. This result can be interesting for the continuity of the work in the communities after the Project ends in the region. There have already been cases of farmers who have individually brought continuity to the selection process on their land, multiplying and distributing some clones to farmers in their communities and other regions.

Challenges and Future Directions

The participatory breeding experience with cassava in Brazil is notable for its great extension; the large number of people involved including farmers, researchers, extension agents and other professionals; and the results that have been obtained thus far. Nevertheless, as in all projects, there are several challenges that have yet to be resolved and that could indicate possible directions for this work in the future:

Possibly the most important challenge is to maintain the quality of the work in a project of such magnitude. This includes the maturation and the evolution of the ongoing trials and meeting the new demands that these are beginning to present the work team. In the first cycles it was relatively easy to establish the priorities for the trials given that the problems of drought, bacterial blight and witches' broom were, without a doubt, the factors most limiting cassava production in the respective communities of the region. Although it has not been difficult to identify experimental clones with a potential for responding to these demands, it is possible that once they have been released, and these initial production problems overcome, the farmers will be more exigent and seek more specialized criteria such as supplying specific markets, other uses and other crop management practices, including combinations of these with other criteria. At the same time it is expected that differences in selection criteria and preferences among farmers within communities as of yet not notable, possibly due to the need to solve pressing problems of diseases and drought, will begin to be noted more clearly. This will require more attention and time on the part of the plant breeder in addition to the participation of a social scientist. Given the current magnitude of the Project, there is a need to reflect upon the feasibility of carrying out this work in greater depth.

Rapid determination of the farmers' selection criteria is also critical. At the beginning the work team took several cycles to identify and confirm these criteria, as well as to delineate the profile of an ideal variety or prototype for the region. Until now, with the adapted procedure, the criteria have been established in two cycles, partly because the IPMY suggests doing it that way. Over the last few years, however, it has been seen that PPB projects can establish the criteria after the first diagnosis, without changing too much during the evaluation cycle (Weltzien/Smith, 2000). It has also been found that even though it is possible to summarize farmers' preferences within a given region in an ideal variety or prototype, the initiation of PPB based on this profile risks the exclusion of materials that could be of great interest for certain stakeholder groups such as women, poorer farmers or farmers who seek

specific market opportunities. It is important therefore to do a complete diagnosis at the beginning of the Project, including the biophysical and social aspects of the communities.

It is also important for this work or for a future project related to it to integrate the different levels of production, processing and marketing cassava in the region. To date the work has focused on overcoming the limitations of drought and the attack of several diseases in order to increase crop production. The next step would be to integrate market considerations for the eventual commercialization of the crop, thereby opening up a source of income for the cassava-growing communities in northeastern Brazil (Hershey and C. Fukuda, pers. com.)

An important outcome of this work is the interest and the enthusiasm of some of the farmers in the research and the trials. Thus far it would appear that this interest has arisen spontaneously as a result of their participation in the trials; in other words the work team has not made a specific effort to stimulate this interest. In order to try to guarantee the continuation of the germplasm evaluations in the communities after the Project ends, it would be necessary to plan some activities for maintaining and exploring the farmers' interest in greater depth in the future. As a starting point, the plant breeder organized a workshop for farmers at the EMBRAPA-CNPMF experiment station in May 2000.

Another way to increase the farmers' interest is to begin working with segregating materials in the fields of those farmers who stand out for their interest and knowledge in breeding. As mentioned, the team has begun to work with materials in preliminary stages in farmers' fields. Given that cassava is propagated vegetatively, a clone in the preliminary phase does not change after the F_1, except in the number of times that it has been submitted to evaluation. At the time of writing this document, there are plant breeders in other institutions who were doing PPB with farmers in preliminary stages of other crops such as grains, where the segregating material changes considerably from one generation to another (generally until the F_7 or F_8). Although the results of this work are not yet known, a critical effect that is beginning to be observed consists in the farmers' developing and refining their abilities and their interest in continuing to improve their crops. The idea is not to replace the plant breeder, but to give the farmers the tools with which they can continue working with the formal research system, but in a more independent and equitable relationship.

Finally, it is essential to conduct an adoption- and an impact study of this work, including a comparison of costs and benefits. The work team has already begun to study adoption in some municipalities, but there is a need for a broader perspective, comparing the

costs and impacts of the participatory program versus those of the conventional program, which was used previously. It is important that in such a study, several indicators of impact be used. Given the size of the area and the number of communities in which the work has been done, this in itself is a project that could constitute a new line of action and it will be necessary to include new professionals in social, political and economic areas.

Conclusions

The experience with participatory breeding of cassava in northeastern Brazil has meant a profound change in the way of doing breeding in this region. The inclusion of farmers and extension agents in the process, the participatory evaluations in the farmers' fields, the constant communication and interactions of these actors with the researchers, the consideration of the farmers' criteria and preferences in the breeding process by the breeders are all significant. The same holds true for the large geographic area that the Project covers and the latent impact of this work. Even without having finished the Project, results such as the spontaneous adoption and diffusion of new varieties and the farmers' interest in trying out new technologies offered by the formal research institutions, which conventional breeding has not been able to accomplish thus far, can be observed.

This case in northeastern Brazil shows that participatory approaches can be extremely efficient and effective for working with small farmers located in marginal areas with subsistence crops, who have limited access to new technologies and often resist their introduction in their plots. For this type of farmer, participatory research can function as an excellent tool in the development, diffusion and adoption of new technologies that can increase production and satisfy other needs, thereby improving their quality of life.

It is important that this work have continuity and that— as opposed to what has happened with other projects—it does not end before accomplishing the goals, whether for lack of resources, institutional interest or a well-formed structure to be able to administer it in the long term. For that reason it is fundamental to raise the consciousness of the institutions that form part of this Project, helping them to see the need for a continuous and dynamic work, which should become more independent in accordance with the farmers' capacity and interest.

It is also important to continue the adaptation of the methods used and their diffusion among researchers, farmers and extension agents. For this purpose it is necessary to invest

more in training and follow-up in order to guarantee that the results of the work are multiplied and known with a reduced, but continuous participation of the research institutions.

Finally, it would be very useful to conduct a follow-up study of the implementation and the adjustments made to the IPMY procedure in order to learn the specific results in the Brazilian context and what the changes have been in this procedure that is has been validated through this experience.

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