United Nations Development Programme

Ecologically Sustainable Cassava Plant Protection in South America and Africa: An Environmentally Sound Approach.

1995 Annual Report of Activities in South America

Prepared by project personnel in Colombia and Brazil.

South American component of a global project involving:

Centro Internacional de Agricultura Tropical (CIAT) at Cali, Colombia, the International Institute of Tropical Agriculture (IITA) in Nigeria, and the Empresa Brasileira de Pesquisa Agropecuária, Centro Nacional de Pesquisa de Mandioca e Fruticultura Tropical (EMBRAPA/CNPMF) at Cruz das Almas, Bahia, Brazil.

30 January, 1996

"Ecologically Sustainable Cassava Plant Protection in South America and Africa: An Environmentally Sound Approach."

Technical Report on Activities conducted during 1995 by PROFISMA (Proteção Fitossanitária Sustentável da Mandioca): the South American component of a global UNDP project.

Project Ref. GLO/91/013

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Technical Report on Activities conducted during 1995.

1. EXECUTIVE SUMMARY

PROFISMA completed its third project year at the close of 1995. The project has made notable progress in areas of basic research (e.g., development of a serological assay for detection of Cassava Vein Mosaic Disease) and applied research (e.g., on-farm trials of cover crops) while emphasizing a participatory approach to implementation of Cassava Integrated Crop Management technologies through training and participatory research in growers' fields.

Success in biological control of the cassava mealybug

The successful control of the mealybug *Phenacoccus manihoti* in Africa depended on its correct taxonomic identification, thereby distinguishing it from *P. herreni* that infests cassava in northeastern Brazil. Just as the parasitic wasp *Epidinocarsis lopezi* has controlled *P. manihoti* in Africa, PROFISMA has introduced three species of parasitic wasps (including a congeneric species, *E. diversicornis*) into northeastern Brazil in the hope that one or more will become established and provide control of *P. herreni*. The most successful establishment to date has occurred with *E. diversicornis* in the state of Bahia. First introduced near the municipalities of Cruz das Almas, Bahia and Feira Nova, Pernambuco in July and August of 1994, respectively, *E. diversicornis* has now been recaptured from cassava plants as far away as 250 km from the initial release site. Another parasitic wasp, *Acerophagus coccois*, was released at Itaberaba, Bahia and Gloria de Goitá, Pernambuco in December, 1994 and January, 1995, respectively. Although this species appears to be spreading more slowly than *E. diversicornis*, it also seems to have established well and has been recovered 40 km from its release site in Bahia. A third species, *Aenasius vexans*, is the most recent introduction but its establishment has not yet been confirmed. In areas where parasitic wasps have established, parasitism rates of *P. herreni* are high. Actual biological and economic impact of the establishment of these species are now being evaluated.

In August of 1994, *P. herreni* infected with a fungal pathogen, *Neozygites fumosa*, were found in Bahia and Pernambuco. Infection in some fields was as high as 65%. While this fungus has been reported as an efficient natural enemy of several mealybug species, nothing is known about its effect on *P. herreni* in northeastern Brazil. Further work on this pathogen will need to focus on establishing its importance as a natural control of *P. herreni* in farmers' fields and to evaluate the potential for its manipulation.

Progress in biological control of the cassava green mite

Introduction of phytoseiid predators for control of the cassava green mite (CGM) continued in 1995 with improvements in shipping and rearing methods leading to improved survival of predators upon arrival in Brazil. During 1995, two phytoseiid species were introduced: *Typhlodromalus tenuiscutus* and *Neoseiulus californicus*. Releases of *T. tenuiscutus* (approximately 11,000 mites) did not succeed in establishing that species as it was not recovered from the field subsequent to release. Hope is now focussed on *N. californicus*. Between May and September, 1995, more than 38,000 individuals of *N. californicus* were released at Piritiba and Itaberaba in Bahia and at Petrolina in Pernambuco. Establishment has yet to be confirmed, but in the meantime, releases will continue in several locations.

The fungal entomopathogen *Neozygites* sp. is a common cause of mortality of CGM in the field in northeastern Brazil. Little is known about this fungus, partly because it is difficult to rear outside of its hosts, the two-spotted spider mite and CGM. Because of its prevalence in the field, the fungus has been studied with the objective of increasing its efficiency in Brazil and introducing Brazilian strains into Africa. Work at CNPMF/EMBRAPA at Cruz das Almas, has developed in vivo and in vitro rearing methods. The in vivo technique allows for multiplication in the laboratory by infecting healthy mites with spores produced by infected dead mites referred to as mummies. While this technique permits studies of basic biology, it is not efficient for producing large amounts of fungus. An alternative is to rear the fungus on artificial medium, but this has been difficult due to poorly understood nutritional requirements of *Neozygites*. Recent advances at CNPMF, however, now permit isolation and some growth of the fungus in a chemically-defined liquid growth medium. This has produced sufficient pure fungus to allow researchers at CIAT to extract DNA and sets the stage for genetic characterization.

Currently, there is no technique for taxonomic identification of species of *Neozygites*, separation of isolates into strains, or comparison of strains for pathogenicity. Such a technique will be necessary if Brazilian strains are released into Africa where the fungus also exists. It is thought that African strains of the fungus that have not co-evolved with CGM are less aggressive than Brazilian strains. With current methods, it is not possible to distinguish between African and Brazilian strains and therefore the impact of introductions will be impossible to determine. Since morphological characters are few and of doubtful significance, work was started under PROFISMA to genetically characterize the fungus and identify genetic markers that will allow identification of strains. By rearing the fungus in liquid medium according to the technique developed at CNPMF, researchers at CIAT have been able to extract DNA from protoplasts. Using PCR, the genetic material was amplified and compared with DNA from healthy mites and a common fungal contaminant, *Fusarium*. The presence of bands unique to the *Neozygites* sample indicates that no contamination occurred and that this technique can be used to differentiate fungal species. Work at CIAT will continue to refine the method to distinguish fungal isolates from sites in Colombia, Brazil and Africa. The techniques developed will allow identification and selection of strains for pathogenicity to CGM, thereby opening the way for the use of *Neozygites* as an introduced agent of biological control in Africa and, in Brazil, as an augmentative form of biological control.

Training and Participatory Implementation

Training of extensionists and researchers of state institutions proceeded according to the training model put forward previously (PROFISMA Annual Report, 1994). Excellent progress has been made in establishing community research committees (COPALs) and in training extensionists and researchers in farmer participatory research (FPR) methods. Cassava's long cropping cycle in the semi-arid makes it difficult to evaluate results of these efforts yet in terms of increased productivity. However, impact as measured by extensionist and farmer enthusiasm and by the interest repeatedly expressed by state agencies is significant. One measure of success is the response from national and state research and extension agencies as exemplified by requests for training and the desire to continue collaborating with PROFISMA. The training courses conducted in participatory methods to date have enjoyed a high rate of return of those extensionists and researchers trained in previous events, leading to a coherent and highly capable cadre of FPR practicioners through 4 states of northeastern Brazil. Follow-through on these efforts will be critical to the success of the project and the investment made so far.

The second phase (Planning Technology Testing with Farmers) was covered through a course held at CNPMF with 30 participants from four states as well as PROFISMA and CNPMF staff. The course was executed with support of CIAT's IPRA project. Four members of PROFISMA staff participated while only two CNPMF researchers attended the course. Six cassava-dependent communities in Bahia were visited by course participants as part of hands-on training. A workshop on COPAL (Local Agricultural Research Committees) was conducted for 10 trainees selected to act as catalysts for COPAL formation.

Eighteen COPALs (Local Research Committees) have been established in four states (Bahia, Ceará, Pernambuco and Paraíba). Each COPAL received US$400 from PROFISMA as seed money in a rotating fund to finance the first cycle of technology testing. In each, the community COPAL members selected a constraint to be addressed and together with extensionists and researchers, designed an experiment to test a given technology to alleviate that constraint (Table 1.1). Constraints and technologies to be tested were identified through participatory diagnosis. Experiments were designed collaboratively with farmers, researchers and extensionists. Second cycle experiments are currently being designed for 1996.

Feedback from participatory surveys to the research agenda

PROFISMA has attempted to fully subscribe to the principles of participatory methods by allowing the results of particpatory diagnoses to adjust the research and development agenda initially generated by researchers at CIAT and CNPMF. While the relevance of activities proposed by researchers has been confirmed in many cases, some new activities have been suggested and are being incorporated into the project. Two new activities have been proposed.

Researchers at CNPMF and CIAT in the area of soil fertility management have been requested to propose activities relevant to an integrated crop management context. Cultural practices such as intercropping, green manure, use of deep-rooting legumes, ridge planting, quality stake production, etc. all influence pest, disease and weed incidence and severity as well as cassava productivity. Most of these technologies are already developed and are being tested through participatory methods in communities throughout the northeast (Table 1.1). In many cases, however, these techniques require adaptive research and validation in farmers' fields. This will be done through the COPALs.

Leafcutting ants (*Atta* and *Acromyrmex* spp.) are not mentioned in the original project document because they were not perceived to be a limiting constraint. Existing technology (mirex-based baits) were seen to provide adequate and cost-effective control and are widely used by farmers throughout the northeast. However, with the removal from the Brasilian market of myrex (dodecachlor), many complaints have been received that the new baits (now based on sulfuramide but still using the unfortunate commercial name of Mirex-S) are not effective, contradicting most industry and academic studies. The diagnostic surveys also demonstrate that leafcutters are considered a priority pest by farmers. The new baits do act more slowly but should be just as effective. Farmers, however, observe that colony activity continues after bait deployment and may conclude that the bait doesn't work even if eventual colony mortality is the same as with the faster-acting myrex baits. Participatory trials to demonstrate proper bait handling and deployment and to test efficacy of different baits are proposed as a second phase activity of PROFISMA. There are also new baits being developed based on fungal entomopathogens (*Metarhizium*) that could be tested and would present a non-toxic alternative.

Project financial management

As the project enters its final year (1996), it becomes critical to plan for funding contingencies to avoid disruption of ongoing and productive research and development components of the project if funding is terminated at the conclusion of the current phase (12/96). UNDP has not as yet indicated its interest in a second project phase despite highly favorable project reviews and general approval of the project. The most recent review was particularly supportive of the participatory research approach adopted by PROFISMA. As noted by the authors of the review conducted at CIAT in August, 1995, "...FPR may have much more than local significance. It may actually be an effective way to foster the development of the scientific and technological culture so urgently needed as a basis for increasing the prosperity of agrarian-based developing nations. In any case, FPR certainly eliminates the technology transfer problems of the past, and PROFISMA is to be commended for embarking on and apparently succeeding in this venture." While we remain optimistic that funding will be forthcoming for continued activities, prudent planning requires scaling back of current activities in order to assure continuity with project renewal. This is being done according to priorities set in a review and planning meeting held at CNPMF in November, 1995 when state extensionists and researchers and CNPMF and PROFISMA staff participated. Some cost overruns related to an inflated personnel budget have occurred as the result of the revaluation of both national currencies: the Colombian peso and the Brazilian real. While some devaluation of the real occurred relative to the dollar during 1995, it was slight compared to the large revaluation that occurred during 1994 and the real is still stronger than the dollar - approximately 0.96/US$ at year's end. The project management's intention is to reduce junior personnel costs by between 30 and 50% by 1 July 1996, thereby assuring adequate operational funds to continue priority activities to the end of 1996 and into the first semester of 1997.

Planning for a second project phase

During the review and planning meeting in November, participants were requested to project their activities to the year 2000. Workplans based on that time frame were elaborated and will be analyzed, returned to all project participants and discussed to generate a final workplan for a second project phase. Concepts notes related to various project components are being circulated to identify possible alternative sources of funding for activities within Brazil. Requests have been received from Caribbean and Andean countries and other regions within Brazil to provide training in participatory methods and in cassava production technologies. Donors are being solicited to support initiatives in these new target areas. See Figure 1.1 for distribution of the cassava crop in Latin America.

Table 1.1 Constraints and technologies selected by farmers for testing by Local Research Committees organized in 1995. Primary constraints are thought most limiting by farmers; secondary pests are those ranked among the 5 most limiting constraints of any origin (biotic, abiotic, political, etc.).

Location	COPAL community	Primary constraint	Secondary pests	Technology to be tested
Alagoa Grande	Quiteria	Root rot		Varieties (3); ridges.
Alagoa Nova	Gameleira	Root rot	Leafcutter ants	Varieties (2); ridges.
Aporá	Chapada	Root rot	Cassava Green Mite (CGM), leafcutter ants	Varieties (2); +/- ridges; Screen of 25 varieties
Gloria de Goita	Gameleira	Root rot	Hornworm	Varieties (4); double vs single rows
Salgado Sao Felix	Sousa	Root rot	Shoot fly	Varieties (2) ridges.
Vitoria de Sto. Antao	Campina Nova	Root rot	Cassava mealybug, leafcutter ants	Varieties (3); Single vs double rows
Crisopolis	Buril	CGM	Root rot	Varieties (6)
Inhambupe	Colonia Agricola Roberto Santos	CGM	Hornworm, leafcutter ants	Varieties (6)
Piritiba	Sumaré	Whiteflies, Fertility		Quality stake production: double rows, fertilizer & intercropping.
São Miguel das Matas	Barra	Whiteflies (*Aleurothrixus aepim*)	Leafcutter ants	Varieties (5)
Acaraú	Lagoa Grande	Soil fertility	Hornworm, root rot	Varieties (21); intercropping, double-rows
Acaraú	Vila Moura	Lack of fertilizer	Hornworm, root rot	Compost, intercropping, double rows; Varieties (2)
Anguera	Embuzeiro	Soil fertility	CGM, Hornworm, root rot	Intercropping; single & double-row planting.
Cruz das Almas	Cadete	Soil fertility	Hornworm, leafcutters, white-flies, root rots	Varieties (2); mineral and organic fertilizer.
Sao Bento de Una	Tatu	Lack of fertilizers		Varieties (4); intercropping & single vs double rows
Tiangua	Valparaiso	Soil fertility	Hornworm, root rot	Compost & intercropping in double rows; Varieties (2)
Piritiba	Caldeirão	Quality stake material		Stake production via fertilization & intercropping
Ubajara	Nova Veneza	Planting material	Witches' broom	Varieties (2); Compost & intercropping in double rows

Figure 1.1 Distribution of cassava in Latin America. Each point represents 1,000 ha of cassava. Data provided by the Agroecological Studies Unit, CIAT.

2 TRAINING AND PARTICIPATORY RESEARCH

The training model developed for PROFISMA consists of three stages, each one composed of three phases (Fig. 2.1). The first stage, participatory diagnosis, was carried out during 1994 when 51 researchers and extensionists from seven state institutions and two EMBRAPA national research centers participated in two courses conducted at EMBRAPA/CNPMF. The first stage produced participatory diagnoses of 77 communities, located in 51 townships of Bahia, Ceará, Paraíba and Pernambuco, with participation of 1,662 cassava growers.

The second training stage (Planning and Evaluation of Technology) consisted of one seminar and one course, conducted during 1995. The seminar, entitled "Establishment of Local Committees for Agricultual Research (COPALs)", March 30 - April 1, was attended by 10 researchers and extensionists from six collaborating institutions of Bahia, Ceará, Paraíba and Pernambuco, and CNPMF. Participants discussed attitudes and concepts necessary to the establishment of COPALs and follow-up activities.

The course (*Participatory Methods for Planning of Technology Testing Activities with Farmers*) was conducted April 3 - 12 at CNPMF to provide extensionists and researchers with skills for organizing farmer participation in research activities, planning participatory trials, and participatory evaluation of technologies. A total of 30 trainees participated from CNPMF, EBDA, EMATER-CE, EMATER-PB, EMATER-PB, EPACE and IPA, representing Bahia, Ceará, Paraíba, and Pernambuco. The course provided researchers and extensionists with skills for organizing and stimulating farmer participation in technology-testing relevant to problems identified by each community during the previous participatory diagnosis. As per the training model, the course included a learning-by-doing approach with a field work component. Trainees interacted with 6 farmer groups to gain first-hand experience in methods, skills, and attitudes needed for practicioners of farmer participatory research. Upon returning to their institutions, trainees were expected to conduct similar activities with communities and COPALs in these regions.

As a result of this second training stage, 18 COPALs were established in cassava grower communities of Bahia, Ceará, Paraíba and Pernambuco. The topics selected for participatory experiments by the COPALs include evaluation of cassava varieties for resistance to the cassava green mite (CGM), root rot, and whiteflies; effect of cover crops on soil fertility and soil physical characteristics; production of high quality planting material; effect of cultural practices and planting systems on root rot control and yield (Table 2.1).

Other PROFISMA training activities included in-service training and participation of PROFISMA staff in other training events (Table 2.2). Consultancies on soil physics/cassava root rot, mealybug biological control, and socieconomy were also carried out by experts from the University of São Paulo, U. of Massachusetts at Amherst, and from the Federal University of Bahia, respectively.

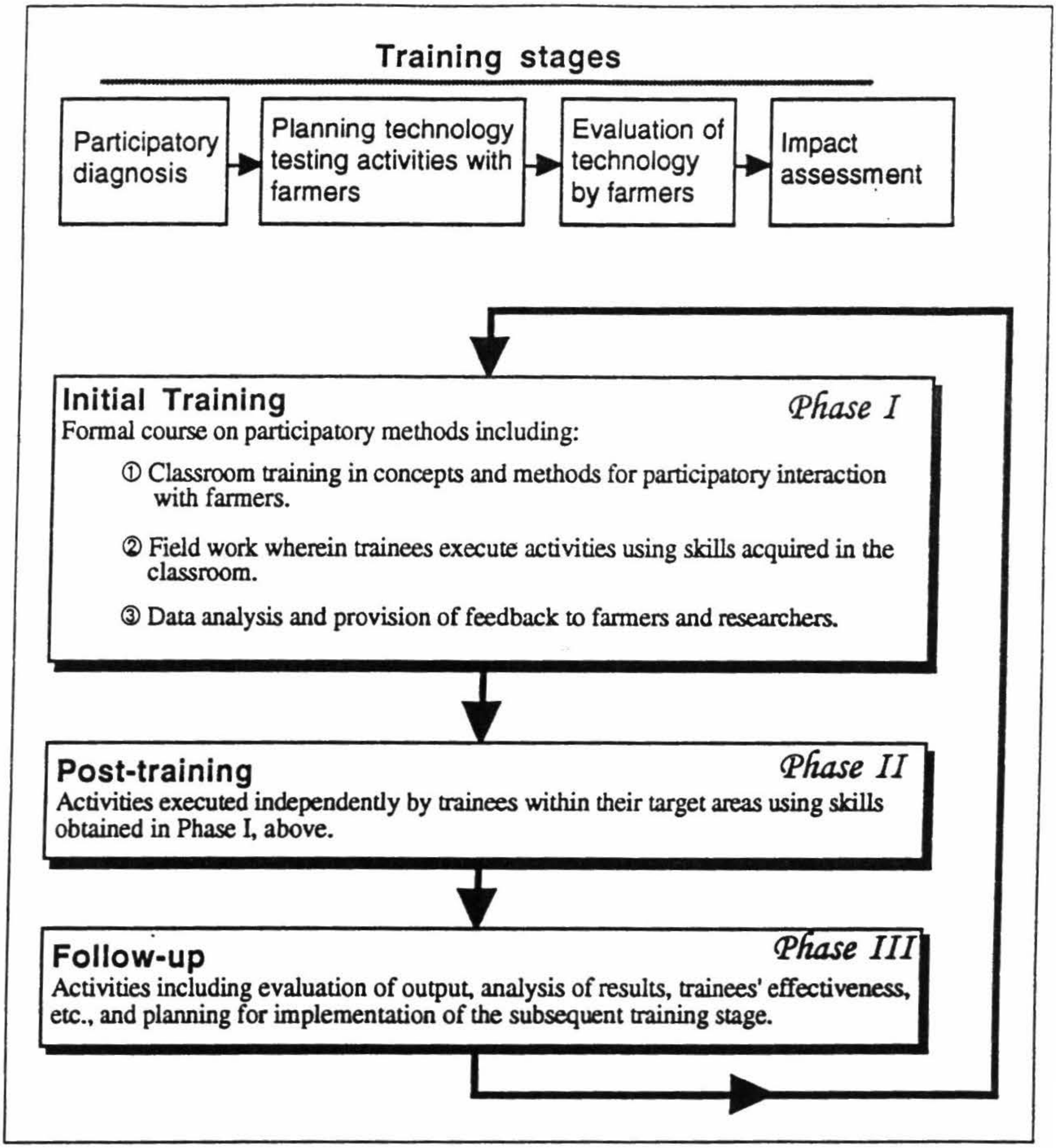

Figure 2.1 PROFISMA training model including 4 stages (above), each comprised of 3 training phases (below) with feedback to initial phase of subsequent training stage.

Table 2.1 Local Committee of Agricultural Research (COPAL) and technology tests planted in each COPAL during 1995

State	Municipio	COPAL	Technology test	Area (m^2)	Planting Date
Bahia	Inhambupe	Colônia	Evaluation of 6 cvs. for CGM resistance	384	06/06/95
	Aporá	Chapada	1. Effect of cultural practices on root rots 2. Evaluation of 25 CNPMF clones for root rot resistance	872	10/06/95 21/06/95
	Crisópolis	Buril	Evaluation of 6 cvs. (2 local, 4 from CNPMF) for CGM resistance	699	16/06/95
	Cruz das Almas	Cadete	Effect of cvs. and fertilizers on soil fertility and cassava yield	1,176	15/08/95
	Anguera	Umbuzeiro	Effect of jack bean & cow pea intercrops in single & double rows on soil fertility & root yield	187	
	São Miguel das Matas	Barra	Evaluation of 5 cultivars (2 local, 3 from CNPMF) for whitefly resistance	900	10/07/95
	Piritiba	Caldeirão	Production of high quality planting material using fertilizer & cow pea intercrop	1,061	07/04/95
		Sumaré	Production of high quality planting material using fertilizer & cow pea intercrop	1,061	06/04/95
Ceará	Acaraú	Vila Moura	Effect of organic fertilizers on yield in double rows with intercrops (jack bean & velvet bean)	2,450	17/02/95
		Lagoa Grande	Evaluation of 21 sweet cassava cvs. in dble rows & 6 legume intercrops	1,450	03/03/95
	Tianguá	Valparaiso	Effect on yield of organic fertilizer & intercrops (*Crotalaria* & *Vigna*)	2,450	22/02/95
	Ubajara	Nova Veneza	Effect of organic fertilizer & intercrops on soil fertility & yield of 2 cvs. (1 local, 1 from CNPMF)	2,450	23/02/95
Paraíba	Alagoa Nova	Gameleira	Evaluation of 3 cvs. & cultural practices on root rots	959	06/06/95
	Salgado de São Felix	Souza	Evaluation of 2 cvs. & cultural practices on root rots	729	09/08/95
	Alagoa Grande	Quitéria	Evaluation of 3 cvs. & cultural practices on root rots	371	30/05/95
Pernambuco	Vitória de Sto Antão	Campina Nova	Evaluation of 3 cvs. & cultural practices on root rots	1,159	21/06/95
	Glória de Goitá	Gameleira	Evaluation of planting systems & 4 cvs. on root rots	1,576	03/08/95
	São Bento de Una	Tatu	Yield trial of 4 cvs. with velvet bean intercrop	1,932	06/06/95

Table 2.2 Participation of PROFISMA and CNPMF/EMBRAPA research staff in training activities

Subject	Place	Participants
Mite rearing methods	IITA - Benin	1
Mealybug rearing methods	CIAT - Colombia	1
Environmental Impact Assessment	CATIE, Costa Rica	1
Farmer Participatory Research	CIAT, Colombia	1
Virology	CIAT, Colombia	1
Symposium on Crop Production Systems	Paraná, Brazil	1
XXVIII Congress, Brazilian Plant Pathological Soc.	Bahia, Brazil	4
Coordination Meeting	CNPMF, Brazil	≈50
Coordination Meeting	CIAT, Colombia	3
Course on mite taxonomy	Piracicaba, SP	2
XV Brazilian Entomology Meetting	Caxambu, MG	5

Last year's successful efforts to promote farmers participation in identification of common constraints were used as the entry point for mobilizing farmers' interest and involvement in the next stage of PROFISMA's training and participatory research strategy: the implementation of participatory methods for planning and evaluation of adaptive technology testing at the community level. The organizational model followed by PROFISMA to achieve this objective was based on formation of Local Agricultural Research Committees (COPALs). This methodology has been implemented by CIAT since 1987 in Colombia and other countries of Latin America. The COPAL develops community level capacity for improving agriculture by promoting farmers' participation in agricultural technology research and dissemination. The COPAL is formed by a group of 4 farmers elected by their community who are responsible for coordinating overall community participation in the testing of new agricultural technologies chosen as potential solutions to problems defined and prioritized by the community. The COPALs operate with direct technical support and guidance from the cadre of trainees (researchers and extension agents), especially in relation with the statistical design of the experiments. Each COPAL receives and administers a small grant (US$400) from PROFISMA to finance its first cycle of technology-testing trials. As a result of the second training stage, 19 COPAls were established in cassava-dependent communities of Bahia, Ceará, Paraiba and Pernambuco.

Topics selected for participatory experiments by COPALs included evaluation of cassava varieties for resistance to CGM, root rots, and whiteflies; effect of cover crops, organic and chemical fertilizers on soil fertility and soil physical characteristics; production of high quality planting material; effect of cultural practices and planting systems on root rot control and yield (Table 2.1).

Establishment of COPALs has strengthened integration among researchers, extensionists and farmers. COPALs now function as viable and accountable partners of research and extension agencies and as external pressure groups demanding input from these institutions regarding their problems and priorities. By the end of 1995, a total of 21,866 m^2 of experimental area was administered by COPALs throughout the region of influence of PROFISMA including 56 local cassava cultivars and 41 cultivars introduced by CNPMF/EMBRAPA. Appendix I presents a more detailed information on the participatory experiments installed by each COPAL.

3 STRATEGIC RESEARCH AT CIAT, COLOMBIA

3.1 Biological Control of Cassava Green Mite in Latin America and Africa

Geographic distribution of phytoseiids

The PROFISMA computer database now contains 3,800 records of mites collected during 10 years of foreign exploration for predatory mites on cassava. Data include description of collection sites, host plant, taxonomic identification, and long-term climate. A substantial effort was made to "clean up" the database and update geographic and climatic data in collaboration with CIAT's Agroecological Studies Unit. Distribution maps of the common phytoseiid species found on cassava have been updated (Figs. 3.1.1, 3.1.2). Statistical analysis of climatic distribution of the species has begun. The incidence (number of times collected/total number of collections) of phytoseiid species was extracted for elevation and number of dry months (Figs. 3.1.3, 3.1.6). The specific objectives are to identify species (and collection sites) based on climatic matching, best adapted to target release regions. Target regions are: 1) transitional and semi-arid regions of NE Brazil and 2) the East African plateau. The number of species encountered in relation to the sampling effort indicates that Colombia has a particularly rich phytoseiid fauna (Fig. 3.1.7).

Exploration for phytoseiid predators of cassava green mite

Classical biological control of CGM is currently targeted for the drier regions of NE Brazil (PROFISMA) and the East African plateau (IITA). Foreign exploration continued this year with collection trips to dry regions: Guajira, Colombia (Feb.); Lara, Falcon, Yaracuy and Zulia, Venezuela (Mar.); Mato Grosso do Sul, Brazil (May); Guayas, Ecuador (Nov. 1994); and high altitude regions: Cajibio, Cauca (Aug.) (Table 3.1.1). Colonies maintained during the year at CIAT are listed in Table 3.1.2.

Table 3.1.1 Explorations for phytoseiids in cassava Oct. 1994 - Oct. 1995.

Date	Locations	Species colonized
Nov. 1994	Guayas, Ecuador	*Galendromus helveolus* *Typhlodromalus manihoti* *Euseius ho*
Feb. 1995	Guajira, Colombia	*Neoseiulus idaeus*
Feb.-Mar. 1995	Guajira & Venezuela	*Neoseiulus idaeus*
May 1995	Mato Grosso do Sul, Brazil (de Moraes, Yaninek & Smith)	(no live collections)
Aug. 1995	Cajibio, Cauca	*Typhlodromalus manihoti*

Table 3.1.2 Phytoseiid strains maintained in laboratory colonies at CIAT, 1995.

SPECIES	ORIGIN				CLIMATE				
	Country	Dept./State	Municipality	Locality	Date collected	PPT (mm)	DM	Temp (°C)	RH %
N. idaeus	Ven.	Lara	Trinidad	Torres	03-95				73.3
		Lara	Jiménez	Jiménez	03-95				
		Lara	Carora	Los Palmitos	06-93	627	5	27.6	73.3
		Zulia	Mara	Las Cruces	03-95	790	9	27.6	
		Zulia	Mara	Las Cruces	06-93	790	9	27.6	
		Zulia	Altagracia	Miranda	03-95				
		Falcon	Dabajuro	Buchivacoa	03-95				
	Col.	Guajira	Aremasahin		03-95	361	11	30.2	60.7
		Guajira	Aremasahin		06-94	361	11	30.2	60.7
		Guajira	Fonseca		07-94	946	5	29.0	
	Bra.	Bahía	Piritiba		1993	856	3	22.0	
		Bahía	Capim Grosso		1993	490	9	24.0	
		Pernambuco	Petrolina		1993	430	8	25.0	
		Ceará	Crato		1993	1065	6	25.0	
N. californicus	Ecu.	Manabí	Chone	Calceta	11-94	1291	7	25.5	86.0
		Manabí	Portoviejo		11-94	523	8	25.0	79.0
		El Oro	Machala		11-94	577	8	24.9	83.0
		El Oro	El Guabo	La Iberia	11-94	733	8	24.2	85.0
T. limonicus	Bra.	Sao Paulo	Jaguariuna		06-90	1241	6	20.0	
T. manihotae	Ven.	Yaracuy	Marín	San Felipe	03-95				
	Bra	Bahía	Cruz das Almas		02-93	1160	2	23.0	68.6
	Col.	Cauca	Cajibío		06-95				
		Córdoba	Montería		01-94	1175	4	28.0	
	Ecu.	Manabí	Calderón		04-93	523	8	25.0	79.0
T. tenuiscutus	Ecu.	Guayas	Guayaquil		02-94	778	8	25.1	86.0
		Manabí	Portoviejo		11-94	523	8	25.0	79.0
		Manabí	Chone		04-93	1291	7	25.5	
	Col.	Córdoba	Los Córdobas		01-91	1242	4	28.0	
E. ho	Ecu.	Manabí	Portoviejo		11-94	523	8	25.0	79.0
G. helveolus	Ecu.	Manabí	Portoviejo		11-94	523	8	25.0	79.0

PPT = Accumulated annual precipitacion; DM = dry months (< 60 mm rain); Temp = ave. annual temperature; RH = ave. annual relative humidity.

Table 3.1.3 Recent exportations of phytoseiid mites from CIAT

Date	Species	Source	Colony age	No. sent	No. rec'd	Destination	Method
2/1/94	*T. tenuiscutus*	Los Córdobas, Colombia	1/91	570	201	CNPMA, Brazil	agar vials
2/29/94	*T. tenuiscutus*	Los Córdobas, Colombia	1/91	1,200	176	CNPMA, Brazil	agar vials
8/18/94	*T. tenuiscutus*	Los Córdobas, Colombia	1/91	2,000	2,000	CNPMA, Brazil	CGM-infested leaves
4/8/95	*N. californicus*	Portoviejo, Ecuador	9/94	2,000	800	CNPMA, Brazil	CGM-infested leaves, with salt + cloth vents
9/1/95	*T. manihoti*	Cajibio, Col.	8/95	600	292	Amsterdam	CGM-infested leaves
	"	"	"		160	Benin	
9/19/95	*N. californicus*	Portoviejo, Ecuador	9/94	2,000	1,288	CNPMA, Brazil	CGM-infested leaves + filter paper via Fedex

Shipment of predators to Brazil and Africa

Two species of phytoseiids were sent to Brazil through the EMBRAPA/CNPMA quarantine laboratory at Jaguariúna, SP for release in the northeast (Table 3.1.3). One phytoseiid species from a high elevation site in Colombia was sent to IITA, Benin, via quarantine at the University of Amsterdam, for use in East Africa. This is our first effort at targeting the East African plateau, which was recently requested by collaborators at IITA.

Laboratory evaluation of phytoseiid species

A set of evaluations has been developed to characterize relevant biological attributes of candidate natural enemies to select the most promising species with respect to effectiveness and specificity: adaptation to low relative humidity (RH), prey preference, and effect of host plant.

Adaptation of phytoseiids to low RH: Ten strains of four species of phytoseiids were analyzed for egg survivorship at different RH. Eggs were placed on glass slides and held in closed containers containing saturated salt solutions. *Neoseiulus idaeus* showed the highest survivorship at low RH, followed by *N. californicus* (Fig. 3.1.8). *Typhlodromalus manihoti* and *T. tenuiscutus* were most susceptible. There was little difference among strains of *N. idaeus* or *N. californicus*, but the two strains of *T. manihoti* did respond differently (Fig. 3.1.9). This suggests that, while some intraspecific variability for adaptation to low RH may occur in geographic strains, such variability is small compared with interspecific differences.

Prey preference of phytoseiid species: We have been exploring in the dry regions of Colombia, Ecuador and Venezuela, for phytoseiid predators suitable for release against CGM in northeast Brazil or dry regions in Africa. The dominant indigenous prey in the exploration regions is *Mononychellus caribbeanae*, not *M. tanajoa*, the target for control in Brazil and Africa. Therefore, it was necessary to confirm whether phytoseiids collected from these regions accept *M. tanajoa* as suitable prey. Preference by adult female phytoseiids was measured in two-choice, split-leaf-disk experiments run for 24 hours (starting at 15:00). Four parameters were measured: consumption of prey eggs, consumption of prey immatures, location of phytoseiid eggs, and location of the phytoseiid at five observation times (08:00, 11:30, 13:00, 14:00 and 15:00) (Fig. 3.1.10). None of the phytoseiid species showed preference with respect to the consumption of prey eggs (Table 3.1.4). *Galendromus helveolus*, *N. californicus* and *N. idaeus* showed substantial preference for *M. tanajoa*. *T. tenuiscutus* was the only species that failed to show a preference for either tetranychid in any of the parameters tested. *T. manihoti* preferred *M. tanajoa* only with respect to consumption of immatures. None of the phytoseiids exhibited preference for *M. caribbeanae* in any of the assays and are therefore considered suitable biological control candidates with respect to prey preference. These results suggest that useful species may be found in further collections of predators from the dry regions of northern South America regardless of the prey species present in those areas.

Table 3.1.4 Prey preference of five phytoseiids for *M. tanajoa* and *M. caribbeanae*[1]

		Consumption of		Site of	Location
	Olfactometer[2]	Eggs	Immatures	Oviposition	of female
N. idaeus	=	Mt	Mt	=	=
N. californicus	=	Mt	Mt	Mt	+
G. helveolus	=	Mt	Mt	Mt	
T. tenuiscutus	=	=	=	=	=
T. manihoti	=	Mt	=	=	+

[1] Mt, preference for *M. tanajoa*; Mc, preference for *M. caribbeanae*; =, no preference.

[2] Data from Janssen et al. 1990; + preference for *M. tanajoa*-infested leaves over clean leaves; =, no preference.

Table 3.1.5. Brasilian varieties of cassava being multiplied for tritrophic evaluation.

			Mite damage[1]	
Variety house	Common name	Comments	Field	Screen
MBRA 99	Boticuda	resistant	3.0	5.0
MBRA 105	Cidade Rica		5.0	5.0
MBRA 117	Olho Roxo		3.5	4.0
MBRA 159	Platina Preta	popular	3.7	4.5
MBRA 191	Amarela Casca Roxa	resistant	3.2	3.0
MBRA 192	Buja		3.5	3.5
MBRA 201	Fio de Ouro		3.7	4.0
MBRA 252	Lagoa		3.5	4.5
MBRA 255	Engana Ladrao	popular		4.5
MBRA 293	Amansa Burro		3.5	4.5
MBRA 532	Osso Duro		4.5	4.5

[1] Mite damage was evaluated at CIAT using the scale: 1, 0%; 2, 1-25%; 3, 26-50%; 4, 51-75%; 5, >75% of first fully-developed leaf damaged.

Evaluation of cassava varietal effects on phytoseiids: Work is was initiated during 1995 on tritrophic interactions (plant/prey/predator). Experiments have confirmed reduced oviposition and survivorship of *M. tanajoa* on Ecu 72 compared to Bra 12 (tolerant) and CMC 40 (susceptible). Work in 1996 will study the effects that varietal resistance may have on predatory mites. We have also multiplied 11 varieties from Brazil (Table 3.1.5) to determine whether any of these have negative effects on candidate phytoseiids.

Optimization of mass rearing methods for phytoseiids

Laboratory methods and a computer model are being developed to optimize efficiency and improve planning of phytoseiid mass rearing. Laboratory methods are based on the simple, low technology Mesa-Bellotti method, using small containers containing CGM-infested cassava leaves. Development time, age-specific fecundity and survivorship have been measured for the model species, *T. tenuiscutus*. Data have also been collected to measure the effects of crowding of females on per capita oviposition rate (Fig. 3.1.11; $Y=1/(0.272 + 0.008X)$). Experiments to measure functional response and validate the model with rearing chambers are underway. Data on the effect of varying the frequency of harvesting adult females indicate that harvesting every week is more productive than harvesting twice a week or every other week (Fig. 3.1.12).

Field trials of variety, mulch, intercropping, prey refuge in field at Pivijay

Field experiments were conducted in the dry climate at Pivijay, northern Colombia to study management strategies in an ecological zone similar to the transitional zone of northeast Brazil. These experiments were terminated in October; data are being processed.

Intercropping with maize: An experiment was performed to determine the effect of intercropping maize with cassava on CGM damage, phytoseiid populations and root yield. The first experiment was planted 4 May 1994 at the beginning of the longer of two rainy seasons. The local cassava variety ICA-Negrita was planted in 10 by 10m plots. Plants were spaced 1 by 1m in monoculture and 1m by 1.4m intercropped with maize in hills spaced 1 by 1.4m. The maize was harvested in early September. CGM populations and damage were estimated. Phytoseiid populations were measured by counting adult females on the first fully-developed leaf. There were six replicates of two treatments (mono- and intercrop); 30 randomly-selected plants were sampled each date. This year had more rain than usual with 795 mm falling between May and mid November.

CGM population was higher in the cassava monoculture (scale 1.6 versus 1.4), but this seems biologically insignificant (Fig. 3.1.13). CGM damage was significantly higher in the intercropped cassava during August and September, but was the same afterwards (maize was harvested in early September) (Fig. 3.1.14). Phytoseiid populations were the same in both treatments except for Nov. 17, when the population was much higher in the monocropped cassava (Fig. 3.1.15). We have no anecdotal observations that might explain this. Rains peaked in September and stopped by mid-November. Based on weather, we would expect to see the highest CGM populations in Nov.-Dec., the beginning of the dry season. This change in season could account for the general increase in phytoseiid populations during November. Because the maize was already dead by September, the only physical difference between the treatments in November was plant spacing. Since higher phytoseiid populations were found in the more closely planted treatment, it is possible that the denser canopy favored phytoseiids. Possible mechanisms for this effect are higher RH and easier dispersal. Sustained low CGM populations and damage suggest there was substantial natural control of CGM. No observations were made of other natural enemies such as insect predators or the fungal pathogen *Neozygites*.

Phytoseiid release strategies

N. californicus was released at CIAT to determine the effect of the number of phytoseiids released on establishment success (Fig. 3.1.16). Adult females were released on four adjacent plants in the center of 20 x 20m cassava plots. Release rates were 0, 50, 100, 500 females per plant. Variance was large relative to the low number of phytoseiids recovered, but the data suggest substantially more phytoseiids were recovered when 500 per plant (2000 per plot) were released.

Taxonomic key to phytoseiids on cassava in South America

Correct mite identification is crucial to the success of the biological control effort. One important phytoseiid species now established in Africa, *T. manihoti*, is a newly described species (de Moraes et al. 1994). Much of our taxonomic expertise was developed with the support of specialists in Brazil at CNPMA and University of São Paulo, Piracicaba. Elsa Liliana Melo (PROFISMA/CIAT) spent 2 months at CNPMA, Jaguariúna, Brazil working with the phytoseiid taxonomist, Dr. G. J. de Moraes to complete morphological drawings and descriptions of 25 species new to science. They are working with Aloyseia Noronha (EMBRAPA/CNPMF) on a taxonomic catalog and key to phytoseiids in South America, based largely on surveys on and near cassava. Elsa has developed a preliminary key that covers 22 phytoseiid species commonly found on cassava in South America.

Molecular genetic characterization

Molecular genetic techniques promise to be very powerful tools for resolving taxonomic questions. Resolution of species and strain identities for pests and natural enemies is critical for finding successful biological control agents. Through PROFISMA, expertise has been developed at CIAT to exploit these new tools.

Characterization of *Neozygites*: *Neozygites* sp. is an entomophthoralean fungal pathogen of CGM found in Colombia, Brazil and W. Africa by scientists from CIAT, EMBRAPA and IITA. In NE Brazil, but not in Africa, virulent epizootics have been observed in CGM. IITA would like to introduce strains from South America. However, we do not currently have methods to identify strains and thereby distinguish introduced from native African strains. The taxonomy of *Neozygites* is not fully developed. We are developing molecular genetic methods for identification of strains and species.

We have adopted *in vitro* culture methods developed by Dr. R Humber (USDA, Ithaca, NY) and I. Delalibera (PROFISMA/CNPMF) for isolation of axenic cultures of *Neozygites*. Grace's medium was innoculated with hemolymph from surface-sterilized infected CGM and incubated for 10 days. It is not clear whether the fungal hyphal bodies actually replicate, but they increase in size with no sign of contamination. This has allowed extraction of pure DNA for molecular genetic analysis. The ribosomal DNA amplified from *in vitro* cultures using ITS4-IST5 and NS7-NS8 primers can be detected on acrylomide gels. These bands were compared to those from infected and uninfected *T. urticae* mites and from *Fusarium* and *Phytophthora* fungal hyphae (possible contaminants). The NS7-NS8 region is highly conserved but bands from the ITS4-IST5 region showed similarity between *Neozygites* and *Fusarium*, but differences from *T. urticae* and *Phytophthora*. The medium M-199 was found to be less suitable than Grace's for culturing the hyphal bodies, with none surviving beyond a few days.

One strain of *Neozygites* was collected at CIAT from *T. urticae* in a screenhouse colony on cassava. Specimens of this strain were sent to Cruz das Almas for pathogenic analysis by collaborators at CNPMF. No other infected mites were observed this year during explorations for phytoseiids nor during field studies at CIAT.

<u>Characterization of CGM</u>: Results of genetic sequencing of the ITS1 and ITS2 regions of ribosomal DNA of 5 populations of *M. tanajoa* and one of *M. caribbeanae* were reported last year. Populations from Colombia, Uganda, Venezuela and Brazil were not significantly different ($\leq$ 6 bases out of 580). This supports the theory that *M. tanajoa* s.l. is a single species, a subject of debate. However, the sample set was small, and more sensitive genetic techniques are now available. Collaborators at IITA have collected 30 samples from national program collaborators throughout Africa, and a similar number are being collected by collaborators in Brazil at CNPMA and CNPMF. These specimens will be analyzed to learn more about CGM diversity and population genetics.

<u>Characterization of phytoseiids</u>: Four closely related phytoseiid species were sent to Dr. Marjorie Hoy (University of Florida, Gainesville), where Owain Edwards conducted PCR-RAPD analysis. He confirmed that the species (*Typhlodromalus limonicus*, *T. manihoti* & *T. tenuiscutus*), which have been morphologically and behaviorally described as separate species, are indeed genetically isolated (Table 3.1.6). Strains of *T. manihoti* from

Colombia and Brazil were similar enough to be considered one species ($\leq$ 5% level). Such molecular techniques offer a fast method to determine species status. This technique can be used on preserved specimens, greatly facilitating comparison of samples from different countries.

Table 3.1.6 DNA analysis of phytoseiids by Owain Edwards, University of Florida.

		RAPD "species"[1]		
T. limonicus	SP, Brazil	x		
T. manihoti	Colombia		x	
T. manihoti	Bahía, Brazil		x	
T. tenuiscutus	Ecuador			x

[1] 0-5% similarity

Preparation of documents for Cassava CD-ROM

The goal is to format a variety of documents pertaining to cassava research and place them on a CD-ROM for distribution to scientists in developing countries. The project was initiated by S. Yaninek (ESCaPP/IITA), and it involves collaboration with Dr. H. Beck (University of Florida), A. Thro (CIAT, Cassava Biotechnology Network), and E. Goldberg (CIAT Library). Formatting is compatible with the World Wide Web (WWW), so documents can also be made available by that medium (excluding copyrighted bibliographic abstracts).

We have selected recent publications from the CIAT Cassava Program to prepare for inclusion on the CD. Documents not available on diskette are being scanned and converted to text by an optical character reader (OCR) program. Figures and tables are being scanned as bitmap images. Programers in Florida are "tagging" the files to convert them into hypertext documents. They have already mounted some hypertext documents from IITA on their WWW site in Florida (http://hammock.ifas.ufl.edu).

CIAT's contribution of documents includes:

- Cassava bibliography (25,000 records, many with abstracts)
- CBN address (500 records) and project databases
- Cassava Program address database
- Cassava Program Annual Reports (1987-94)
- Cassava Working Documents / Documentos de Trabajo (since 1990)
- Cassava Newsletters & Yuca Buletins
- 2 Biotechnology publications

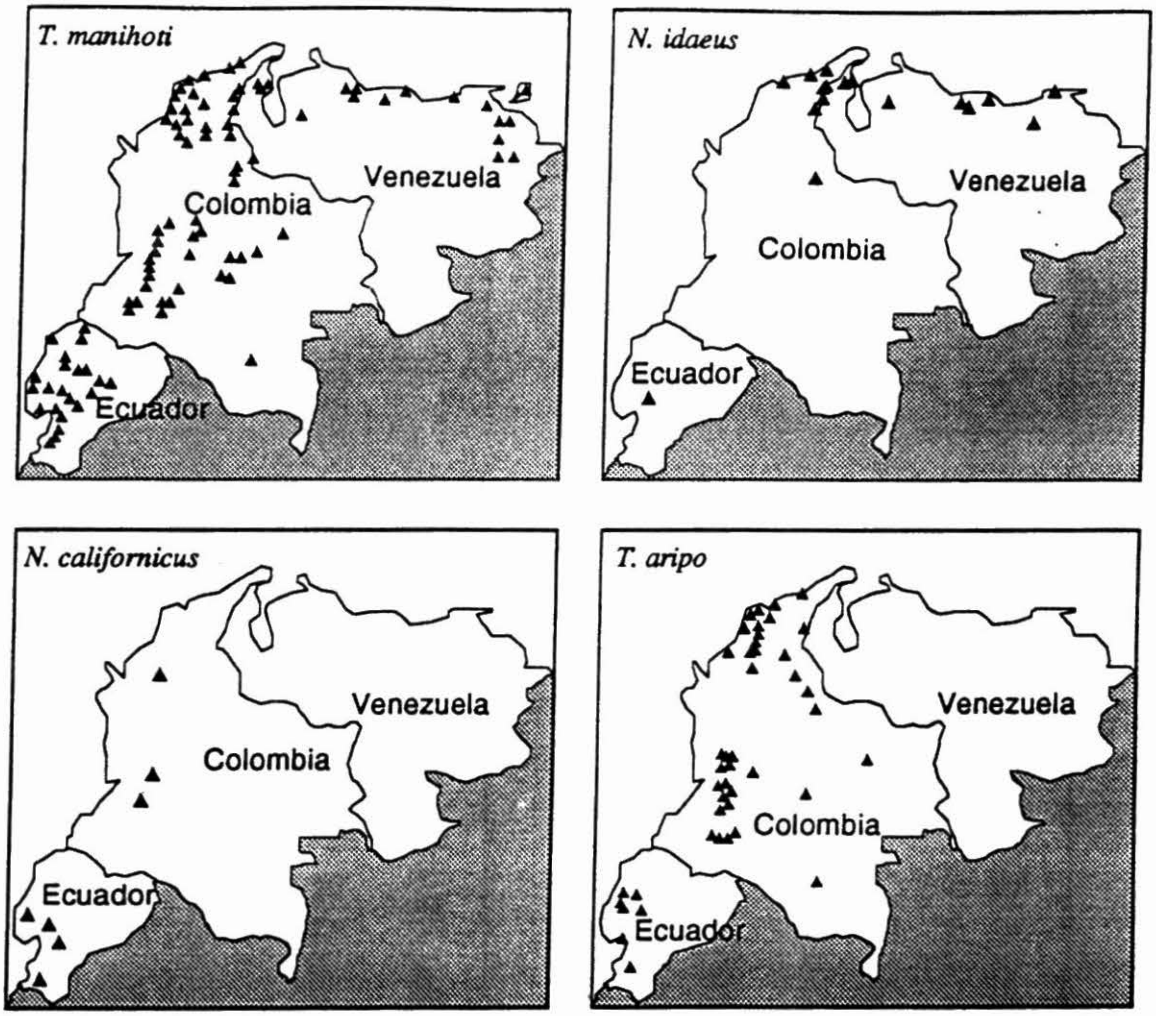

Figure 3.1.1 Geographic distribution of 4 species of phytoseiid predator mites in northern South America.

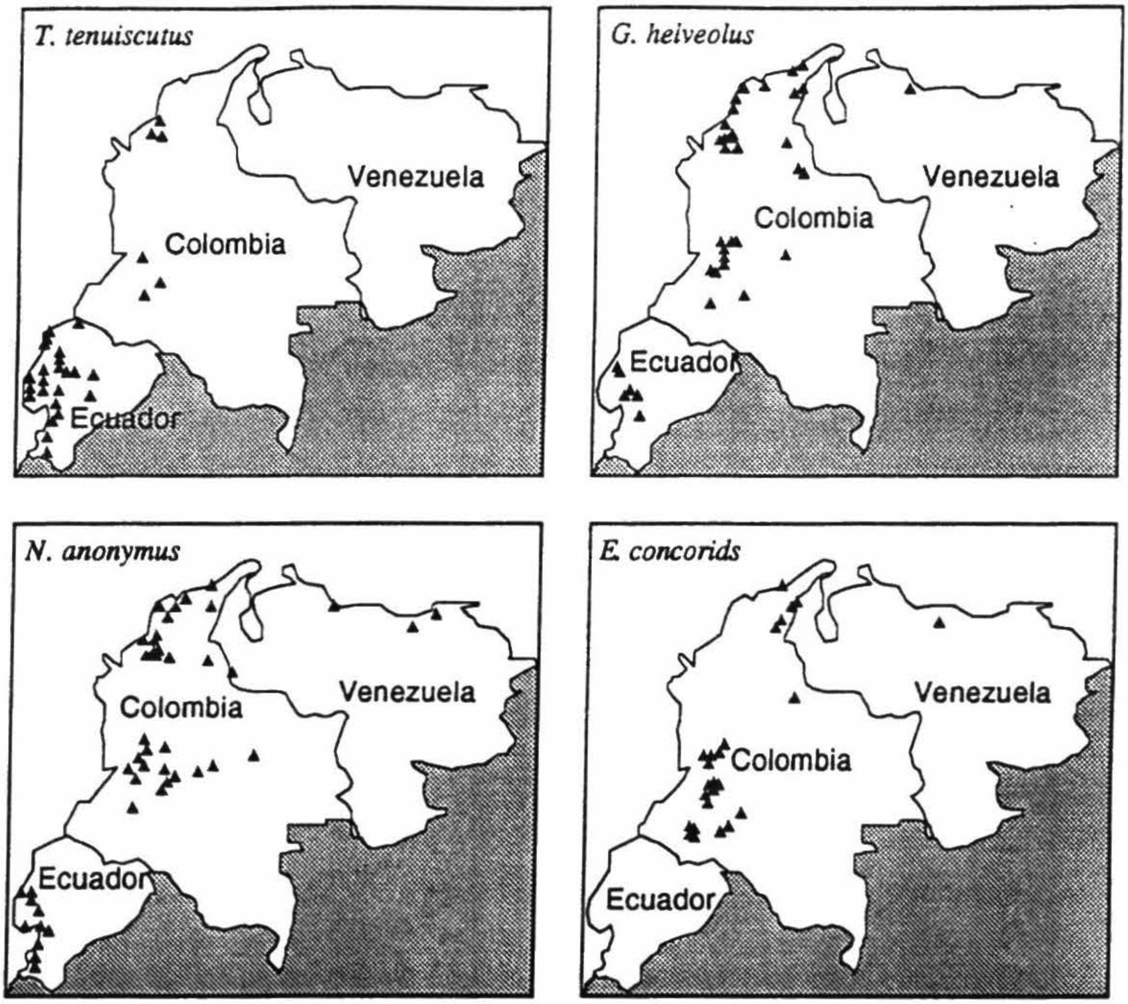

Figure 3.1.2 Geographic distribution of 4 species of phytoseiid predator mites in northern South America.

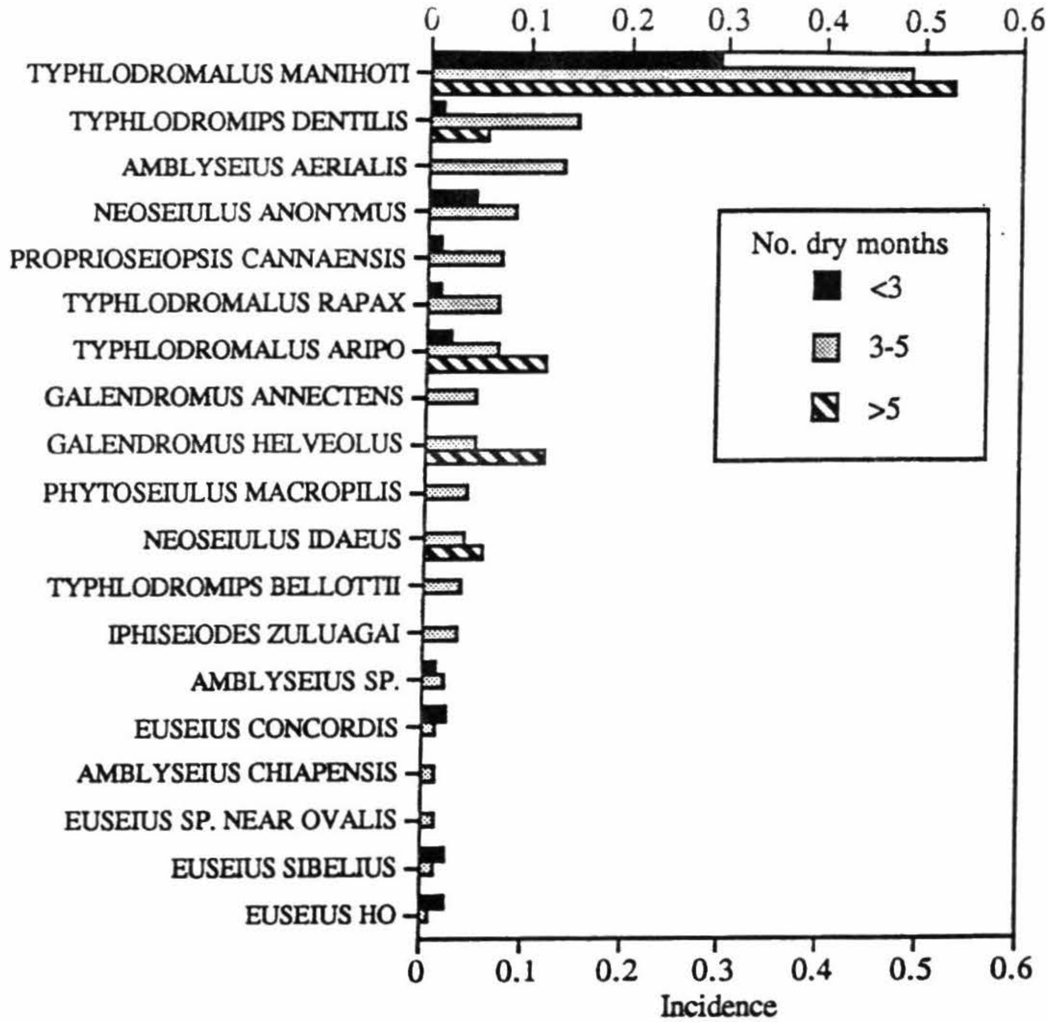

Figure 3.1.3 Incidence of phytoseiids in Colombia with respect to number of dry months (<3, 3-5, >5) at <800 m elevation (dry = <60 mm).

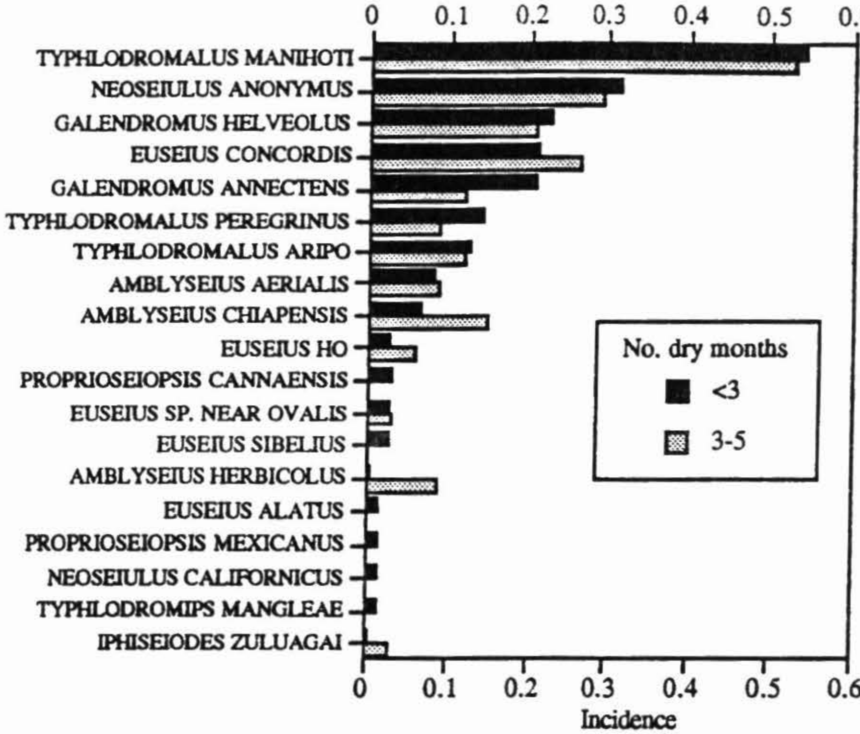

Figure 3.1.4 Incidence of phytoseiids in Colombia with respect to number of dry months (<3, 3-5) at 800-1200 m elevation.

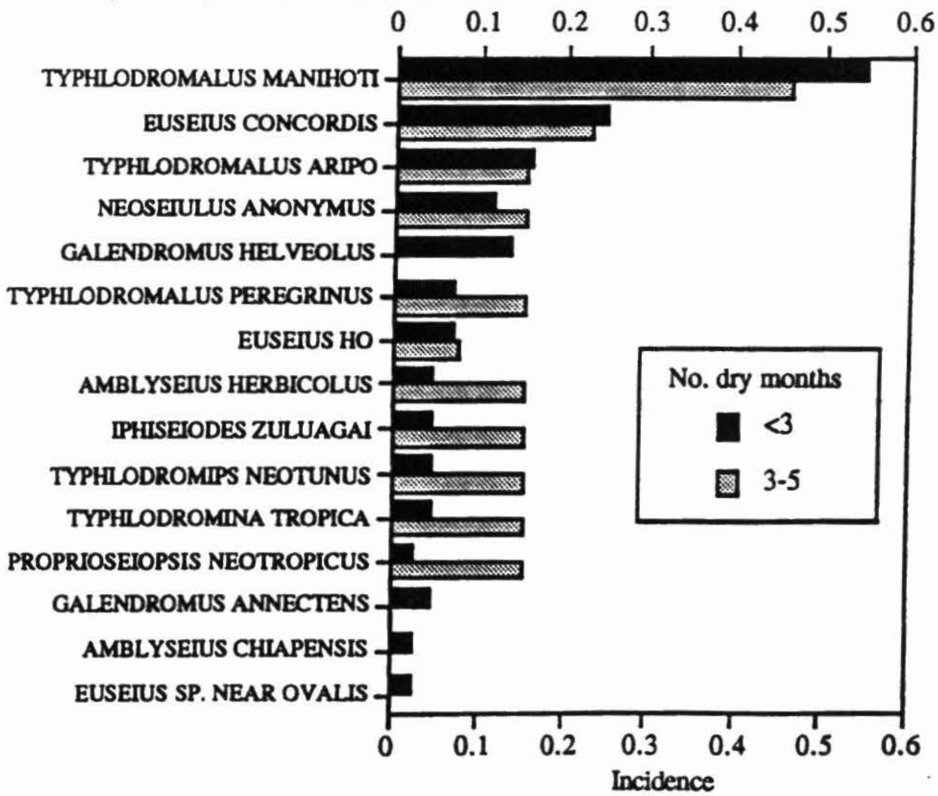

Figure 3.1.5 Incidence of phytoseiids in Colombia with respect to number of dry months (<3, 3-5) at 1200-1600 m elevation.

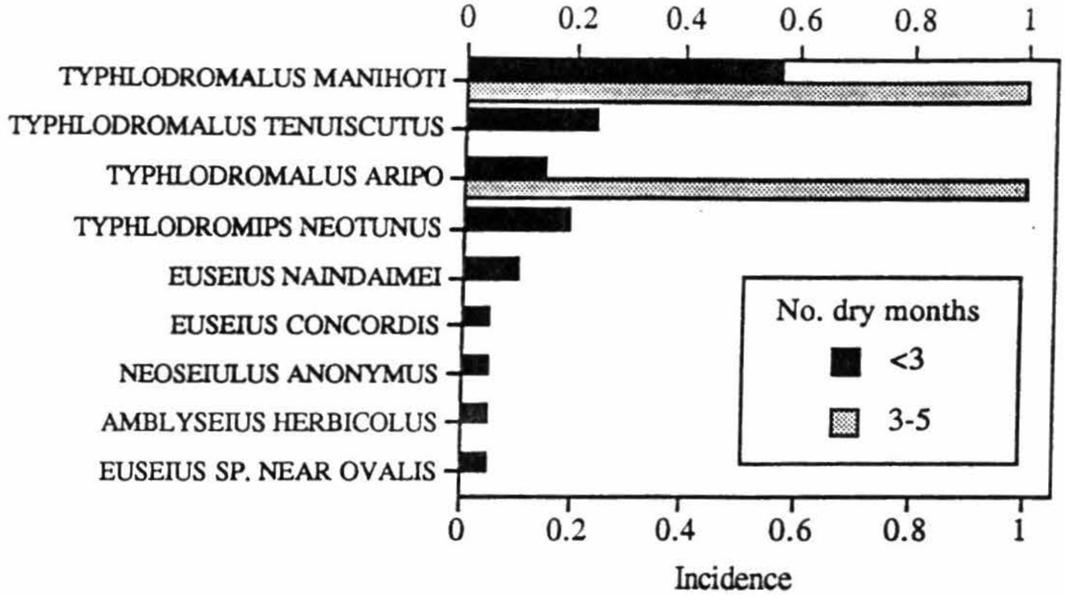

Figure 3.1.6 Incidence of phytoseiids in Colombia with respect to number of dry months (<3, 3-5) at >1600 m elevation.

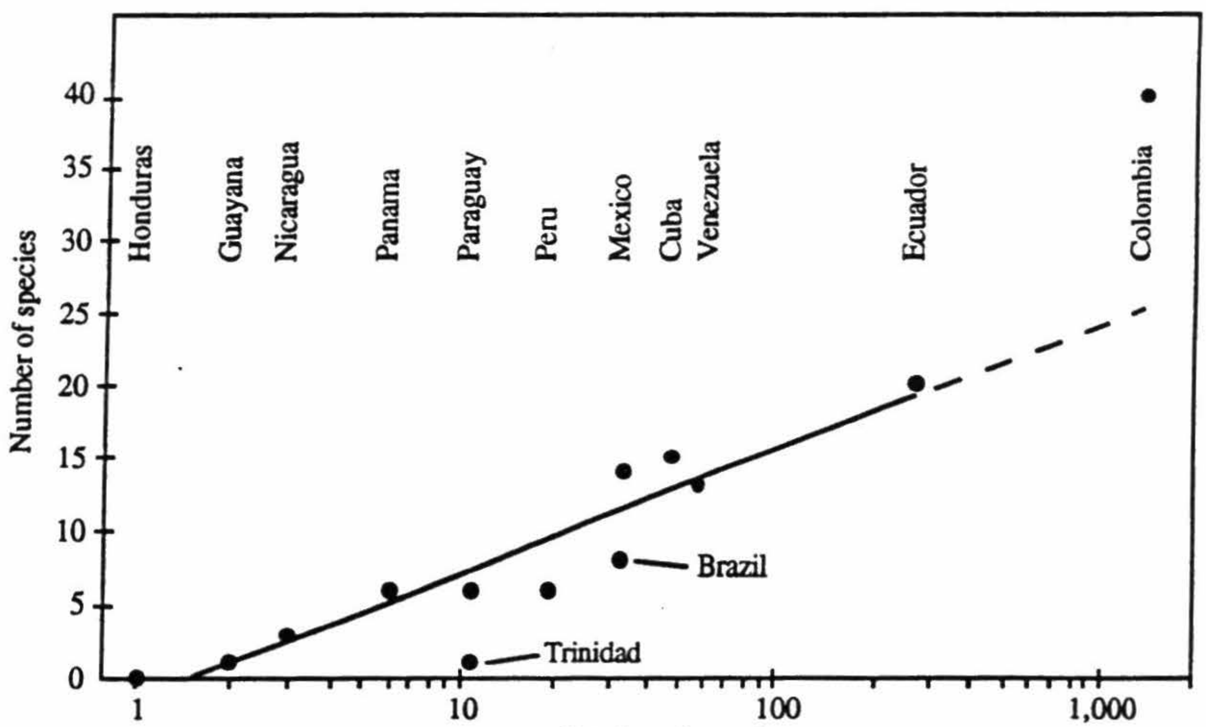

Figure 3.1.7 Relation of number of phytoseiid species collected to sampling effort in Latin America.

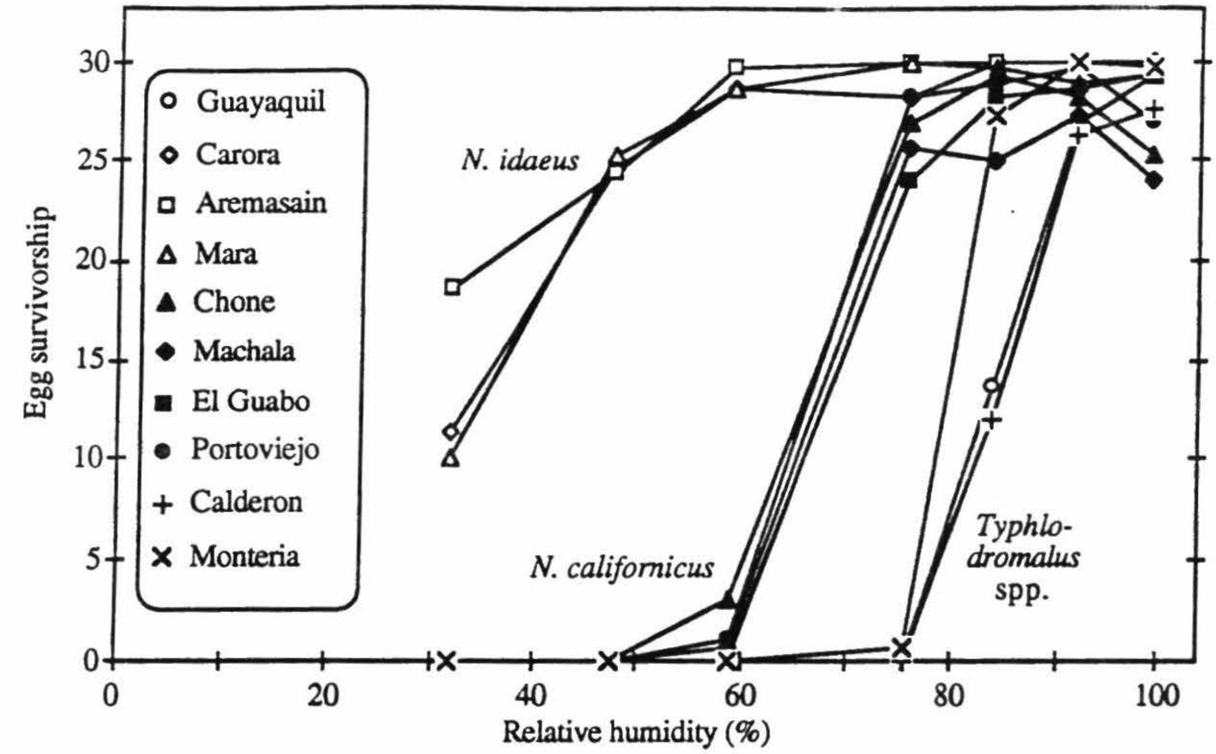

Figure 3.1.8 Effect of relative humidity on survivorship of phytoseiid eggs at 25°C.

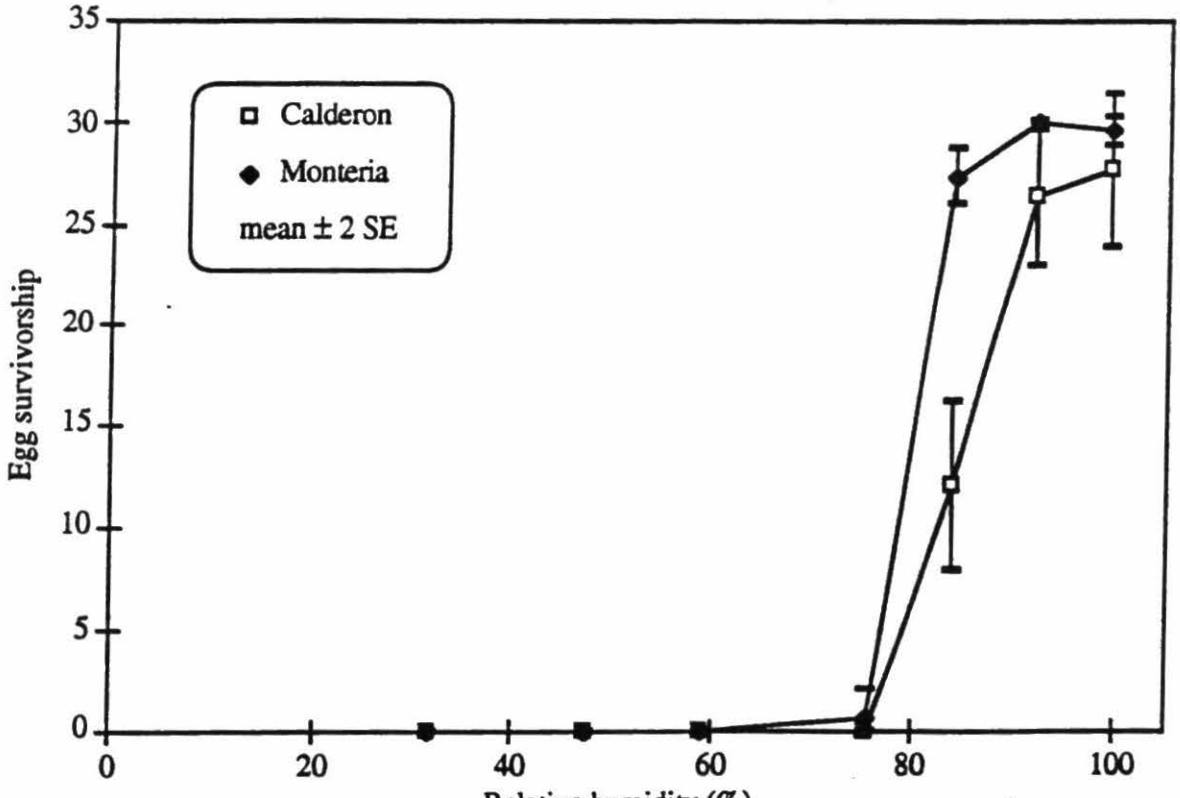

Figure 3.1.9 Effect of relative humidity on egg survivorship of strains of *Typhlodromalus manihoti*.

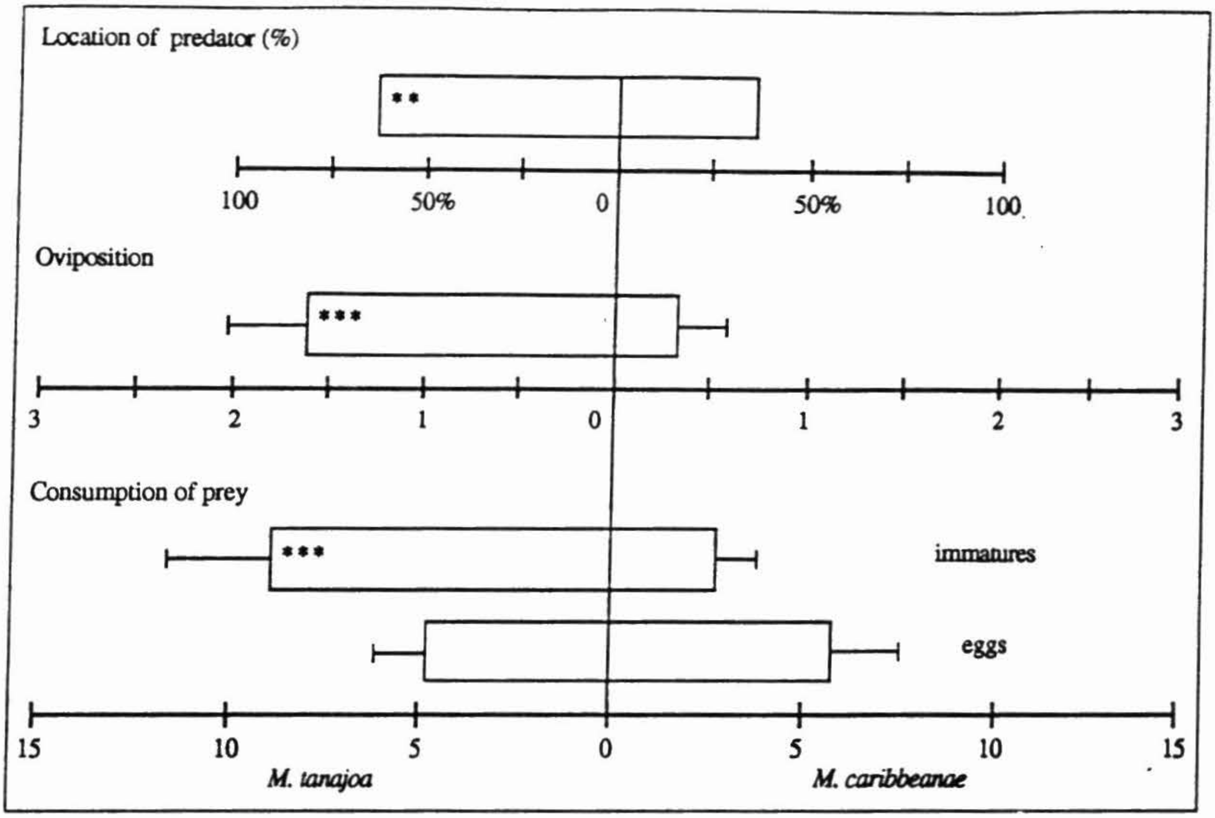

Figure 3.1.10 Preference of *Neoseiulus californicus* for *M. tanajoa* and *M. caribbeanae* (mean ± 95% CI; *, $p < 0.05$; **, $p < 0.01$; ***, $p < 0.001$; chi-square for location, paired *t*-test for others).

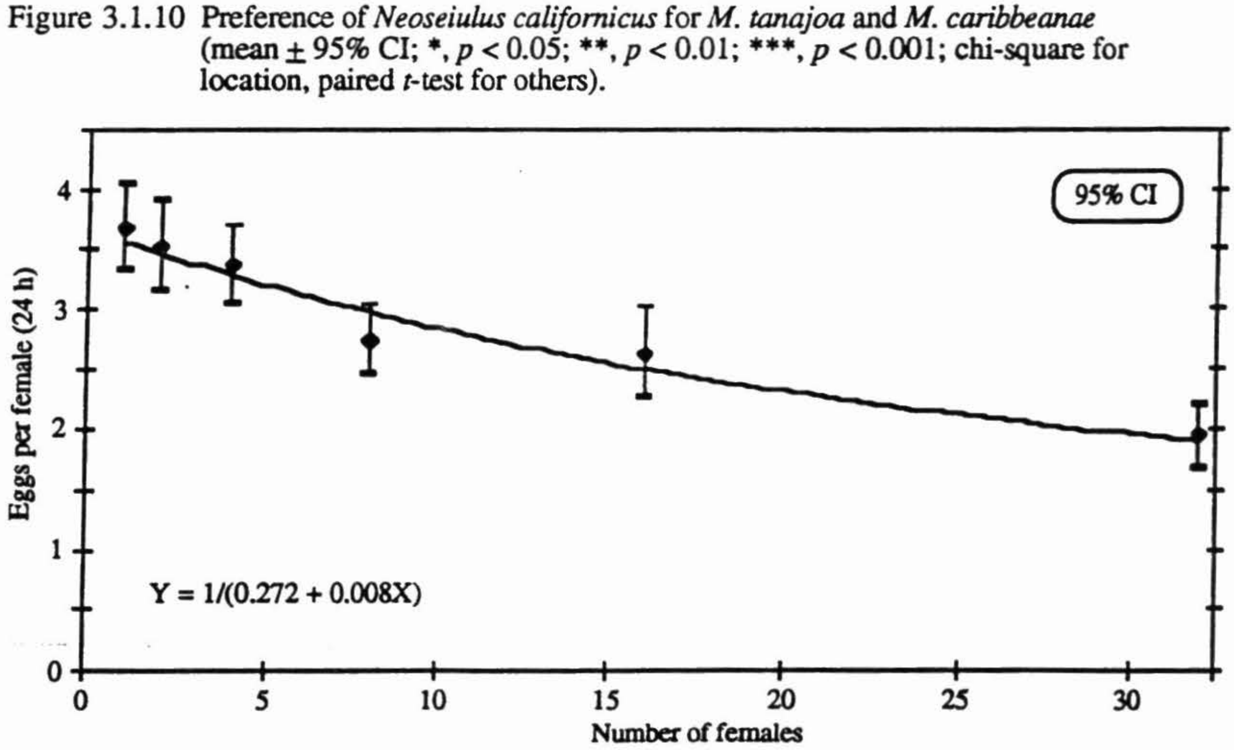

Figure 3.1.11 Effect of crowding adult female *T. tenuiscutus* on fecundity (mean ± 95% CI).

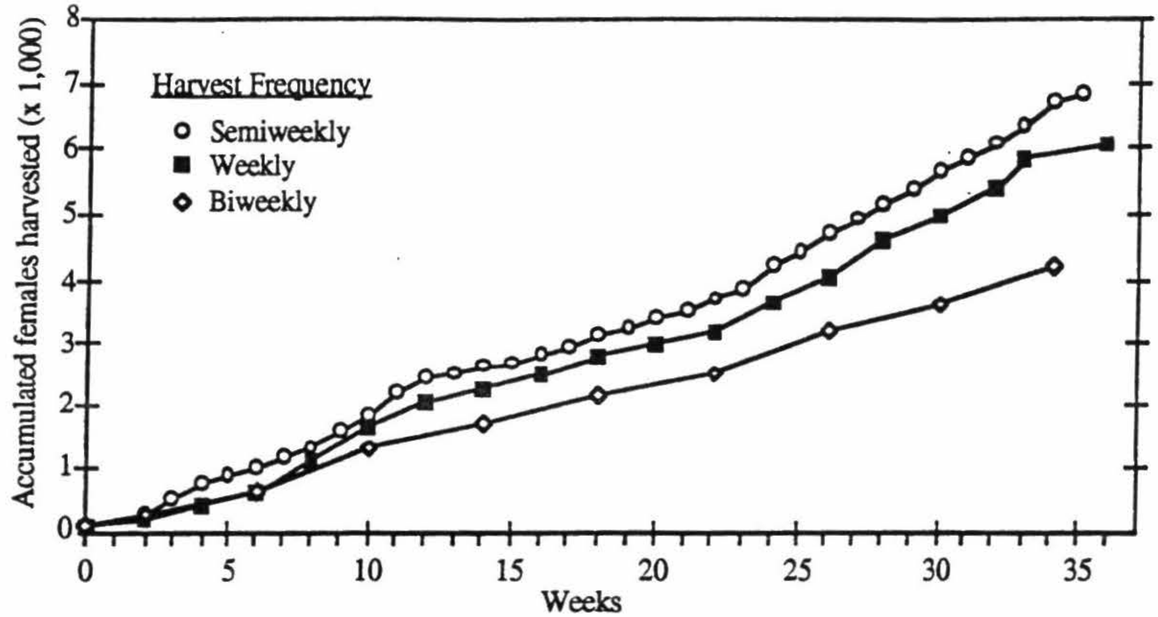

Figure 3.1.12 Effect of harvest interval on production of adult female *Typhlodromalus tenuiscutus* reared on *M. caribbeanae* (average of 20 infested leaves per day).

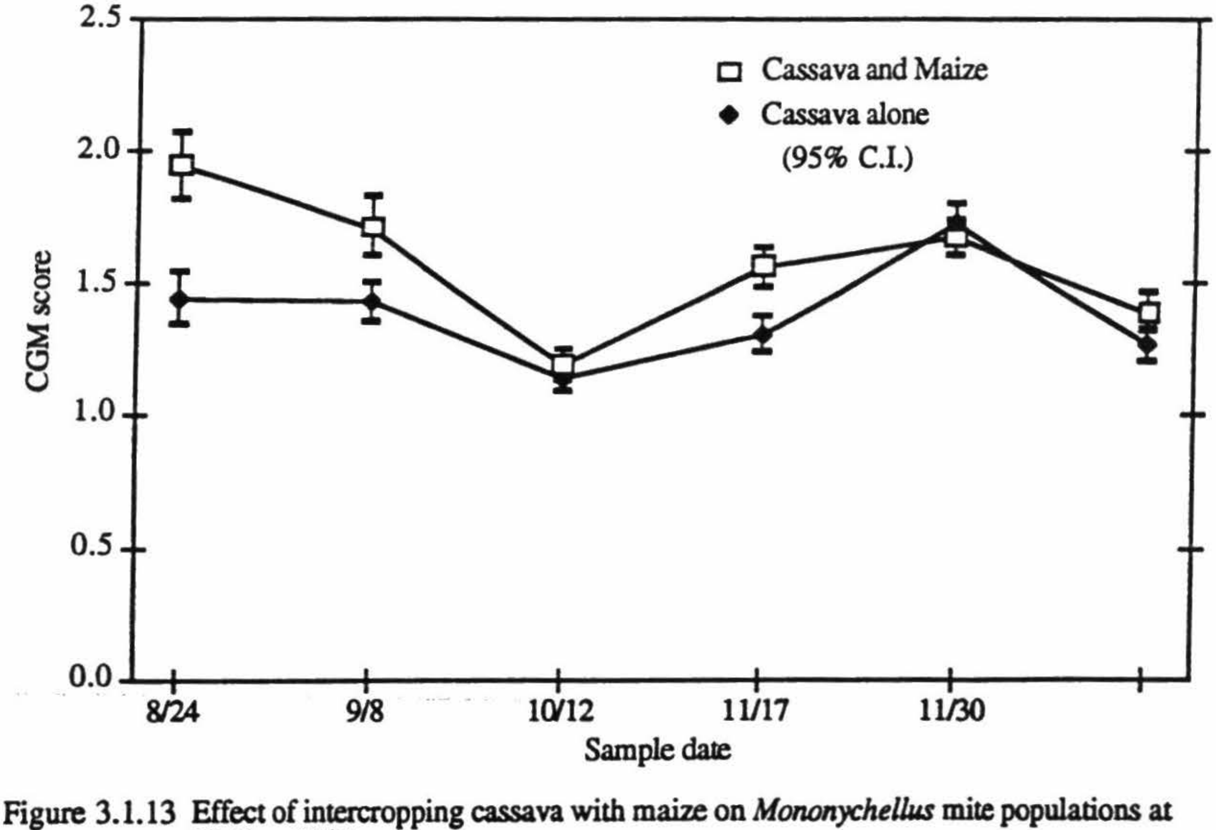

Figure 3.1.13 Effect of intercropping cassava with maize on *Mononychellus* mite populations at Pivijay, 1994.

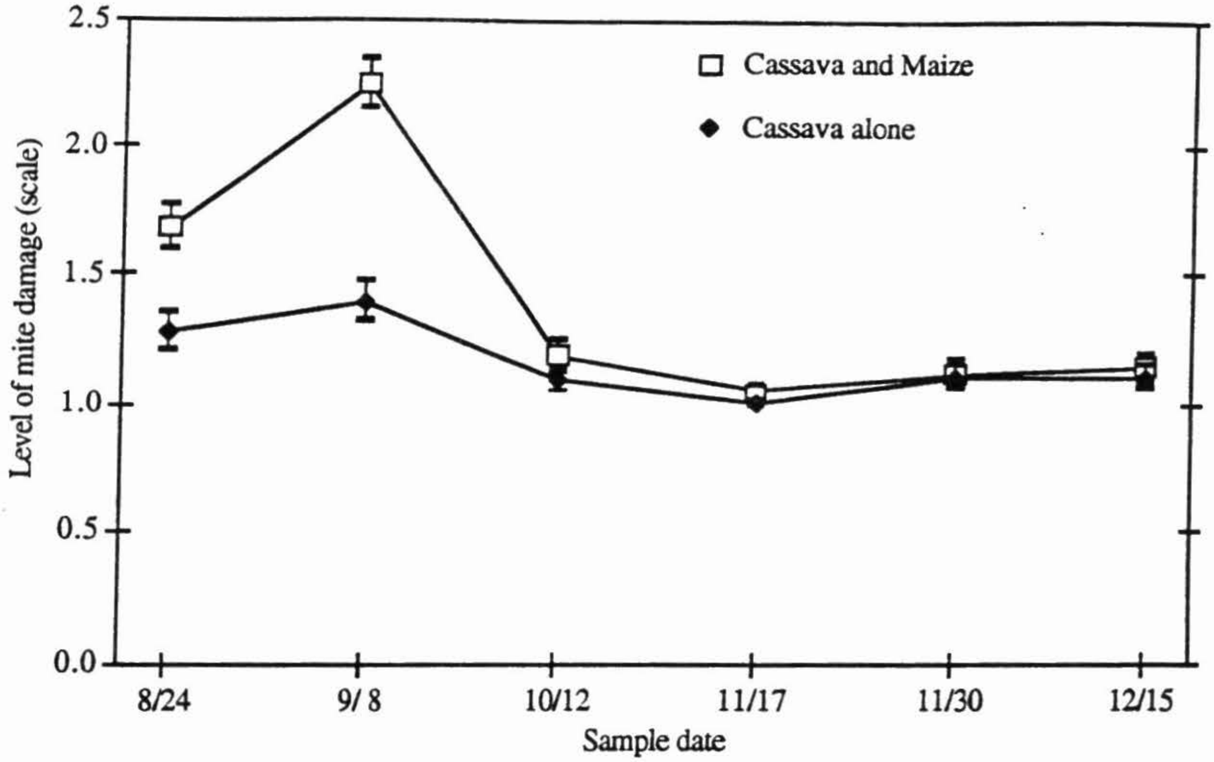

Figure 3.1.14 Effect of intercropping cassava with maize on cassava mite damage. Pivijay, 1994.

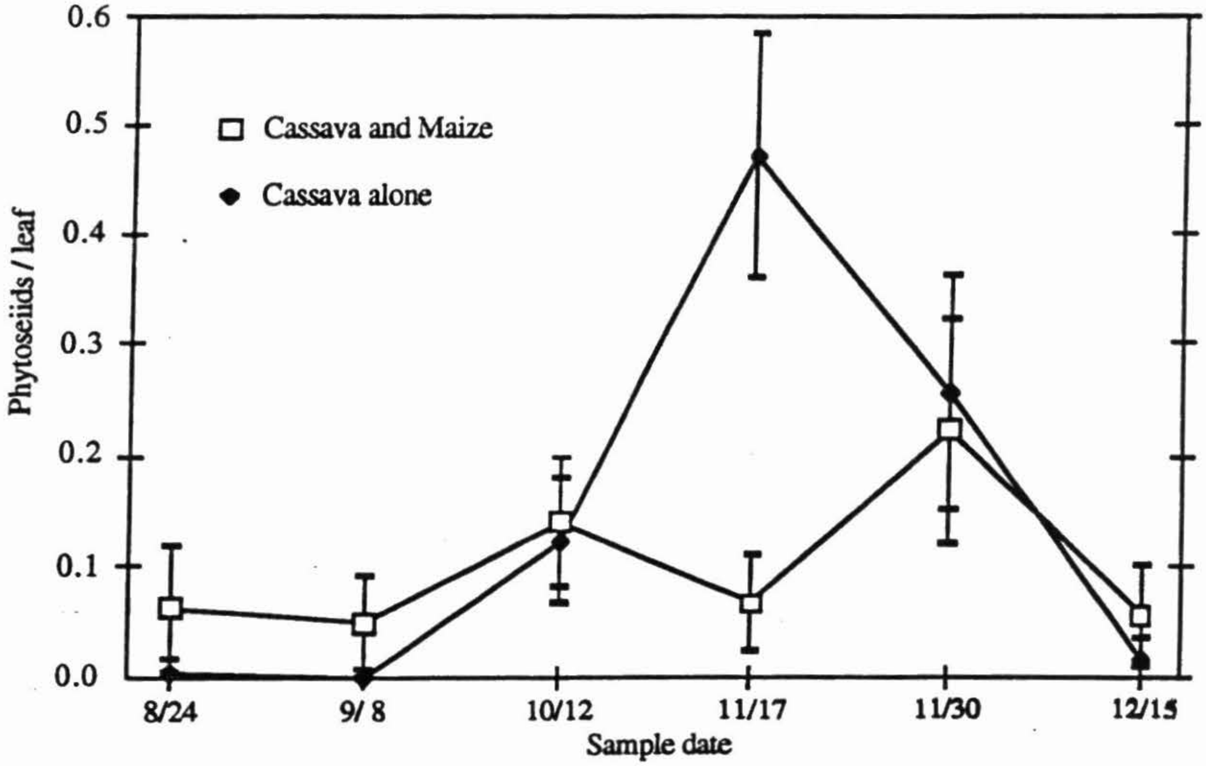

Figure 3.1.15 Phytoseiid populations on mono- and intercropped cassava. Pivijay, 1994.

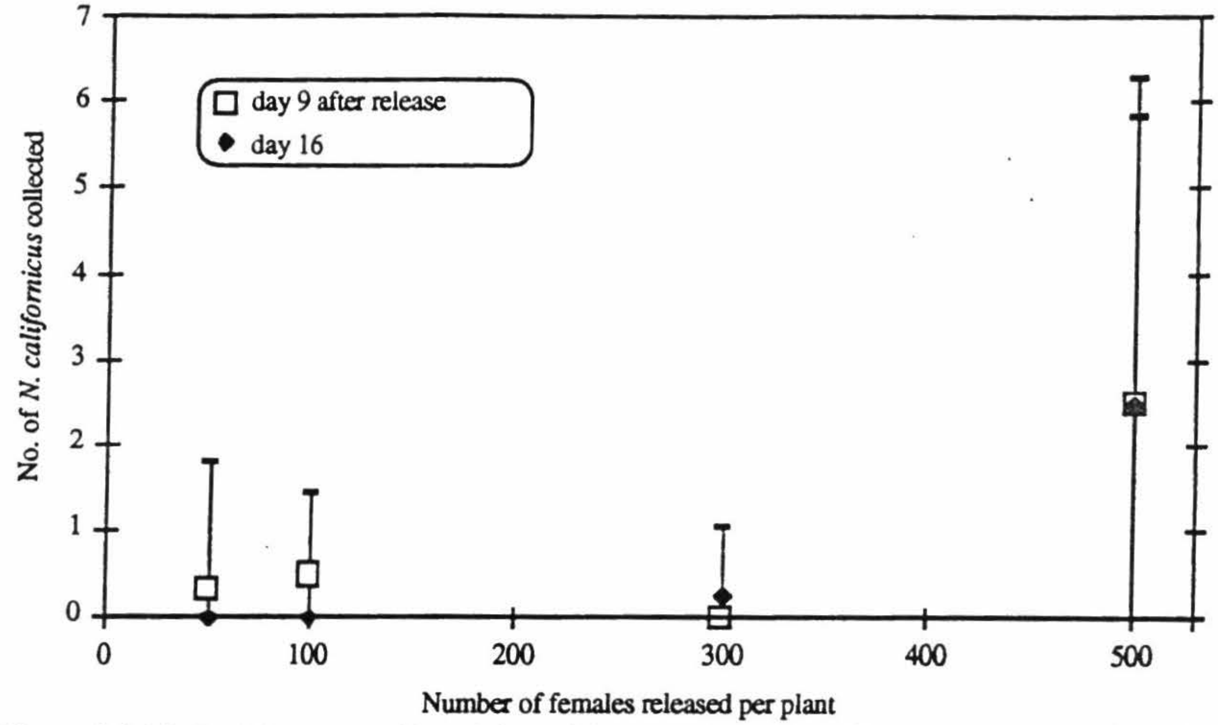

Figure 3.1.16 Establishment of *Neoseiulus californicus* released at different rates on four plants in the center of cassava plots at CIAT.

3.2 Entomology

The Cassava Mealybug: *Phenacoccus herreni*

P. herreni can cause considerable yield loss in seasonally dry ecosystems. High populations are consistently found in areas of northeastern Brazil and the savannas (Llanos) of Venezuela. Adequate host plant resistance to mealybugs has not been found. Emphasis, therefore, is given to biological control, especially the identification and evaluation of hymenopteran parasitoids. Research has concentrated on three parasitoids: *Aenasius vexans, Epidinocarsis diversicornis* and *Acerophagus coccois*. PROFISMA introduced *E. diversicornis* and *A. coccois* into NE Brazil where they have become established. Additional shipments of these species were made during 1995. *A. vexans* was also released in Brazil during 1995. Recent observations indicate that *E. diversicornis* has dispersed more than 100 km from its release site in one year. The efficiency of, and competition between, the three species are being evaluated (see below).

Methods for rearing *P. herreni* and its parasitoids have been developed at CIAT. These methods were transferred to Brazil (CNPMF/EMBRAPA) through the training at CIAT during 1995 of a PROFISMA staff entomologist.

Studies on competition between the three parasitoid species have continued at CIAT in screened cages (40 x 40 x 80 cm) in a greenhouse. One hundred females and 100 males of each species are introduced into a cage containing three cassava plants infested with mealybug nymphs. Infested plants are replaced every eight days. Emerging parasites are counted and returned to the cage daily. This procedure has been maintained for 16 generations.

Results indicated that all three species can co-exist (Fig. 3.2.1); no species was displaced after 16 generations. The greatest fluctuation between generations occurred when the population of *A. coccois* rose to ≈3,500 and fell to ≈500 in the succeeding generation. Large oscillations in populations of *A. coccois* also occurred in previous experiments when only two parasitoid species were evaluated. Such oscillations have not occurred in populations of *A. vexans* and *E. diversicornis*.

A. coccois produced the greatest number of individuals over the 16 generations (Table 3.2.1), significantly higher than the other two species. *A. vexans* averaged higher (but not significantly higher) populations than *E. diversicornis*. These results indicate that all three parasitoids species could co-exist in an ecosystem to control *P. herreni*.

Table 3.2.1 Populations of three parasitoid species (*A. coccois, E. diversicornis* and *A. vexans*) preying on *P. herreni* for 16 generations.

Parasitoid	Number of Individuals				
	Min.	Max.	Total	Mean[1]	Std. dev.
A. coccois	297	4009	30279	1892 a	1116.5
E. diversicornis	2	968	6589	412 bc	300.3
A. vexans	169	1454	9719	607 c	399.5

[1] Means followed by the same letter within the column do not differ ($\alpha = 0.05$, Fisher's Protected LSD)

Chemically Mediated Searching Behavior of Parasitoids

Plants when attacked by insects often release volatiles that attract natural enemies. A study to identify parasite-attracting volatiles in cassava was initiated in 1994 by evaluating the influence of volatiles on searching behavior of *E. diversicornis, A. coccois,* and *A. vexans.*

Females of the three species were tested in a Y-tube olfactometer to see if they respond to cassava plant odors. Plants used as odor sources were infested with mealybugs ovisacs and isolated in nylon cages in the greenhouse. In the control treatment, parasitoids were given a choice between odors from infested plant and wet cotton wool. The three species responded significantly to infested plants (Fig. 3.2.2).

The following tests were subsequently carried out: Control (wet cotton wool) vs. leaves from a noninfested cassava plant (Var. CMC-40); Control vs. mealybug-infested cassava leaves; Healthy vs. infested cassava leaves. Results show that two species, *A.*

vexans and *E. diversicornis* responded significantly to infested leaves (Fig. 3.2.3 and 3.2.4), indicating their ability to distinguish between infested and healthy leaves. *A. vexans* did not differntiate between the control and healthy leaves, but responded positively to infested leaves (Fig. 3.2.3). *E. diversicornis* responded positively to infested leaves and to noninfested leaves when offered with the control in the first test (Fig. 3.2.4). *A. coccois* will be tested later. Additional experiments will attempt to isolate the attractive factor (mealybugs, honeydew, fungus, or plant synomones).

Whiteflies

Whiteflies cause damage to cassava as a result of direct feeding damage and transmission of virus diseases. Until recently, research at CIAT has concentrated on host plant resistance to the predominant species *Aleurotrachellus socialis*. During 1995, considerable attention was given to whitefly species distribution and biological control. Particular emphasis was given to Colombia because previous surveys have indicated a greater diversity of parasitoid species in Colombia.

Three areas of Colombia were evaluated; the Andean Zone (Cauca, Valle del Cauca, Risaralda, Caldas and Quindío), the eastern plains (Llanos) of Caquetá, Meta and Casanare, and the North Coast (Magdalena, Atlántico, Bolívar, Sucre and Córdoba). *A. socialis* and *Bemisia tuberculata* are distributed in the three zones with the highest concentration in the Llanos and the North Coast (Table 3.2.2). *Trialeourodes variabilis*, was not found in the Llanos. Highest populations of *T. variabilis* were recorded in the Andean region, where both *A. socialis* and *B. tuberculata* were found in low numbers. *T. variabilis* was not found feeding on cassava in Venezuela in 1994. *A. socialis* was found in very high populations in the Llanos and the North Coast.

Table 3.2.2 Whitefly populations on cassava in Colombia from 1995 survey.

		Species[1]			
Zone	Department	*A. socialis*	*T. variabilis*	*T. tuberculata*	No. Sites
Andean	Cauca	569	749	31	18
	Valle	31	8	21	2
	Risaralda	1	248	0	4
	Caldas	0	0	0	2
	Quindío	21	4	1	6
Plains	Caquetá	1,482	0	0	3
	Meta	135,642	0	2,865	9
	Casanare	2,572	0	2,823	1
North Coast	Magdalena	31,587	0	795	2
	Atlántico	1,431	24	3,338	1
	Bolívar	1,286	115	302	3
	Sucre	447	103	547	4
	Córdoba	1,795	65	460	4

[1] Total of eggs, nymphs and pupae collected from 15 randomly selected leaves per site.

Natural enemies of the three species were collected in all three zones; the most frequently observed were parasitoids. Cassava leaves containing whitefly pupae were collected from survey sites and brought to CIAT, where three genera of parasitoids were collected; *Encarsia* sp. and *Eretmocerus* sp. (Aphelinidae), and *Amitus* sp. (Platygasteridae). All three taxa were collected from the three whitefly species in the three zones surveyed. In the Andean zone, greatest parasitism occurred on *A. socialis* (Fig. 3.2.5), especially by *Eretmocerus* sp. and *Amitus* sp. In the Llanos, *A. socialis* was also the most parasitized species and the major parasitoids were *Encarsia* sp. and *Eretmocerus* sp (Fig. 3.2.6). This zone also had the highest number of parasites. On the North Coast, *Encarsia* sp and *Eretmocerus* sp were most frequently collected from *A. socialis* (Fig. 3.2.7). Parasitism of *T. variabilis* and *B. tuberculata* was low in all zones.

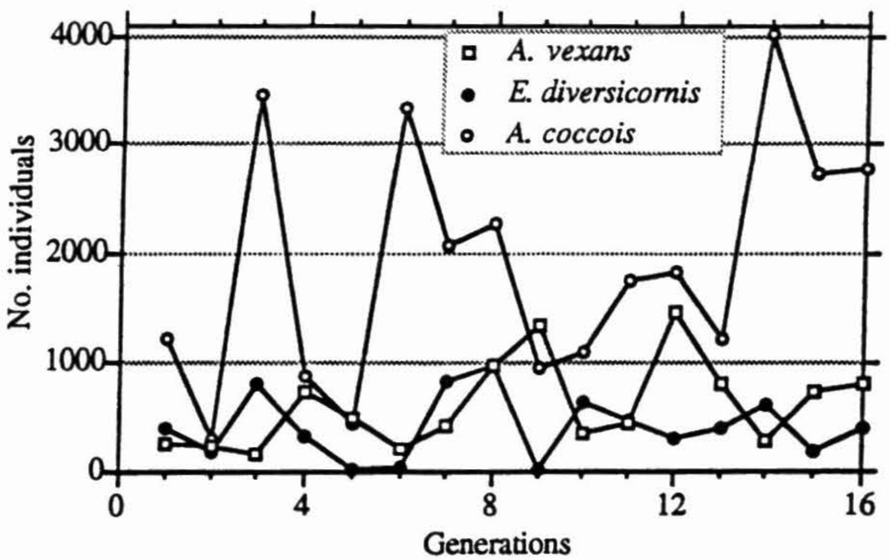

Figure 3.2.1 Populations of three parasitoid species preying in competition on *P. herreni* in cages in the greenhouse.

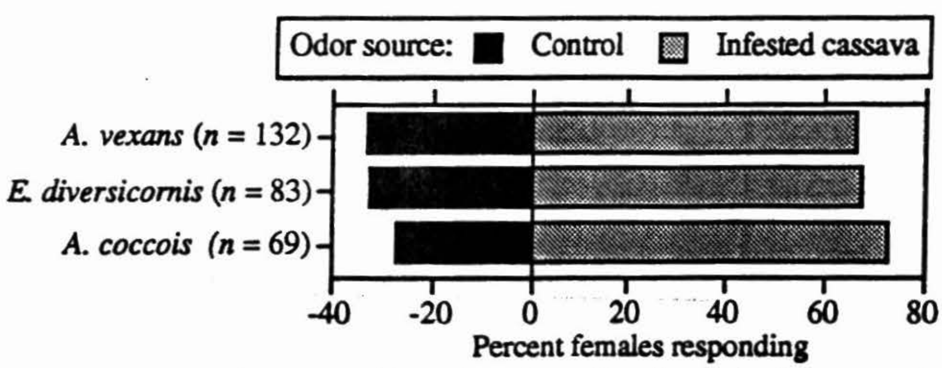

Figure 3.2.2 Response of 3 parasitoid species when offered a choice between odors from mealybug-infested plants and a control. n = number of tested females. Responses of all species to the infested plant odor was significant at $P<0.025$.

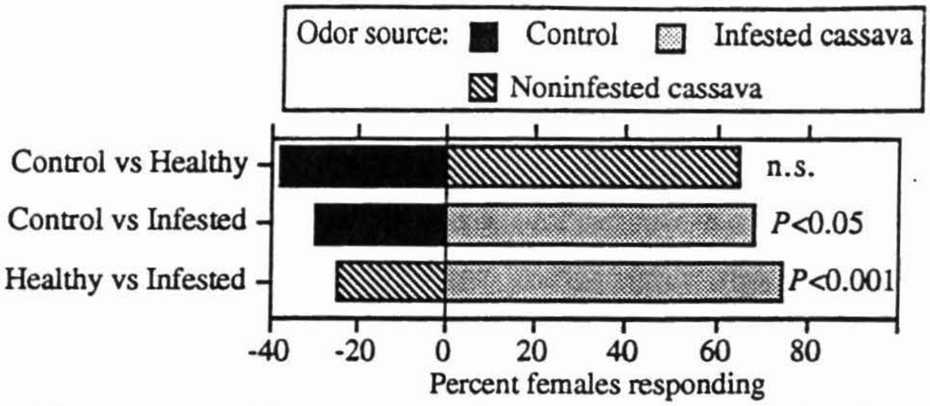

Figure 3.2.3 Response of *A. vexans* when offered a choice between odors from mealybug-infested plants, noninfested plants and a control.. n = 62 females each.

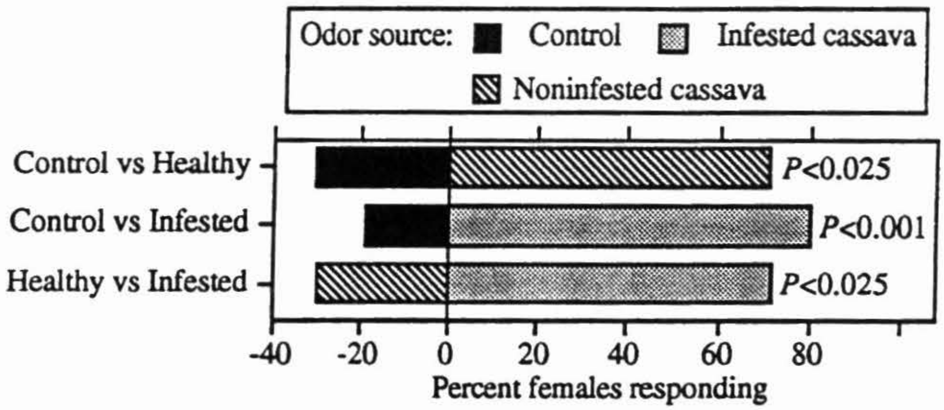

Figure 3.2.4 Response of *E. diversicornis* when offered a choice between odors from mealybug-infested plants, noninfested plants and a control.. n = 54 females each.

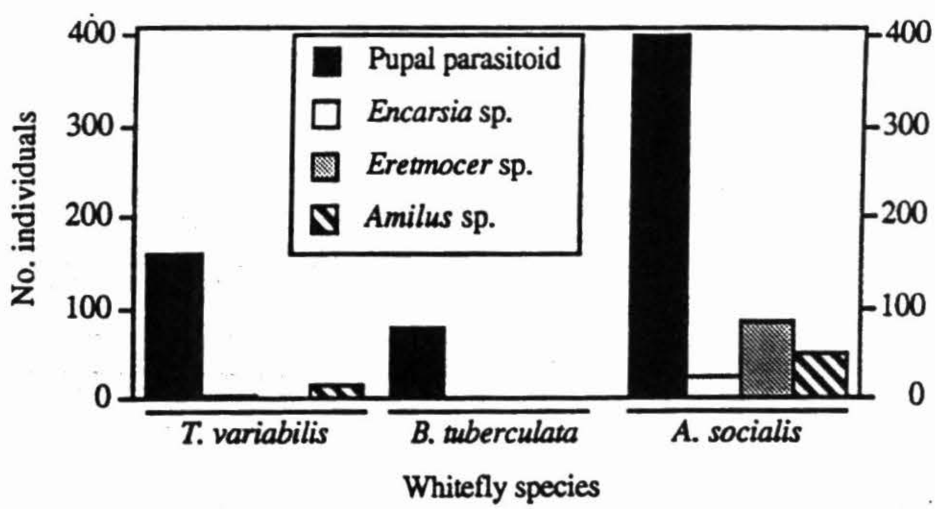

Figure 3.2.5 Parasitoid species collected from whitefly pupae from the Andean Zone of Colombia during 1995.

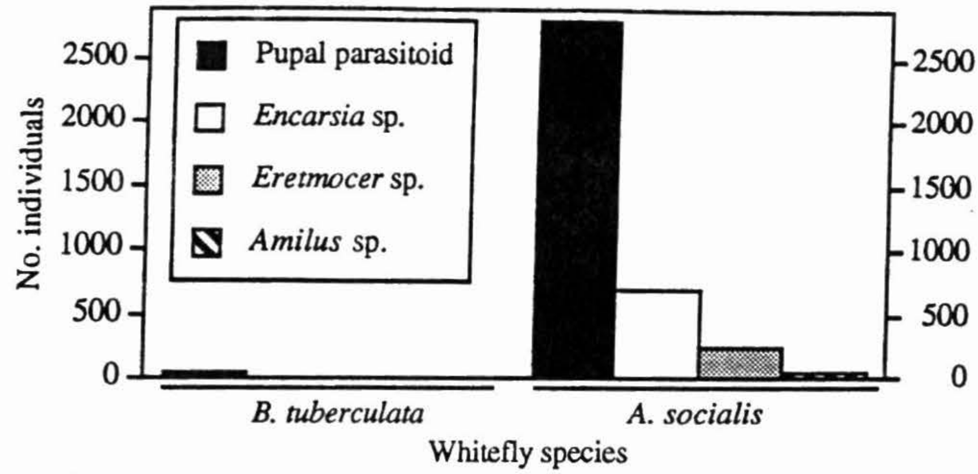

Figure 3.2.6 Parasitoid species collected from whitefly pupae from the Colombian Llanos, 1995.

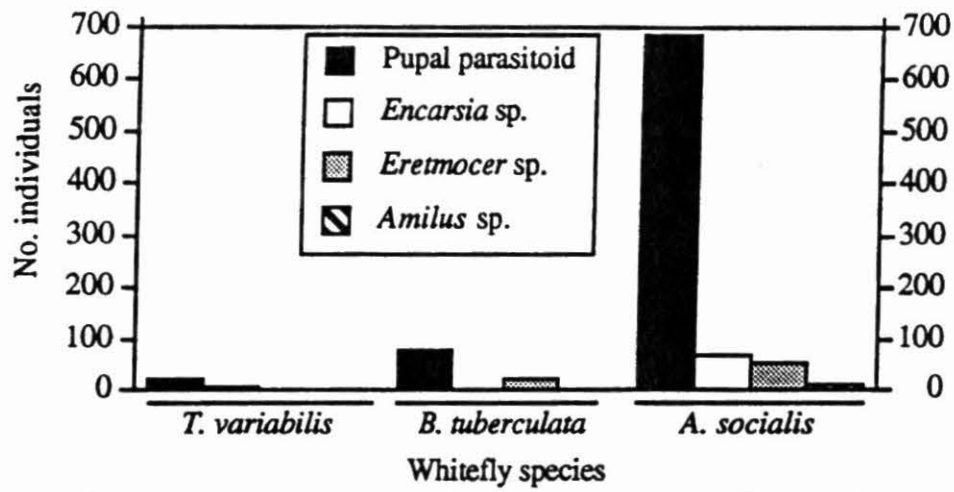

Figure 3.2.7 Parasitoid species collected from whitefly from the Colombia's North Coast, 1995.

3.3 Biological Control of Root Rot Pathogens

In vitro selection of *Trichoderma* strains

Fifty *Trichoderma* strains collected from roots of cassava grown in different edaphoclimatic zones were tested for antagonistic capacity in dual culture with pathogenic strains of *Diplodia manihotis* (strain 47), *Fusarium oxysporum* (strain 64), *F. solani* (strain 8) and *Phytophthora parasitica* (strain 4 in vitro. Nine *D. manihotis* strains, 6 *F. oxysporum* strains, 8 *F. solani* strains, and 13 *P. parasitica* strains were selected to test at the greenhouse. These strains produced zones of inhibition of pathogen development and/or growth of more than 10 mm, and/or colonized mycelia more than 75%. Table 3.3.1 indicates frequency of tested strains per inhibition parameter. Four efficient strains which controlled *P. parasitica* (strain 4) in the greenhouse did not inhibit the pathogen by dual culture in vitro. This confirms the need of selection in the greenhouse or development of another rapid in vitro test. Strong inhibition of *D. manihotis* by strain 14PDA-4 was observed by dual culture and a field experiment.

Selection of *Trichoderma* strains to control *P. parasitica* in pot experiments

Twenty six *Trichoderma* strains were evaluated to control *P. parasitica*. One-month-old rooted sprouts of the susceptible variety MCol 1468 were planted in saturated soil. Soil was inoculated by suspensions of *P. parasitica* and *Trichoderma*. Plants of each treatment were distributed in 4 replications with 8 plants each. Four strains showed significant difference in disease incidence: 121PDA, 47% of plants affected; 26TSM-2, 50%; control with only *P. parasitica*, 66%. In a second trial: strain 15PDA-3, 66%; 47PDA-3A, 72%; and the treatment with only *P. parasitica*, 94%.

Two new screens for *Trichoderma* control of *F. solani* and *P. parasitica*

The system described above was modified to select and to quantify control potential of antagonists to control *F. solani* and *Phytophthora* spp. The most consistent system for evaluation of *Trichoderma* against *Phytophthora* spp. was by soil inoculation of rooted 2-budded stem cuttings of variety MBra 12, planted horizontally. By removing leaves before inoculation more uniform results were obtained. Rooted sprouts maintained in deionized water with suspensions of *F. solani* was the second most efficient and rapid selection method (Table 3.3.2). No symptom development was observed when this screen was used for the pathogens *D. manihotis* and *F. oxysporum*.

Table 3.3.1 In vitro selection of 50 *Trichoderma* strains by dual culture.

	Target pathogen[1]			
Antagonistic reaction	*D. manihotis* (strain 47)	*F. oxysporum* (strain 64)	*F. solani* (strain 8)	*P. parasitica* (strain 4)
Inhibition by production of toxic compounds	44	23	37	6
Colonization of mycelia	36	10	0	42
Both inhibition &colonization.	35	2	0	6

[1] **Number of *Trichoderma* strains showing antagonistic reactions.**

Farm research in a root rot endemic region in Colombia

Cassava farmers were visited to assess the potential of introduction of biological control agents in Maria La Baja (Bolívar), a region of endemic root rot. According to 58% of the farmers, economic losses were experienced due to root rots. Drainage and weed control were practiced by 58% and 70%. Other recommended practices (early harvest, planting on ridges, crop rotation and chemical stake treatment) were scarcely mentioned. Lack of technical assistance and labor were cited as main limitations to these practices. Most of the farmers have water of acceptable quality (77%) and oil-drums (33%) for stake treatment in a suspension with a biocontrol agent; 62% have sprayers to inoculate in the field. Continued emphasis will be given to development of economically feasible delivery methods.

Table 3.3.2 Effect of 5 inoculation systems on 4 susceptible cassava varieties to select optimal system for screening of biocontrol agents to control root rot diseases.

Inoculation system[1]	Disease Incidence[2]			
	CM 523-7	CM 3306-4	M Bra 12	M Col 1468
A	100	100	100	100
B	75	0	25	0
C	51	7	75	29
D	100	100	100	100
E	100	100	100	100

1 Inoculum consisted of zoospores, sporangia and mycelia. Method A (wound method), plants propagated by 2-budded stems of 2 months. Placing 3 x 5 mm colonized culture medium on cut stem lesion of 5 mm, covered by paraffine. After inoculation plants were maintained 3 days with air humidity of 90-100%. Other methods: Inoculum delivered by soil application, soil was maintained permanently saturated by water: B, plants with foliage; C, without foliage. Aggregation of inoculum to rooting medium (deionized water) permanently using: D, unrooted; E, rooted sprouts.

2 Percent plants presenting necrosis of sprouts and/or roots.

Efficiency of 4 types of inocula to establish *Trichoderma* in soil

In a greenhouse, inocula prepared with *Trichoderma* strain 14PDA-4 were analyzed 35 days after application in soil. Strain 14PDA-4 was selected because of its efficiency in controlling *D. manihotis* in the field. The following inocula were prepared: colonized filter paper, suspension of colonized filter paper in water, colonized sorghum seeds, and sodium alginate pellets. To simulate conditions in a root rot endemic region, sterilized soil from Maria La Baja was used. Inocula were stored for 4 weeks at 27°C; 0.5 ml (5 l/ha) inoculum per stake (MCol 1505) was applied to the soil before planting; soil was kept saturated with water. High concentrations of *Trichoderma* were achieved in the soil by suspension and sorghum seeds (both 1.1×10^5 colony forming units per g soil). Other treatments were not different from the control ($P>0.01$, LSD).

Colonization of cassava by *Trichoderma*

Gliocladium spp., an endophytic fungus closely related to *Trichoderma*, is known to survive in plant-tissue. It is not known if *Trichoderma* is capable of colonizing cassava and inducing resistance to pathogens. If possible, infected planting material would be an appropriate delivery system biological control of root rots.

Fifty-one cassava varieties from 11 sites were collected in root and stem rot endemic regions in Colombia. Three strains were isolated from stem tissue from plants from CIAT Palmira and Cauca. Stakes from Maria La Baja did not contain *Trichoderma*. Isolates will be tested for plant colonization capacity and disease control potential.

To identify isolates effective in colonization of cassava tissue and control of *Phytophthora*, 1 month old rooted plantlets of MCol 1468 were planted in soil inoculated with suspensions of 26 *Trichoderma* strains and *P. parasitica* strain 4. Treatments consisted of application of a *Trichoderma* strain and a pathogen. Controls included a treatment without applications and one with only *P. parasitica*. Thirty-one days after inoculation, healthy plants were collected and presence of *Trichoderma* was assayed on semi-specific *Trichoderma* medium. There was high variability between strains with regards to presence of *Trichoderma* in plant tissue (Table 3.3.3). There was no correlation between *Trichoderma* presence in plant-tissue and control efficiency. High colonization rates by several strains of *Trichoderma* indicate potential for establishing systemic infection. Experiments are planned to identify highly efficient strains for control and capacity for colonization of roots and stems.

Table 3.3.3 Presence of *Trichoderma* spp. in symptom-less rooted sprouts 31 days after soil inoculation with biomass suspension of *Trichoderma* and *P. parasitica*.

Strain	Colonization rate[1]		No. plants analyzed	Disease incidence[2]
	Stem	Root		
14PDA-4	83	50	6	66 c
121PDA	25	38	4	47 b
41TSM-4	0	0	6	63 c
P. parasitica	17	0	3	66 c
Control	23	0	11	0 a

[1] Percent plant fragments with *Trichoderma*.

[2] Percent plants with stem necrosis (4 replications per treatment; 8 plants per replication). Means followed by same letter do not differ ($\alpha = 0.01$, DMRT).

Inoculation methods

Significant differences were found in effect of concentration of conidia of strain 14PDA-4 on presence of *Trichoderma* in plant tissue of MCol 1468 and MCol 1505, 3 weeks after immersion of 10-cm stakes. A concentration of 1 x 10^7 conidia/ml resulted in 17% (MCol 1468) and 25% (MCol 1505) colonization of examined fragments of stake tissue. Immersion time did not significantly influence colonization. Immersion of roots of MCol 1505 and soil application of conidia (strains 121PDA and 14PDA-4) resulted in the highest

colonization level, 29 and 24%, respectively, of 5 methods tested.

Genetic characterization of root rot pathogens from Colombia, Brazil, and Ecuador

There is no information on genetic diversity and population structure of root rot pathogens. Understanding genetic variability of the pathogens and their hosts is necessary to develop an effective approach to disease management. This research will study the genetic variation of root rot pathogens in terms of virulence and DNA polymorphism to determine correlation between genetic heterogenicity and geographical origin of the strains, and between virulence types and molecular phenotypes. A collection of strains including 76 *Fusarium* spp., 11 *Phytophthora* spp. and 51 *Diplodia* spp. strains has been formed. Forty percent of these strains were compared in pathogenicity tests. Symptoms caused by individual strains were similar although severity differed between strains. Pathogenicity of these strains was determined by wounding cassava stem cuttings (Tables 3.3.4 - 3.3.6).

Characterization of strains is an ongoing activity using PCR amplification of the Internal Transcribed Spacer (ITS) and Nuclear Small (NS) regions of rDNA. PCR analysis using the ITS and NS region of the rDNA clearly distinguished between strains of *Fusarium* spp. and *Phytophthora* spp.

Methods were tested for differentiation of strains, including morphology, growth rate, and site directed polymerase chain reaction (PCR). The majority of strains were not clearly differentiated on PDA by colony type. Pigment production by colonies was inconsistent and strains could not be adequately typed using this system. Strains have been amplified and will be restricted to separate species. RAPD analysis will be performed to distinguish strains within species.

Studies of bacterial roles in root rot disease

Initial experiments have been conducted to determine if bacterial pathogens are involved in cassava root rots. Due to negative isolation of fungal pathogens from soil samples obtained from the North Coast of Colombia, four inoculation systems were used with 15 bacterial strains and 2 cassava varieties. Detailed experiments are ongoing.

Screening methods to evaluate resistance to *Phytophthora* root rot

Five greenhouse inoculation systems were compared to identify a method for detecting resistance sources to root rots. Susceptible varieties CM523-7, CM3306-4, MBra 12 and MCol 1468 were inoculated with a strain of *P. parasitica* (strain 4). Aggressive necrosis development occurred with all inoculation methods. The wound inoculation method gave best results. Comparison of results with field inoculations are underway.

Table 3.3.4 Pathogenicity of *Fusarium solani* strains inoculated on 4 cassava cultivars.

Strain and collection site	Pathogenicity[1]			
	CG1-37	MCol 2215	MCol 1505	MVen 77
#1 Maria la Baja (North Coast)	S	S	R	R
#2 Maria la Baja (North Coast)	S	R	I	I
#7 Carimagua (Llanos)	I	I	I	I
#8 Carimagua (Llanos)	S	I	S	I
#11 Media Luna (North Coast)	S	I	I	R
#13 Pivijay (North Coast)	I	I	I	R
#3 Maria la Baja (North Coast)	I	I	I	I
#12 Pivijay (North Coast)	I	S	I	S
#14 Santander de Quilichao (Cauca)	S	S	I	I
#9 Carimagua (Llanos)	I	R	I	R

[1] R (low): necrosis 5-10 mm; I (intermediate): necrosis 10-15 mm; S (high): necrosis >15 mm.

Table 3.3.5 Pathogenicity of *Fusarium oxysporum* strains inoculated on 4 cassava cultivars.

Strain and collection site	Pathogenicity[1]			
	CG1-37	MCol 2215	MCol 1505	MCol 2063
#22 Calarcá (Quindio)	S	I	R	R
#64 Pescador Cauca	I	R	I	R
#57 Maria la Baja (North Coast)	S	R	R	R
#58 Maria la Baja (North Coast)	I	I	I	I
#54 Maria la Baja (North Coast)	I	I	I	R
#35 Carimagua (Llanos)	S	I	R	R
#18 Pivijay (North Coast)	S	I	I	R
#34 Carimagua (Llanos)	S	R	R	I
#62 Maria La Baja (North Coast)	I	R	I	I
#25 Alcalá (Valle)	I	I	R	R
#50 Maria la Baja (North Coast)	S	I	I	R
#56 Maria la Baja (North Coast)	S	S	I	R

[1] R (low): necrosis 5-10 mm; I (intermediate): necrosis 10-15 mm; S (high): necrosis >15 mm.

Table 3.3.6 Pathogenicity of *Diplodia manihotis* strains inoculated on 4 cassava cultivars.

Strain and collection site	Pathogenicity[1]			
	MCol 1684	MCol 2057	M Mal 2	CM 523-7
#1 North Coast	I	I	R	I
#2 CIAT-Palmira	I	I	S	I
#3 Brasil	I	R	I	R
#4 Brasil	S	I	I	I
#5 Ecuador	I	I	I	S
#6 CIAT-Palmira	S	I	I	I
#7 North Coast	S	S	I	S
#8 North Coast	S	I	S	S
#9 North Coast	S	I	I	S
#11 North Coast	I	I	I	I
#13 North Coast	S	I	S	R
#14 North Coast	S	S	I	I

[1] R (low): necrosis 5-10 mm; I (intermediate): necrosis 10-15 mm; S (high): necrosis >15 mm.

3.4 Characterization of Cassava Vein Mosaic Virus

Since CVMV is not present in Colombia, the work at the VRU has been done using non-infectious cDNA clones of the virus. The primary molecular characterization of CVMV was completed and the article describing the virus was published during 1995. CVMV had been tentatively classified as a caulimovirus, but these studies have determined that CVMV is a unique plant pararetrovirus distinct from the caulimoviruses.

Analysis of variation of cassava vein mosaic virus

Five sets of oligonucleotides were developed for detection and amplification of approximately half the genome using PCR. Investigations using PCR were continued to determine the degree of variation within CVMV isolates in northeastern Brazil.

Parts of four isolates of CVMV were amplified using PCR, cloned and sequenced. Isolates were from Fortaleza (Ceará), Araripina and Petrolina (Pernambuco), and Piritiba (Bahia). Including the original cDNA clone of CVMV, five isolates of CVMV were compared. This analysis of variation will be finished in 1996.

Approximately 1200 nucleotides from the Petrolina isolate were obtained, and these were compared with the type isolate. Homology at both nucleic and amino acid level was 95%. Approximately 500 nucleotides of the Araripina isolate was compared to the type isolate and the Petrolina isolate. Isolates were approximately 95% identical.

These results indicate isolates are closely related within the state of Pernambuco. The PCR primers have amplified every isolate of CVMV that has been collected. These two measures of isolate homology makes it probable that although the virus is spread over a wide geographical area, there is little pathogen diversity. It also demonstrates the effectiveness of the PCR assay as a method of detection of CVMV.

Characterization of a defective cassava common mosaic virus RNA species

The presence of a defective cassava common mosaic virus (CsCMV) RNA species has been detected in total RNA extractions and purified preparations of the virus of the Brazilian and Paraguayan isolates. There was a possibility that some of the RNA detected was a subgenomic species of RNA that encodes for the coat protein. The subgenomic coat protein species reported for other potexviruses are about 800-900 nucleotides in lengths. The defective RNA species is just over 100 nucleotides. Experiments clearly demonstrated that the subgenomic RNA was present in all three isolates. The defective RNA did not appear to be present in the Colombian isolate. The defective RNA species was in high concentrations in both the Paraguayan and Brazilian isolates. In the Brazilian isolate, the genomic CsCMV-RNA was in low concentration. Presence of the defective RNA species did not appear to affect the concentration of the Paraguayan isolate. In both isolates, the concentration of the defective RNA species was much higher than genomic CsCMV RNA.

There is some evidence that the defective RNA species interfers with synthesis of genomic CCMV RNA. It is possible that this defective RNA species could be a natural control agent to mitigate the effects of the virus.

3.5 CROP MANAGEMENT

Effect of surface mulch, tillage and fertilizer on cassava productivity

Data on yield, root dry matter content and total hydrogen cyanide (HCN) in root parenchyma as affected by tillage, mineral fertilizer and surface mulch was collected over a 7-year period at Media Luna, Magdalena Department, North Coast of Colombia (Table 3.5.1). Average root yield was significantly increased by application of fertilizer at moderate rates of 50, 22 and 42 kg ha^{-1} of each N, P and K. Without fertilizer application, root yield was doubled by annual application of surface mulch at the rate of 12 t ha^{-1}. The beneficial effect of mulch was mainly due to partial alleviation of water stress as well as improvement in soil fertility (CIAT Cassava Annual Report, 1994). In these sandy soils with very low level of organic matter and nutrients, cassava productivity can be sustained either by chemical fertilization and/or by application of crop residues as mulch. Mulch application also affected root quality in terms of dry matter content. Irrespective of tillage treatment and fertilizer application, root dry matter was enhanced by surface mulch. Moreover, total HCN in root parenchyma was significantly lower under mulch and in absence of chemical fertilizer.

Effect of mulch and intercropping with *Chamaecrista rotundifolia* on cassava productivity

Data on root yield, top and total biomass of the recently released cassava cultivar, ICA Negrita (CM 3306-4) was collected as affected by fertilizer, mulch and intercropping with the forage legume *C. rotundifolia* (CIAT 8990) (Table 3.5.2). The trial was established toward the end of the rainy season in October 1994. Irrespective of the limited rainfall, *C. rotundifolia* was successfully established and by the end of the growing season total dry matter productivity ranged between 8 to 13 t ha^{-1}, with the highest productivity occurring with soil cultivation. This forage legume species was selected because of its low competitiveness with cassava under subhumid conditions (CIAT Cassava Annual Report, 1994). However, under the edaphoclimatic conditions at Media Luna (sandy soils and 5 month dry season) it showed a high degree of competitiveness with cassava as indicated by large reductions in cassava root yield and total biomass (Table 3.5.2). Reduction in cassava productivity due to association with *Chamaecrista* was pronounced with and without application of chemical fertilizer. This suggests that under drier conditions in sandy soils, association with this legume as a live soil cover can depress cassava yield. Different management practices (e.g., frequent cuttings, strip sowing, mulching) should be tested in association with cassava to assess its potential use as ground cover.

Long-term response of cassava to NPK fertilizer in infertile soil

Data on the long-term response (12th year) to NPK fertilizer was collected in infertile, acidic soils at Quilichao Station (Valle de Cauca, Colombia) (Table 3.5.3). In both cultivars, lack of application of NPK fertilizer resulted in large reductions in dry root yield. The most limiting nutrient was K as indicated by very low yields in absence of K fertilizer when the two other nutrients (N and P) were supplied. In these soils, continuous cassava cultivation will deplete native K through its removal with the root harvest (> 60% of K is in the storage roots). K-fertilizer must be supplied to sustain cassava productivity. Responses to N and P were less pronounced than response to K in both cultivars. The same trend was observed with root dry matter content.

Table 3.5.1 Dry root yield (t ha^{-1}), root dry matter (%) and total HCN content (ppm) (MCol 1505). Media Luna, Magdalena. Values are means of 7 yrs (1988-95).

Treatment	Fertilized[1,3]			Unfertilized[3]		
	Dry root	Root dry matter	HCN	Dry root	Root dry matter	HCN
Conventional tillage	5.69 a	29.7 b	158 a	2.32 b	29.8 ba	227 a
Conv. tillage + Mulch[2]	5.92 a	30.8 a	146 a	4.68 a	30.4 a	149 b
Zero tillage	4.58 b	29.3 b	150 a	2.01 b	28.9 b	224 a
Zero tillage + Mulch	6.01 a	30.8 a	140 a	4.62 a	30.1 a	158 b

[1]330 kg ha^{-1} kg ha^{-1} 15:15:15 NPK (50 N; 21.6 P; 41.7 K kg ha^{-1}). [2] Mulch, 12 t ha^{-1} dry grasses applied annually. [3] Means followed by the same letters do not differ ($\alpha = 0.05$).

Table 3.5.2 Dry root yield, top dry and total biomass in root (CM 3306-4, ICA Negrita) at Media Luna, Magdalena. Season 1994-1995 (first cycle).

Treatment	Fertilized[1,3]			Unfertilized		
	Dry weight (t ha^{-1})					
	Roots	Tops	Biomass	Roots	Tops	Biomass
Cassava only	5.7	11.3	17.0	4.3	8.2	12.5
Cassava + *Chamaecrista* [2]	3.3	3.9	7.2	2.6	4.4	7.0
Cassava + mulch grasses [3]	5.4	9.2	14.6	4.7	7.2	11.9
LSD 5%	1.4	3.5	4.6	1.1	2.1	2.5
Chamaecrista + cassava			8.0			8.1
Chamaecrista only			12.5			9.5
LSD 5%			6.1			2.0

[1]330 kg ha^{-1} 15:15:15 NPK. [2]*C. rotundifolia* CIAT 8990. [3]Guinea grass, *Panicum maximum* (12 t ha^{-1} dry)

Table 3.5.3 Effect of NPK on dry root yield (t ha^{-1}) and root dry matter (%). 1994-1995 season (12th year). Santander de Quilichao.

Fertilizer treatment (kg ha^{-1})			MCol 1684		CM 91-3	
			Dry root	Root dry matter	Dry root	Root dry matter
N	P	K				
0	0	0	2.9	34.0	2.1	37.8
50	50	50	8.0	37.0	2.9	38.8
0	100	100	7.9	38.4	4.7	39.5
50	100	100	8.5	37.5	5.3	40.3
100	100	100	8.4	38.0	4.7	38.6
100	0	100	6.1	37.1	4.7	39.4
100	50	100	9.1	38.6	4.3	40.3
100	100	0	2.9	28.0	1.7	34.2
100	100	50	7.8	36.8	4.3	39.6
LSD 5%			1.7	2.5	1.2	2.9

4 STRATEGIC RESEARCH AT EMBRAPA/CNPMF, BRAZIL

4.1 Biological Control of the Cassava Green Mite in Northeastern Brazil

Introduction, rearing, release and monitoring of phytoseiid mites.

During 1995, colonies of *Neoseiulus californicus* were introduced from CIAT and passed quarantine at the Costa Lima Quartantine Laboratory, EMBRAPA/CNPMA. CNPMF received a total of 19,181 individuals. Colonies of *Typhlodomalus tenuiscutus* and *N. californicus* were maintained under laboratory conditions (25±1 °C, 50±5% RH). *T. tenuiscutus* was fed CGM on cassava leaves. *N. californicus* was fed CGM, castor bean pollen , and *Tetranychus urticae* (two-spotted spider mite) on jack bean leaves (*Canavalia ensiformis*).

N. californicus was mass reared in a screenhouse adapted for that purpose using *T. urticae* on jack bean leaves as prey. This has increased predator mite production from 5,000 phytoseiids/month to 15,000 phytoseiids/month.

Phytoseiid were released in Bahia (Piritiba, Itaberaba, Cruz das Almas, and São Gonçalo), and Pernambuco (Petrolina and Rajada). A total of 7,875 *T. tenuiscutus* individuals and 67,075 *N. californicus* individuals were released.

Monthly monitoring recovered only 11 *T. tenuiscutus* and 3 *N. californicus* (Table 4.1.1). Some material collected in late 1995 is still being identified. The phytoseiids introduced from CIAT came from laboratory colonies kept for 1 to 3 years. During 1996, phytoseiid shipments from CIAT will be made with recently established colonies to improve the possibility of successful establishment.

During the monitoring activities, families/species of arthropods were associated either with cassava plantas or weeds (Table 4.1.2).

Table 4.1.1 Recovery of phytoseiid mites from cassava fields where *T. tenuiscutus* and *N. californicus* were released.

Phytoseiid	Field	Release date	Recapture		Days since release
			No. mites	Date	
T. tenuiscutus	CNPMF	15/2/95	1	02/3/95	15
		2/3/95	10	5/4/95	31
N. californicus	Ananias	20/6/95	2	06/7/95	16
	Adenilton	29/8/95	1*	19/9/95	21

*Egg reared to adult in laboratory.

Table 4.1.2 Arthropods associated with cassava and weeds in fields where phytoseiid predator mites were released.

Arthropods	Families	Species
Mites	Phytoseiidae	*Amblyseius* sp., *Euseius* sp., *N. idaeus*, *Paraphytoseius* sp., *Typhlodromalus* sp. *T. manihot*
	Acarida	
	Saproglyphidae	
	Ascidae	*Aceodromus* sp.
	Tetranychidae	*M. tanajoa*
Insects	Formicidae	*Crematogaster* sp.
	Membracidae	*Enchenopa* sp.
	Aphididae	*Brachycaudus helichrysi*
	Chrysomelidae	*Epitrix* sp.
	Coccinellidae	*Ciclonela sanguinea, Scymnus* sp.
	Curculionidae	*Collabismus* sp., *Naupactus* sp.
	Lampyridae	

Interaction of CGM with other cassava pests

Studies of CGM biology in the presence of whiteflies, lacebugs, and mealybugs were carried out under laboratory conditions, 25±1 °C and 55±5% RH. CGM survival was affected by the presence of the associated pest (Table 4.1.3). CGM were trapped and died in fecal material from associated pests.

Table 4.1.3 Interaction of *Mononychellus tanajoa* with other cassava pests. Values are fate (%) of CGM reared in presence alone or in presence of other pests.

Treatments[1]	*N*	Survival to adult	Normal mortality	Dead in water trap	Dead in feces	Lost
CGM	30	83.3	73.3	20.0	0.0	6.7
CGM + WF	30	40.0	36.7	26.7	30.0	6.7
CGM + LB	30	26.7	46.7	13.3	30.0	10.0
CGM + MB	48	70.8	52.1	8.3	33.3	10.0

[1]CGM=Cassava green mite; WF=Whitefly; LB=Lacebug; MB=Mealybug

Effect of trichomes on CGM mobility

The effect of trichomes of *Hyptis* sp. (Labiatae), a common weed, on CGM mobility was studied. Three days after infesting leaves of *Hyptis* sp. with CGM, 100% of CGM had adhered to the trichomes with 80% remaining at the initial point of infestation.

Population dynamics of *T. manihot*

This study was initiated in May 1994 in collaboration with IITA (PROFISMA 1994 Annual Report). In the laboratory, mean number of *T. manihot* per leaf was higher on leaves 11 through 15. Immature and male *T. manihot* were present in higher numbers than females. In cassava fields,*T. manihot* occurs in absence of CGM provided there are whiteflies in the field as alternative prey.

Neozygites production in vivo

In vivo production methods for the mite fungal pathogen*Neozygites* isolates have been improved. It is now possible to obtain an average of 15 infected CGM from each mummy. However, production is still laborious; weekly production per person working 20 h/wk is ≈600 infected CGM. Studies are underway to develop a method based on mass production of inoculated CGM on whole plants in a rearing room under controlled conditions.

Species of Entomophthorales, including*Neozygites*, are typically difficult to rear in vitro. Using a technique developed by R. A. Humber (USDA, Ithaca, NY) who visited CNPMF as a consultant, it has been possible to isolate and cultivate *Neozygites* from infected CGM. The technique consists of transferring hyphal bodies from artificially infected CGM to Grace's medium (GIBCO) amended with 8% bovine foetal serum (BFS) and 350 mg $NaHCO_3$. Under these conditions, *Neozygites* grew as protoplasts, occasionally producing hyphal bodies, but rarely produced conidia. Although the lack of in vitro conidial production still hinders studies of artificial inoculation, the current technique produces sufficient fungal material for molecular characterization and taxonomy.

Neozygites epizootics

Spacial and temporal variability of *Neozygites* was studied from March through October 1994 in nine cassava fields at Piritiba, Bahia. Infected CGM were found in all fields 23 days after first observation of infected CGM in one of the fields. Infection levels were highly variable between fields. In fields 1 and 4, infection reached 100%, while fields 5 and 8 showed 37 and 40% infection, respectively. CGM densities remained low after epizootics; *Neozygites* incidence also decreased. The observation that there is spacial and temporal variability in *Neozygites* occurrence in cassava fields indicates that introduction of the pathogen (augmentative biological control) may be effective to initiate epizootics.

The proportion of CGM infected by *Neozygites* was greater on apical leaves compared with middle leaves, except for field 7 (Table 4.1.4). CGM numbers were equivalent on apical and middle leaves resulting in a greater density on apical leaves due to the smaller size of apical leaves compared with middle, fully-expanded leaves. Greater CGM density on apical leaves may facilitate *Neozygites* dispersion.

Table 4.1.4 *Neozygites* sp. infection and CGM population density during an epizootic in 8 cassava fields in Piritiba, Bahia.

Field	Infection (%)					
	Apical leaves			Middle leaves		
	Conidia	Hyphal bodies	CGM	Conidia	Hyphal bodies	CGM
1	16.6	16.6	1.0	10.3	8.5	0.9
2	28.7	23.4	1.6	18.6	20.6	1.4
3	23.0	20.7	1.3	21.3	20.7	1.2
4	35.5	21.2	1.6	26.9	24.0	1.6
5	31.6	19.6	1.2	26.4	1.6	1.4
6	25.7	7.6	1.3	14.0	7.0	1.2
7	24.5	7.5	2.1	28.0	20.5	2.0
8	19.8	11.6	1.2	7.3	3.3	1.0

Influence of location and weather on occurrence and variability of *Neozygites*

Cassava fields 7 and 8, where *Neozygites* was first detected, are farthest from field 3 where the pathogen was found last. Infected CGM were initially observed in northwestern fields with apparent dissemination towards the southeast. Independent of RH and temperature variations, *Neozygites* epizootics developed quickly within all fields, although on different dates (Figs. 4.1.1 - 4.1.3). From April 28 to May 11, immediately before epizootics commenced, RH was very high, with a daily average of 83%, and average daily temperatures varied from 23.1 to 23.4 °C. After May 11, when infection foci were first observed, there was large decrease in RH and an increase in temperature. From May 11 to June 25, a period of time during which the highest infection levels were observed in fields 6 and 8, RH varied from 70 to 74% and temperature ranged from 23.9 to 24.3 °C. A large reduction in the CGM populations coincided with the period of highest *Neozygites* occurrence in fields 6, 7, and 8, (late May), and in fields 1 through 5 (early June).

Production of resting spores

Resting spores of*Neozygites* were observed in live mites collected from leaves during the period June 9 to July 20, when infection levels were highest (Fig. 4.1.4). At the begining of the epizootic, the numer of resting spores was low but increased as the epizootic progressed. The highest proportion of infected CGM with resting spores occurred on July 20, when CGM density was low in all fields. The highest percentage of CGM with resting spores was observed during a period preceded by high diurnal temperature variations. It may be possible to induce resting spore formation in the laboratory by replicating the diurnal temperature variation found in the field.

Effect of biocontrol agents on nontarget organisms

Phytoseiid mite predators (*Amblyseius limonicus*, *A. idaeus* and *Neoseiulus californicus*), cassava pests (cassava mealybugs, lacebugs, whiteflies, and thrips), and beneficial insects (*Apis mellifera*) were exposed to *Neozygites* (CGM mummies) to evaluate the effect of the

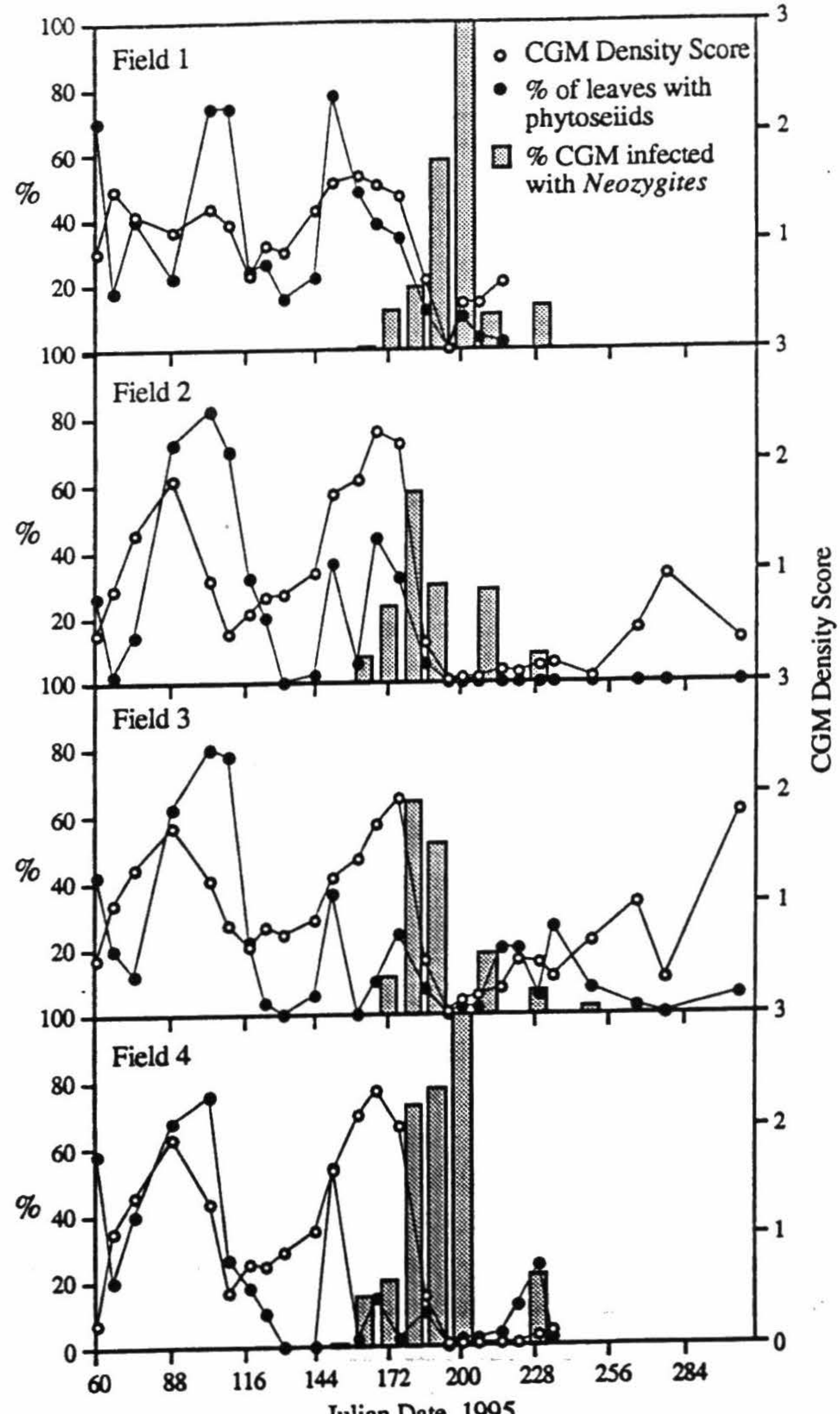

Figure 4.1.1 Incidence of CGM, phytoseiid mites, and infection of CGM with *Neozygites* in four cassava fields in Bahia (fields #1 - 4).

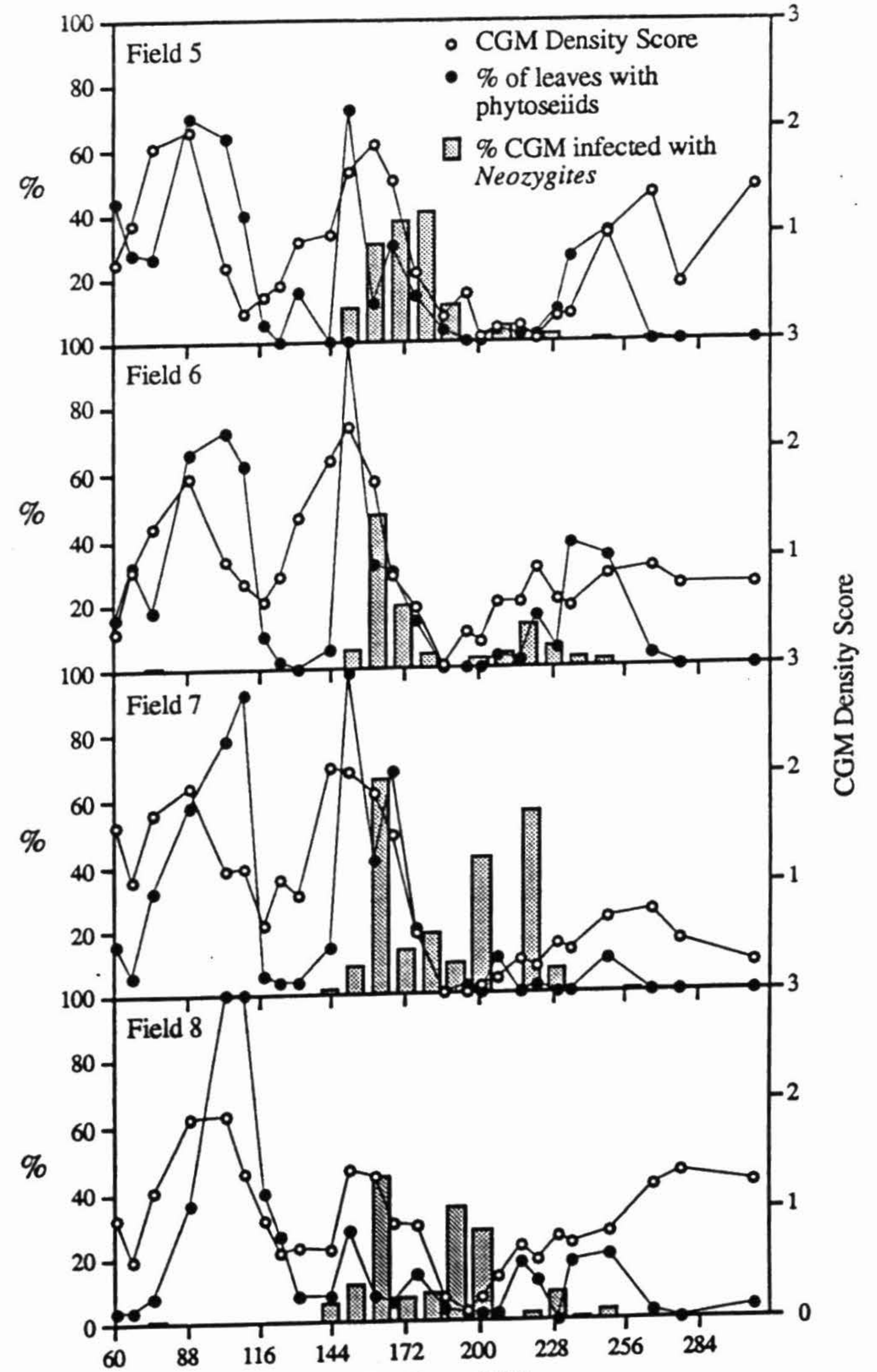

Figure 4.1.2 Incidence of CGM, phytoseiid mites, and infection of CGM with *Neozygites* in four cassava fields in Bahia (fields #5 - 8).

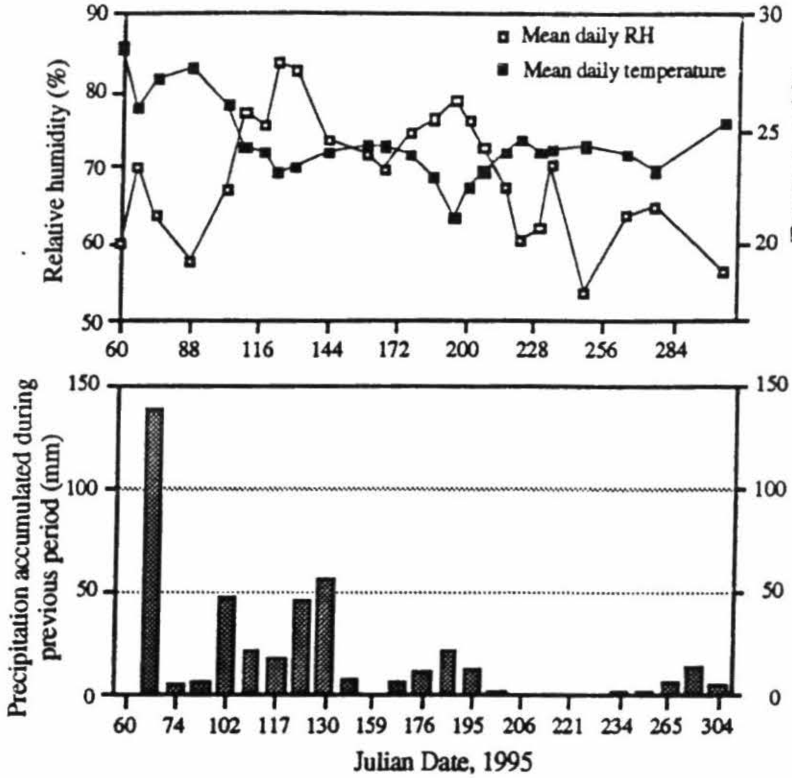

Figure 4.1.3 Temperature, relative humidity, and accumulated rainfall at Sumaré near Piritiba, Bahia during 1995.

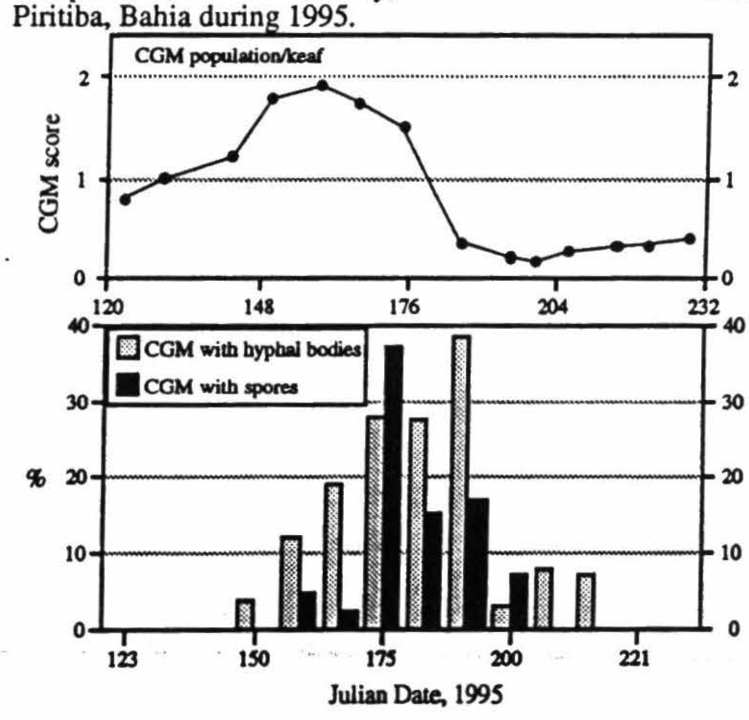

Figure 4.1.4 Production of *Neozygites* resting spores in CGM, relative humidity and temperature 24 to 96 hrs before sampling (CGM density score: 1 = 1 to 14, 2 = 25 to 200, 3 = >200 mites/leaf).

fungus on nontarget organisms. Crop plants (cassava, jack bean, *Crotalaria juncea*) were also inoculated with *Neozygites*. No phytoseiids or honeybees were infected. Ungerminated capilloconidia were observed attached to their bodies after inoculation. Similarly, cassava mealybugs, lacebugs, whiteflies and thrips were not infected. Inoculation of *Neozygites* on *C. ensiforme*, *C. juncea* and *M. esculenta* did not result in infection. These results demonstrate that *Neozygites* is a very specific biocontrol agent. To date, infection has been observed only in CGM.

The effect of *Cladosporium* sp. on nontarget organisms was evaluated as described for *Neozygites*. An inoculum suspension (300,000 conidia/ml) was sprayed on phytoseiids (*A. limonicus, A. idaeus* and *N. californicus*), cassava pests (mealybugs, lacebugs, whiteflies, and thrips), beneficial insects (honeybees) and crops (jack bean, *C. juncea,* pigeonpea and cassava). Whiteflies and mealybugs were heavily infected (94 and 92% infection, respectively) while no effects were observed on other inoculated organisms. A few honeybees found dead (9%) by the end of the experiment did not show any infection by *Cladosporium* sp. The fungus was not pathogenic to any of the inoculated crop plants.

4.2 Biological Control of the Cassava Mealybug in Northeastern Brazil

A program of parasitoid releases for control of the cassava mealybug, *Phenacoccus herreni*, was initiated in July, 1994 for *Epidinocarsis diversicornis*, in December, 1994 for *Acerophagus coccois*, and in April, 1995 for *Aenasius vexans*. During that period, laboratory colonies produced 59,524 parasitoids. Of those, 25,470 were released in Bahia and Pernambuco (Table 4.2.1). Under laboratory conditions of 27 ± 2 °C, development time (period from oviposition to adult emergence) was 18.0 ± 1.5, 16.8 ± 1.6 and 17.1 ± 1.4 days for *E. diversicornis*, *A. coccois* and *A. vexans*, respectively.

The parasitoid species that has spread fastest since release in Bahia has been *E. diversicornis*, dispersing 234 km from its ititial release site (Fig. 4.2.1). *A. coccois* has also established well but has dispersed more slowly, moving up to 180 km from its release site. To date, *A. vexans* has not dispersed despite being recaptured at all its release sites.

Field observations in areas heavily infested with cassava mealybugs suggest the most efficient parasitoid has been *A. coccois*. This may be related to two aspects of its biology in relation to *E. diversicornis*: greater number of progeny per host, and its habit of parasitizing early instars, giving it a competitive advantage over *E. diversicornis*. The greater dispersal capacity of *E. diversicornis* may be related to its wider host range, giving it an advantage during periods of low *P. herreni* infestation. *A. vexans* may have limited dispersal due to its high degree of host specificity.

In areas where *E. diversicornis* and *A. coccois* were released, they have quickly become the predominant mealybug natural enemies. At the respective release sites, the number of *E. diversicornis* individuals was 66% of all natural enemies collected and the number of *A. coccois* was 65%. These sites will be continuously monitored to follow parasitoid population dynamics. Based on the outstanding establishment and apparent impact of releases on mealybug populations, releases are planned for the state of Ceará.

Table 4.2.1 Number of cassava mealybug parasitoids produced in a greenhouse colony and released in cassava fields in Bahia (BA) and Pernambuco (PE).

	1994			1995			1996		
		Released			Released			Released	
Species	Reared	BA	PE	Reared	BA	PE	Reared	BA	PE
E.diversicornis	6190	3010	310	5235	3720	-	1334	-	-
A. coccois	9950	1950	-	11566	500	750	10180	2050	4050
A. vexans	-	-	-	9043	2980	2000	6026	2250	1900
Total	16,140	4,960	310	25,844	7,200	2,750	17,540	4,300	5,950

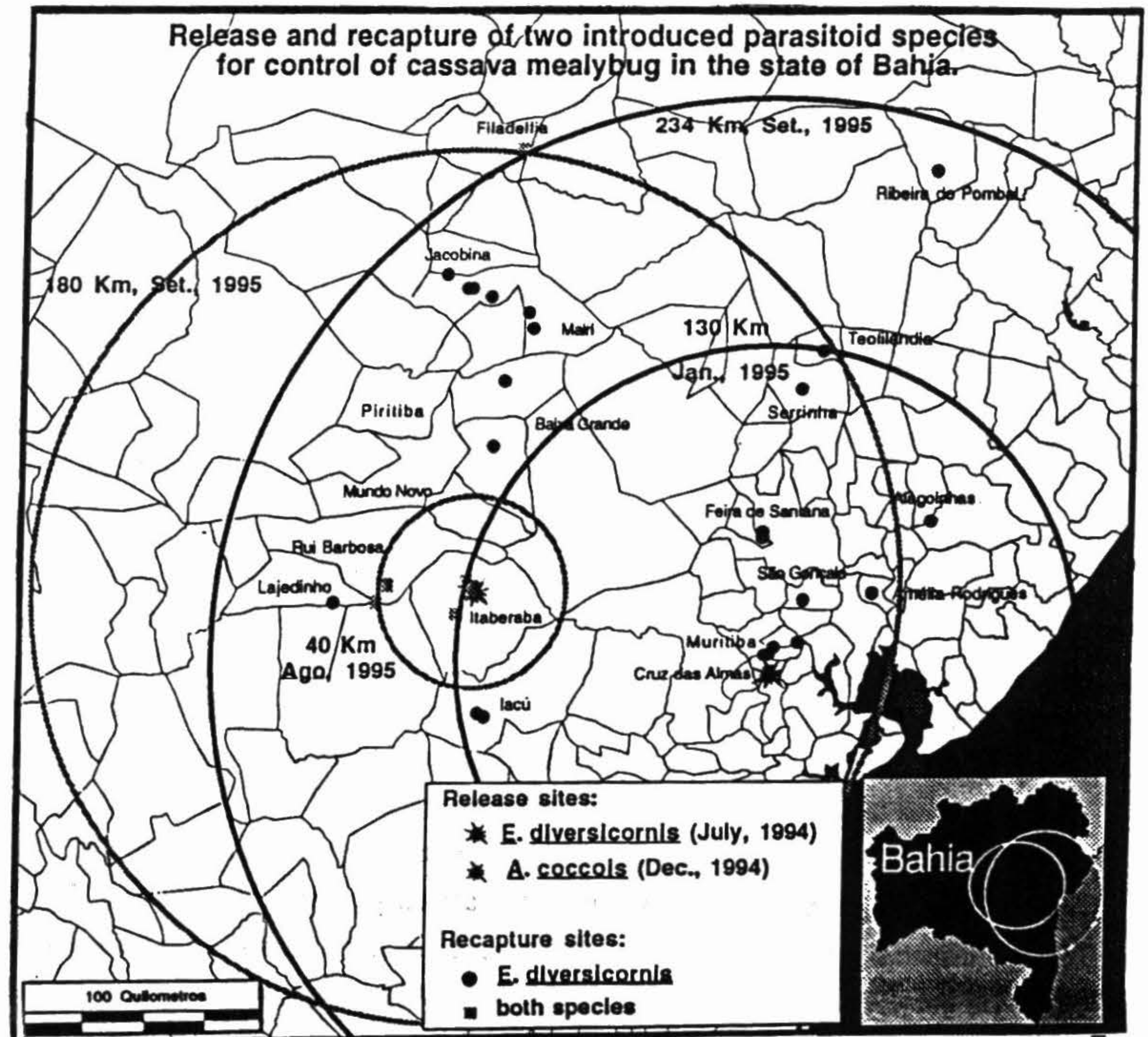

Figure 4.2.1 Release and recapture sites for 2 parasitoids of *P. herreni* in Bahia. Circles represent potential dispersal based on recapture site farthest from release site on 2 dates.

4.3 Crop management

Experiments at Cruz das Almas, Piritiba and Itaberaba, Bahia, evaluated relative importance of weeds in cassava fields, to determine effects on root yield, and to study the potential of weed species as sources of food or shelter for pest and beneficial arthropods.

Surveys identified 40 weed species. Of these, 21 were considered most representative based on relative importance and frequency. *Mollugo verticillata* showed highest relative importance in cassava fields at Itaberaba (Table 4.3.1). However, its importance decreased as soil water availability declined and almost disappeared during the dry season. At Piritiba, *Eupatorium laevigatum* and *E. ballatefolium* showed highest relative importance. At Cruz das Almas, *Digitaria horizontalis* and *Acanthospermum australe* showed highest relative importance. Weed species were classified in 11 botanical families; Compositae was most common (6 spp.), followed by Rubiaceae (4 spp.), and Gramineae (3 spp.); Portulacaeae, Molluginaceae, Cyperaceae, Commelinaceae, Solonaceae, Malvaceae, Euphorbiaceae and Passifloraceae were represented by 1 species each.

Table 4.3.1 Mean relative importance of weeds in cassava fields at three sites.

Weeds	RI (%)[1] Itaberaba	RI (%)[1] Piritiba	RI (%)[1] C. das Almas
Blainvillea rhomboidea	8,85	1,67	1,61
Plant C[2]	10,85	7,80	
Portulaca oleraceae	8,15	3,10	2,77[4]
Diodia teres	8,21		
Acanthospermum hispidum	11,40		
Mitracarpus hirtu	11,32	2,71[3]	
Mollugo verticillata	24,60		13,33[4]
Setaria vulpiseta		8,00	
Eupatorium leavigatum		22,50	
Solanum erianthum		12,00	
Eupatorium ballataefolium	1,91[3]	21,84	1,65[4]
Richardia brasiliensis		17,20	18,28
Acanthospermum australe			26,75
Digitaria horizontalis			36,71
Cyperus rotundus			10,94
Eleusine indica			5,70
Borreria sp.			4,60
Commelina benghalensis			2,45
Croton lobatus	3,44		4,00
Passiflora cincinnata	7,21[3]		
Sida cordifolia		1,35	

[1] Percentage of relative importance, [2] Unidentified Compositae, [3] Found only in August 1994 evaluation, [4] Found only in April 1995 evaluation

Effect of weeds and cover crops on cassava yield

Labor cost associated with weed control is the most expensive single crop management operation for cassava production, approximately 50% of production costs during the first year and between 30 and 45% of total production costs. This is due in part to the slow initial growth of cassava and the period required for canopy formation.

Weed competition in cassava fields, particularly during the dry season, can reduce root yield by as much as 40% (more in extreme cases) and aerial plant production by as much as 30%. It is essential to identify the critical period of weed interference with cassava productivity to optimize weed control while minimizing soil erosion and water loss associated with cultural practices. Work done in Brazil and other countries has demonstrated that under normal rainfall (>1,000 mm/yr), cassava is sensitive to weed competition for a period 4 to 5 months after germination. Beginning 20 to 30 days after germination, the crop requires approximately 100 days weed-free. No further weeding is required beyond that period. This knowledge allows farmers to optimize their inputs, eliminate unnecessary weeding, and maintain soil cover. In southern Brazil, studies have shown that cassava does not require weeding until 90 after planting and that weeding after 150 days was unnecessary, i.e., the critical weeding period for cassava in southern Brazil occurs between 90 and 150 days after planting.

Trials initiated by PROFISMA are attempting to identify the critical period of weed intereference for the semi-arid areas (500 - 600 mm/yr) of northeastern Brazil. Given the different environmental conditions and the longer period required for canopy formation in the semi-arid, it is difficult to extrapolate from results in other ecosystems. Treatments tested for their effect on cassava yield are summarized in Figure 4.3.1.

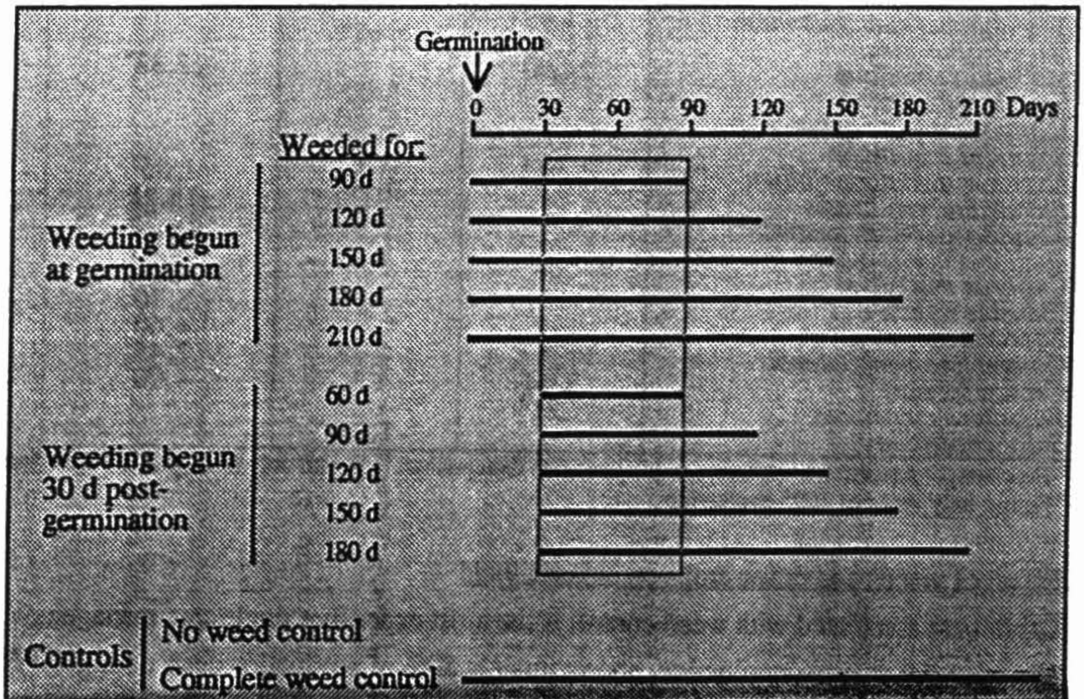

Figure 4.3.1 Treatments used to determine critical period of weed interference with cassava yield.

Cassava yield in all treatments were statistically equivalent except for the control (without weeding during all the crop cycle) (Table 4.3.2). This may be due in part to low rainfall in August that prevented vigorous weed development. Yields were low due to early harvest (9 months) for logistical reasons; Early harvest was necessary to generate planting material to maintain the research agenda. However, results suggest that the critical period for weed control occurs between 30 and 90 days after germination. Weeding during the first 30 days after germination and weeding beyond 90 days did not increase root yield.

Table 4.3.2 Cassava root yield at Itaberaba and Piritiba, Bahia, 9 months after planting.

Treatments	Yield (t/ha)			
	Itaberaba		Piritiba	
Weed control from germination				
01. For 90 days	3.64	a	6.87	ab
02. For 120 days	4.17	a	6.52	ab
03. For 150 days	4.88	a	7.35	a
04. For 180 days	4.61	a	6.66	ab
05. For 210 days	4.57	a	5.76	ab
Weed control begining 30 days after germination				
06. For 60 days	4.30	a	5.87	ab
07. For 90 days	4.83	a	7.62	a
08. For 120 days	4.20	a	6.44	ab
09. For 150 days	5.07	a	5.98	ab
10. For 180 days	5.31	a	5.99	ab
11. Weed control thoughout crop cycle	4.44	a	5.50	ab
12. Without weed control	0.67	b	3.36	b

Regarding the effect of cover crops on cassava root yield, complete weed suppression resulted in higher yields compared with other treatments at Piritiba and Itaberaba (Table 4.3.3) but not at Cruz das Almas where rainfall was significantly greater (Table 4.3.4). This result is probably due to competition for water by weeds and cover crops during the dry season at the drier sites. At Itaberaba and Piritiba, *Canavalia ensiformis* and native weed vegetation depressed cassava root yield. Competition may have been due to delayed cutting of the cover crop to produce higher amounts of organic matter for mulching resulting in competition for water. Rainfall declined in August (Table 4.3.4). Cowpea (*Vigna unguicullata*), and pigeon pea (*Cajanus cajan*) did not germinate well at Cruz das Almas and Piritiba and therefore were not adequately evaluated.

Arthropods belonging to 8 orders, 41 families, and 67 species were collected from the most prevalent weed species and cover crops in cassava fields (Table 4.3.5). Leaf samples were brought collected. The most common arthropods families collected were Cicadellidae, Membracidae, Tingidae, Syrphidae and Curculionidae.

Table 4.3.3 Effect of cover crops on cassava root yield at 9 months at three sites.

	Yield (t/ha)		
Treatments	Piritiba	Itaberaba	C. das Almas
1. Weed control over entire crop	5.08 a	5.33 a	9.57 a
2. Weed control within double rows; weeds between double rows	2.68 b	4.02 abc	3.42 a
3. Weed control within double rows; pigeon pea between double rows	3.56 ab	4.83 ab	9.57 a
4.Weed control within double rows; jack bean between double rows	3.18 b	2.60 c	4.12 a
5. Weed control within double rows; cowpea between double rows	4.17 ab	3.67 bc	5.33 a

Table 4.3.4 Rainfall (mm) at Itaberaba, Cruz das Almas, and Piritiba, Bahia, 1995.

Month	Piritiba	Itaberaba	Crus das Almas
January	56.0	10.0	0.0
February	1.0	45.1	9.4
March	151.5	189.1	73.0
April	87.5	50.9	148.5
May	110.5	41.6	189.5
June	19.5	14.2	85.1
July	39.5	79.1	173.1
August	5.0	9.0	185.5
September	22.5	31.1	160.5
October	7.0	0.8	79.9
November	9.0	23.7	40.4
December	13.0	68.1	14.0
TOTAL	522	563	1,159

The effect of cover crops and weeding on erosion control was studied at Piritiba. Least soil loss resulted when jack bean or cow pea were planted between double rows of cassava (Fig. 4.3.2). Native weed vegetation also resulted in fairly good soil retention. Greatest soil loss, ≈70 t/ha, occurred in the control (weed free during the entire crop cycle).

Arthropod pest incidence and yield loss assessment

Cassava yield losses to pests were assessed at Aracati and Pacajus, Ceará. Chemical control of pests resulted in higher root yields, shoot dry matter, plant height and stake diameter (Table 4.3.6). The negative control (no pest control) produced significantly lower root yield, shoot dry matter, starch yield, plant height and stake diameter. The biocontrol agents *Chrisopa* sp. (lacewing) and *Polistes* sp. (wasp) were found in the untreated plots.

Table 4.3.5 Arthropods collected on weeds commonly found in cassava fields.

Orthoptera	**Hemiptera (cont.)**	**Hymenoptera**
Ommexechidae	Pyrrhocoridae	Formicidae (cont.)
Gryllidae	*Dysdercus* sp	*Crematogaster* sp
Oecanthinae	Reduviidae	*Solenopsis* sp
Oecanthus sp.	Phimatidae	Braconidae
Neuroptera	Lygaeidaea	*Apanteles* sp
Chrysopidae	*Geocoris* sp	*Bracanstrepha* sp
Homoptera	Rhyparochroninae	Encyrtidae
Cicadellidae	Tingidae	*Aenasius* sp
Xerophloea viridis	*Atheas* sp	*Leptomastix* sp
Protalebrella brasiliensis	*Vatiga manihotae*	Diapriidae
Typhlocybinae sp	*Gargaphia torresi*	Pteromalidae
Membracidae	*Corythaica cyathicollis*	**Coleoptera**
Amblyophallus maculatus	*Corythaica monacha*	Curculionidae
Bolbonota melaena	Pentatomidae	*Pheloconus rubicundulus*
Aphididae	*Cytocephala alvarengai*	Bardinae
Aphis gossypii	Cydnidae	Cryptorhynchinae
A. spiraecola	Corimelaeninae	*Sternocoelus granicollis*
A. craccivora	**Diptera**	Anthonominae
Brachycaudus helichrysi	Syrphidae	*Anthonomus* sp
Aleyrodidae	*Ocyptamus* sp	Molytinae
Cixiidae	Tephritidae	*Pheloconus* sp
Coccoidea	*Anastrepha* sp	Tychiinae
Psocoptera	Lonchaeidae	*Sibinia* sp
sp 1	Psychodidae	Bruchidae
Hemiptera	Acalyptradae	*Acanthoscelides* sp
Coreidae	Drosophilidae	Chrysomelidae
Crinocerus sanctus	Cecidomyiidae	*Heterispa costipennis*
Chariesterus armatus	Sciaridae	Lathrididaea
Hypselonatus sp	Psycodidae	Carabidae
Rhopalidae	**Hymenoptera**	Nitidulidae
Niesthrea sidae	Formicidae	Anthribidae
Xenogenus picturatum	*Brachymyrmex* sp	Rhizophagidae
	Ectatoma edentatum	Anthicidae
	Paratrechina sp	

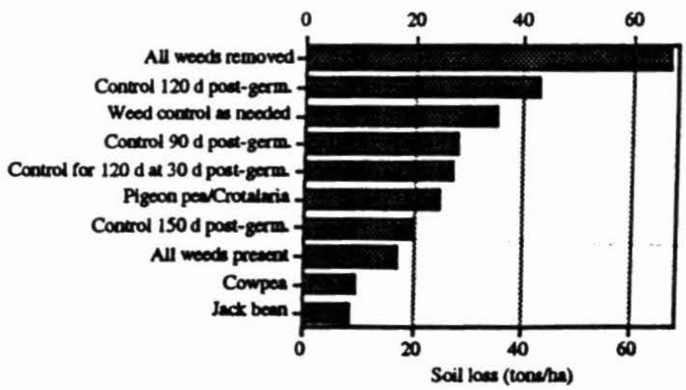

Figure 4.3.2 Erosion due to surface run-off at Piritiba, Bahia under 10 weed control management treatments.

Table 4.3.6 Effect of pest incidence on cassava development and yield in Aracati,Ceará[1].

Treatments	Root yield (t/ha)	Shoot dry matter (t/ha)	Plant height (m)	Stem diameter (cm)	Shoots/ plant	Roots/ plant	Starch yield (%)
No pests (pesticide)	17.6 a	11.0 a	1.8 a	2.4 a	2.2 a	5.6 a	28.3 a
Whitefly infestation	13.0 b	10.2 b	1.5 b	1.8 b	2.2 a	5.6 a	26.1 b
CGM infestation	11.6 c	9.6 b	1.4 c	1.7 b	2.1 a	5.5 a	25.9 b
All pests present	9.6 d	8.2 c	1.1 d	1.5 c	2.0 a	5.5 a	25.3 c

1 Values in columns followed by the same letter do not differ by Tukey's test ($\alpha = 5\%$).

Surveys carried out in Feira Nova, Pernambuco, found gall midges (*Iatrophobia brasiliensis*), CGM, cassava mealybug, and lacebug (*Vatiga illudens*). In Ceará, the most common cassava pests were CGM, red mites (*Tetranychus* spp.), hornworm (*Erinnys ello*), lacebug, whiteflies (*Aleurotrixus aepim*), mealybug, and gall midges. Weed species were collected in cassava growing areas and evaluated at the Entomology Laboratory of CNPMF for presence of pests and beneficial insects. Herbarium specimens were sent to the College of Agriculture, University Federal of Bahia for identification (Table 4.3.7).

Table 4.3.7 Weeds and associated arthropods at São Miguel das Matas & Cruz das Almas.

Weed family	Weed species	Arthropods found
Compositae	*Acanthospermum australe*	07 mites 41 whitefly nymphs 07 whiteflies 02 *Orthezia praelonga* 01 predator mite 03 red mites 02 mealybug nymphs
	Centratherum puntatum	45 whitefly nymphs 03 thrips 03 mite eggs 07 CGM 02 predator mites 01 *Crysopa* sp. egg 02 *Ocyptamus* sp. larvae
	Eupatorium pauciflorum	04 whitefly nymphs 01 mealybug nymph 02 thrips 01 aphids
	Blainvillea latifolia	03 Ladybug larvae
	Blainvillea rhomboidea	13 whitefly nymph
Rubiaceae	*Ageratum conyoides*	02 CGM 06 whitefly nymphs 03 mealybug nymphs 01 mealybug 02 thrips
	Borreria verticillata	no arthropods found
	Richardia brasiliensis	01 predator mite
Tiliaceae	*Corchorus hirtus*	no arthropods found

Table 4.3.7 (cont.)

Euphorbiaceae	*Croton grandulosus* *Euphorbia hyssopifolia*	04 whitefly nymphs 10 predator mites 05 CGM 14 whitefly eggs 147 whitefly nymphs
Graminae	*Echinochloa pavonis*	no arthropods found
Labiatae	*Hyptis suaveolens* *Marsypianthes chamaedrys*	01 whitefly nymphs 01 ladybug larvae 01 thrips
Malvaceae	*Sida cordifolia* *Sida santamarensis* *Sida rhombifolia* *Sida spinosa*	01 CGM 08 thrips 01 thrips 02 predator mites 02 lacebugs 02 CGM 04 whitefly nymphs 07 lacebugs
Solanaceae	*Solanum erianthum*	01 CGM 06 red mites 01 whitefly egg 01 whitefly nymph 01 whitefly 37 lacebug nymphs 28 lacebugs 03 *Orthezia praelonga* 01 *Crysopa* sp. egg 01 predator mite
Leguminosae	*Zornia diphylla* *Desmodium* sp. *Stylosanthes viscosa* *Cassia* sp.	08 mite eggs 03 CGM 04 thrips 06 mites 03 aphids 02 aphids no arthropods found
Commelinaceae	*Commelina nudiflora*	no arthropods found
Verbenaceae	*Lantana camara*	no arthropods found

4.4 Plant Pathology

Cultural and genetic control of Cassava Witches' Broom Disease

Selection of healthy planting material from susceptible varieties based on visual symptoms greatly reduces loss to cassava witches' broom disease (CWBD, a phytoplasm). Infection during the growing season, however, makes the crop useless as planting material for subsequent cycles. Cassava clones generated by the cassava breeding program of EMBRAPA/CNPMF were selected for resistance to CWBD in on-farm trials with farmer participation in the Serra de Ibiapaba (Ceará) area where CWBD is particularly virulent. Subsequently, participatory trials with 25 farmers compared selected clones with 'Cruvela', the local susceptible variety, and 'Bujá', a cassava variety recently introduced by the Secretariat of Agriculture of Ceará. Bujá was selected for its resistance to CWBD as well, but for the littoral zone of Ceará, an area ecologically distinct from the Serra de Ibiapaba.

Root yields of the farmer-selected clones 8709-02 and 8911-16 were higher than Cruvela at 12 months after planting. Clones 8911-16 and 8709-02 produced 11.0 and 9.6 tons/ha, respectively, compared to 4.5 ton/ha for Cruvela. Clone 8911-16 had the highest root yield at 18 months after planting (Fig. 4.4.1). Bujá appeared to be the least adapted to local conditions with the lowest root yield at both 12 and 18 months. The poor response of Bujá demonstrates the importance of conduting varietal selection within the targeted ecological zone. Also, the previous participatory screening of clones guaranteed that elite clones satisfied farmers' selection criteria. Thus, farmer preference among this group of pre-screened clones was largely based on yield.

No signifcant differences were detected among selected cassava clones or varieties in dry matter content (Fig. 4.4.2) or starch content (Fig. 4.4.3) within harvest dates. Except for the clone 8735-01, dry matter content and starch were higher at 18 months compared with 12 months. No differences were detected for above-ground plant production within variety when harvest was performed at 12 or 18 months after planting (Fig. 4.4.4). The large amount of foliage produced by Cruvela in some repetitions may have been due to CWBD infection (sprouting due to loss of apical dominance). The high variability in plant growth by Cruvela (susceptible) may be due to uneven CWBD distribution in the cassava fields. A diagnostic test for CWBD is needed.

Cassava growers participated in selection of CWBD-resistant clones and their preference criteria were noted. At 12 months, preferred clones were 8911-16 (>60% preference) and 8709-02 (58%) compared with Cruvela (15%) (Fig. 4.4.5). At 18 months, growers preferred 8952-06, 8709-02, 8811-16, 8735-01 and Cruvela. Growers' preference for clones 8952-06, 8709-02 an 8911-16 was >50% while for Cruvela it was about 36%. Interestingly, clone 8952-06 was rejected by farmers at 12 months but showed the highest approval when harvested at 18 months. This is probably due to low root yield of 8952-06 at 12 months (5 ton/ha). At 18 months, 8952-06 produced 20 ton/ha compared with 11.7 ton/ha for Cruvela.

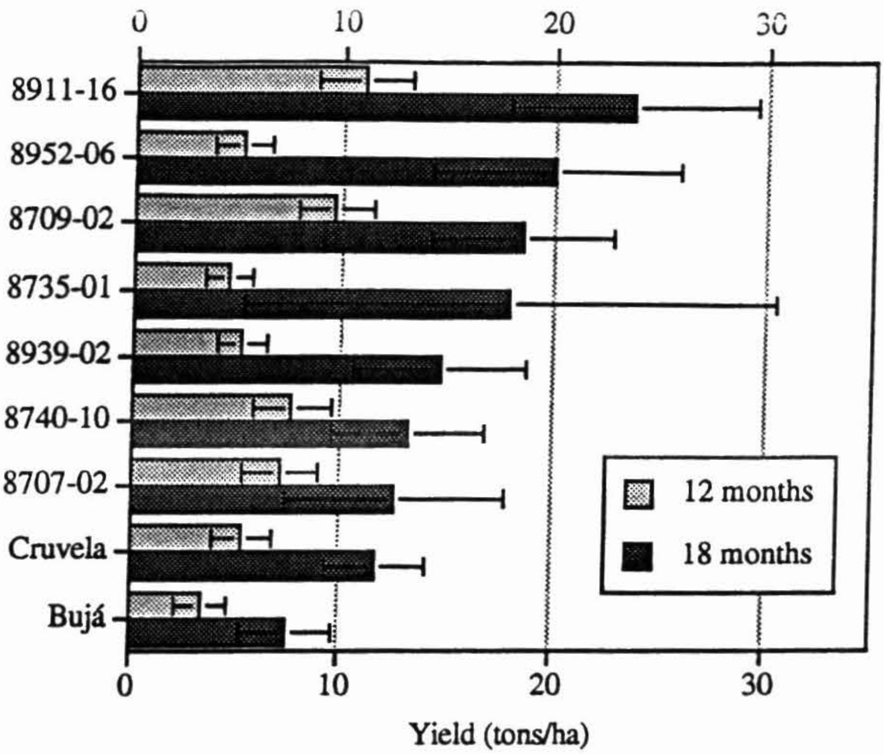

Figure 4.4.1 Fresh root yield at 12 and 18 months of clones selected for CWBD resistance.

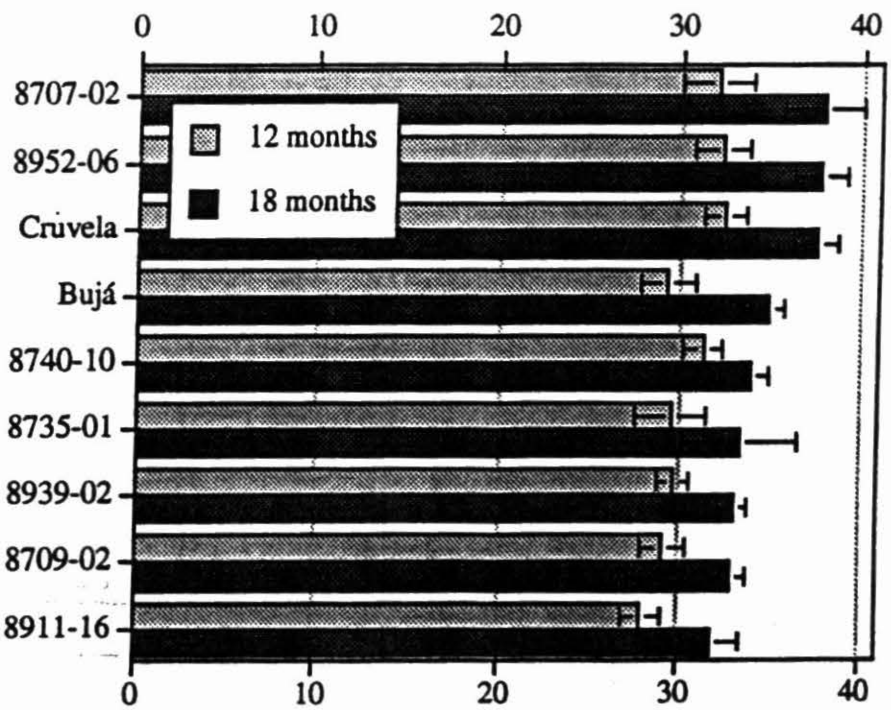

Figure 4.4.2 Dry matter content at 12 and 18 months of clones selected for CWBD resistance.

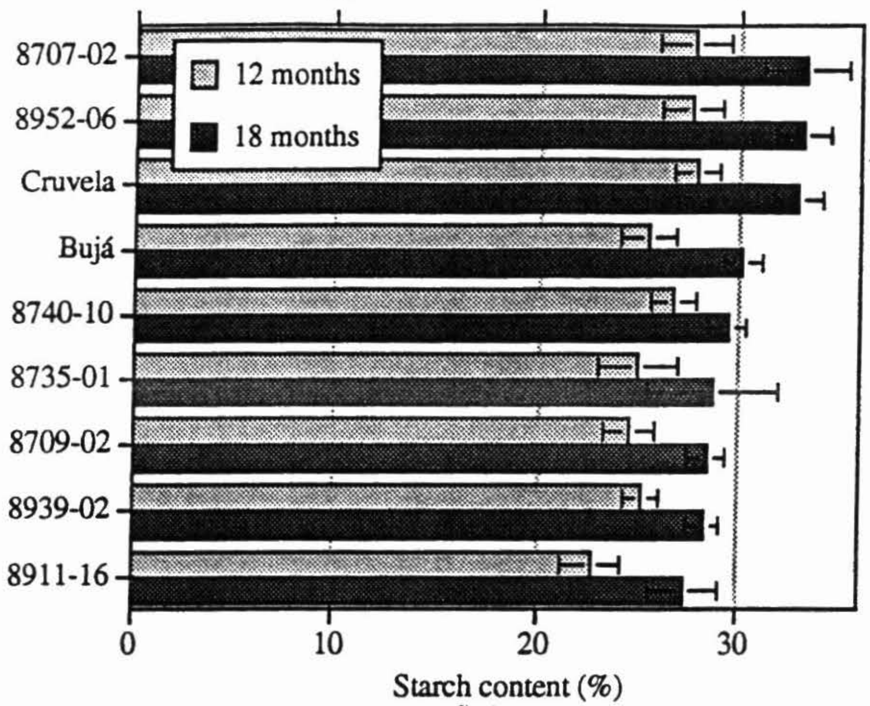

Figure 4.4.3 Starch content at 12 and 18 months of clones selected for CWBD resistance.

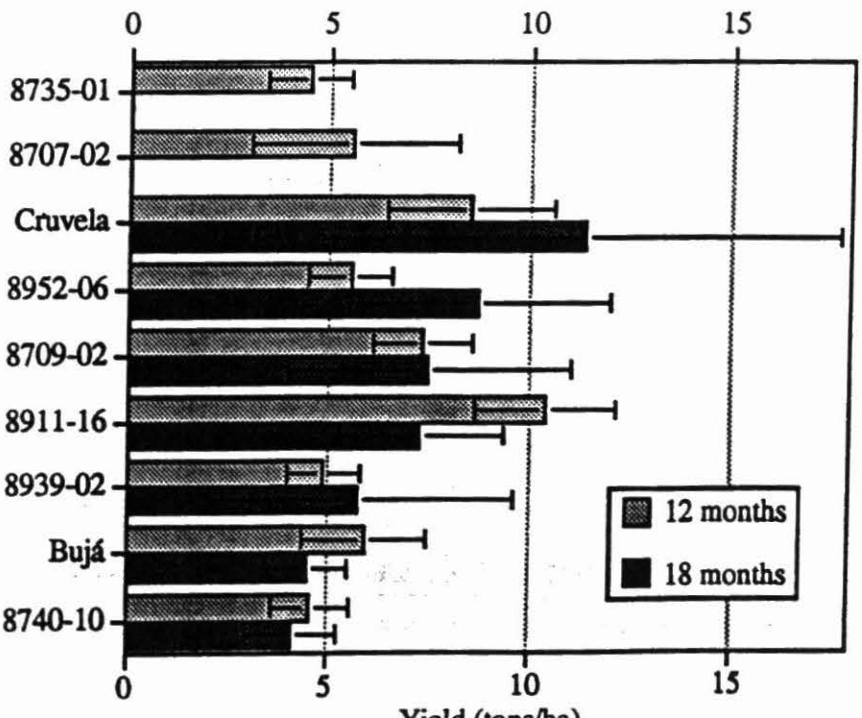

Figure 4.4.4 Aerial plant yield at 12 and 18 months of clones selected for CWBD resistance.

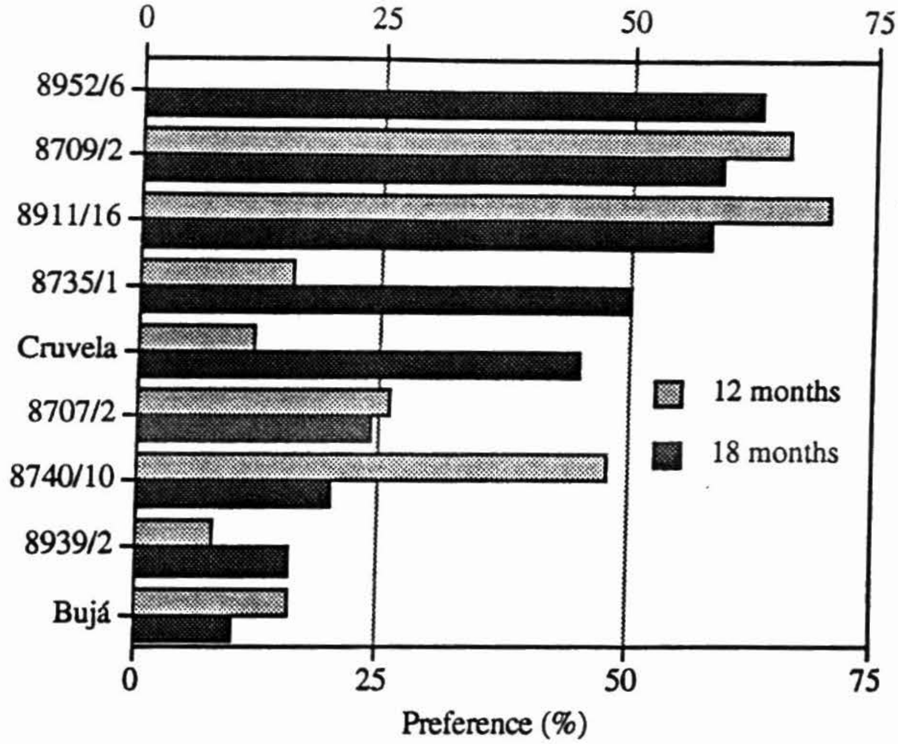

Figure 4.4.5 Grower preference for cassava varieties/clones in a CWBD-endemic area.

Root rot survey

Cassava root rots are caused by several pathogenic fungi including *Phytophthora* sp., *Fusarium* spp., *Scytalidium* sp. and *Diplodia* sp. Surveys carried out in cassava growing regions of northeastern Brazil determined the distribution of genera responsible for root rot (Table 4.4.1). Infected material was collected and pathogens isolated at CNPMF.

Table 4.4.1 Geographic distribution of genera of root rot pathogens in northeast Brazil.

State	Township	Predominant pathogen
Bahia	Inhambupe	*Phytophthora* sp
	Alagoinhas	*Phytophthora* sp.
	Cachoeira	*Fusarium* sp.
Pernambuco	Feira Nova	*Phytophthora* sp., *Fusarium* sp., *Scytalidium* sp., *Diplodia* sp.
	Goiana	*Phytophthora* sp., *Fusarium* sp., *Scytalidium* sp., *Diplodia* sp.
	Araripina	*Fusarium* sp.
Paraiba	Areia	*Fusarium* sp., *Scytalidium* sp.
	Alagoa Grande	*Fusarium* sp., *Phytophthora* sp.
	Guariba	*Fusarium* sp., *Scytalidium* sp. (low frequency)
Alagoas	Taquarana	*Fusarium* sp.
	Viçosa	*Phytophthora* sp.
Sergipe	Umbauba	*Fusarium* sp., *Phytophthora* sp., *Scytalidium* sp.
	Itabaiana	*Fusarium* sp.
Ceará	Caucaia	*Fusarium* sp.

Pure cultures were obtained and Koch's postulates were satisfied. Diagnosis, based on external symptom expression, were also performed under field conditions.

Root rot genetic control

Studies of genetic resistance to cassava root rots at CNPMF date from 1985. In 1993, on-farm trials were set up through PROFISMA to evaluate genotypes for resistance or tolerance to root rot pathogens. Experiments were established in areas where root rot pathogens are endemic to assure sufficient disease pressure. Cassava genotypes have been evaluated in on-farm trials in 5 northeastern states (Table 4.4.2). Of 3,220 genotypes evaluated for resistance to root rot, 79 were selected as promising based on disease incidence and root yield. Selected clones will be re-evaluated in on-farm trials.

Table 4.4.2 Field evaluation of cassava genotypes for resistance/tolerance to root rots.

State	Township	1993	1994	1995	Selected genotypes
Alagoas	Taquarana	478	48	14	14
	Viçosa	570	92	32	32
Sergipe	Umbauba	370	44	11	11
Pernambuco	Feira Nova*	1,070	-	-	-
Paraiba	Areia	362	42	8	8
	Gauribas	-	155	14	14
	Remígio**	370	-	-	-
Bahia	Inhambupe	-	-	26	-
TOTAL		3,220	381	105	79

* Trial terminated due to low root rot incidence; ** Trial lost due to poor germination

Development of root rot inoculation technique

Two species of *Phytophthora* were isolated from infected cassava roots and compared. In general, *P. drechsleri* was more pathogenic to the varieties tested compared with *P. nicotiana* var. *parasitica* (Fig. 4.4.6). No differences were found in varietal reaction to *P. nicotiana* var. *parasitica*. However, there was a significant effect of variety when the same varieties were inoculated with *P. drechsleri*. These results agree with field observations that Olho Verde and Osso Duro are resistant to root rots and indicate that cassava root rot disease is largely due to infection by *P. drechsleri*.

Effect of *Trichoderma* spp. on cassava root rot

The effect of *Trichoderma* spp. on development of root rot induced by *P. drechsleri* was studied under laboratory conditions by simultaneous inoculation with the pathogen and the potential biocontrol agent in wounds on root surfaces (Table 4.4.3). Results indicate potential for biocontrol of *P. drechsleri* by *Trichoderma* spp. (Figure 4.4.7). **Isolates T11,** ***T. pseudokoningii*****, T 2-2,** ***Trichoderma*** **sp., T 19,** ***T. aureoviride*****, T Nat IR,** ***T. pseudokoningii*****, and T Rib,** ***Trichoderma*** **sp., are promising biocontrol agents of** ***P.***

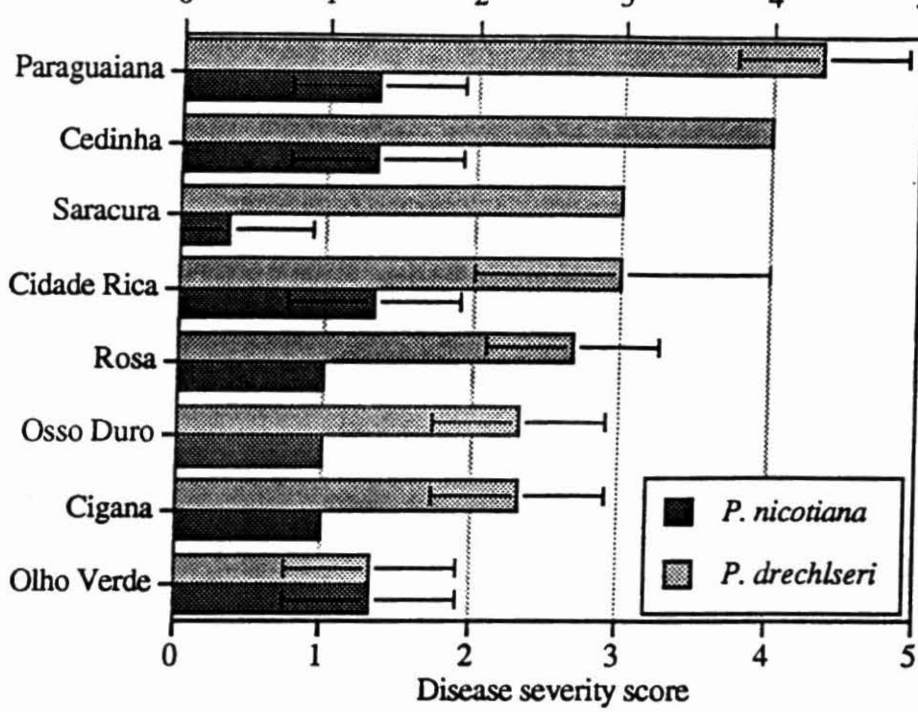

Figure 4.4.6 Reaction of cassava varieties to wound inoculation with the root rot pathogens *Phytophthora drechsleri* and *P. nicotiana* var. *parasitica*.

drechsleri in cv. Cidade Rica. Cv. Saracura showed a similar tendency, with isolates T 2-2, *Trichoderma* sp., T 11-2, *Trichoderma* sp., and T 15-4, *Trichoderma* sp. having an antagonistic effect to *P. drechsleri*. A synergistic effect was observed when Cidade Rica was inoculated with isolates T 25, *T. harzianum*, T 4-3, *Trichoderma* sp., T Solo I and T 01-A simultaneously with *P. drechsleri*. Synergism was also detected when Saracura was inoculated with T 19, *T. aureoviride*, T 4, *T. harzianum*, T Nat IR, *T. pseudokoningii*, and T Verde, *T. koningii* simultaneously with *P. drecsleri*.

Results (Figure 4.4.7) suggest an interaction between biocontrol agent, pathogen, and cassava variety. Such effect is clearly noticed on the isolate T Nat IR, *T. pseudokoningii*, which showed an antagonistic effect against *P. drechsleri* when inoculated on Cidade Rica, and expressed synergism to the pathogen when inoculated on Saracura. The interaction between root rot pathogens and*Trichoderma* spp. is isolate-specific and can vary from antagonism to synergism or have no effect at all. These results demonstrate the need for genetic characterization and mapping of geographic distribution of root rot pathogens in addition to characterization of biological control organisms.

The effect of *Trichoderma* spp. (Table 4.4.3) on development of root rot induced by *P. drechsleri* was studied under laboratory conditions by simultaneous inoculation with the pathogen and the potencial biocontrol agent in wounds on root surface. As shown in Fig. 4.4.7, no effect of *Trichoderma* spp. was observed on root rot development on the cassava variety Cidade Rica when this pathogen was simultaneously inoculated with the biocontrol agent. On the other hand *Trichoderma* sp., isolate T 2-2, showed antagonistic effect to *P. drechsleri* when simultaneous inoculations were performed on the cassava varieties Saracura and Osso Duro. Antagonism was also expressed by *Trichoderma* sp., isolate T Rib., to *P. drechsleri* inoculated on Osso Duro. Even though these results suggest interaction between cassava variety, *P. drechsleri*, and *Trichoderma* isolates, they also indicate potential for biocontrol of *P. drechsleri* by *Trichoderma* spp.

T. harzianum, isolate T 4, and *T. koningii*, isolate T Verde, showed synergistic effect to *P. drechsleri* when inoculations were performed on Saracura; synergism was also observed when *T. viride*, isolate T 01 B was simultaneously inoculated with *P. drechsleri* on Osso Duro.

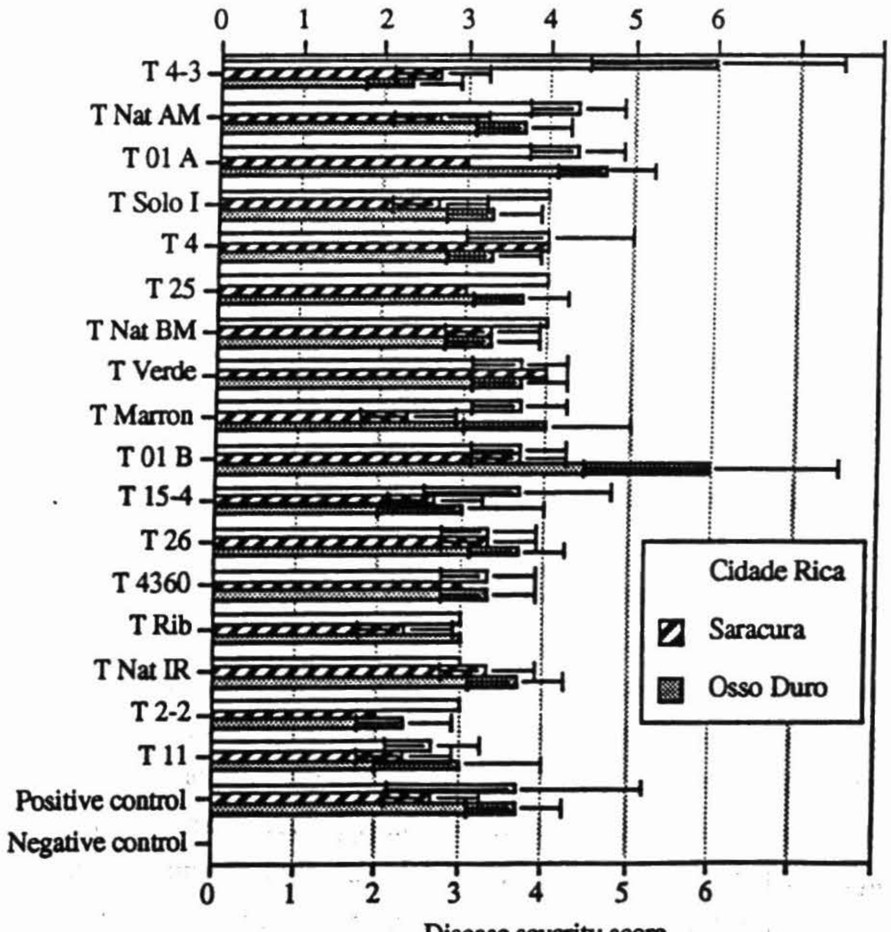

Figure 4.4.7 Effect of *Trichoderma* isolates on root rot development of inoculated roots of two cassava varieties. Positive control was inoculated with pathogen but without a *Trichoderma* isolate. Negative control was not inoculated.

Cultural control of cassava root rot

The effect of rotation with legume fallows on cassava root rot incidence is under study in Taquarana, Alagoas, and in Remigio, Paraíba. Jack bean and pigeon pea were planted between double rows of cassava. In subsquent cycles, the position of cassava and intercrop rows will be reversed. At Taquarana, soils typically have a superficial compaction layer that impedes water infiltration and favors development of root rot pathogens. It is expected that the rotation will reduce root rot severity by improving soil physical characteristics and promoting drainage. Soil fertility improvement is also expected due to incorporation of the intercrop. At Remigio, the area on which the experiment is planted has a superficial layer less compact than Taquarana however, the soil shows a 35% porosity, interfering on root development.

Virology

Diagnostic methods for detection of CVMV and the superelongation mycoplasm were developed at the Vegetable Virology Laboratory of Ceará Federal University (UFC), from January through November 1995.

Isolation, characterization and development of diagnostic methods for cassava virus mosaic virus (CVMV)

Polymerase chain reaction in identification infect plants. Leaf samples of infected and healthy cassava plants identified serologically were used to extract DNA according to the method of Dellaporta et al. (1993). After spectophothometric analysis, preparations were used for CVMV amplification. The DNA obtained was amplified using primers provided by CIAT's Virology Unit. Amplified DNA was analysed by gel electrophoresis using a 1 kb DNA marker ladder. After electrophoresis, the DNA bands were colored and visualized through a uV transilluminator. Viral DNA was amplified only from infected plants and purified virus.

Virus transmission by whitefly

Whitefly specimens (*Bemisia* sp.) were allowed to feed for 24 hours on CVMV-infected cassava plants and then tranferred to healthy cassava plants in cages in the greenhouse. Each plant was challenged with 8 to 10 whiteflies, and observed symptoms development. To date, challenged plants have not developed virus symptoms. Challenged plants will be tested by PCR for presence of the virus.

PCR with captured whitefly in cassava infected plants by CVMV

DNA was extracted from whiteflies collected on CVMV-infected cassava plants and amplified by PCR. Preliminary tests used 5, 10, 20 or 30 whiteflies to determine optimal numbers for DNA extraction. The DNA obtained was analyzed spectrophotometrically to produce a uV absorbtion curve to estimate DNA concentration. Results of electrophoresis in agarose gel showed no amplification of DNA extracted from whitefly.

Detection of Mycoplasm in Cassava Plants by PCR

Cassava plants with superelongation symptoms were submitted to PCR, using a fragment of the 16S rRNA gene of the mycoplasm and two primers from conserved areas of this gene produced in CIAT's Virology Unit as a DNA model. Agarose gel electrophosis demonstrated the method to be efficient for detection of mycoplasm.

Table 4.4.3 *Trichoderma* spp. isolates evaluated as antagonists of root rot pathogens.

Isolate	Species	Place of origin
T O1-A	*T. viride*	Goiânia, Goiás
T 01-B	*T. viride*	Goiânia, Goiás
T 2-2	*Trichoderma* sp.	Circaria, Colombia
T 4	*T. harzianum*	Cali, Colombia
T 4-3	*Trichoderma* sp.	Circaria, Colombia
T 11	*T. polysporum*	-
T 11-2	*Trichoderma* sp.	Guaraciaba, Ceará
T 15-4	*Trichoderma* sp.	Belém, Pará
T 19	*T. aureoviride*	-
T 25	*T harzianum*	-
T 26	*T. pseudokoningii*	Goiânia, Goiás
T 4360	*T. koningii*	Goiânia, Goiás
T Marron	*T. pseudokoningii*	Goiânia, Goiás
T Nat AM	*T. harzianum*	Cruz das Almas, Bahia
T Nat BM	*T. harzianum*	Cruz das Almas, Bahia
T Nat CM	*T. koningii*	Cruz das Almas, Bahia
T Nat IR	*T. pseudokoningii*	Cruz das Almas, Bahia
T Rib	*Trichoderma* sp.	Ribeirópolis, Sergipe
T Solo I	*T. viride*	Cruz das Almas, Bahia
T Verde	*T. koningii*	Goiânia, Goiás

4.5 Socioeconomics

PROFISMA's extensive diagnostic was performed in 1994, with the participation of 1,652 cassava growers in Bahia, Ceará, Paraiba, and Pernambuco. During 1995, a questionaire was prepared as part of PROFISMA's intensive diagnostic survey. Surveys were conducted by either researchers or extensionists from CNPMF-EMBRAPA and state institutions. Survey data are still undergoing analysis. Results will be presented in PROFISMA's 1996 Annual Report.

PROFISMA conducted an extensive diagnostic survey in 1994 with the participation of 1,652 cassava growers in Bahia, Ceará, Paraíba and Pernambuco. During 1995, a questionnaire was prepared as part of PROFISMA's intensive diagnostic survey. The questionnaire was field tested in a cassava grower community (Cadete) and adjusted accordingly (Appendix II). The intensive survey was conducted by either researchers or extension workers from CNPMF-EMBRAPA and state agencies in 18 communities where

COPALs have been organized (Table 17) involving 21 cassava growers of each community as follows: 9 COPAL members; 6 non-COPAL members; and 6 cassava growers from the neighborhood of the community. A total of 378 cassava growers were surveyed. Survey data were collected over a 4 month period until December 1995. Data are undergoing analysis. Preliminary results indicate that leafcutter ants, hornworm and root rot are the most prevalent probelms of the cassava crop (Fig. 4.5.1).

Cassava distribution in Bahia, Ceará, Paraíba, and Pernambuco is concentrated in *agreste* or transition areas between the coast and the drier interior *caatinga* (Figure 4.5.2). In Bahia, cassava is concentrated in the *Recôncavo* region around Salvador. Survey data will be combined with population and crop distribution data to develop a weighted priority for pest and diseases based on incidence, severity, and population affected.

Table 17. Cassava intensive diagnostic of northeastern Brazil.

State	Municipality	Growers Community
Bahia	Inhambupe	Colônia
	Chapada	
	Buril	
	Cruz das Almas	Cadete
	Amargosa	Barra
	Piritiba	Caldeirão
	Sumaré	
	Feira de Santana	Umbuzeiro
Ceará	Ubajara	Nova Veneza
	Tianguá	Valparaiso
	Acaraú	Vila Moura
Pernambuco	S. Bento do Una	Tatu
	Araripina	S. da Boa Vista
	Vitória de S. Antão	Campina Nova
Paraiba	Alagoa Grande	Quitéria
	Alagoa Nova	Gameleira
	Salgado de S. Felix	Souza

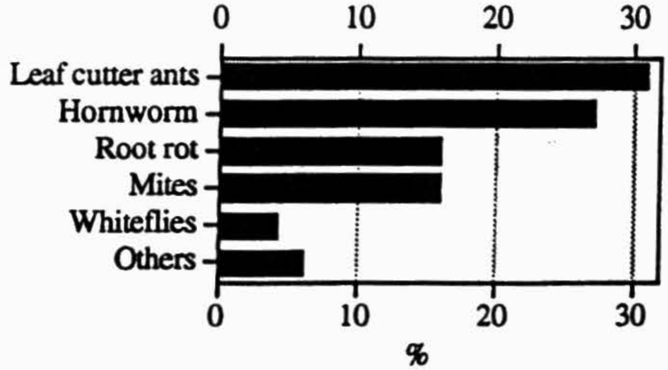

Figure 4.5.1 Importance of cassava pests and diseases as perceived by cassava farmers.

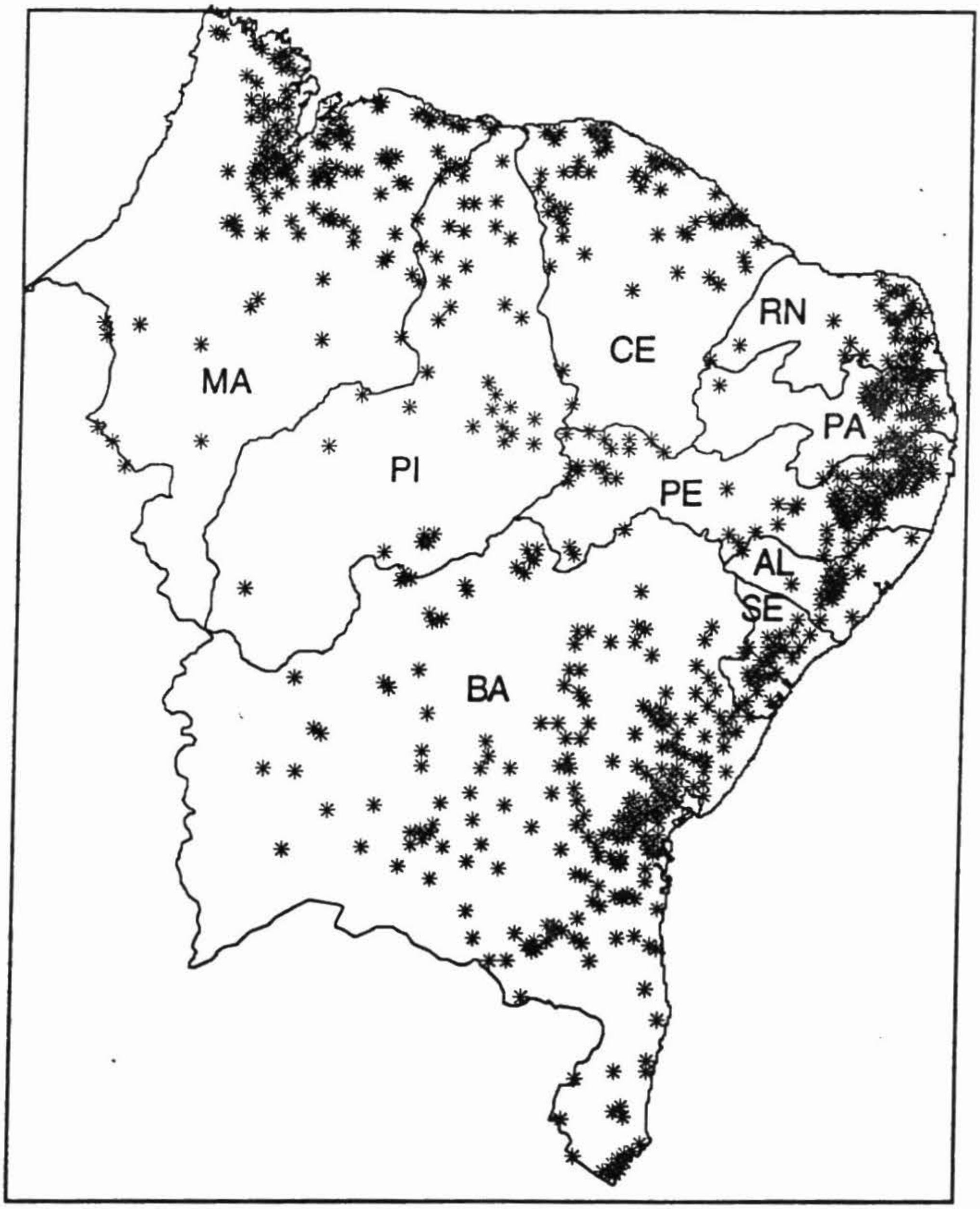

Figure 4.5.2 Distribution of cassava in northeastern Brazil. Each point = 1,000 ha of cassava. Data provided by the Agroecological Studies Unit, CIAT.

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INSTITUTIONAL ACRONYMS

CIAT....................Centro Internacional de Agricultura Tropical
CNPMA................Centro Nacional de Pesquisa de Monitoramento e Avaliação de Impacto Ambiental
CNPMF................Centro Nacional de Pesquisa de Mandioca e Fruticultura Tropical
CNPq...................Conselho Nacional de Desenvolvimento Científico e Tecnológico
CPATC.................Centro de Pesquisa Agropecuária dos Tabuleiros Costeiros
CPATSA...............Centro de Pesquiasa Agropecu[aria do Trópico Semi-Arido
EBDA...................Empresa Baiana de Desenvolvineto Agrícola
EMATER-CE..........Empresa de Assistência Técnica e Extensão Rural do Ceará
EMATER-PB..........Empresa de Assistência Técnica e Extensão Rural da Paraiba
EMATER-PE..........Empresa de Assistência Técnica e Extensão Rural do Pernambuco
EMBRAPA............Empresa Brasileira de Pesquisa Agropecuária
EMDAGRO............Empresa de Desenvolvimento Agropecuário de Sergipe
EMEPA.................Empresa Estadual de Pesquisa Agropecuária de Paraíba S/A
EPACE.................Empresa de Pesquisa Agrpecuária do Ceará
ESCaPP................Ecologically Sustainable Cassava Plant Protection
IFAD....................International Fund for Agricultural Development
IICA.....................Instituto Interamericano de Cooperacion para la Agricultura
IITA.....................International Institute of Tropical Agriculture
IPA......................Empresa Pernambucana de Pesquisa Agropecuária
PROFISMA............Proteção Fitossanitária Sustentável da Mandioca na América Latina e Africa
UFAL....................Universidad Federal de Alagoas
UFC......................Universidade Federal do Ceará

OTHER ACRONYMS

CGM	Cassava Green Mite (*Mononychellus tanajoa*)
CM	Cassava Mealybug (*Phenacoccus herreni*)
COPAL	Comité de Pesquisa Agricola Local
CVMV	Cassava Vein Mosaic Virus
CWBD	Cassava Witches' Broom Disease
FPR	Farmer Participatory Research

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Noronha, A. S., G. J. de Moraes e A. I. Ciocioloa. 1995. Biologia de *Ambliseius limonicus* Garman; McGregar s. l. sobre *Mononychellus tanajoa* (Bondar) (Acari:Phytoseiidae, Tetranychidae) em variedades de mandioca. Anais da Sociedade Entomologica do Brasil 24(2): 305-313.

Noronha, A. S., G. J. de Moraes e A. I. Ciocioloa. 1995. Biologia de *Mononychellus tanajoa* (Bondar) (Acari:Tetranychidae) em variedades de mandioca. Anais da Sociedade Entomologica do Brasil 24(3):489-494.

Noronha, A. S., G. J. de Moraes, P. C. L. de Carvalho, J. E. B de Carvalho e A. M. M. Eloy. Artrópodos associados as plantas daninhas na cultura da mancioca. Anais do XV Congresso Brasileiro de Entomologia (in press).

Noronha, A. S. e G. J. de Moraes. Observações preliminares sobre *Amblyseius manihoti* Moraes (Acari:Phytoseiidae) alimentando-se de mosca branca em mandioca. Anais da Sociedade Entomológica do Brasil (in press).

Noronha, A. S., G. J. de Moraes, e L. Smith. Introdução de ácaros predadores da família Phytoseiidae para o controle biiológico do ácaro verde da mandioca *Mononychellus tanajoa* (Bondar) no Nordeste do Brasil. Pesquisa em Andamento, EMBRAPA-CNPMF (in press).

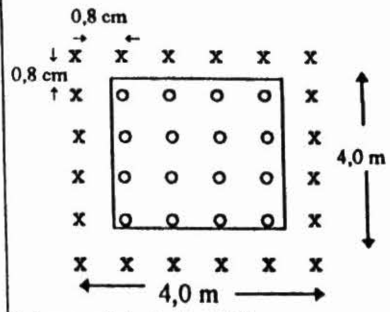
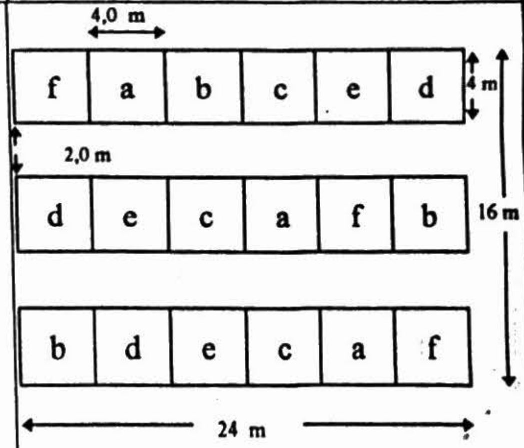
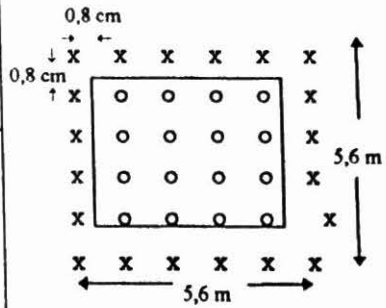
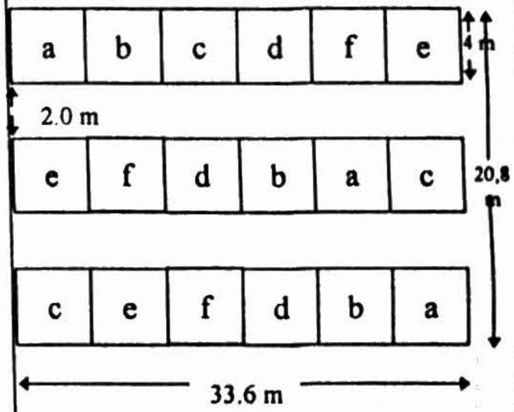
Vale, C.C., J. A. A. Lima, L. A. Calvert e A. E. B. A. Sousa. 1995. Polymerase chain reaction for identification of plants infected with cassava vein mosaic virus. In: Virológica, Ribeirão Preto, Brasil. (Resumo).

Vale, C.C., J. A. A. Lima, L. A. Calvert e A. E. B. A. Sousa. 1995. Detecção do DNA do micoplasma do superbrotamento da mandioca através de polymerase chain reaction. Fitopatol. bras. 20: 325 - 326. (Resumo).

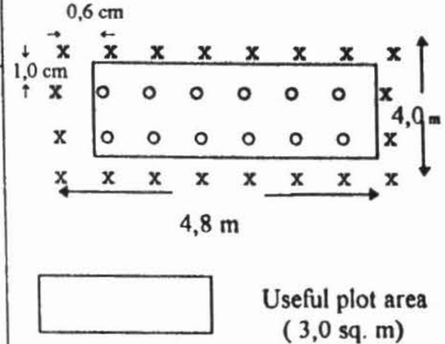
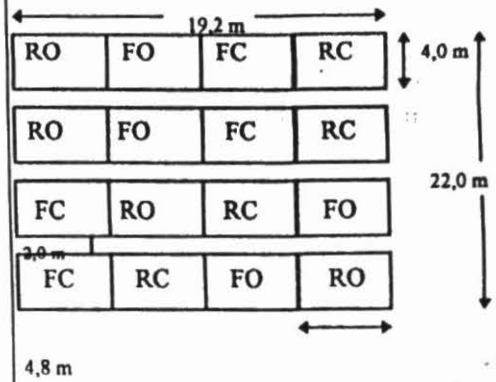
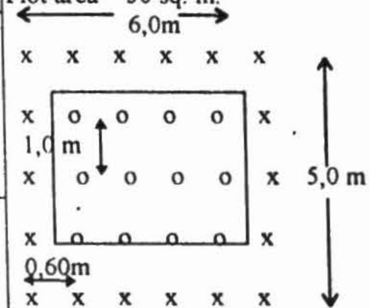
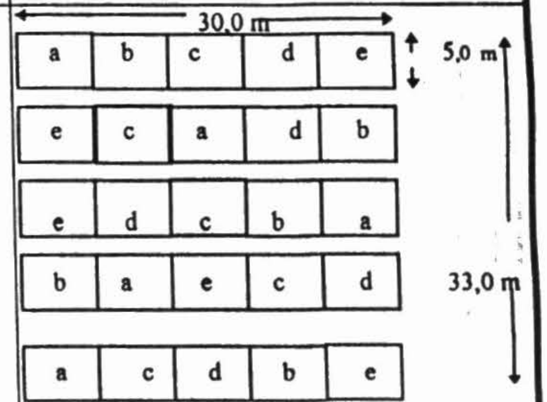
Appendix I

Participatory Technology Evaluation Trials installed by Community Agricultural Research Committees (COPALs) during 1995 in Bahia, Pernambuco, Paraíba, and Ceará, Brazil.

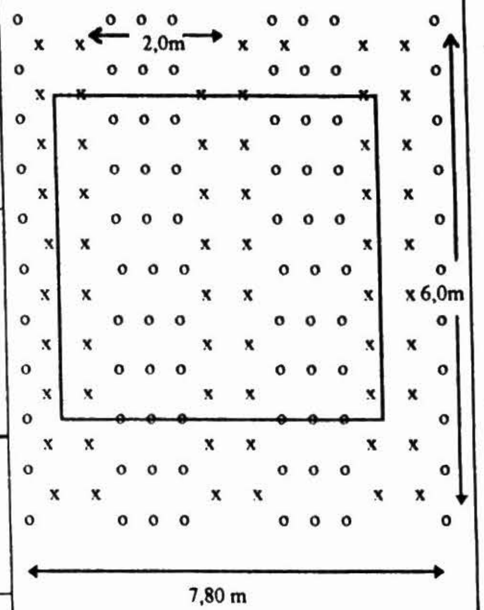
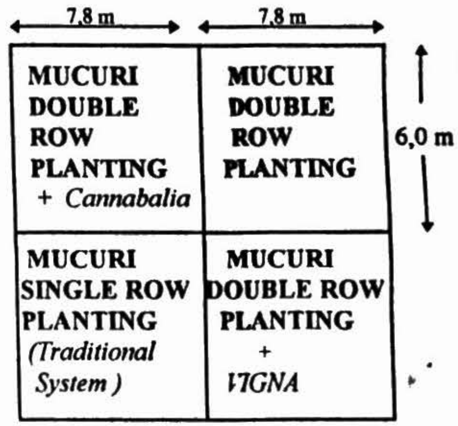
Technology tests installed in State of Bahia.

<table>
<tr><th>Munnicipality</th><th>Prioritized problems</th><th>Experiment</th><th>Experimental Design</th><th>Experimental Plot</th><th>Experimental Block</th></tr>
<tr>
<td>Inhambupe
COPAL:
Colonia Agricola Roberto Santos
Planting date: 06/06/95</td>
<td>1- lack of credit
2. Innapropriate use of fertilizers
3..Mononychellus tanajoa (CGM)
4. Erinnyis Ello
5. Ants</td>
<td>Evaluation of six cassava cultivars for CGM resistance</td>
<td>Randomized Blocks;
Five Treatments:
Varieties:
a. Cravelão
b. Bom Jardim
c. Voadeira
d. Barrinha
e. Branca laite
One Check:
Variety:
f. Platina
Three repetitions</td>
<td>Plot area = 16 m²

(o) = useful plants (16);
(x) =border plants (20)
Useful plot area= 5,76 sq. m</td>
<td>
Total Block Area = 96 sq.m.
Total Trial Area = 384 sq.m.</td>
</tr>
<tr>
<td>Crisópolis
COPAL:
Buril
Planting date: 16/06/95</td>
<td>1- Cassava root rot
2. Mononychellus tanajoa(CGM)
3 Inapropriate use of fertilizers
4. Lack of alternative uses and markets for cassava sub-products</td>
<td>Evaluation of six cassava cultivars (2 local and four introduced from CNPMF) for CGM resistance</td>
<td>Randomized Blocks;
05treatments:
Local Varieties:
a. Platina
f. Jalé
Introduced varieties:
b. Osso Duro
c. 128/08
d. 47/19
e. Maria Pau 118Local
03 blocks</td>
<td>Plot area = 31,6 sq. m.

Useful plot area (5,76 sq. m)
o = useful plants
x = border plants</td>
<td>
Total block area: 188,16 sq.m
Total trial area+ 698,88 sq.m.</td>
</tr>
</table>

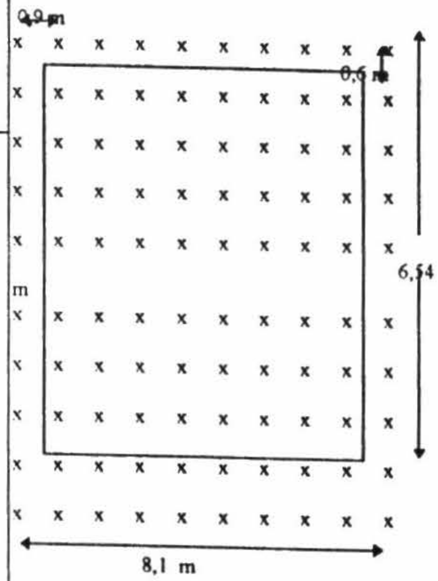
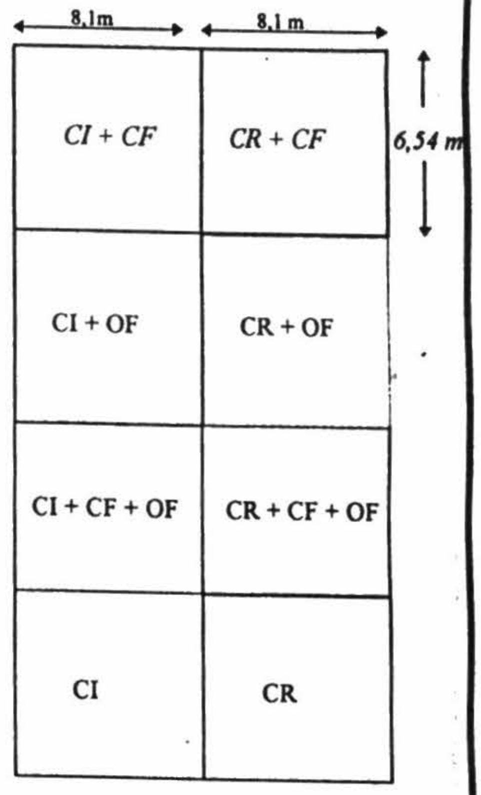
Technology tests installed in the State of Bahia

Municipality	*Prioritized problems*	Experiment	*Experimental Design*	*Experimental Plot*	*Experimental Block*
Aporá ***COPAL:*** **Chapada** **Planting date: 10/06/95**	**1- Cassava Root rot** 2. *Mononychellus tanajoa* (Acaro verde da mandioca) 3. Innapropriate use of fertilizers 4. Lack of farinha "flour houses"	1. Effect of cultural practicess on the control of Cassava Root rot	Randomized Blocks; ***Two varieties***: one susceptible (Cemitério) and one tolerant (Osso Duro) **Four treatments**: 1. Ridges planting with cultivar Össo Duro" (RO) 2. Ridges planting with cultivar "Cemitério" (RC) 3. Flat planting with cultivar "Osso Duro" (FO) 4. Flat planting with cultivar "Cemitério" (FC) **Four repetitions**	Plot area = 19,2 sq. m.  o = useful plants (12) x = border plants (20)	 Total Block Area = 19,2 sq. m.. Total Trial Area = 422,4 sq. m.
Planting date: 21/06/95		2. Evaluation of resistance to cassava root rot of 25 seedlings introduced from CNPMF	Randomized Blocks; ***Twenty five varieties***: **Two repetitions**	Ten plants per cultivar; planting distances: 1,0 x 0,6 m	Total Block Area = 150 sq. m. Total experimental area = 450 sq. m.
São Miguel das Matas COPAL: Barra **Planting date: 10/07/95**	**1. Whiteflies (*Aleurothrixus aepim*)** 2. Lack of credit 3. Lack of machinery 4. Lack of technical assistance 5. Ants	Evaluation of five cultivars (2 local and 3 introduced from CNPMF) for whitefly resistancxe (*Aleurothrixus aepim)*. Total block area ; 150 sq.m. Total trial area: 900 sq.m	Randomized blocks **05 treatments:** Varieties: a. 192/13 b. 128/8 d. São José e. 189/11 **01 Check:** Local variety: c. Corrente **05 repetitions** Useful plot area (12 sq. m.)	Plot area = 30 sq. m.  o = useful plants (12) x = border plants (20)	

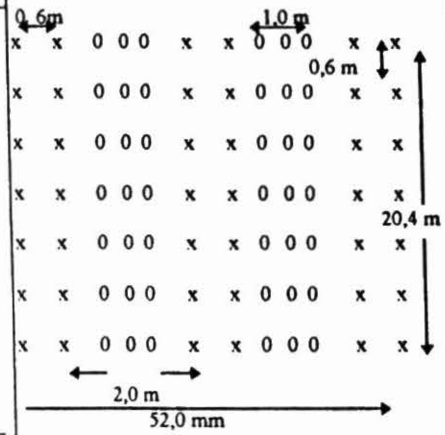
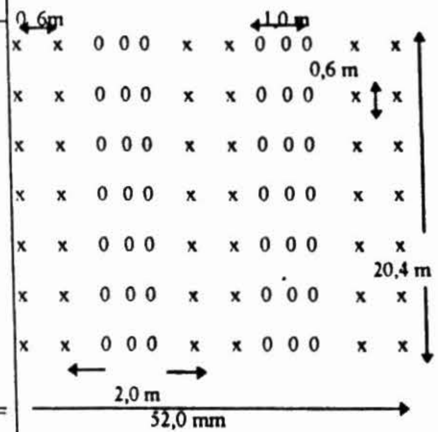
Technology tests installed in the State of Bahia.

Munnicipality	*Prioritized problems*	Experiment	*Experimental Design*	*Experimental Plot*	*Experimental Block*
Anguera COPAL: Umbuzeiro **Planting date:** **14/08/95**	1.Lack of resources **2.Poor soils and lack of fertilizers** 3. Lack of land 4. Lack of alternative uses for cassava leaves and stems 5. Pests and diseases: (*Mononychellus tanajoa, Erinnyis ello)* and cassava roots rot.	Effect of jack bean and cow pea bean intercrop in single and double rows on soil fertility and root	Randomized blocks **04 treatments:** 1. **Cassava variety:** Mucuri ; double rows planting **Legume:** *Cannabalia* 2. **Cassava variety**: Mucuri ; double rows planting **Legume:** *Vigna* 3. **Cassava variety**: Mucuri; double rows planting 4. **Cassava variety:** Mucuri single row planting (Traditional system) 03 repetitions (in three different locals)	Plot area = 46,80 sq. m.  x = cassava ; o = legume Useful area = 19,8 sq. m Cassava planting distances: (0,60 x 0,60 m) Legume planting distances : (0,50 x 0,50 m)	 Total Experimental Area = 187,2 sq. m.

Technology tests installed in the State of Bahia

Munnicipality	*Prioritized problems*	Experiment	*Experimental Design*	*Experimental Plot*	*Experimental Block*
Cruz das Almas COPAL: Cadete **Planting Date :** **15/08/95**	1.Pests (*Eryinnis Ello, Ants and Bemiscia Tabascis)* **2.Poor soils and lack of fertilizers** 3. Drought 4. Cassava Roots Rot.	Effect of cultivars, and fertilizers (organic and chemical) on soil fertiity and cassava yield.	Randomized blocks Two varieties: Cigana (CI) and Cidade Rica(CR) 08 treatments: **T1:** CI + Chemical Fertilizer (CF) **T2:** CI + Organic Fertilizer (OF) **T3:** CI + CF + OF **T4:** CI without fertilizer **T5:** CR + CF **T6:** CR + OF **T7:** CR + CF + OF **T8:** CR without fertilizer 03 repetitions (in three different locals with different soil characteristics)	Plot area = 52,97 sq. m.  Cassava planting distances: (0,90 x 0,60 m) Useful plot area = 34,5 sq.m	 Total Experimental Area = 1271,2 sq. m.

Technology tests installed in the State of Bahia

Municnicipality	*Prioritized problems*	Experiment	*Experimental Design*	*Experimental Plot*	*Experimental Block*
Piritiba COPAL: **Caldeirão** **Planting Date :** **07/04/95**	1. Drought 2. Lack of machinery **3. .Poor soils and lack of fertilizers** 4. Lack of tehcnical assisance. 4. Lack of land.	Production of high quality planting material using fertilizer & cow pea intercrop.	One block One local variety: Oulho Roxo Legume: Cow pea macassar Fertilizer rate: Superpfosphatus simple =100 kg/ha Potassium chlorate = 50 kg/ha Ureia = 50 kg/ha	 Total experimental area= 1,060.8 sq.m.	**Cassava planting distances: (2.0 x 0,60 x 0,60 m)** **Legume planting distances: (0,5 x 0,2 m)**
Piritiba COPAL: **Sumaré** **Planting Date :** **06/04/95**	1. Drought 2. Whiteflies *(Aleurothrixus aepim)* 3. Lack of financial resources 4. Poor soils 5. Lack of land.	Production of high quality planting material using fertilizer & cow pea intercrop.	One block One local variety: Oulho Roxo Legume: Cow pea macassar Fertilizer rate: Superpfosphatus simple =100 kg/ha Potassium chlorate = 50 kg/ha Ureia = 50 kg/ha	 Total experimental area= 1,060.8 sq.m	Cassava planting distances: (2.0 x 0,60 x 0,60 m) Legume planting distances: (0,5 x 0,2 m)

Technology tests installed in the State of Ceará

<table>
<tr><th>Municipality</th><th>Prioritized problems</th><th>Experiment</th><th>Experimental Design</th><th>Experimental Plot</th><th>Experimental Block</th></tr>
<tr>
<td>Acaraú

COPAL:

Vila Moura

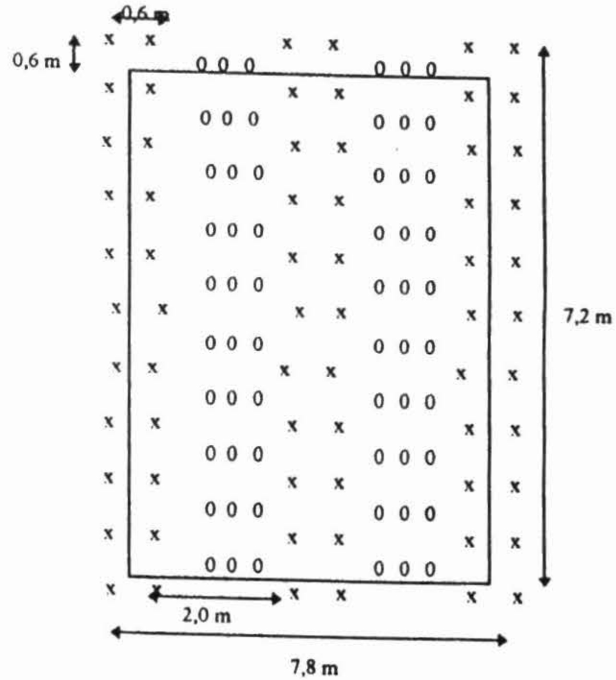
Planting date:

17/02/95</td>
<td>1. Lack of land
2. Lack of financial resources
3. Erynnis ello
4. Cassava roots rot

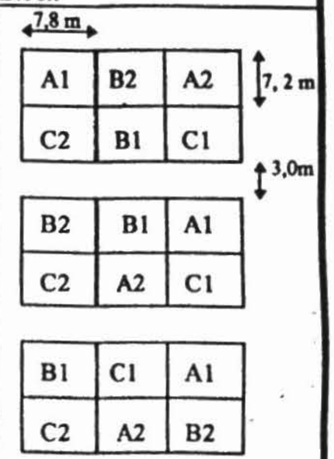
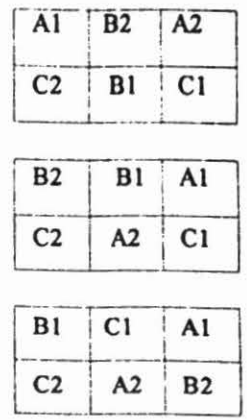
5. Lack of fertilizers.</td>
<td>Effect of organic fertilizers (OF) on yield in double rows with intercrops (jack bean & velvet bean) rows.

Two local varieties: <u>Fragosa</u> and <u>Geraldo Lopes</u></td>
<td>02 Experiments; Randomized blocks

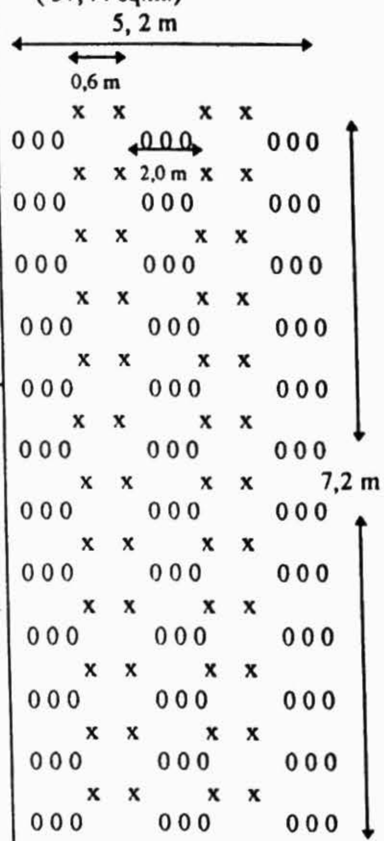
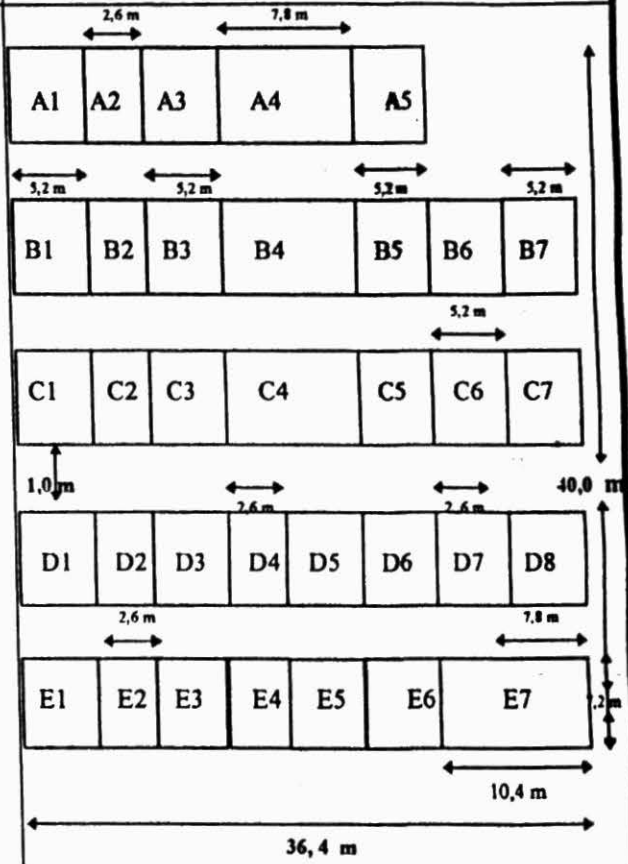
06 treatments:
<u>A1</u>. : Cassava + CE + OF
<u>A2</u>. : Cassava + CE
<u>B1.</u> Cassava + MP + OF
<u>B2.</u> Cassava + MP
<u>C1.</u> Cassava + OF
<u>2.</u> Cassava

03 Repetitions</td>
<td>Plot area = 56,16 sq. m.

Useful experimental area = 31,2 m
0000 = legumes
XXXX = cassava

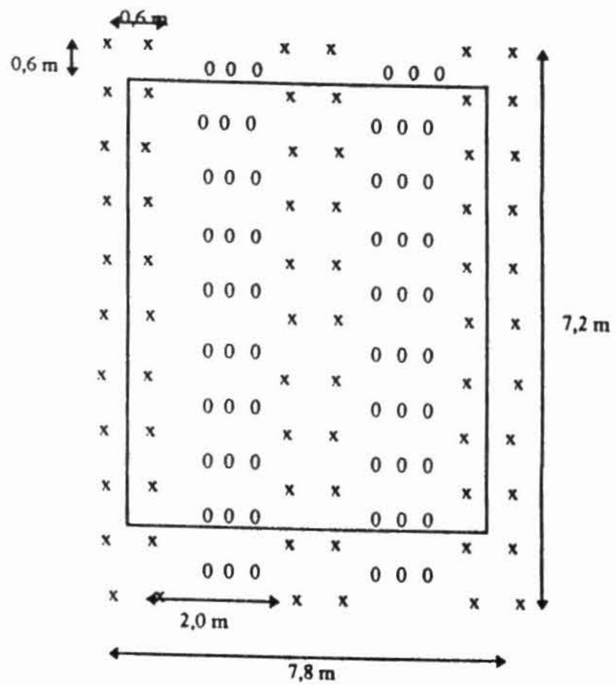
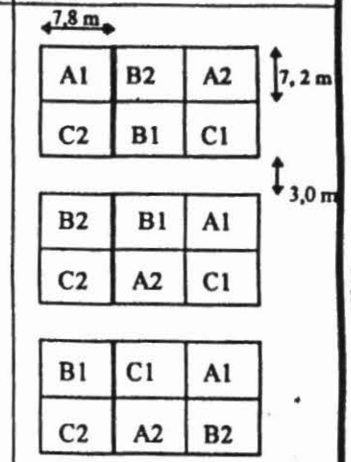
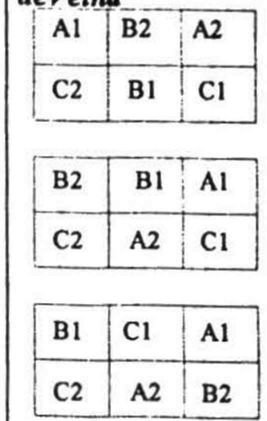
Planting distances cassava = 2.0 m x 0,6 x 0,6 m

Legumes = 0,20 x 0,20 m</td>
<td>
Experiment 1
Cultivar : Geraldo Lopes

Experiment 2 ;
Cultivar: Fragosa
Total Experimental Area
2.450,1 sq. m.</td>
</tr>
</table>

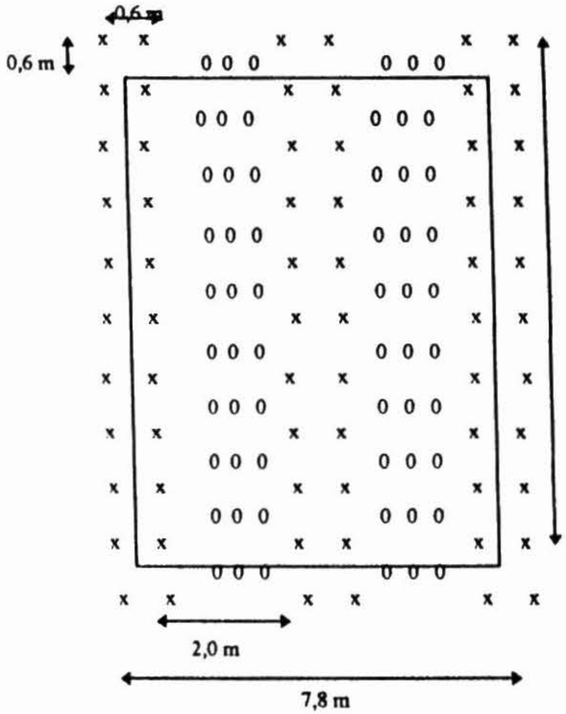
Technology tests installed in the State of Ceara

Munnicipality	*Prioritized problems*	Experiment	*Experimental Design*	*Experimental Plot*	*Experimental Block*
Acarau **COPAL: Lagoa Grande** **Planting Date:** **03/03/95**	1. Lack of financial resources 2. Lack of markets and minimum prices policies for agricultural products. 3. Poor soils and lack of use of fertilizers 4. *Erynnis ello* 5. Cassava roots rot.	Evaluation of 21 sweet cassava cvs. in double rows & 6 legume intercrops *Cassava varieties:* 1. Agua Morna folha estreita 2. Macaxeira preta 3. Agua Morna folha larga 4. Madrugada 5. Manteiga 6. Pão de Chile 7. Cacau 8. Aciolina 9. Pao de Cheiro 10. Casca Roxa 11. Pão de Chile local 12. Jaburú 13 Abacate 14. Paraguay 15. CL-84 16. Rosa 17. Pão de Chile 18. Tataibura 19. Paraense 20. Branca 21. Franco Rabelo ***Legumes:*** *A Colapogone* *B Mucuna Ralada* *C Mucuna Preta* *D. Cannabalia Ensiformis* *E Cunhá* ***F. Crotalaria Juncea***	Single blocks **34 treatments:** **A1:** Var. (1) + A **A2:** Var. (1) + B **A3:** Var. (1) + C **A4:** Var. (1) + D **A5:** Var. (1) + E **B1:** Var. (2) + A B2: Var. (3) + B **B3:** Var. (3) + C B4: Var. (3) + D **B5:** Var. (3) + E **B6:** Var. (4) + F **B7:** Var. (5) + F **C1:** Var. (6) + A C2: Var. (6) + B **C3:** Var. (6) + C C4: Var. (7) + D **C5:** Var. (8) + E **C6:** Var. (9) + F **C7:** Var. (10) + F **D1:** Var. (11) + A D2: Var. (11) + B **D3:** Var. (11) + C D4: Var. (12) + D **D5:** Var. (13) + D **D6:** Var. (14) + E **D7:** Var. (15) + F **D8:** Var. (16) + F **E1:** Var. (17) + A E2: Var. (17) + B **E3:** Var. (18) + C E4: Var. (19) + D **E5:** Var. (20) + D **E6:** Var. (21) + E **E7:** Var. (22) + F	Experimental block area = (37,44 sq.m.)  Legume planting distances = (0,17 x 0,20 m) Cassava planting distances = (2,0 x 0,6 x 0,6 m)	 **Total Experimental Area = 1.454,0 sq. m.**

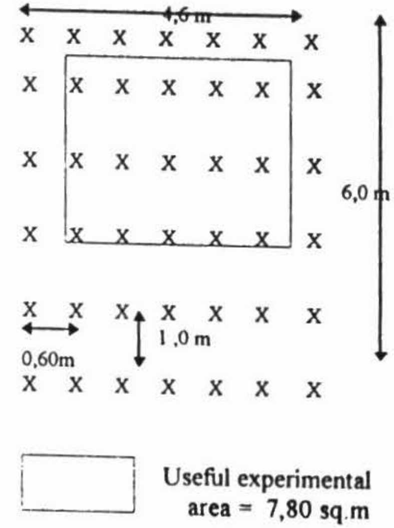
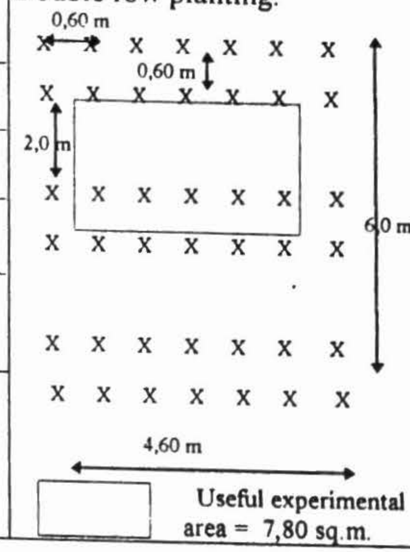
Technology tests installed in the State of Ceara.

Municipality	*Prioritized problems*	Experiment	*Experimental Design*	*Experimental Plot*	*Experimental Block*
Tiangua COPAL: **Valparaiso** **Planting date:** **22/02/95**	1. Lack of land 2. Lack of financial resources 3. *Erynnis ello* 4. Cassava roots rot 5. Lack of fertilizers.	Effect on yield of organic fertilizer & intercrops (*Crotalaria & Viagna)* Two varieties: **Cabelo de Velha** (Variedade Local) and **8709-02** (Variedade Introducida from CNPMF/Embrapa	02 Experiments; Randomized blocks **06 treatments:** **A1.** : Cassava + VU + OF **A2.** : Cassava + VU **B1.** Cassava + CJ + OF **B2.** Cassava + MP **C1.** Cassava + OF **C2.** Cassava 03 Repetitions	Plot area = 56,16 sq. m.  Useful experimental area = 31,2 sq. m. 0000 = legumes xxxx = cassava Planting distances cassava = 0,6 x 0,6 m Planting distances Legumes = 0,20 x 0,20 m ***Total Experimental Area = 2.450,1 sq. m***	 ***Experiment 1*** ***Cultivar: Cabelo deVelha***  ***Experiment 2 ;*** ***Cultivar: 8709-02.***

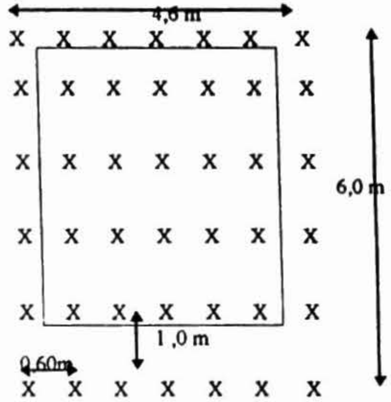
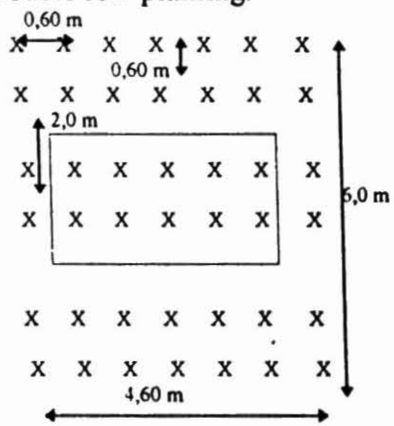
Technology tests installed in the State of Ceará

Municipality	*Prioritized problems*	Experiment	*Experimental Design*	*Experimental Plot*	*Experimental Block*
Ubajara COPAL: **Nova Veneza** **Planting Date:** **23/02/95**	1.Lack of financial resourcesland 2. Lack of machinery for land preparation 3. Lack of cassava planting materia 4.Cassava witches broom (Super-brotamento da mandioca) 5. Drought.	Effect of organic fertilizer (OF) and intercrops in double rows on soil fertility & yield of 2 cvs. (1 local, 1 from CNPMF Varieties: **Cruvela** and **Bujá Preta**	02 Experiments; Randomized blocks **06 treatments:** **<u>A1</u>. :** Cassava + VU + OF **<u>A2</u>**. : Cassava + VU **<u>B1.</u>** Cassava + CJ + OF **<u>B2.</u>** Cassava + MP **<u>C1.</u>** Cassava + OF **<u>C2.</u>** Cassava 03 Repetitions	Plot area = 56,16 sq. m.  Useful experimental area = 31,2 m 0000 = legumes xxxx = cassava Planting distances cassava = 2.0 x 0,6 x 0,6 m Legumes = 0,20 x 0,20 m ***Total Experimental Area = 2.450,1 sq. m.***	7,8 m; 7,2 m; 3,0 m A1 B2 A2 / C2 B1 C1 B2 B1 A1 / C2 A2 C1 B1 C1 A1 / C2 A2 B2 ***Experiment 1*** ***Cultivar: Cruvela*** A1 B2 A2 / C2 B1 C1 B2 B1 A1 / C2 A2 C1 B1 C1 A1 / C2 A2 B2 ***Experiment 2 ;*** ***Cultivar: Bujá Preta-02***

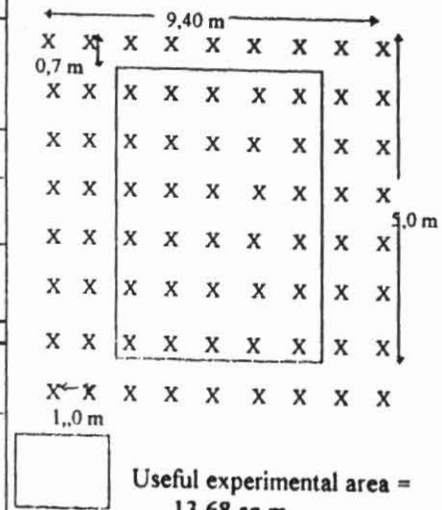
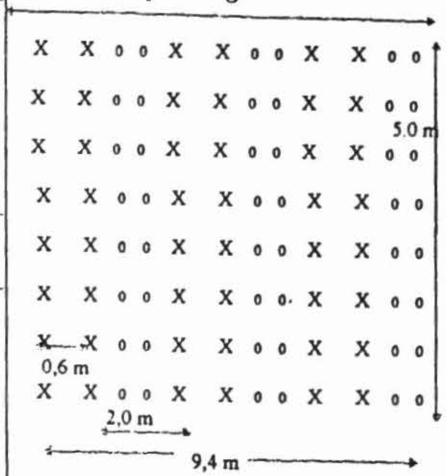
Technology tests installed in the State of Pernambuco

Munnicipality	*Prioritized problems*	Experiment	*Experimental Design*	*Experimental Plot*	*Experimental Block*
Vitória de Santo Antão **COPAL: Campina Nova** **Planting Date:** **21/06/95**	1. Cassava root rot 2. *Phenacoccus Herreni* 3. Macheio 4. Lack of fertilizers 5. Ants	Evaluation of 3 cvs. & cultural practices on root rots One local variety: **Retroz (L)** Two Varieties introduced as resistant: **Cambadinha(I1) and Chapéu de Couro (I2)** Single row planting (SR) Double Row planting (DR) Ridge planting (RP)	01 Experiments; 03 repetitions; Randomized blocks **12 treatments:** **01.** : L1 + SR **02.** : I1 + SR **03:** I2 + SR **04.** L1 + Lime **05:** L1 + RP **06:** L1 + DR **07** : I1 + lime **08 :** I1 + RP **09 :** I1 + DR **10:** I2 + Lime **11 :** I2 + RP **12:** I2 + DR	Single row planting: Plot area = 27,60 sq. m.  Useful experimental area = 7,80 sq.m Double row planting:  Useful experimental area = 7,80 sq.m.	**Repetition I (Severino Cristovam de Melo's farm)** 6 m: 08 | 03 | 05 | 07 | 04 | 06 4,6 m; 27,6 m; 2,0 m 6 m: 02 | 12 | 01 | 11 | 10 | 09 **Total Experimental Area I = 386,4 sq.m.** **Repetition II (João Antônio Silva's farm)** 04 | 07 | 01 | 05 | 09 | 02 11 | 03 | 10 | 06 | 12 | 08 **Total experimental area II = 386,4 sq.m** **Repetition III (Manoel Soares's farm** 10 | 07 | 02 | 08 | 06 | 03 01 | 09 | 11 | 05 | 12 | 04 **Total experimental area III = 386,4 sq. m.** Total experimental area = 1159,2 sq.m

Technology tests installed in the State of Pernambuco

Munnicipality	*Prioritized problems*	Experiment	*Experimental Design*	*Experimental Plot*	*Experimental Block*
Gloria de Goitá **COPAL: Gamileira** **Planting date:** **03/08/95**	1. Cassava root rot 2. Lack of financial resources 3. Lack of machinery 4. Low prices for "farinha de mandioca" 5. Mandarová	Evaluation of planting systems & 4 cvs. on root Two local varieties: **Tuninha (L1)** and **Roxinha(L2)** Varieties introduced as resistant: **Dona Cosma(I1)** and **Flor de Amazonas (I2)** Single row planting (SR) and Double row planting (DR)	01 Experiments; 03 repetitions; Randomized blocks **16 treatments:** **01.** : L1 + SR **02.** : L2 + SR **03:** I1 + SR **04.** I2 + SR **05:** L1 + lime +SR **06:** L2 + lime +SR **07** : I1 + lime +SR **08 :** I2 + lime +SR **09** : L1+Sulfur+SR **10:** L2+Sulfur SR **11** : I1+Sulfur + SR **12:** I2 +Sulfur +SR **13:** T1+Sulfur +DR **14:** T2+Sulfur +DR **15:** I1+Sulfur +DR **16:** I2+Sulfur +DR	Single row planting: Plot area = 27,60 sq. m.  Useful experimental area = 7,80 sq.m Double row planting:  Useful experimental area = 7,80 sq.m.	**Repetition I (Jose Vicente's farm)** 6 m: 13 | 09 | 07 | 15 | 12 | 08 | 06 | 02 4.6 m; 2,0 m; 27,6 m 6 m: 11 | 03 | 16 | 05 | 01 | 04 | 14 | 10 Total Experimental Area I = 525,2 sq.m. Repetition II (Carlos's farm) 16 | 07 | 14 | 12 | 15 | 10 | 02 | 13 01 | 05 | 11 | 04 | 06 | 09 | 03 | 08 Total experimental area II = 525,2 sq.m Repetition III (Anastacio's farm) 04 | 07 | 10 | 14 | 01 | 05 | 12 | 03 09 | 15 | 13 | 02 | 08 | 11 | 16 | 06 Total experimental area III = 525,2 sq. m. Total experimental area = 1575,6 sq.m.

Technology tests installed in the State of Pernambuco

Munnicipality	*Prioritized problems*	Experiment	*Experimental Design*	*Experimental Plot*	*Experimental Block*
São Bento de Una **COPAL:** **Tatú** **Planting date:** 06/06/95	1. Lack of fertilizers 2. Lack of animal traction for land preparation 3. Low prices for "farinha de mandioca" 4.. Lack of land	Yield trial of 4 cvs. with velvet bean Two local varieties: **Pai Antônio (L1)** and **Isabel de Souza (L2);** Two varieties introduced as resistant: **Dona Cosma (I1)** and **Flor de Amazonas (I2)** Single row planting (SR); Double row planting (DR); Intercropping with Mucuna Preta (MP); **Total experimental area = 1931,7 sq.m.**	01 Experiments; 03 repetitions; Randomized blocks **12 treatments:** **01. :** L1 + SR **02.** : L2 + SR **03:** I1 + SR **04.** I2 + SR **05:** L1+ DR + MP **06:** L1+ SR + MP **07** : L2 + DR+ MP **08 :** L2 + SR+ MP **09 :** I1+ DR + MP **10:** I1+SR + MP **11 :** I2+ DR + MP **12:** I2 + SR + MP	**Single row planting:** Plot area = 47,0 sq. m.  Useful experimental area = 13,68 sq.m. **Double row planting**  ooo = Mucuna Preta (MP) Legume planting distances= 0,5 x 0,2 m Useful experimental area = 12,96 sq.m	**Repetition I (João Oliveira Sales's farm)** 05 12 06 01 02 07 9,4m 1,5 m 56,4 m 11 04 03 08 09 10 **Total Experimental Area I = 648,6 sq.m.** **Repetition II (João Severo's farm)** 10 07 02 08 06 03 01 09 11 05 12 04 **Total experimental area II = 648,6 sq.m** **Repetition III (José Pimenta's farm)** **Total experimental area III = 634,5 sq.m.** 01 02 11 09 10 04 07 05 12 03 06 08

Appendix II

Intensive Diagnostic Survey Questionnaire applied by PROFISMA in four states of northeastern Brazil in 1995.

Projeto Proteção Fitossanitária Sustentável da Mandioca no Nordeste do Brasil: Bahia. Pernambuco, Ceará e Paraíba

Perfil dos Produtores de Mandioca

Área da Pesquisa

Comunidade :__________________

Município :__________________

Região :__________________

Estado :__________________

Beneficiário :__________________________________

Entrevistador :__________________________________

Data da entrevista: ____/____/____

Assinalar com X o agricultor que:

1. Participa do COPAL ☐
2. Reside na comunidade e não participa do COPAL ☐
3. Mora na periferia da comunidade ☐

1. IDENTIFICAÇÃO DO PRODUTOR:

1.1 Nome: ______________________________

1.2 Há quantos anos reside na região? ☐☐ anos.

1.3. Onde o Sr. morava antes de vir para a região?

______________ ______________

(cidade) (estado)

1.4 Que atividade o Senhor exercia antes de ser agricultor?

____

1.5 Principal atividade econômica do produtor.

1. ☐ Agrícola no imóvel

2. ☐ Agrícola fora do imóvel

3. ☐ Não Agrícola

Se não agrícola, qual? ______________

2. LOCALIZAÇÃO DA PROPRIEDADE

2.1 Município: ______________________ ☐☐

2.2 Distrito: ______________________

2.3 Comunidade: ______________________ ☐☐

2.4 Distância da sede do município (em km): __________

2.5 Itinerário: ______________________

____

____

2.6 Acesso à propriedade da sede do município:

Estrada asfaltada: _____ km, Estrada de chão: _______ km

Estrada de piçarra: _____ km, Ramal: _______ km

3. COMPOSIÇÃO, EDUCAÇÃO, LOCAL DE RESIDÊNCIA E TRABALHO FAMILIAR

Nome /1	Posição na Família /2	Sexo		Idade	Instrução				Residência		Trabalho (em %)	
		Masc	Fem		Série	Grau	Estuda?	Analfabeto	No campo	Na cidade	No imóvel	Fora do imóvel
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												
9.												
10.												
11.												
12.												
13.												
14.												
15.												

/1 - começar pelo proprietário

/2 - chefe, esposa, filho, genro, nora, mãe, etc...

4. INVENTÁRIO DA PROPRIEDADE

4.1 Informe a unidade de medida de área adotada pelo produtor:

Nome: ________________ código:

4.2 Informe a equivalência em ha da unidade de área.............. □□ . □□□

4.3 Área da Propriedade

Própria (título definitivo).. □□□.□

Outros títulos de posse .... □□□.□

Tomada em arrendamento.. □□□.□

Sem documentação.. □□□.□

TOTAL.. □□□.□

a) Parceria

Se tem parceiros indique o número de parceiros: □□

Área total cedida em parceria: □□.□

Formas de parceria mais comuns: ____

____

____

b) Outras áreas da propriedade

Área cedida em arrendamento.................................... □□□.□

Áreas tomada em parceria.. □□□.□

Se tem área tomada em parceria, indique as formas mais comuns:

____

____

____

4.4 Uso da terra

Uso	Área
Culturas (anuais e perenes)	☐☐.☐
Campo nativo	☐☐.☐
Pastagem cultivada	☐☐.☐
Capoeira	☐☐.☐
Mata	☐☐.☐
Varzeas	☐☐.☐
Área improdutiva	☐☐.☐

4.5 Valor da Terra:

Se o Sr. fosse comprar uma propriedade igual a esta sua, quanto seria capaz de pagar?

(terra nua - sem benfeitorias). R$ ☐☐☐☐☐☐☐

4.6 Valor dos bens de capital. (R$ 1,00)

Casas	☐☐☐☐☐☐
Máquinas e equipamentos	☐☐☐☐☐☐
Veículos	☐☐☐☐☐☐
Armazéns e galpões	☐☐☐☐☐☐
Estábulos, pocilgas, aviários	☐☐☐☐☐☐
Cercas	☐☐☐☐☐☐
Instalações elétricas	☐☐☐☐☐☐

4.7 Culturas (inclusive consórcios)

Especificação	Código	Área	
		Cultivada	Colhida
	□□□□□	□□□.□	□□□.□
	□□□□□	□□□.□	□□□.□
	□□□□□	□□□.□	□□□.□
	□□□□□	□□□.□	□□□.□
	□□□□□	□□□.□	□□□.□
	□□□□□	□□□.□	□□□.□
	□□□□□	□□□.□	□□□.□
	□□□□□	□□□.□	□□□.□
TOTAL		□□□.□	□□□.□

OBS.: Na coluna Especificação escreva o nome da cultura isolada ou das culturas consorciadas. Ex.

1. Mandioca
2. Mandioca x Milho
3. Feijão x Milho

5. DESPESAS E RECEITAS

5.1. Despesa

5.1.1. Compra de Insumos

Item	Unidade	Quantidade total adquirida	Quant. usada na mandioca	Valor Total (R$ 1,00)	Época de compra (mes/ano)
Mudas					
Manivas					
Sementes:					
Adubos Orgânicos:					
Estercos					
Outros:					
Inseticidas (Formicidas)					
Fungicidas					
Herbicidas					
Outras Despesas:					
TOTAL				□□□□□	

5.1.2. Compras de animais

ESPECIFICAÇÃO	Nº	Época de Compra	Valor total (R$ 1,00)
Ovinos			
Caprinos			
Bovinos			
Suínos			
Equinos			
Muares			
Aves			
Total Geral			□□□□□

5.1.3 Despesas com Mão-de-Obra assalariada permanente

Tipo	Quantidade	Salário total anual (R$1,00)	Vantagens adicionais (tipo e valor anual)				Despesa Total anual (R$ 1,00)	Valor p/ a mandioca (R$ 1,00)
			Alimentação	Casa	Outras	Total (R$ 1,00)		
Homens			□	□	□			
Mulheres			□	□	□			
Crianças			□	□	□			
TOTAL							□□□□	□□□□

5.1.4. Despesas com Mão-de-Obra assalariada temporária

Tipo	Nº de diárias pagas na safra	Valor total anual (R$1,00)	Vantagens adicionais(tipo e valor anual)				Despesa Total Anual (R$ 1,00)	Valor p/ a mandioca (R$1,00)
			Alimentação	Casa	Outras	Total em (R$ 1,00)		
Homens			□	□	□			
Mulheres			□	□	□			
Crianças			□	□	□			
Total							□□□□	□□□□

5.1.5. Mão-de-obra assalariada temporária: Indique as principais atividades que usam mão-de-obra temporária, o número de pessoas envolvidas e a época em que essa mão-de-obra é utilizada

Atividades desenvolvidas	Nº de pessoas	Época	Observações

5.1.6. Despesas gerais

Especificação	Valor total anual (R$1,00)	Valor para a mandioca (R$1,00)
Aluguel de trator		
Aluguel de outras máquinas		
Peças e acessórios		
Combustíveis		
Lubrificantes		
Reparos e manutenção		
Imposto Territorial Rural		
Outros Impostos		
Seguro de Veículos		
Seguro de Culturas		
Indenizações trabalhistas		
Indenizações diversas		
Transporte de pessoal		
Transporte de produtos		
Arrendamento (área: ____________ ha)		
Outras despesas: ____		
Total	□□□□□□	□□□□□□

5. 2. Receitas

5.2.1. Venda de produtos agrícolas na última safra de 94

Produtos	Unidade	Quan-tidade	Preço por unidade	Valor total (R$ 1,00)	Época de venda
Raiz de mandioca					
Farinha de mandioca					
Tapioca					
Beiju					
Goma de mandioca (amido)					
Feijão					
Milho					
Outros:					
Total				☐☐☐☐☐	

5.2.2. Venda de animais

Categoria	Nº	Preço médio (R$/cab)	Valor total (R$ 1.00)	Época de Vendas
Bovinos				
Ovinos				
Caprinos				
Bubalinos				
Suínos				
Equínos				
Muares				
Aves				
Total			☐☐☐☐☐	

5.2.3. Venda de leite e derivados

a) Leite : **Venda média diária (litros)** ☐☐☐

. **Preço médio (R$/litro)** ☐☐.☐

: **Receita média mensal (R$ 1,00)** ☐☐☐☐☐

b) Derivados : ☐ **Manteiga** ☐ **Queijo** ☐ **Outros:**_______________

Receita média mensal com derivados do leite (R$ 1,00) ☐☐☐☐☐

5.2.4. Outras receitas

Especificação	Valot total (R$ 1.00)
Aluguel de máquinas	☐ ☐ ☐ ☐ ☐
Aluguel de equipamentos	☐ ☐ ☐ ☐ ☐
Arrendamento (área:__________ha)	☐ ☐ ☐ ☐ ☐
Aluguel de mão-de-obra	☐ ☐ ☐ ☐ ☐
Parceria	☐ ☐ ☐ ☐ ☐
Outras:	☐ ☐ ☐ ☐ ☐
	☐ ☐ ☐ ☐ ☐
	☐ ☐ ☐ ☐ ☐
	☐ ☐ ☐ ☐ ☐
	☐ ☐ ☐ ☐ ☐
	☐ ☐ ☐ ☐ ☐
	☐ ☐ ☐ ☐ ☐
	☐ ☐ ☐ ☐ ☐
Total	☐ ☐ ☐ ☐ ☐

6. TECNOLOGIA DE PRODUÇÃO DE MANDIOCA

6.1 Limpeza da área

1. ☐ Roçagem
2. ☐ Destoca
3. ☐ Queima total
4. ☐ Queima em coivara

6.2 Preparo do solo

1. ☐ Apenas com enxada
2. ☐ Aração
3. ☐ Gradagem
4. ☐ Aração + gradagem

6.3 Origem da maniva

1. ☐ Própria
2. ☐ Doada
3. ☐ Comprada

6.4 Seleção da maniva

1. ☐ Antes da colheita
2. ☐ Depois da colheita
3. ☐ Não faz seleção

6.5. Armazenamento das manivas

1. ☐ Não armazena
2. ☐ Período menor que 60 dias
3. ☐ Período maior que 60 dias

6.6. Local de armazenamento da maniva

1. ☐ Embaixo de árvores
2. ☐ Céu aberto
3. ☐ Ao abrigo de bosque

6.7- Local onde se tira a maniva-semente

1. ☐ Parte baixa da planta
2. ☐ Parte mediana da planta
3. ☐ Parte apical

6.8. Tamanho da maniva

1. ☐ Menor que 10 centímetros
2. ☐ De 10 a 20 centímetros
3. ☐ Maior que 20 centímetros

6.9 Diâmetro da maniva-semente

1. ☐ Menor que 2 centímetros
2. ☐ Maior que 2 centímetros

6.10 Corte da maniva

1. ☐ Reto
2. ☐ Bisel
3. ☐ Lascado

6.11 Poda (decote)

1. ☐ Faz poda
2. ☐ Não faz poda

6.12 Transporte de maniva

1. ☐ Em feixes (arrumado)
2. ☐ Soltas (qualquer forma)

6.13- Meio de transporte da maniva

1. ☐ Animal
2. ☐ Carroça
3. ☐ Carro

6.14 Forma de plantio

1. ☐ Sulco
2. ☐ Camalhão
3. ☐ Cova rasa
4. ☐ Cova alta ou virada (matumbo)

6.15 Posição da maniva

1. ☐ Horizonal
2. ☐ Vertical
3. ☐ Inclinada

6.16 Época plantio

1. ☐ Inicio das chuvas
2. ☐ Meado das chuvas
3. ☐ Fim das chuvas

6.17 Localização do mandiocal

Local	Área
1 - Plana	☐☐.☐
2 - Encostas	☐☐.☐
3 - Baixios	☐☐.☐

6.18 Se o plantio for em encosta qual a direção das fileiras

1. ☐ Morro abaixo
2. ☐ Sentido transversal
3. ☐ Curva de nivel

6.19 Calagem/Adubação

1. ☐ Realizou analise de solo
2. ☐ Realizou calagem
3. ☐ Realizou adubação quimica (base)
4. ☐ Realizou adubação quimica-cobertura
5. ☐ Realizou adubação orgânica
6. ☐ Realizou compostagem

6.20 Variedade utilizadas

Indique as variedades de mandioca que o Sr. mais utiliza: (marque com um X as caracteristicas que têm)

VARIEDADE	CÓDIGO	TIPO		COR DA POLPA		OBTENÇÃO		ÁREA PLANTADA
		Brava	Mansa	Branca	Amarela	Fácil	Difícil	
1.	□□□	①	②	③	④	⑤	⑥	□□.□
2.	□□□	①	②	③	④	⑤	⑥	□□.□
3.	□□□	①	②	③	④	⑤	⑥	□□.□

6.21 Para as mesmas variedades acima, assinale:

Variedade	Código	Germinação (%)	Produtividade (t/area)	Comprimento da rama (m)	Resistência (1-alta, 2-média, 3-baixa)		
					seca	praga	doença
1.	□□□						
2.	□□□						
3.	□□□						

6.22 Sistema de plantio da mandioca:

Sistema	Código	Área plantada	Área colhida	Produção da mandioca (t)	Produção do consórcio	
					Unid.	Quant.
Mandioca solteira	□□	□□.□	□□.□	□□□.□		□□□.□
Mandioca consorciada com:						
	□□	□□.□	□□.□	□□□.□		□□□.□
	□□	□□.□	□□.□	□□□.□		□□□.□
	□□	□□.□	□□.□	□□□.□		□□□.□
	□□	□□.□	□□.□	□□□.□		□□□.□
	□□	□□.□	□□.□	□□□.□		□□□.□

6.23 Espaçamento

Sistema de plantio	Área plantada	Espaçamento entre plantas	Espaçamento entre fileiras	Espaçamento entre carreiras
Fileiras simples	□□.□	□.□□	□.□□	
Fileiras duplas	□□.□	□.□□	□.□□	□.□□

6.24 Ervas daninhas

Descrição da Erva ou seu Nome Comum	Código	Tipo de Folha	
		Larga	Estreita
	□□	□	□
	□□	□	□
	□□	□	□
	□□	□	□

6.25. Como controlou as ervas daninhas?

Sistema de Controle	Nº de vezes por safra	Época do ano (Assinale com um **X**)											
		J	F	M	A	M	J	J	A	S	O	N	D
Capinas Manuais													
Capinas Mecânicas													
Controle químico													
Controle Integrado													

6.26 Quais as pragas e doenças que mais incomodam a sua plantação e que parte da planta elas mais atacam?

Insetos e doenças	Código	Parte Atacada			Época de ocorrência (meses)		Há quantos anos observou?	Idade da planta (meses)	% de perda de raiz
		Raiz	Rama	Folha	Inicio	Fim			
1.	□□	□	□	□	□□	□□	□□	□□	□□
2.	□□	□	□	□	□□	□□	□□	□□	□□
3.	□□	□	□	□	□□	□□	□□	□□	□□
4.	□□	□	□	□	□□	□□	□□	□□	□□
5.	□□	□	□	□	□□	□□	□□	□□	□□
6.	□□	□	□	□	□□	□□	□□	□□	□□
7.	□□	□	□	□	□□	□□	□□	□□	□□

6.27 Controle de pragas e doenças

Nome da praga ou doença	Código	Nome do produto usado para controle	Código	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez
	□□		□□												
	□□		□□												
	□□		□□												
	□□		□□												
	□□		□□												

6.28 Adubação

Fertilizante	Unidade	quantidade/ ud. de área
Esterco de gado		□□□
Esterco de galinha		□□□
Torta de mamona		□□□
Ureia		□□□
Superfosfato simples		□□□
Superfosfato triplo		□□□
Cloreto de potássio		□□□
Fórmulas:		□□□

6.29 - Colheita

1. □ Manual
2. □ Semi-mecanizada
3. □ Mecanizada

6.30 - Rotação de culturas

1. □ Não faz
2. □ Faz

Quais as culturas usadas ______________

____

Há quanto tempo a mandioca é cultivada nesta área sem fazer rotação de culturas?________ anos.

7. CRÉDITO AGRÍCOLA

7.1 O Senhor tem algum financiamento de crédito rural em banco?

1. ☐ Sim
2. ☐ Não

7.2 Se sim, indique o produto favorecido (principal) e a finalidade do mesmo

Produto	Finalidade	
	Custeio	Investimento
	①	②
	①	②
	①	②
	①	②

7.3 Se não tem financiamento oficial (crédito agrícola bancário), indique quais as razões.

1. ☐ Nunca precisou de financiamentos
2. ☐ Não tem banco por perto
3. ☐ É muito trabalhoso obter financiamento
4. ☐ As garantias exigidas são normalmente elevadas
5. ☐ Resolve os problemas de crédito com financiamento particular
6. ☐ Os juros são muito elevados
7. ☐ A renda da propriedade não dá para pagar o empréstimo
8. ☐ Não tem garantias por não ser dono do imóvel
9. ☐ Outras:______________________________

7.4 Dificuldades geralmente encontradas na execução dos financiamentos

1\. ☐ Sem dificuldades
2\. ☐ Falta de assistência técnica
4\. ☐ Demora na liberação dos recursos
5\. ☐ Dificuldade na aquisição do previsto (insumos, máquinas, etc)
7\. ☐ Outros:__________________________

7.5. Dificuldades geralmente encontradas no pagamento dos financiamentos obtidos

1. ☐ Sem dificuldades
2. ☐ Juros elevados
3. ☐ Prazo curto
4. ☐ Frustração da produção
5. ☐ Outros:______________________

7.6 Fiscalização na execução dos financiamentos

Indique a instituição responsável pela fiscalização e a frequência normal das visitas

Instituição	Frequência			
	Trimestral	Semestral	Anual	Nunca houve
Banco	①	②	③	④
Emater	①	②	③	④
EBDA	①	②	③	④
Outros:	①	②	③	④

7.7 Perfil dos financiamentos em andamento

Trace um perfil dos financiamentos obtidos e ainda em execução

Identificação do financiamento	Itens	Especificação
A:	Banco outorgante	
	Linha de crédito	
	Valor (R$ 1,00)	
	Saldo devedor (R$ 1,00)	
	Pagamentos efetuados	

Identificação do financiamento	Itens	Especificação
B:	Banco outorgante	
	Linha de crédito	
	Valor (R$ 1,00)	
	Saldo devedor (R$ 1,00	
	Pagamentos efetuados	

Identificação do financiamento	Itens	Especificação
C:	Banco outorgante	
	Linha de crédito	
	Valor (R$ 1,00)	
	Saldo devedor (R$ 1,00	
	Pagamentos efetuados	

8. BENEFICIAMENTO E COMERCIALIZAÇÃO DA MANDIOCA

8.1 O que o Senhor faz com a mandioca produzida? (Percentagem)

1. ☐ Vende na forma de raiz.......... ☐☐☐
2. ☐ Faz farinha............................ ☐☐☐
3. ☐ Produz raspa........................ ☐☐☐
4. ☐ Dá para animais.................. ☐☐☐
5. ☐ Outros usos:_____________ ☐☐☐
6. ☐ _____________________ ☐☐☐
7. ☐ _____________________ ☐☐☐

Obs: o somatório deverá ser igual a 100%

8.2 Aproveitamento da parte aérea da mandioca (em %)

1. ☐ Não aproveita ☐☐
2. ☐ Vende ☐☐
3. ☐ Utiliza para sementes ☐☐
4. ☐ Dá para animais ☐☐

8.3 Caso o produtor faça farinha qual a casa de farinha utilizada?

1. ☐ Própria
2. ☐ Da Cooperativa
3. ☐ Comunitária
4. ☐ Arrendada de terceiros
5. ☐ Cedida
6. ☐ Outra:____________

8.4 Se a casa de farinha não é própria, como e quanto paga pelo uso?
(Especificar a unidade de medida utilizada para pagamento: Ex.: kg/saco de 50 kg, litro/quarta, dias de trabalho por saco de 50 kg, etc...)

FORMA DE PAGAMENTO	UNIDADE	QUANTIDADE
Paga em produto (farinha)		
Paga em dinheiro	R$/	
Paga em trabalho		
Outros:		

8.5 Quantas farinhadas produz no ano? ☐ ☐ ☐

QUANTIDADE E ÉPOCA DA FARINHADA											
JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ

8.6 Quantas pessoas da família participam numa farinhada?

1. ☐ Homens ☐ ☐
2. ☐ Mulheres ☐ ☐
3. ☐ Crianças ☐ ☐

8.7 Quantos empregados o Senhor contrata para uma farinhada?

1. ☐ Homens ☐ ☐
2. ☐ Mulheres ☐ ☐

8.8 Média de trabalhadores por farinhada

Trabalhador	Mão-de-obra familiar	Mão-de-obra contratada (homens/dia)		Valor da Diária R$1,00
	(H/D)	Homem	Mulher	
Arrancador				
Transportador				
Cevador/prenseiro/peneirador				
Forneiro				
Comeiro (espremedeiro)				
Lenhador				
Cozinheiro				

8.9 Como o Senhor aproveita a casca da mandioca?

1. ☐ Vende
2. ☐ Usa para animais

8.10 De que forma o Senhor se informa sobre os preços dos produtos?

Fonte	Produto			
	Raspa	Farinha	Goma	Raiz
Cooperativa	☐	☐	☐	☐
Técnico	☐	☐	☐	☐
Outro Produtor	☐	☐	☐	☐
Intermediário/Comprador	☐	☐	☐	☐
Rádio	☐	☐	☐	☐
Jornal/TV	☐	☐	☐	☐
Mercado local	☐	☐	☐	☐
Não recebe	☐	☐	☐	☐

8.11 Destino da produção de raiz e produtos derivados da mandioca

Destino da Produção	Farinha (em %)	Beiju (em %)	Tapioca (em %)	Goma (em %)	Raspa (em %)	Raiz (em %)
Diretamente ao consumidor	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐
Caminhoneiro	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐
Outros atacadistas	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐
Feirantes	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐
Cooperativa	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐
Consumo Próprio	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐

9. INDICADORES SOCIAIS

9.1 Condições habitacionais

Itens	Material	Estado		
		Bom	Regular	Ruim
Piso		①	②	③
Paredes		①	②	③
Telhado		①	②	③
Iluminação natural		①	②	③

9.2 Bens básicos: assinale os bens possuídos em casa

1. ☐ Geladeira
2. ☐ Rádio
3. ☐ Televisão
4. ☐ Veículo motorizado

9.3 Fonte de água:

1. ☐ Encanada
2. ☐ Poço ou mina
3. ☐ Fonte pública

9.4 Destino do lixo

1. ☐ Buraco ou barroca
2. ☐ Espalha no terreiro
3. ☐ Usa como adubo
4. ☐ Outros:____________________

9.5 Destino dos dejetos humanos:

1. ☐ WC dentro de casa
2. ☐ WC fora de casa
3. ☐ Fossa
4. ☐ Outros

9.6 Utilização de serviços de assistência médica e odontológica

1. ☐ Assistência médica
2. ☐ Assistência odontológica
3. ☐ Recebimento de medicamentos

9.7 Aposentadorias e outros auxílios previdenciários

1. ☐ Aposentadoria
2. ☐ INPS
3. ☐ Funrural
4. ☐ Outros:

9.8 Contatos pessoais com técnicos de instituições oficiais ou privadas

Especificação	Sim	Não	Vezes /ano	Finalidade principal
EMBRAPA	①	②		
Assistência Técnica do Governo	①	②		
Assistência técnica privada	①	②		
Delegacia Federal de Agricultura	①	②		
Cooperativa	①	②		
Secretaria de Agricultura	①	②		
Firma comercial	①	②		

9.9 Contatos informais: O Senhor trata de assuntos relacionados com práticas agricolas com quais das seguintes pessoas e com que frequência?

Especificação	Sim	Não	Nº de vezes/mês
Amigos	①	②	
Líderes da comunidade	①	②	
Vizinhos	①	②	
Parentes	①	②	
Outros	①	②	

9.10 Uso de informação instrumental agricola

Meio de cominicação	Ouve/Assiste/Lê		Frequência	
	Sim	Não	Diário	Semanal
Rádio	①	②		
Televisão	①	②		
Jornal	①	②		
Revista	①	②		

9.11 Associativismo: O Senhor é sócio de quais das seguintes organizações ?

Especificação	É sócio ?		Participa de reuniões?			É ou já foi membro da diretoria ?	
	Sim	Não	Muito	Pouco	Não	Sim	Não
a) Cooperativa	①	②				①	②
b)Sindicato Rural	①	②				①	②
c) Assoc de produtores	①	②				①	②
d) Comunidade religiosa	①	②				①	②
e) Clube/Soc recreativa	①	②				①	②
f) Outros (especificar)	①	②				①	②
	①	②				①	②
	①	②				①	②

9.12 Consumo de alimentos: informe as quantidades médias consumidas por semana, inclusive dos alimentos produzidos no imóvel

Alimento	Unid	Quant	Alimento	Unid	Quant
Carnes e Leites			Frutas e Verduras		
Carne fresca	kg				
Carne Salgada	kg				
Sardinhas	und				
Carne de lata	und				
Frango	kg				
Peixe	kg				
Ovos	und				
Leite em pó	g				
Leite "in natura"	l				
Cerais			**Gorduras**		
Arroz	kg		Toucinho	kg	
Macarrão	pacote		Manteiga	g	
Feijão	kg		Margarina	g	
Café	kg		Banha	g	
Açucar	kg		Óleo	litro	
Biscoito	pacote				
Pão	und				
Milharina	caixa		**Outros**		
Goma	kg		Rapadura		
Tapioca	kg				
Fubá de milho	kg				
Farinhas de Mandioca	kg				

PARECER DO ENTREVISTADOR

A partir de 19____, estão previstos novos estudos usando-se os mesmos grupos de produtores selecionados a partir da amostra do perfil de entrada Para tanto, considera-se como subsídio indispensável a opinião do entrevistador sobre o produtor ora entrevistado (receptividade, seriedade nas respostas, nível de instrução, memória, etc,)

OS DADOS DEVERÃO SER ENVIADOS PARA :

PROJETO PROFISMA:

NOME: JOSÉ HUMBERTO ALMEIDA DE CERQUEIRA

ENDERECO: EMBRAPA/CNPMF - CAIXA POSTAL - 007
CEP - 44380 - CRUZ DAS ALMAS - BAHIA

CONSULTAS ADICIONAIS::

EMBRAPA/CNPMF - TEL (075) 7212120 - RAMAL 167

TELEX - 75-2074 - FAX (075)7211118/075

Data da Entrevista ___/___/___

Assinatura do entrevistador

ANEXO I:

Informação sobre as formigas cortadeiras de folhas de mandioca (saúvas, quem-quem, cabeças de vidro, etc.), os diferentes tipos de cortadeiras reconhecidos pelos produtores, e os métodos de controle usados pelos mesmos.

1. Nomes, incidência, e observações sobre o dano:

Nome usado pelo produtor	Meses de maior incidência	Variedade de mandioca mais atacada	Variedade de mandioca menos atacada	Quais os prejuízos que causam à mandioca?

2. Métodos de controle das formigas cortadeiras:

Método (isca, inseticida em pó, método tradicional)	Produto utilizado (nome comercial da isca, inseticida, planta, etc.)	Forma de aplicação (onde, como, quando, etc.)	Funciona? (Sim, Não)

ANEXO II:

PARA SER PREENCHIDO PELO ENTREVISTADOR:

No quadro abaixo, relacione o nome vulgar, nome científico e principais características das pragas e doenças informadas pelo produtor:

Nome vulgar	Nome científico	principais características