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CASSAVA AND FRUIT CROPS RESEARCH GUIDELINES  
IN BRAZIL



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IN BRAZIL

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## FOREWORD

The two fundamental lines of action set up by the Brazilian Corporation for Agricultural Research (EMBRAPA) on cassava and fruit crops, namely, pineapple, banana, citrus and mango, in Brazil, are summarized here, aiming to answer some basic questions.

Participation of research teams of the National Center for Cassava and Fruit Crops Research in this "Documento" was fundamental and thanks are given to Getulio Augusto Pinto da Cunha (Pineapple Research Coordinator), Élio José Alves (Banana Research Coordinator), Igor da Silva Coelho (Citrus Research Coordinator), José Avelino Santos Rodrigues (Mango Research Coordinator) and Marcio Carvalho Marques Porto (Cassava Research Coordinator).

The Author

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# CASSAVA AND FRUIT CROPS RESEARCH GUIDELINES IN BRAZIL<sup>1</sup>

Mário Augusto Pinto da Cunha<sup>2</sup>

## INTRODUCTION

The Brazilian Corporation for Agricultural Research (EMBRAPA), a public enterprise under the patronage of the Ministry of Agriculture, was founded on December 7, 1972, by Law 5,581. EMBRAPA's missions are:

a) To undertake researches on priority crops and special areas such as the Cerrados, Semi-arid Tropic and Humid Tropic not fully exploited.

b) To establish the state sub-system of research to answer local farm problems.

c) To establish a research cooperative system, including universities, extension service and private sectors to reduce research time and costs.

d) To strengthen international cooperation.

The National Research Center for Cassava and Fruit Crops (CNPMPF) was created in June 13, 1975, but started operating only in 1977. The Center's responsibility is to promote advancement and coordinate research on pineapple, banana, citrus, mango and cassava crops. CNPMPF's aim is to increase production, improve quality, reduce costs of production and determine their adaptability in areas not yet adequately exploited. Its creation was decided by 99 experts from various organizations all over the country.

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1 Translation of Documentos CNPMPF nº 13, Diretrizes da Pesquisa em Mandioca e Fruticultura no Brasil, Março, 1984.

2 Agronomist, PhD, Chief of the National Research Center for Cassava and Fruit Crops, CP: 007, 44.380 - Cruz das Almas, Bahia.

CNPMF occupies an area of 260 ha, in Cruz das Almas county , State of Bahia. The county has an elevation of 220 m above sea level with 23.8°C annual average temperature, 80% air relative humidity and 1.224mm average annual precipitation.

CNPMF has a total of 50 researchers and 209 supporting staff. Among the researchers 9 are with BS, 26 with MS and 7 with PhD or Doctorate degrees. Eight additional researchers are currently enrolled for MS (6) and PhD (2) degrees. By National Program researchers are distributed as follows: 6 in pineapple, 7 in banana, 10 in citrus, 4 in mango and 14 in cassava.

## NATIONAL AGRICULTURAL RESEARCH SYSTEM

EMBRAPA set up a new institutional and operational model for agricultural research in Brazil, called the National Agricultural Research System (Fig. 1), which includes two fundamental lines of action, direct action and coordinating action.

The direct action is carried out by the national centers working on crop research, by those on the natural resources and agricultural production systems for humid and semi-arid tropical areas and cerrado areas and by the auxiliary services and State or Territory Research Units. The coordinating action involves the development of programs and norms for all research projects at the State Agricultural Research Corporations, for Programs within the States and for special projects implemented by other agencies, particularly Brazilian universities (Tables 1,2,3).

The National Agricultural Research System operates in seven areas and aims for the expansion of knowledge for a modern agriculture:

a) Humid Tropic - to develop production systems adapted to local conditions.

b) Cerrados - to create new ways of agricultural production in the area.

c) Semi-arid Tropic - to develop production systems adapted to savannah conditions and maximum usage of the savannah natural resources.

d) To develop more efficient production systems in relation to soil fertilization, pesticides etc., bringing about an increasing man and land productivity.

e) To create technology for energy production from biomass.

f) To develop production systems for small farms to increase income.

g) To reduce production losses.

EMBRAPA considers the development of knowledge a "continuum" that starts in a research project seeking an answer to an agricultural problem originated from a farmer. Research results are then put into practice to increase productivity and income.

#### Circular Research Model

As the research process begins at the farmer's level and also ends at that level, three phases are recognized: a) survey and definition of problems that require research, b) creation of technology and c) interaction measurement and research action in the technology diffusion (BLUMENSCHHEIN, 1978). At this point, it must be added that the research corporation works toward an interdisciplinary action since this is the rule in the farm. Related to it, EMBRAPA knows that research methods are monodisciplinary and the creation of multidisciplinary research teams will avoid the interdisciplinary compartmentalization.

Henceforth the idea of the Circular Research Model is essential



to the understanding of EMBRAPA's way of knowledge development (Fig. 2).

## NATIONAL RESEARCH PROGRAMS

The National Programs are composed by projects that reflect the real problem of the farmer, according to the circular model discussed above. The tropical fruit crops and cassava are studied in five national programs.

### PINEAPPLE NATIONAL RESEARCH PROGRAM<sup>1</sup>

According to Brazilian Institute of Geography and Statistics (1982) pineapple was grown in all Brazilian States in 1980, meaning that Brazil has soil and climate favorable to this crop (Table 4). In fact, the country is the 4<sup>th</sup> pineapple producer in the world, giving 7.5% of the world's total production.

However, many problems have hindered the development of pineapple cultivation, leading to yields of 14,977 fruits per hectare. The observed low yields are due to social, economic and technical problems listed as research priorities below.

#### Research Priorities for Pineapple

The priorities for this program were established in 1980 and reviewed in 1983 as follows:

- a) Fusarioses (Fusarium moniliforme var. subglutinans)

<sup>1</sup> Annual Technical Report. CNPMF, 1984.

- b) Soil fertilization
- c) Wilt (Dysmicoccus brevipes)
- d) Fruit Borer (Thecla basilides)
- e) Inappropriate use of cultural waste and industry residues
- f) Plant production in diverse soil and climate conditions.
- g) Nematodes
- h) Degradation of physical soil properties

### Goals of the Pineapple National Research Program

a) To establish production systems, according to natural resources conservation practices.

b) To stimulate the whole plant utilization as human and animal food, as well as raw material for industry and energy from biomass.

### Projects of the Pineapple National Research Program

This program consists of 36 projects carried out by 11 research institutions all over the country (Table 5). These projects involve many areas of study, but more specifically on insect and disease control, soil management and plant nutrition. A positive correlation is observed between regional production, number of projects and number of researchers, as seen in Tables 4, 5 and 6.

## BANANA NATIONAL RESEARCH PROGRAM<sup>1</sup>

Brazil produces more than 4 million tons of banana, placing the country on top among the banana producers in the world (Table 4). This production

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<sup>1</sup> Annual Technical Report. CNPMF, 1984.

is sufficient to satisfy the internal demand, above 30 kg/person/year.

In terms of "per capita", however, yield is considered low due to diverse causes that lead to the research priorities listed below.

#### Research Priorities for Banana

The priorities to this program were established in 1980 and reviewed in 1983 as follows:

- a) "Moko" or Bacterial Wilt
- b) Banana Borer
- c) Sigatoka Disease
- d) Soil and Plant Management
- e) Plant Nutrition
- f) Water deficiency
- g) Panama Disease
- h) Basic informations on economy
- i) Production systems

#### Goals of the Banana National Research Program

- a) To establish efficient production systems, according to natural resources conservation practices .
- b) To stimulate banana growing for agro-industry.

#### Projects of the Banana National Research Program

The program consists of 41 projects carried out by 16 research

institutions all over the country (Table 7). These projects are related to many areas of study, but mainly on plant breeding, insect and disease control, and soil fertility.

Positive correlation between regional production, number of projects and number of researchers is observed in Tables 4, 6 and 7.

## CITRUS NATIONAL RESEARCH PROGRAM<sup>1</sup>

Although different citrus species are grown in every State of the country, 92.0% of the area cultivated for the crop is located in the sub tropical region, equivalent to 91.0% of the total national citrus production.

Brazil is currently heading the world in sweet orange production and in concentrated orange juice export.

Reports indicated a substantial increase in citrus production in recent years. Such increase, however, was actually due to increase in cultivated areas rather than productivity. The causes of low productivity are listed below as national research priorities.

### Research Priorities for Citrus

These priorities were established in 1980 and reviewed in 1983 as follows:

- a) Citrus Canker (Xanthomonas campestris pv. citri.)
- b) Tree decline (blight)
- c) Increase quality of propagating material

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<sup>1</sup> Annual Technical Report. CNPMF, 1984.

- d) "Tristeza"
- e) Psorosis
- f) Increase soil fertility
- g) Plant early decline
- h) Orthezia praelonga Douglas
- i) Citrus rust mite
- j) Foot rot (Phytophthora sp.)
- l) Early fruit drop
- m) Plant population
- n) Citrus Borer

#### Goal of the Citrus National Research Program

- a) To establish production systems capable of increasing yield and farmer's income.

#### Projects of the Citrus National Research Program

The program involves 64 projects, carried out by 14 research institutions all over the country (Table 8). The projects deal with diverse areas of study, specially plant breeding, insect and disease control and plant nutrition. Positive correlation between regional production, number of projects and number of researchers is observed, with the exception of Northeastern region, in Tables 4, 6 and 8.

### MANGO NATIONAL RESEARCH PROGRAM<sup>1</sup>

Brazil produces 6.9% of the total world production, ranking the

<sup>1</sup> Annual Technical Report. CNPMF, 1984.

country as 2nd largest mango producer in the world. The crop is grown in every state of the Federation, most especially in Northeastern region (Table 4).

Productivity of mango in Brazil is very low and fruit quality is poor as consequences of problems currently considered as research priorities.

#### Research Priorities for Mango

The following priorities to the program were established in 1980 and reviewed in 1983:

- a) Anthracnose
- b) Increase fruit quality
- c) Bearing alternated
- d) Seasonal production
- e) Plant architecture
- f) Powdery mildew
- g) Fruit fly

#### Goals of the Mango National Research Program

a) To introduce and evaluate varieties in the Germplasm Active Bank.

b) To establish better spacings, better combinations canopy x rootstocks, methods of vegetative propagation and anthracnose control.

#### Projects of the Mango National Research Program

The program consists of 12 projects, carried out by 6 research

institutions in the country (Table 9). These projects are related to plant breeding and insect control. Positive correlation between regional production, number of projects and number of researchers is also observed here, with the exception of the central area of the country where the state corporations and the Natural Resource Center for Cerrados exert greater efforts studying the crop despite the low production observed in the region (Tables 4, 6 and 9).

## CASSAVA NATIONAL RESEARCH PROGRAM<sup>1</sup>

Cassava is practically grown in every state of Brazil, which is the 1<sup>st</sup> producer in the world, with 24 million tons being produced in 2 million hectares. The northeastern part of the country contributes with approximately half of this production (Table 4).

In the past, cassava received little attention from agricultural research institutions. Its wide adaptation to the most diverse soils and climatic conditions as well as its accumulated traditional knowledge through many years of cultivations as subsistence crop did not motivate researchers to improve some of the primitive cultural practices utilized by the low-income farmer. Low and variable yields occurred as a consequence of the following factors:

- a) There is no stable price stimulus to the farmer. It lacks guarantees of production absorption.
- b) There is no selection of planting material as related to age, health, diameter and length.
- c) Plantations are in marginal areas with inadequate planting times.
- d) Poor soil preparation and cultural practices.

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<sup>1</sup> Annual Technical Report. CNPMF, 1984.

- e) Liming and soil fertilization are minimum.
- f) Poor insect and disease control.

#### Research Priorities for Cassava

The following priorities of the program were established in 1980 and reviewed in 1983 as follows:

- a) Improvement in agricultural practices
- b) Production and market systems
- c) Adaptation to diverse eco-systems
- d) Cultivation in low fertility soil
- e) Tillage and soil conservation
- f) Alternative use
- g) Bacterial blight
- h) Root rot
- i) Superelongation
- j) Leaf spot
- l) Anthracnose
- m) Virus diseases and physiological problems
- n) Mites
- o) Hornworm
- p) Lace bugs
- q) Scale insects
- r) Shoot flies

#### Goals of the Cassava National Research Programa

- a) To establish efficient production systems taking into account natural resources and conservation practices.



b) To stimulate the integral utilization of the plant as human and animal food and as industrial raw material.

c) To increase cassava yield through planting of superior varieties adapted to the environment.

d) To develop a more efficient plant ideotype in relation to modern inputs.

### Projects of the Cassava National Research Program

The program is composed of 99 projects, carried out by 24 research institutions in the country (Table 10). These projects are related to many areas of study, mainly plant breeding, soil and plant nutrition, insect and disease control, intercropping and production system. There is a positive correlation between regional production, number of projects and number of researchers (Tables 4, 6 and 10).

## DIFFUSION OF TECHNOLOGY

As the interaction of technologies is the rule in the farm, EMBRAPA has defined the interdisciplinary work as a goal that must be pursued in the research cooperative system.

The proposed actions for this area are based on: a) farmer training on technologies developed by CNPMF and b) implantation of demonstration plots with those technologies in the farm.

## STATISTICS AND ECONOMY

The best technology is the one that gives the maximum economic return to the farmer. So it is observed the treatments that allow less

utilization of modern inputs and energy per production unit.

## INFORMATION AND DOCUMENTATION

The library maintains a system up to date in terms of contacting other libraries all over the world in order to bring the information needed for research.

Besides this service, the library is responsible for the maintenance of books, journals, slides and maps.

## EMBRAPA/CNPMF AND THE EXTENSION SERVICE

In Brazil research and technical assistance are executed by different corporations but they are tightly linked in the work towards the farm. The extension service has a representative in the Consultant Councils for cassava and fruit crops and participate in meetings carried out in order to define the national programs every 3 years.

Also, jointly with the technology diffusion staff of CNPMF, they go to the field and see what the farmer needs. Actions such as the ones already cited under the Diffusion of Technology title are undertaken together by EMBRAPA and the corporation for extension service.

## EMBRAPA/CNPMF AND THE UNIVERSITY

The University plays a vital role in the research cooperative system under way in Brazil, as responsible for basic research.

In the case of CNPMF and the University of Bahia campus at Cruz das Almas, the center's researchers serve as professors in the graduate course of the university's agronomy school, a fact illustrating the multi-disciplinary work cited above.

## RESEARCH RESULTS

### Pineapple National Research Program

#### a) Active germplasm Bank

Two hundred ninety accessions from 14 species (Table 11) are being evaluated in the germplasm bank of CNPMF according to its previously defined descriptors. 'Perola' and 'BAG-6' have shown resistance to fusarioses, the most important pineapple disease in Brazil.

#### b) Resistance to fusarioses

Hybrids of 'Smooth Cayenne' x 'Roxo de Tefé' and of 'Smooth Cayenne' x 'Alto Turi' have shown resistance to fusarioses in 53 and 40% of their progenies respectively. Fruits from 8 plants of the firsts cross showed good characteristics for the industry.

#### c) Obtaining plants free of fusarioses by means of rapid propagation

The rapid propagation technique consists in production of plantlets from axillary buds of the mother plants or other such as fruit crown by dividing it in small sections and growing them in nurseries before transplanting to the field. This permits a previous selection for plant free of fusarioses.

## Banana National Research Program

### a) Active germplasm Bank

One hundred twenty four accessions are being evaluated in the germplasm bank of CNPMF according to its previously defined descriptors. At the same time, 250 diploids, triploids and tetraploids hybrids produced at CNPMF are being evaluated in the field.

### b) New cultivars

'Prata Anã' and 'Mysore' (AAB group) were selected as substitutes to Prata and Maça cultivars (AAB group) respectively. 'Prata Anã' is smaller than 'Prata', with identical taste, and is less susceptible to Sigatoka disease. It yields 25 t/ha/cycle, against 13 t/ha/cycle of 'Prata'. 'Mysore' is resistant to Sigatoka and Panama diseases, its taste is similar to 'Maça' and yielding around 17 t/ha/cycle, against 15 t/ha/cycle of 'Maça'.

### c) Soil management

Mulch with banana leaves and stems gave a mean yield of 51.3 t/ha in plants 18 years old of Terra banana cultivar, while the treatments with Canavalia ensiformis intercropped and manual weeding yielded 18.5 and 8.5 t/ha, respectively.

## Citrus National Research Program

### a) Active germplasm Bank

Four hundred accessions of the genus Citrus and relatives are being evaluated in the germplasm bank according to its previously defined descriptors.

## b) Rootstock selection and mother plants free of viruses

Citrus orchards in Brazil have 95% Rangpur lime as rootstock. In order to diversify, it is shown in Tables 12, 13 and 14 alternative rootstocks. Also, a project of micro-grafting to establish mother plants free of viruses is under way.

c) Integrated control and biology of the citrus borer Cratosomus flavofasciatus

The plant Cordia verbenacea has been used in the control of the citrus borer. It was observed that 94.13% of citrus borer adults collected from February to June were captured on that plant.

## Mango National Research Program

## a) Active germplasm Bank

Ninety two accessions are being evaluated in the germplasm bank and Santa Alexandrina, Surpresa, Itamaracá, Van Dyke, M. 13269, M. 202222, Tommy Atkins, Maçã, Ruby, Extrema, Florigon and Haden varieties have yielded more than the others. With regard to physical and chemical qualities as well as anthracnose resistance Surpresa, Van Dyke, M. 202222, Elson, Florigon and Haden varieties are considered superior.

## Cassava National Research Program

## a) Active Germplasm Bank

Around 1.500 accessions are registered by the Genetic Resources National Center (CENARGEN) and 900 accessions are being evaluated in the germplasm bank of CNPMF according to its previously defined descriptors.

## b) New cultivars

The program has already identified cultivars for the regions of

Cerrados, South, Humid Tropic, Savannah and the transition between Humid Tropic and Cerrados.

c) Crop management

The mean yield of cassava grown in minimum tillage plots was similar to the traditional soil preparation practice but it was observed a 75% reduction in time and costs by using the minimum tillage system as seen in Table 15.

Cassava intercropped in the double row planting system with common beans, cowpea, groundnut, and sweet potato were 76, 62, 87 and 70%, respectively, more efficient in land utilization than the isolated crop, as shown in Table 16.

### LITERATURE CITED

- ALVES, E.R. de A. A importância do investimento na pesquisa agropecuária. Brasilia, DF, EMBRAPA/DID, 1980. 36p. (DID. Documentos,5).
- BLUMENSCHIN, A. Princípio da pesquisa no sistema EMBRAPA. Brasilia, DF, EMBRAPA/DTC, 1978. 48p.

**APENDIX**

**(Tables and Figures)**

TABELA 1 - National Centers for crop and natural resources research and special services of EMBRAPA

Type	State
National Center for Cotton	Paraíba
"	Goiás
"	Ceará
"	Mato Grosso do Sul
"	Minas Gerais
"	Bahia
"	Minas Gerais
"	Amazonas
"	Paraná
"	Santa Catarina
"	Rio Grande do Sul
"	Brasília
"	Rio Grande do Sul
Natural Resource Center for Cerrados	Brasília
"	Pernambuco
"	Pará
"	Paraná
Regional Unit for Forestry Research	Brasília
Special Services:	Rio de Janeiro
Center of Genetics Resources	Rio de Janeiro
Center of Food Technology	Rio de Janeiro
Service of Soil Survey and Conservation	Rio de Janeiro
Service for Production of Basic Seed	Brasília



TABLE 2 - Composition of the State Research System

State Agricultural Research Corporations		Headquarter Location
Minas Gerais	- EPAMIG	Belo Horizonte
Goiás	- ENGOPA	Goiânia
Espírito Santo	- ENCAPA	Vitória
Santa Catarina	- EMPASC	Florianópolis
Rio de Janeiro	- PESAGRO	Rio de Janeiro
Ceará	- EPACE	Fortaleza
Pernambuco	- IPA	Recife
Bahia	- EPABA	Salvador
Alagoas	- EPEAL	Maceió
Rio Grande do Norte	- EMPARN	Natal
Maranhão	- EMAPA	São Luiz
Paraíba	- EMEPA	João Pessoa
Mato Grosso do Sul	- EMPAER	Campo Grande
Mato Grosso	- EMPA	Cuiabá
Integrated Program		Headquarter Location
São Paulo		Campinas
Paraná		Curitiba
Rio Grande do Sul		Porto Alegre

TABLE 3 - State and Territory Agricultural Experiment Stations of EMBRAPA(UEPAE or UEPAT)

UEPAE or UEPAT	State or Territory
UEPAE of Corumbá	Mato Grosso do Sul
" " Dourados	Mato Grosso do Sul
" " Bagé	Rio Grande do Sul
" " Pelotas	Rio Grande do Sul
" " Bento Gonçalves	Rio Grande do Sul
" " São Carlos	São Paulo
" " Aracaju	Sergipe
" " Teresina	Piauí
" " Altamira	Pará
" " Manaus	Amazonas
" " Rio Branco	Acre
" " Porto Velho	Rondonia
UEPAT of Macapá	Amapá Territory
UEPAT of Boa Vista	Roraima Territory

TABLE 4 - Participation (in %) by region in the total production of pineapple, banana, citrus, mango and cassava crops in Brazil

Commodity	Participation (%)				Total	
	North	Northeast	Southeast	South		West
Pineapple	4,0	52,1	37,8	3,2	2,9	100,00
Banana	6,0	48,7	27,2	9,2	8,9	100,00
Citrus(orange)	0,6	9,0	83,4	6,3	0,7	100,00
Mango	1,4	66,8	28,8	1,8	1,2	100,00
Cassava	10,8	53,8	13,3	17,7	4,4	100,00

TABLE 5 - Research area, number of projects and of research institutions of the Pineapple National Research Program by region of Brazil

Research	Number of projects by region				Total	
	North	Northeast	Southeast	South		West
Food technology	-	-	1	-	-	1
Disease Control	-	2	2	1	-	5
Insect Control	-	6	4	1	-	11
Plant Nutrition	-	3	3	1	-	7
Soil Management	-	4	1	4	2	8
Plant Physiology	-	-	1	-	-	1
Intercropping	-	3	-	-	-	3
Total of Projects	-	18	12	4	2	36
Total of Research Institutions	-	4	4	1	2	11

TABLE 6 - Number of researchers by National Program for each region of Brazil

National Program	Region				Total	
	North	Northeast	Southeast	South		West
Pineapple	-	21	14	4	3	42
Banana	2	30	27	11	9	79
Citrus	3	21	48	16	4	92
Mango	-	21	5	2	11	39
Cassava	19	89	65	15	8	196
<b>Total</b>	<b>24</b>	<b>182</b>	<b>159</b>	<b>48</b>	<b>35</b>	<b>448</b>

TABLE 7 : Research area, number of projects and of research institutions of the Banana National Research Program by region of Brazil

Research Area	Number of projects by region					Total
	North	Mortheast	Southeast	South	West	
Plant Breeding	1	4	2	1	-	8
Insect Control	-	4	2	-	-	6
Disease Control	-	2	1	-	1	4
Nematology	-	1	1	1	-	3
Soil Management and Conservation	-	2	1	-	-	3
Soil Fertility	-	3	4	1	1	9
Irrigation	-	3	-	-	-	3
Economy	-	1	-	-	-	1
Production Systems	-	-	1	1	2	4
<b>Total</b>	<b>1</b>	<b>20</b>	<b>12</b>	<b>4</b>	<b>4</b>	<b>41</b>
<b>Total of Research Institutions</b>	<b>1</b>	<b>5</b>	<b>5</b>	<b>2</b>	<b>3</b>	<b>16</b>

TABLE 8 - Research area, number of projects and of research institutions of the Citrus National Research Program by region of Brazil

Research Area	Number of projects by region					Total
	North	Northeast	Southeast	South	West	
Plant Breeding	1	5	5	4	2	17
Management	-	1	-	3	-	4
Disease Control	-	5	13	6	-	24
Insect Control	-	5	1	1	-	7
Plant Nutrition	-	6	-	1	1	8
Plant Physiology	-	2	-	-	-	2
Production Systems	-	-	1	1	-	2
<b>Total</b>	<b>1</b>	<b>24</b>	<b>20</b>	<b>16</b>	<b>3</b>	<b>64</b>
<b>Total of Research Institutions</b>	<b>1</b>	<b>4</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>14</b>

TABLE 9 - Research area, number of projects and of research institutions of the Mango National Research Program by region of Brazil

Research Area	Number of projects by region				Total	
	North	Northeast	Southeast	South		West
Plant Breeding	-	6	2	1	2	11
Insect Control	-	1	-	-	-	1
Total	-	7	2	1	2	12
Total of Research Institutions	-	5	1	1	2	9



TABLE 10 - Research area, number of projects and of research institutions of the Cassava National Research Program by region of Brazil

Research Area	Number of projects by region					Total
	North	Northeast	Southeast	South	West	
Plant Breeding	5	11	5	2	1	24
Intercropping	1	6	2	-	-	9
Planting Systems	2	5	1	1	-	9
Weed Control	-	1	1	-	-	2
Soil and Plant Nutrition	-	11	1	2	-	14
Insect Control	-	6	4	2	-	12
Propagating Material	-	2	-	-	-	2
Production System	-	4	1	-	-	5
Soil Conservation	-	1	-	-	-	1
Soil Management	-	1	-	-	-	1
Pruning	-	2	-	-	-	2
Disease Control	-	4	3	1	1	9
Planting Time	-	1	-	-	-	1
Harvesting Time	-	2	-	-	-	2
Crop rotation	-	1	-	-	-	1
Food Technology	-	-	3	-	-	3
Mechanical Harvesting	-	-	1	-	-	1
Technology Diffusion	-	-	-	1	-	1
<b>Total</b>	<b>8</b>	<b>58</b>	<b>22</b>	<b>9</b>	<b>2</b>	<b>99</b>
<b>Total of Research</b>						
<b>Institutions</b>	<b>5</b>	<b>10</b>	<b>5</b>	<b>2</b>	<b>2</b>	<b>24</b>

TABLE 11 - Accessions of the Pineapple Active Germplasm Bank - CNPMF, 1983

<u>Species</u>	<u>Number of Accessions</u>
<u>Ananas comosus</u>	132
<u>Ananas bracteatus</u>	11
<u>Ananas anamassoides</u>	18
<u>Ananas erectifolius</u>	03
<u>Ananas parguazensis</u>	01
<u>Ananas sp.</u>	15
<u>Pseudonanas sagenarius</u>	09
<u>Bromelia balansae</u>	02
<u>Bromelia laciniosa</u>	01
<u>Bromelia goediana</u>	05
<u>Bromelia plumiere</u>	01
<u>Bromelia sp.</u>	31
<u>Bilbergia sp.</u>	02
<u>Tilandsia sp.</u>	01
Germplasm without classification	58
<b>Total</b>	<b>290</b>

TABLE 12 - Rootstock effect on 'Pera' orange production in boxes of 40.8 kg/hectare

Rootstock <sup>1</sup>	Year					Yr.	
	1976	1977	1978	1979	1980	1981	Average
'Oneco' tangerine	355	1.359	1.141	1.667	1.311	1.866	1.283
'Swaton' tangerine	429	1.307	1.259	1.220	1.440	1.885	1.256
'Sunki' tangerine	402	1.233	1.214	1.511	1.348	1.740	1.241
'National' Rough lemon	430	1.042	856	1.366	1.492	1.861	1.174
'Mazoe' Rough lemon	435	873	895	1.085	1.094	1.567	991
'Morton' citrange	553	997	881	1.104	1.089	1.197	956

<sup>1</sup> Spacing of 7.0m x 3.5m

TABLE 13 - Rootstock effect on 'Bahia' orange production in boxes of 40.8 kg per hectare

'Bahia I' I	Average	'Bahia II' I	Average
'Carrizo' citrange	1.103,0	'National' Rough lemon	957,4
Uvalde I	1.055,3	'Estes' Rough lemon	923,4
Morton	1.044,0	'Orlando' tangelo	794,1
Rusk	937,6	'Swingle' citrumelo	784,9
Savage	865,5	'Bessie' orange	682,5
'Rubidoux' trifoliolate	780,7	'Caipira' orange	605,2
'Beneke'	763,1	'Koethen' orange	492,6
'Pomeroy'	719,2		
'Yuma' citrange	697,8		
Sacaton citrumelo	631,0		
'Uvalde II' citrange	601,2		

I Spacing of 6.0m x 4.0m

TABLE 14 - Rootstock effect on 'Hamlin' orange production in boxes of 40.8 kg per hectare

Rootstock	Average
Florida rough lemon	1.209,6
Volkamer lemon	1.090,3
Rangpur lime	1.020,3
Sunki tangerine x English trifoliolate	936,2
Rangpur lime x carrizo citrange	806,5
Sunki tangerine	799,6
Cleopatra tangerine x Rangpur lime	758,0
Caipira orange	750,7
Carrizo citrange	620,0
Sunki tangerine x Single citrumelo	371,4

TABLE 15 - Effect of minimum tillage in cassava as compared to traditional soil preparation (Results are average of three years - 1978/79, 1979/80, 1980/81)

Treatment	Root production (t/ha)	Starch (%)	Starch (t/ha)	Number of roots per plant	Manual harvesting facility (%)
Normal plow	24.8	31.3	7.7	5	87.0
Normal plow + legume incorporated	24.2	30.9	7.5	6	87.4
Minimum tillage of double rows	26.0	31.2	8.1	6	82.2

TABLE 16 - Effect of double row planting system in cassava root production alone and intercropped with beans, cowpea, groundnut and sweet potato and Land Efficient Usage (UET)

Treatment	Planted with cassava		Total (t/ha)	UET
	At planting time (t/ha)	After pruning (t/ha)		
Beans	0.81	0.49	1.30	-
Cowpea	0.79	0.76	1.55	-
Sweet-potato	11.63	10.56	22.19	-
Groundnut	1.23	1.26	2.49	-
Cassava	-	-	32.86	-
Cassava +	-	-	29.87	-
Beans(04 rows between double rows)	0.61	0.49	1.10	1.76
Cassava +	-	-	28.79	-
Beans(3 rows between double rows)	0.58	0.37	0.95	1.64
Cassava +	-	-	26.79	-
Cowpea(4 rows between double rows)	0.53	0.62	1.15	1.62
Cassava +	-	-	27.57	-
Cowpea (3 rows between double rows)	0.54	0.69	1.23	1.63
Cassava +	-	-	27.44	-
Sweet potato(3 rows between double rows)	10.02	9.13	19.15	1.70
Cassava +	-	-	30.16	-
Sweet potato(2 rows between double rows)	8.22	7.65	15.87	1.63
Cassava +	-	-	30.63	-
groundnut (4 rows between double rows)	1.14	1.21	2.35	1.87
Cassava +	-	-	31.26	-
groundnut (3 rows between double rows)	1.02	1.02	2.04	1.77



- National Center for Crop Research
- ◐ Regional Corporation
- State and Territory Experimental Stations
- Integrated Programs
- Special Services
- ▲ Natural Resources Research Center
- △ State Corporation

FIG. 1 - The National Agricultural Research System set up by EMBRAPA in Brazil



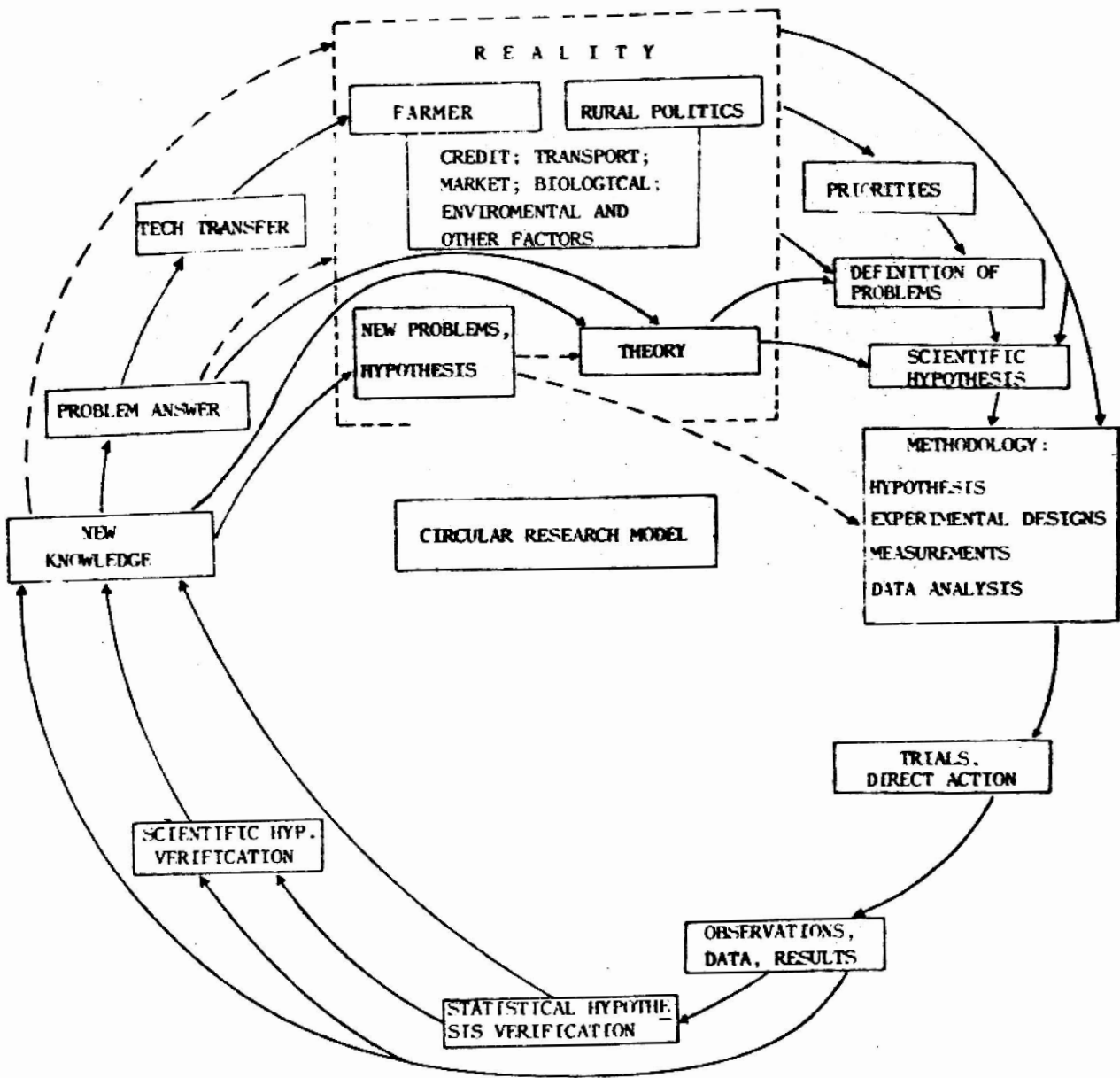


FIG. 2 - Circular research model employed by EMBRAPA

Datilografia, montagem, impressão e arte final  
Setor de Reprografia - CNPMF