Operational Plan 1992 - 1996

CASSAVA PROGRAM

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CIAT
Centro Internacional de Agricultura Tropical

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Program goal and objectives

The goal of the Cassava Program is to increase incomes, particularly in the less favored sectors of the rural population, and improve overall availability, quality and convenience of cassava in the tropics. The Cassava Program seeks to achieve this goal through interaction with its partners in a global network dedicated to promoting cassava as an important rural and urban food and to developing new forms of utilization suitable for changing economic circumstances Within this context the Program pursues the following objectives

1 Effective utilization of wild and cultivated Manihot genetic resources to improve the expression of yield potential and the stability and overall acceptability of cassava germplasm under prevailing farm and market conditions

2 Improve cassava production by making available sustainable crop management practices for farming systems in selected agroecosystems.

3 Realize the demand potential for cassava through improved quality for diverse end uses

4. Strengthen the research and technology transfer capabilities of national research and development systems.

Operational activities

The Program meets these objectives through the following areas of activity

(a) Managing the world cassava germplasm collection,

(b) Contributing to the body of knowledge on the cassava crop,

(c) Developing improved component technologies for crop production and utilization, and

(d) Strengthening and supporting national programs in the development of sustainable cassava production/ utilization systems.

A description of specific activities in these four areas envisaged for 1992-1996 follows.

Germplasm management

Germplasm management includes the activities of collection, conservation, characterization and documentation of cassava and wild Manihot species. The size of the cassava germplasm collection will be increased through incorporation of additional existing Latin American materials, and also from collection expeditions, mainly in Brazil. Representative subsets of the collection will be selected and studied to streamline efforts to conserve and characterize genetic variation within Manihot esculenta. This will include characterization for HCN and starch quality. A duplicate germplasm bank will be established in collaboration with IBPGR.

High research priority will be given to collection, sexual and asexual propagation requirements, characterization and agronomic evaluation of wild species of Manihot, and to evaluation of interspecific crosses.

Isoenzyme characterization, and DNA fingerprinting will provide tools for clarifying the phylogenetic relationships between species of Manihot and within Manihot esculenta. This information will lead to more effective and efficient choices of parents for gene pool formation and for progeny selection.

Building the knowledge base

This area of activity is concerned with generating widely applicable knowledge about cassava Starting from a low base in 1972, the Program assembled a comprehensive body of knowledge which led to a general understanding of cassava's adaptation to different environments Research must now focus more on identifying specific mechanisms of adaptation to abiotic stresses and of resistance to biotic stresses, increasing expression of yield potential, integrating crop management and protection technologies, understanding root quality factors and development of better socio-economic diagnostic tools The Cassava Biotechnology Network will act as an important mechanism for promoting basic research on cassava among advanced laboratories The Cassava Program will draw on the knowledge generated by these labs to carry out many of the activities described below.

Diagnostic methods To be effective in strategic research, reliable socio-economic diagnostic tools must be developed and used together with national programs for definition of research needs and priorities. Improvement of diagnostic methods is a high priority for the next five years Gender-sensitive characterization of client groups (farmers, processors, consumers) with regard to their needs is especially critical in Asia and Latin America, as cassava moves more toward a diversification in end uses. Diagnosis of the dynamics of varietal adoption will be instrumental to formulation of relevant selection criteria and effective release strategies.

Ecosystem definition. A basic physical and biological description of cassava-growing environments exists, but needs further refinement. Estimates of the impact of cassava cropping in different environments provided by the Natural Resources Management Division (NRMD) will facilitate prioritization of regions for targeted development of germplasm, and crop protection and management technology.

Crop physiology Continued progress in cassava genetic improvement will rely increasingly on understanding plant mechanisms of biotic and abiotic stress resistance and adaptation, the physiological basis of yield, and interactions between genotype and environment for root quality

Recent research has uncovered the existence of a unique photosynthetic system in cassava intermediate between the C_3 and C_4 types The next five years will bring solid progress in manipulation of this novel system so that its advantages can be better utilized in breeding programs and in the design of improved production components.

The efficient water use capabilities of the cassava plant will be further exploited by new research on mechanisms of drought tolerance. The effects of improving drought tolerance on other agronomic traits will be studied The compatibility of different mechanisms will be determined in order to assess the feasibility of pyramiding water use efficiency mechanisms for maximization of drought tolerance through breeding

As the Program places increased emphasis on the subtropics, a clearer understanding of temperature and photoperiod interactions will be needed The feasibility of simulating key subtropical conditions for efficient pre-selection of genotypes for the subtropics will be investigated

Nutrient use efficiency is an important consideration in the development of sustainable agricultural systems Significant differences between genotypes are recognized, however, present screening techniques are cumbersome and imprecise. More effective screening methods will be developed and basic research will elucidate physiological mechanisms operating in efficient genotypes

Root quality High root quality is crucial to improvement of existing uses and successful development of new uses for cassava Assuring the stability of quality in a given genotype and environment is also critical to the expansion of cassava utilization possibilities The importance of root quality will grow as new specialized markets develop. Ways to select for specific quality traits such as very low HCN and use-dependent amylose/amylopectin ratios must be developed The physico-chemical root tissue characteristics which determine good eating quality for fresh cassava will be identified in collaboration with NRI, London In research, emphasis will be placed on development of screening methods for assessing quality and its stability. An aim of the Biotechnology Network is the production of acyanogenic cassava The Program will contribute towards this through investigating the role of HCN in pest and pathogen resistance since the implications of removing HCN must be assessed. The reasons for farmer and processor preferences for high cyanide varieties for certain end uses are unclear and must be investigated so that possible benefits of cyanogenesis can be weighed against its costs.

Crop protection Considerable basic research on biology and ecology remains to be done for several arthropod pests, root rot pathogens, viruses and their vectors, and mycoplasmas. Growing diversification of cassava markets will result in an increasing demand for solutions to pest and pathogen problems in dried, stored cassava

Although resistance to many pests and pathogens has been incorporated into improved gene pools, mechanisms are generally unknown Understanding how resistance works for major cassava pests and diseases is a priority for crop protection research Mechanisms which operate against more than one pest or pathogen will receive greatest emhasis.

Resistance stability has received little attention in cassava Methods for detecting the breakdown of resistance, and for selecting for durable resistance will be developed The possibility of tapping wild cassava species for sources of resistance to recalcitrant organisms such as mealybug and root roots will be explored Molecular techniques and other biotechnology tools will be used increasingly in germplasm screening and selection

The interaction of host plant resistance, cultural practices and biological control in cassava is poorly understood and will receive more attention in order to optimize the effectiveness of crop protection technologies

The Virology Research Unit will continue virus isolation and identification, with a view toward elaborating control methods Host plant resistance for viruses has been virtually unexplored, with the exception of African Mosaic Virus Research on coat protein-mediated resistance is being initiated within the Cassava Biotechnology Network for Cassava Common Mosaic and African Mosaic Virus, and will remain a priority Exploratory resistance work will begin for several other major viruses

Genotype/cultural practice interactions Genotype interactions with major cropping system components such as tillage methods, intercropping, fertilization and weed control practices will be investigated to make selection more effectively directed to farmers' needs Adoption of the use of inputs is slow in cassava-based cropping systems and other means of maintaining soil fertility will be investigated, such as the use of green manures or tree legume foliage. Increased cassava responsiveness to fertilization will become a breeding objective in order to anticipate the move towards increased fertilizer use in some areas over the next decade.

Process research In collaboration with NRI, the kinetics of cyanide elimination from cassava root tissues during drying will be studied with the aim of optimizing quality (HCN, DM content, microbial counts) and fuel use efficiency In collaboration with CIRAD/CEEMAT and together with the BRU, the studies on the effect of starch fermentation variables on sour starch quality will continue.

Development of component technologies

Sound knowledge of the crop and the environments in which it is grown is the basis for development of component technologies Three areas of activity can be identified genetic improvement, crop management, and utilization and marketing research

1 Genetic improvement

Gene pool development. Once new genetic diversity is created, superior genotypes are selected based on established criteria Selection of varieties for release to farmers is a national program task CIAT works principally on the long-term process of developing broadly-based gene pools targeted to regional needs, and major shifts in this strategy are not anticipated Refinements to further stratify and target gene pools will be made by selecting high and low HCN pools for some edaphoclimatic zones, and also by adding a new gene pool for the semiarid tropics. The tools of biotechnology permit faster progress toward specific breeding goals, and allow formulation of completely new goals The Program will collaborate closely with the BRU and the Cassava Biotechnology Network to capitalize on new technologies for utilizing recombinant DNA, when appropriate

True seed. The Program projects a major effort to make commercial production from true cassava seed a viable option for farmers. The benefits, in view of the many constraints resulting from vegetative propagation, could be enormous, however, the payoff

will only begin to be visible by the end of the decade. To ensure success, a broad range of disciplines will be involved biotechnology to define an appropriate genetic structure and increase flowering, virology to improve virus detection techniques, agronomy of seed production and growing cassava from seed and ex-ante socio-economic analysis of farmers' attitudes to true cassava seed

2. Crop management

Because cassava is cultivated under heterogeneous conditions, crop management technology must be developed for each of the major ecosystems. The drier regions of tropical America, Asia, and Africa, and the subtropics of Latin America and Asia will be the principal target regions The Program will collaborate with the NRMD in crop management research for the hillside, savanna and forest margin ecosystems in tropical America. Technology developed for the hillsides may be relevant for the African highlands.

Although crop management tends to be location specific, certain components can be applied over a broad range of conditions This research is best undertaken in close collaboration with national programs in specific but representative sites. CIAT's vantage point permits comparison of results across agroecosystems, leading to the formulation of general principles which provide the basis for the design of improved technology

Soil fertility and erosion The Program has substantial knowledge of soil fertility management and erosion control; however further effort is required. Available component technologies will be tested and adapted under farmer conditions through linkages to integrated cassava development projects in Latin America, and to NRMD at CIAT. Soil fertility and erosion management principles developed in Asia will be tested by Asian and Latin American institutions which work directly with farming systems issues These

processes will provide feedback to be used in the design of future research.

Crop protection Integrated management is an effective means of controlling pests and diseases in a long cycle crop grown by small farmers Efforts will focus on the root rot pathogens, Fusarium and Phytophthora, the chinch bug, and dry season pests such as mites, mealybugs and whiteflies Close links with IITA will be maintained in the development of IPM for Cassava Green Mite Implementation of available crop protection technologies with national programs will receive greater attention

Cropping systems. Production of cassava in rotation and in association with other species remains the predominant cropping pattern in most countries Research in the area of crop associations will focus on the testing of new varieties of cassava and associated crops across different environments.

Integration of component technology development A greater level of integration will be sought between activities in soil fertility and erosion management, crop protection, and cropping systems research Integration will be catalyzed by socio-economic research which will ensure the efficiency and effectiveness of new technology and a contribution to the economic growth, equity, and sustainability goals of the Program and of the Center as a whole

3. Utilization and marketing

Product and process development Product and process development has been one of the most important areas of research within the Cassava Program. Through hosting scientists from CIRAD/CEEMAT and the maintenance of links with NRI, the Program will ensure a continued effort in research on cassava flour and starch. The gradual reduction of product and process development using CIAT core resources will proceed in step with the identification of institutions which can carry on these activities

and with the formation and strengthening of regional post-harvest networks Through these networks the Program will continue to work with national organizations in identification of market opportunities for cassava-based products and an important task will be the promotion of market research as an integral part of product and process development

Strengthening national cassava R and D systems

The purpose of strengthening national systems is two fold Firstly, it is a means of promoting the application of the knowledge, technology and methodologies generated by the Program for the subsequent benefit of the farmers and consumers to whom the research is targeted Secondly, a close interaction with national programs provides invaluable feedback on the relevance of the Program's outputs The national cassava R and D systems include public sector institutions, non-governmental organizations, growers' federations and the private commercial sector involved with cassava The Cassava Program and the Institutional Development Support Program (ISDP) act together in a number of ways to strengthen and support these R and D systems The Program responds to the needs of African countries through its collaborative activities with IITA.

Information exchange. Information exchange is enhanced through (a) the cassava abstracts produced by the Documentation Center, (b) the Cassava Newsletter published in Spanish, English and French (through IITA) and (c) workshops usually organized within the framework of the regional networks (see below)

Joint generation of knowledge and development of technology In an increasing number of areas the National Programs are collaborating with the Program in the generation of knowledge and the development of component technologies This is of particular importance where problems of global importance cannot be researched

at headquarters The Program's scientists provide back-up technical support for these activities

Integrated Cassava R and D Projects The Program has developed through hands-on experience with national agencies in several countries, an institutional model for the execution of integrated cassava production, processing and marketing projects These projects provide an institutional framework for the validation and adaptation of cassava technology with the participation of research, extension and development organizations and farmers They also form the basis from which subsequent technology diffusion can take place The number of these projects in Latin America is increasing The Program and ISDP will place a major emphasis on assisting countries to design and formulate projects and link them with possible donor agencies

Training Two types of training are offered In-service discipline oriented training for periods of upto three months and short courses in specialized areas Training in the following areas will be intensified as a means of devolving certain research and technology transfer activities to national systems 1 Training of trainers, 2. Diagnosing problems and opportunities, 3. Development of cassava research methods and 4 Conceptualization, formulation, execution and evaluation of integrated cassava projects Opportunities for M Sc and Ph D research are also provided.

Networks The following networks have been fostered by the Program· 1. Breeding and agronomy research networks in Asia; and 2 Breeders' network in Tropical America Network activities will be intensified as a means of promoting horizontal cooperation between countries, the prioritization of regional research priorities and devolving training in applied production and utilization technology The Program will play a catalytic role in the formation of the following networks 1 Cassava utilization

and marketing research in Asia, 2. Three subregional networks in Tropical America (Southern Cone, N and N.E. Brazil, Andean and Central American countries) and 3. An integrated cassava projects network in Tropical America

Program outputs

1 Broader and better characterized germplasm which will provide the basis for sustainable progress in cassava breeding.

2. Quicker and more reliable germplasm screening methods that will allow the evaluation of the range of genetic variability present in the germplasm collection

3 Gene pools with a higher frequency of favorable recombinants for selecting by national program breeders

4 Additional and improved techniques that permit the detection and cleaning of cassava reproductive material for safe movement between regions.

5. Enhanced crop production and stability through the use of genetic material adapted to abiotic and biotic stresses.

6. Crop management practices that permit the expression of the full potential of improved germplasm in selected ecosystems

7. Scientific knowledge and feasibility studies to support further work on true seed.

8 Better macro-economic information of cassava demand, together with improved socio-economic characterization of cassava farmers and the impact on them of improved cassava technology.

9. Methodologies for the implementation of cassava research and development projects and, within these projects, for the in-situ testing of improved cassava production and processing technologies.

10 Improved small-scale processes for the production of cassava flour and starch

11 Trained cadres of national program research, extension and development personnel.

12. Consolidated regional cassava research and development networks.

Program organization

The Cassava Program is composed of.

1. A headquarters based interdisciplinary team
2. A regional office in Bangkok, Thailand
3. A CIAT/IITA liaison office in Ibadan, Nigeria
4. A regional program for Tropical America centered at headquarters

It is proposed to maintain this general organizational outline

Resource allocation

Using staff positions as the basic unit for the projection of required resources, the following is a description of the positions and functions that the Program considers to be essential for carrying out the activities detailed in this operational plan Table 1 shows the allocation of these staff positions according to area of activity

Headquarters

Program Leader (Core). Research coordination and supervision of all activities of headquarters and outposted team members. Liaison with CIAT Research Support Units Coordination and participation in the preparation of proposals for the acquisition of complementary resources Liaison with IITA and other IARCs in cassava related areas.

Physiologist (Core). Further research on the C_3-C_4 intermediate in collaboration with scientists in advanced institutions, genotype responses and the underlying mechanisms of those responses to stress factors such as water use efficiency and stress tolerance, low soil fertility, emphasizing phosphorus and potassium nutrition Fundamental physiological research for true seed cassava production system (e g mechanisms involved in flowering, dry matter partitioning and plant architecture)

Table 1 Projected Allocation of Senior Staff Positions according to Area of Activity

Period 1992 1996

Area of Activity	1992		1993		1994		1995		1996	
	Core	Comp	Core	Comp	Core	Comp	Core	Comp	Core	Comp
Headquarters										
Leadership	1 0	-	1 0		1 0		1 0		1 0	
Physiology	0 6		0 6	-	0 7		0 8		0 8	-
Pathology	1 0		1 0	-	1 0	-	1 0	-	1 0	
Entomology	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0
Breeding	0 8	0 5	0 8	0 5	0 8	0 5	0 8	0 5	0 8	0 5
Soil fertility/conservation	0 4	-	0 4	1 0	0 3	1 0	0 2	1 0	0 2	1 0
Cropping systems	0 3		0 2	-	0 1					
Quality	0 2		0 3	-	0 4	-	0 5		0 5	
Process/product devpt	0 3	-	0 4	-	0 3		0 2		0 2	-
Socio economics	0 4	-	0 5		0 6	-	0 6	-	0 6	
Subtotal	6 0	1 5	6 2	2 5	6 2	2 5	6 1	2 5	6 1	2 5
Latin America										
Breeding	0 2	0 5	0 2	0 5	0 2	0 5	0 2	0 5	0 2	0 5
Agronomy	0 7	-	0 7		0 7	-	0 7		0 7	
Utilization	0 4	1 0	0 3	1 0	0 2	1 0	0 1	1 0		1 0
Socio economics	0 4	1 0	0 3	1 0	0 2	1 0	0 2	1 0	0 2	1 0
Subtotal	1 7	2 5	1 5	2 5	1 3	2 5	1 2	2 5	1 1	2 5
Asia										
Breeding	1 0	-	1 0	-	1 0	-	1 0		1 0	
Agronomy	1 0		1 0	-	1 0		1 0		1 0	
Utilization	0 1	0 5	-	0 5		0 5	-	0 5		0 5
Socio economics	0 2	1 0	0 2	1 0	0 2	1 0	0 2	1 0	0 2	1 0
Subtotal	2 3	1 5	2 2	1 5	2 2	1 5	2 2	1 5	2 2	1 5
Africa										
Breeding	0 8	1 0	0 8	1 0	0 8	1 0	0 8	1 0	0 8	1 0
Physiology	0 2		0 2	-	0 2	-	0 2	-	0 2	
Subtotal	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0
TOTAL	11 0	6 5	10 9	7 5	10 7	7 5	10 5	7 5	10 4	7 5

Soil fertility/erosion control specialist (complementary). Research on basic mechanisms controlling nutrient use efficiency and identifying plant characteristics related to nutrient use efficiency for possible use as selection criteria for cassava improvement Focus on sub-humid and semi-arid ecosystems

Pathology (Core). Research on fungal and bacterial disease complexes focused on the key cassava ecologies, emphasizing both germplasm improvement and the development of a framework for the application of integrated disease control methodologies Maintenance research on the means for the safe and efficient international transfer of germplasm.

Entomology (Core). Research on major cassava pests with emphasis on germplasm evaluation for resistance and biological control through the identification, rearing and distribution of beneficial insects Coordination with IITA on the biological control of the major cassava pests in Africa. Program liaison with the BRU and the Cassava Biotechnology Network.

Entomologist (Complementary). Coordinate research activities on integrated management of dry season pests with national programs, particularly EMBRAPA Oversee research on implementation of IPM including diagnosis of farmer pest control practices, research in augmentation and conservation of natural enemies, classical biological control and effect of cropping systems on pests

Breeder (Core). Genetic improvement of cassava through evaluation of cassava germplasm collection and incorporation of sources of tolerance or resistance to abiotic and biotic factors Collaborative decentralized breeding and selection activities with national programs in Latin America and outposted CIAT breeders in Africa and Asia Coordination of the breeding activities undertaken by EMBRAPA and EMPASC, Brazil for the semi-arid and subtropical ecosystems Liaison with GRU on germplasm conservation

and wild species collection and management Coordination of the efforts on true seed propagation.

Breeders (Complementary). Collection, characterization and evaluation of germplasm for the semi-arid and sub-tropical ecosystems. Decentralized positions based at Cruz das Almas (CNPMF) and Santa Catarina (EMPASC) Responsibility for exchange of germplasm for these two ecosystems within Latin America

Utilization/quality specialist (Core). Definition of biochemical and physico-chemical quality parameters and development of screening techniques for discrimination among genotypes Development of methodologies for improvement of quality during processing Promotion of regional networks for cassava utilization and marketing Transitorial responsibility in supporting Integrated Cassava Projects in Latin America. Liaison with CIRAD/CEEMAT, NRI and other food research institutes for development of existing and new processing systems As from 1994 Head of the joint cassava/bean quality lab

Socio-economist (Core). Support to national programs in the execution and analysis of bench mark surveys to determine present and potential demand Participation with Program scientists in the development of efficient and effective production technologies and technology diffusion methodologies. Provision of an economic framework for the Integrated Cassava Projects in Latin America Realization of ex-post impact assessment of component technologies in Latin America. Assembly and maintenance of a cassava socio-economic data base Ex-ante socio-economic studies on research alternatives (e g true seed). Liaison with socio-economic research activities in Asia and Africa

<u>Latin America</u>

Agronomist (Core). Responsible for collaborative activities with national programs for the joint development of crop management

technologies within the framework of the integrated cassava projects. Headquarters based research will be phased out Collaborative activities with the NRMD will initiate as from 1993. Catalysis of subregional research networks.

Utilization specialist and Socio-economist (Complementary with ISNAR). Support to integrated cassava projects with special emphasis on transferring knowledge on project conceptualization, design, execution and evaluation to national organizations interested in setting up projects. Monitoring of impact and feedback to the HQ Program Development with the IDSP of training materials and guidelines for research and development personnel working on projects

<u>Asia</u>

Breeder (Core). Coordination of Asian regional program. Provision of guidance to national programs on breeding and selection methodologies Stimulate effective and safe intercontinental exchange of improved germplasm Support to the regional cassava research network in capacity of secretary to the Advisory Committee

Agronomist (Core). Assist national programs in the development of production technologies that reduce erosion and maintain soil fertility. Collaboration with regional farming systems initiatives for promoting research-extension-farmer linkages around cassava-based cropping systems.

Socio-economist (Complementary). Macro-economic studies on the overall direction of cassava development in the region to provide redirection of research efforts if necessary Ex-post impact studies on production technology adoption. Micro-economic studies to identify current production and processing constraints and the effectiveness of new technology in the intricate Asian cropping systems

Utilization specialist (Complementary with CIP). Catalysis of formation of a regional network on cassava and sweet potato utilization and marketing Definition of regional research priorities and opportunities for horizontal cooperation Transfer of relevant technologies across continents

Africa

CIAT/IITA scientist (Core). Broaden the African germplasm base through introduction of materials from Tropical America Participate with IITA scientists in the evaluation and selection of promising materials, providing feedback to HQ on performance Undertake drought stress physiology research. Act as general liaison between CIAT and IITA on matters of mutual interest

CIAT/IITA scientist (Complementary with IITA). Specific responsibility for introducing mid altitude and sub-humid/ semi-arid adapted germplasm to East and Southern African countries

NOTE These projections do not include complementary positions for: 1 Coordination of the Cassava Biotechnology Network, 2. Exploratory research on cassava propagation from true seed.