Identifying Information

Project title: Participatory development of low-cost simplified rustic tissue culture for cassava

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Collaborating institutions: International Center for Tropical Agriculture (CIAT)
Santa Ana Women's Group, Cauca
El Socorro Farmers' Association

1. Achievements and Constraints

Project results aiming to fulfill the proposed objective and work plan were as follows:

1.1 Low-Cost Equipment and Method

- Sophisticated equipment, for example pH-meter, oven pipettes, autoclave, and glass containers, were replaced with low-cost alternatives such as indicator paper, gas stove, pressure cooker, and baby food jars, respectively.

- Expected cost per plant has been reduced 5 times by using the rural tissue culture laboratory.

- Locally available media reagents, for example all–purpose fertilizers, table sugar, vitamin tablets, thiamin, jelly, and running water, were used to replace imported analytical reagents (basal salts, growth regulators, agar, and vitamins).

- Supplementing the media with fruit juices (pineapple or coconut water) improved propagation rate.

1.2 Growth Regulators

Alternative sources of low-cost growth regulators were found that were efficient for propagation (Hormonagro® as NAA and Progibb® as GA_3).

1.3 Training

- A representative farmer from Cauca was trained by CIAT and FIDAR to design, manage, and produce cassava seed using tissue culture techniques.

- This farmer trained a group of 11 women, who now operate a rural tissue culture laboratory in their area.

- Other groups in the Cauca area are following the process closely. From time to time they visit the rural tissue culture laboratory to monitor results, purchase plants, use the lab, or users or help set up other rural facilities to apply tissue culture techniques to other crops.

1.4 Participatory Research

- Parameters for building a tissue culture laboratory were defined, as well as the equipment and inputs required. Researchers gave farmers recommendations.

- Technical aspects of cassava seed production and laboratory management were defined jointly with participants.

- Farmers and researchers prepared new proposals for *in vitro* work with other plant species.

1.5 Gender Analysis

- The intensity and periodicity of activities were defined on the basis of the daily activities carried out by women.

- Women were positioned as actors in the improvement of the community's quality of life.

- The self-esteem of group members was enhanced as they identified and recognized their capacity to learn and to manage time.

2.6 Monitoring

- The procedure of evaluating technical training (success and error method) was carefully planned.

- Farmers and researchers published a procedures manual for the tissue culture laboratory.

- The different activities conducted were recorded systematically.

2. Outstanding Results

During this 2-year period, the most outstanding results were as follows:

2.1 The participation of men and women in the validation and adaptation of tissue culture technology was basic to the orientation of future project goals, taking into account individual, family, and community perspectives.

2.2 From the technical viewpoint, a tissue culture laboratory was set up with local equipment and tools that cost 20 times less than those used in a conventional laboratory. A culture medium was also produced with local inputs, which was 4 times less expensive than the check medium and had a higher multiplication rate (1:4) (Annex 1).

2.3 Rural tissue culture laboratories will allow farmers to control the availability of planting material, increase the supply of preferred materials, increase the diversity and flexibility of small farming systems, stimulate the interest in cassava R&D and enhance its impact, and serve as a model for other regions.

2.4 Based on the partial results of the project presented by researchers at different seminars, 15 Colombian institutions and two international entities have expressed their interest in repeating this experience in other cassava-producing regions that present problems of cassava seed quality and supply.

3. Difficulties with the Work Plan

During this 2-year period, all parameters to build the tissue culture laboratory were defined, taking care that the environmental conditions, the specifications and type of materials used, and the nationally manufactured equipment and tools selected were the most appropriate. Two laboratories were constructed—the first at the CIAT experiment station and the second at the farm level. No technical difficulties arose because of the preliminary research conducted by CIAT's Biotechnology Unit in previous years. The participation of farmers before the project initiated its activities also facilitated the

process. Farmers shared their views on the type and quality of materials and tools they considered should be used in the low-cost laboratory or module.

The definition of culture media components took 3 months longer than planned because all culture media components (salts, hormones, etc.) were to be replaced by local products of good quality (Table 2 and Figure1) while ensuring a plant growth in the laboratory similar to that obtained in conventional medium (CIAT-4E). A total of 106 different combinations were tested; of these, culture media 9 and 10 proved most promising for cassava growth. Because each culture media requires a previous handling period of 1.5-2 months for evaluation, the 3-month delay was not too extended, especially if we consider the knowledge learned and experience acquired for developing similar proposals with other crops.

The methodology selected to train farmers in tissue culture techniques, farmer-to-farmer, proved to be best option from the viewpoint of learning and skills gained by group members in managing tissue culture techniques. However, more time is needed (four months) for the group to specialize in each process (planting, preparation of media, hardening of plants) and thus reduce contamination problems and accelerate plant production.

To summarize, according to the project's monitoring and evaluation plan (Table 1), 96% of the activities planned for the 2-year period (1, 2, 3, 4, 5, and 8) were fulfilled. Pending activities indicated in the timetable (6-13) can only be carried out as of year 3 because of technical reasons.

5. Communication and Dissemination of Information

Preliminary project results have been disseminated at the local, national, and international levels, through participation in different forums and workshops on biotechnology and its use in seed quality and multiplication.

The different project researchers participated in the following seminars and workshops as lecturers:

- La Biotecnología, Herramienta Valiosa en la conservación, Protección y Producción de Plantas. Seminar for schoolteachers of northern Cauca. Colegio Fernández Guerra. Santander de Quilichao. June 1999.

- International Symposium and Workshop on Participatory Plant Breeding in Latin America and the Caribbean. Quito, Ecuador. September 1999.

- Agricultural Biotechnology in Developing countries: Optimizing the Benefits for the Poor. Bonn, Germany. 13-19 November 1999.

- Producción de Semilla en Forma *In Vitro*: Una Alternativa para Mejorar la Calidad y Productividad del Cultivo de Yuca. Workshop on cassava seed banks. Ministry of Agriculture- CIAT-FIDAR. Santander de Quilichao. 22-23 June 2000.

- Sistemas de Multiplicación Rápida de Semillas de Yuca. Curso Internacional sobre Sistemas Modernos de Producción y Procesamiento de la Yuca. 23 October-10 November 2000. CIAT–CLAYUCA.

- III International Seminar and Small Grant Workshop. Uniting Science and Participation in Research. Nairobi, Kenya. 6-11 November 2000.

- Transferencia de Tecnología *In Vitro* a los Agricultores. Symposium on the contributions of Dr. William Roca to CIAT's Biotechnology Unit (Tribute). 4 December 2000.

As a result of these seminars, 15 national and 2 international entities (Table 3) showed interest in working with this low-cost *in vitro* seed production technology for cassava.

A meeting with representatives of those institutions interested in the topic will be convened for the second week of February 2001 to specify the scope of this technology and to exchange ideas. A training scheme will be developed for technicians of governmental and nongovernmental entities interested in using low-cost tissue culture techniques to produce seed. Subsequently, a technical and economic feasibility study will be conducted to establish two pilot laboratories in other regions of Colombia.

The following articles about the project's experiences were published during 1999-2000:

- Can *in vitro* biology have farm-level impact for small-scale cassava farmers in Latin America? A. M. Thro; W. M. Roca; J. Restrepo; H. Caballero; S. Poats; R. Escobar; G. Mafla; and C. Hernandez. IN VITRO Cell. Dev. Biol–Plant 35:382-387. September–October 1999.

- Participatory development of low–cost simplified rustic tissue culture for cassava. R. Escobar; C. Hernandez; J. Restrepo; and W. Roca. CIAT 1999. Annual Report.

- Participatory development of low-cost simplified rustic tissue culture for cassava. R. H. Escobar; C. Hernandez; J. Restrepo; J. Tohme; and W. Roca. CIAT 2000. Annual Report.

- Manual para la producción de semilla de yuca a bajo costo por cultivo de tejidos (borrador). Sin publicar.

6. Justification for Requesting Project Extension

The project's initial work plan (Table 1) presented by FIDAR and CIAT to PRGA indicated that a period of at least three years was needed to meet all project objectives and fulfill proposed activities. Phase 1 (year 1) involved the adjustment and evaluation of all equipment and inputs necessary for the *in vitro* production of plants at CIAT and at the on-farm pilot laboratory built. Phase 2 (year 2) involved the definition of all parameters to initiate the orientation and training of producer organizations in the management and administration of the low-cost tissue culture laboratory. Finally, during the last phase (year 3), the *in vitro* seed produced in the farmers' laboratory will be evaluated in the field and compared with the conventional seed used by farmers in the region.

Because of the interest showed by numerous cassava programs of other institutions in applying this technology in other regions of Colombia, it is important to culminate the research and work carried out with farmers in these three phases (years).

6.1 Activities to be conducted during Phase 3 (year 3)

- Strengthening of organizations of cassava producers and definition of the type of enterprise for *in vitro* cassava seed production.

- Testing of the response of cassava material propagated *in vitro* under field conditions and comparison with the traditional system used in the area (propagation of cassava using stakes).

- Establishment of a combined *in vitro* production and rapid propagation scheme.

- Designing of a technical manual or pamphlet and systematization of the experience.

- Designing of the strategy to apply the experience in other regions of Colombia and in other countries.

6.2 Outputs of Project Extension

- A farmer organization producing cassava seed using low-cost *in vitro* technology in northern Cauca.

- Ten hectares of cassava planted in the field using *in vitro* seed.

- Publication of a technical handbook on *in vitro* cassava seed production.

- Thirty technicians of other Colombian institutions trained in all entire low-cost *in vitro* seed production technology.

6.3 Duration of Project Extension

12 months, as of 1 March 2001

6.4 Activity Timetable

Table 4 shows the temporary distribution of activities.

6.5 Required Funding

The project extension has a total cost of US$70,300, of which CIAT-FIDAR and farmer organizations will contribute US$34,000.

Table 1. Follow-up and Evaluation of Work Plan.

What will be monitored	Process	Indicators	Timetable	Outputs obtained	Fulfillment (%)
1. Environmental conditions and sanitation in the experimental rustic labs and hardening nurseries.	Weekly measurements	Temperature, light intensity, humidity, contamination	At intervals from the beginning	Determination of environmental conditions for growth rooms: 30 °C during the day and 25 °C during the night, with a 12.8–h day length (light)	100
2. Culture media	Ingredients: lists and measurements Cultures: visual evaluation and weighing at biweekly intervals	Ingredients, concentrations, costs, availability of all formulations tested; growth rate and condition of cultures	At intervals from the beginning	Identification of a low-cost medium composed of locally available ingredients A growth rate of 1:3	100
3. Equipment and supplies	Equipment performance, first with biotech operators and then with farmer operators, monitored by number, survival, and condition of cultures	Features of versions tested, speed of operation, contamination frequency, ease of use, costs to purchase or make, availability	As each component is developed, rechecked at intervals for the remainder of the 3 years	Identification of the basic equipment needed to operate a low-cost laboratory (flow chamber, pressure cooker, gas stove, wooden table, washing facilities, shelving, flasks with plastic cover for culturing, tweezers, scalpel, spoon) Specifications for a growth room (screen house, tables, floor of washed gravel) Operational speed of 500 explants per day Contamination rate lower than 1%	100

4. Costs and returns of local pilot project	Daily recording in books Estimation of market value of resources (e.g., land lent for facility)	Costs of all inputs, including labor and land; returns from sale of plantlets or stakes, or from field production from early generation stakes	As soon as a technically feasible system is operating, continue as method is refined. Analyze data at 12 months and at year 2	Establishment of a laboratory with low-cost infrastructure Use of low-cost local inputs	90
5. Efficiency of planting material production	Record books of laboratory production and nursery production; record books of daily activities and time required; data from costs monitoring (above)	Vitro plantlets produced* per unit of resource invested (including time, purchased inputs) Vitro plantlets successfully hardened and established in stake production nursery, per unit of resource (Long term: evaluate effect on local price fluctuations of cassava planting material)	Lab and hardening- off nursery output: starting as soon as a technology is operational; continuous; stake nursery outputs, years 2 and 3	Good quality material produced in lab by farmers Trials with vitro materials produced by farmers, adapted in moist chamber and in the greenhouse	90
6. Performance productivity and quality in farmer's fields, compared to conventionally propagated plants of same variety	Standard field performance measurements; acceptance by processing plants, home processors; market prices; survey of farm income	Establishment; presence of systemic pests and diseases; fresh yield; year-to-year yield variation; starch content; other characteristics of importance to the evaluators; prices; production income per field or unit of farmer labor	Year 3 and post project		0
7. Farm and community income	Record books, interviews	Income from cassava production and cassava by-products, sale of material from the rustic lab, other related sources; and total income	Years 2 and 3; and post project		0

8. Other aspects of importance to farmers, e.g., opportunity.	observations	Availability of farmer time form this activity; demands of other activities, relative importance of competing activities	During and after project	Two economic proposals related to cassava established by farmers to improve their income	90
9. Others Spin off from technology or small business skills?	Observations, community interviews...	New business started, potential immigrants remaining in the community.	Post project		0
10. Distribution of benefits	Observations, informal surveys, effect of gender or farm size on ability to benefit	Income or other benefit of various groups or population sectors from this project	Post project		0
11. In-field varietal diversity	Field visits and farmer surveys	Number of different varieties grown in major production fields and in small plots or home gardens	At start up (baseline data) and after system has been in operation (post project)		0
12. Farmer participation in breeding and selection (independent or participatory)	Informal farmer survey, information from CIAT cassava breeding, appearance of new varieties	Number of different varieties appearing, farmer participation with breeders, farmer replies to surveys	At start up (baseline data) and after system has been in operation (i.e., post project)		0
13. Local seed sources	Informal farmer survey	Source of stakes used in planting major fields and home gardens	At start up (baseline data) and after system has been in operation (i.e.. post project)		0

* Should improve from Year 1 to Year 2; does not need to equal or exceed conventional method if costs (cash, time, other opportunity costs) are low enough to balance a slower rate.

Table 2. Comparison of the Ionic Composition of Culture Media Test Solutions.

Item	MS (1962)	Farmer solution
pH (Un)	5.72	6.81
P (ppm)	32	46.44
K (ppm)	764.27	357.47
Ca (ppm)	104.42	1.15
Mg (ppm)	34.44	39.62
Fe (ppm)	3.059	0.0496
Mn (ppm)	4.7805	0.0237
Cu (ppm)	0.0088	0.1476
Zn (ppm)	1.6247	0.168
Na (ppm)	3.323	84.13
CE (umh/cm)	3675	1500
B (ppm)	0.52	0
SO_4 (ppm)	471	478
N-NH_4 (ppm)	304.83	16.2
N-NO_3 (ppm)	561.52	283.41

Table 3. Institutions interested in low-cost tissue culture technology to produce cassava seed.

Institution	Contact	Phone number
FAO	María Zimmerman	(091) 315 15 09 Bogotá
PNUD	Jaime Escobar	(091) 340 55 43 Bogotá
Min. Agricultura	Humberto Guzmán	(091) 334 11 99 Bogotá
C C I	David Celis	(091) 283 49 88 Bogotá
COL YUCA	Jaime Beltran	(091) 609 24 77 Bogotá
ANUC	Luis Alfredo Londoño	(091) 268 12 79 Bogotá
U. Nacional	María Teresa Riguero	(091) 316 50 00 Bogotá
Secretaría Agricultura del Cauca	Plutarco Olave	(0928) 233836 Popayán
Secretaría Agricultura Antioquia	Dorotea Martínez	(094) 8280547 Medellín
Secretaría Agricultura del Tolima	Ana Sol Barrera	(982) 611517 Ibague
CORPOICA - Montería	Antonio López	(0947) 860216 Montería
INCORA	Wilson Quiroga	(0976) 345006 Bucaramanga
UMATA Puerto Boyacá	Felicia Valeror	(0987) 383200 Puerto Boyacá
UMATA Espinal	Carlos G. Vera	(0982) 484131 Espinal
CORPOICA Espinal	Heber Vargas	Espinal
Comité Cafeteros de Restrepo	Gloria I. Martínez	(092) 2521198 Restrepo
Secretaría Agricultura del Casanare	Omar Fuquene	Casanare

Table 4. Activity Plan (Year 3)

Activity	Quarter 1	Quarter 2	Quarter 3	Quarter 4
TASK I: Will it work under farmers' conditions?				
STEP 1: Getting the system up and running	X	X	X	X
STEP 2: The post-flask hardening stage: controlling losses		X	X	X
STEP 3: The nursery stage	X	X	X	X
STEP 4: Bookkeeping and small business management training	X	X		
STEP 5: Distribution of planting stakes				X
STEP 6: Socioeconomic and agronomic evaluation		X	X	X
TASK II: Extension for other locations				
STEP 1: Workshop	X			
STEP 2: Technical publication (Spanish and English)	X			
STEP 3: Marketing study		X		
STEP 4: Training technicians			X	X
TASK III: Follow up and evaluation				
STEP 1: Data collection	X	X	X	X
STEP 2: Data analysis		X	X	X
Reports		X		X

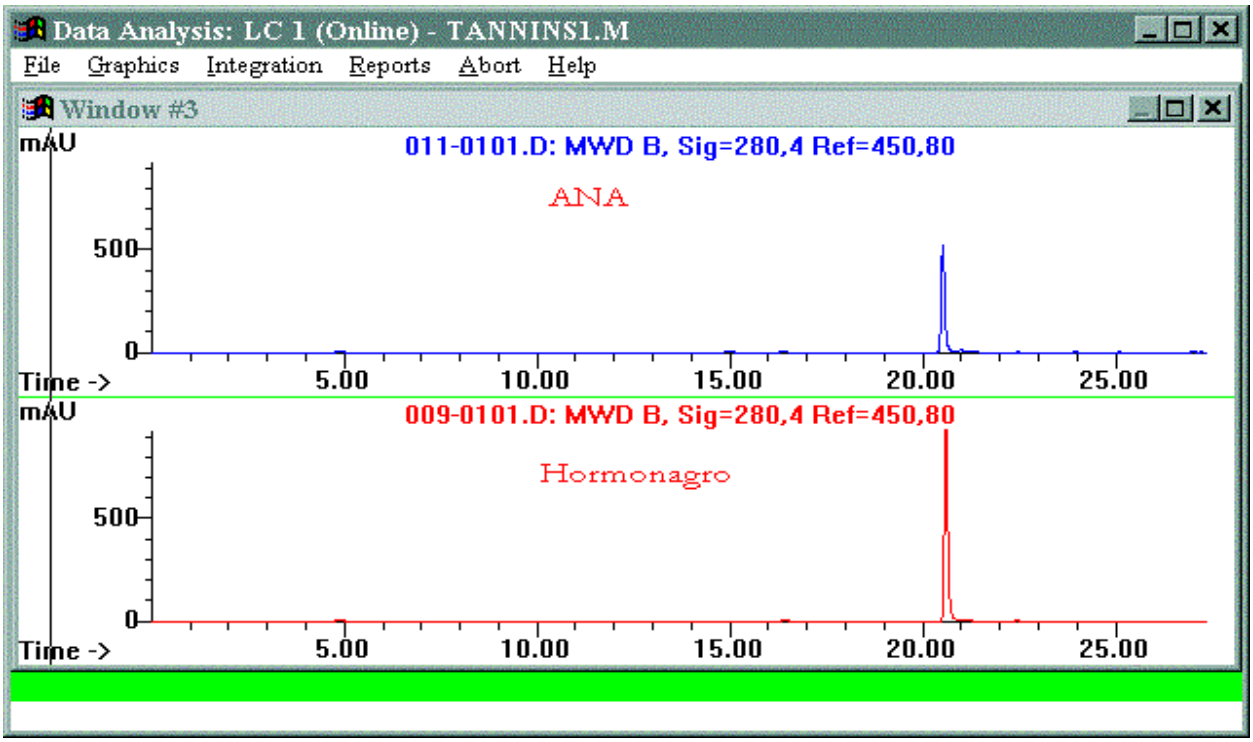
Table 5. Detailed Budget of Funds Requested for Year 3.

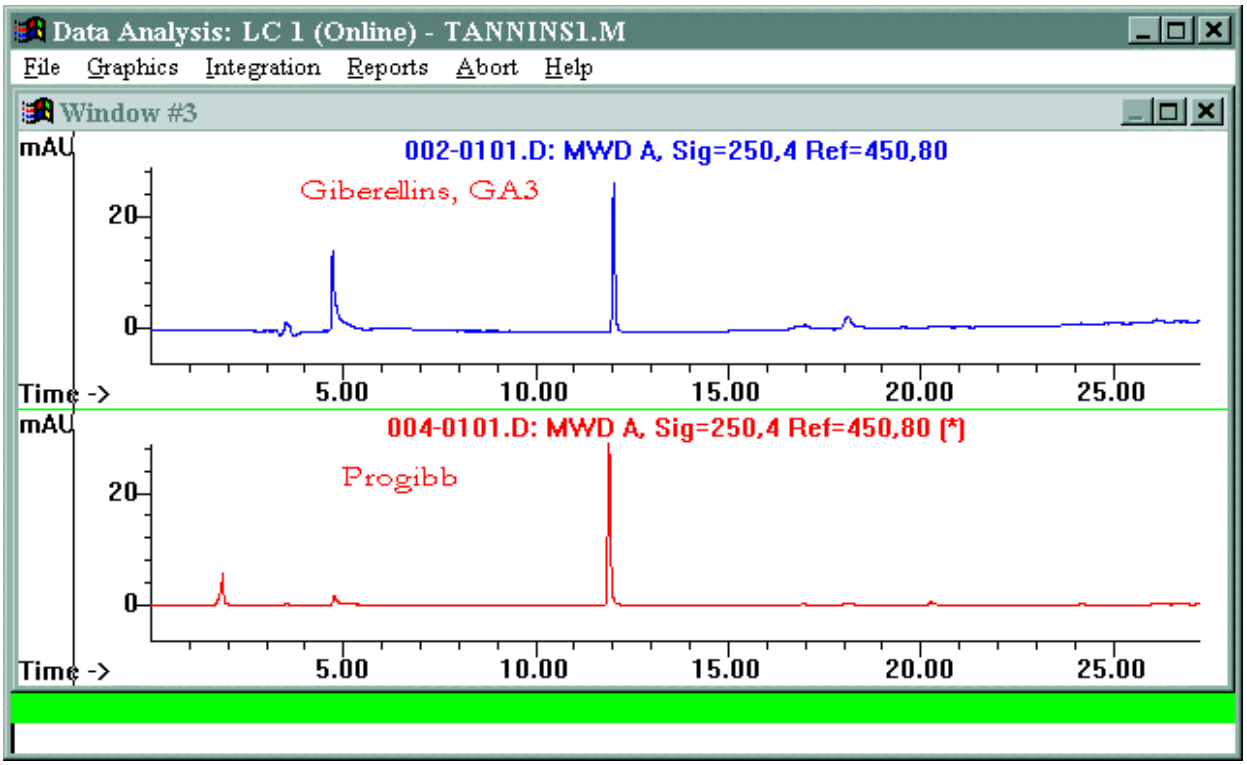
Item	Amount (US$)
A. Farmers/Community Associations	
Full time *in vitro* propagation technician	4,000
Lab supplies	2,000
Electricity, water	200
Transportation and meal for participants	1,000
Nursery (5 hectares)	1,800
Equipment (irrigation, hoses, buckets, shovels)	3,000
Subtotal	**12,000**
B. FIDAR	
Transportation and meals for data collection	1,000
On-farm field trials for collection of agricultural data	2,000
Sampling and data analysis	500
Workshops (2)	2,000
Project coordination	2,500
Technical publications (2)	3,000
Subtotal	**11,000**
C. CIAT	
Laboratory supplies	3,000
Transport and meals, technical monitoring visits	1,000
Laboratory assistant (505)	6,000
Subtotal	**10,000**
Total direct costs for Year 3	33,000
Indirect costs (10%)	3,300
Total for Year 3, all partners	**36,300**

D. Partner Contributions

Farmers	
Loan of land for the rustic laboratory site	5,000
Personnel (time) 10 days per month	1,500
Subtotal	**6,500**
FIDAR	
20% time Coordinator	3,500
20% time Assistants	4,000
Office space	3,000
Subtotal	**10,500**
CIAT	
5% time Senior Scientist	5,000
20 % time Research Assistants	3,000
Space/land for prototype microclimate experiments	6,000
Laboratory and equipment	2,000
Library and internet	500
Office supplies	500
Subtotal	**17,000**
Total Year 3 for all partners	**34,000**

Figure 1. Chromatogram of VS analytical degree hormones (low-cost products used for production).





Fugure 2. Chronomatogram of GA3

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