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Executive Summary

Project IP-4. Improved Rice Germplasm for Latin America and the Caribbean

1. Project Description

Objectives:
To add to the well being of the rice sector with emphasis on the resource poor rice farmers by increasing genetic diversity and the stability of high yielding varieties. These will require lower inputs that will reduce the production costs, help protect the environment, and make rice locally available at a reasonable price.

Outputs:
1. Enhancing Gene Pools
2. Integrated Pest and Disease Management
3. Education and Rice Cultivation as a Vehicle to Alleviate Poverty

Gains: Robust high yielding rice varieties requiring lower inputs will be developed. We will provide well-characterized progenitors and advanced materials with an ample genetic base as well as training to our partners. The focus will be on developing the capability to increase the number of desirable traits in varieties. This will lower unit costs giving farmers higher profits as well as maintain rice as an affordable food for the consumers.

Milestones and Indicators:

2004
Output 1 New rice varieties with greater diversity
Rice germplasm nurseries CIAT-ION will be evaluated by partners in at least 9 countries.
Control of major rice pests and pathogens
Two training courses in Integrated Pest Management

Genetic progress and gains for populations enhanced by recurrent selection for different traits will be assessed in several countries. Studies of the genetics of complex traits including yield that used interspecific crosses and molecular markers will be completed. Marker aided selection will be used to combine complete resistant genes to produce rice that has a more durable resistance to rice blast. Molecular and virulence characterization of Rhizoctonia, which causes sheath blight, will be started. Advanced populations using wild rice genes and recurrent selection will continue to be developed. These populations will include characteristics additional traits such as resistant to crinkling disease, good yield potential, aggressiveness, water stress adaptation. The CIAT rice website will present 2 modules on specific crop management problems.

2005

Marker aided selection for multiple traits will be initiated. Participatory rice selection and breeding will be releasing new rice varieties for resource poor farmers. Advanced lines with multiple traits from wild species of rice will be tested for national programs for their release as varieties. An interactive training for rice researchers and extension agents will be available through as E-learning tools. Many of the modules will be appropriate for farmers as printed materials. The developing systematic selection methods for complex traits will increasingly become the focus of the genetic studies. Near isogenic lines for blast resistant genes will be used in regional studies to understand the dynamics of the pathogen and develop locally resistant varieties. Using water efficiently in rice systems will be a focus of varietal development and crop management.

2006

The effectiveness of MAS as a breeding tool will be evaluated and if it proves cost effective then implemented as a routine activity. More systematic breeding for complex problems such as rice blast as well as simpler characteristics will be the focus of the MAS activities. E-learning activities will be used to join crop and pest management practices and participatory breeding activities. Rice as one component in the agricultural community will be analyzed as a means to increase farmer's incomes. Regional networks that have been strengthen through breeder's workshops, E-learning, evaluation of CIAT-ION and participatory selection and breeding will lead to the more rapid development and adoption of high yielding rice varieties with good grain quality and multiple stress resistance. Monitoring the use of the CIAT rice germplasm and the release of commercial varieties by our partners is a way to assess impact.

Users: Rice researchers especially in Latin America. Ultimate beneficiaries are the LA rice farmers most of whom are small farmers, and the resource poor consumer who are eating rice because it is available and affordable.

Principal Collaborators: France: CIRAD, IRD & Génoplante, FLAR, IRRI, WARDA, Japan JIRCAS, Korea RDA, Brazil EMBRAPA, Colombia FEDEARROZ & CORPOICA, Peru INIA, Venezuela INIA & DANAC, Cuba IIA, Nicaragua INTA, Bolivia CIAT Santa Cruz, Chile INIA, Uruguay INIA, Argentina U. Corrientes & U. Tucumán, China, US Universities: KSU, Cornell, Purdue, LSU, University of Arkansas, Texas A&M and Yale University.

CGIAR system linkages: Enhancement and Breeding (50%); Protecting the Environment (20%); Saving Biodiversity (15%); Transfer of Technologies (10%); Crop Systems (5%). Linked to IRRI and WARDA.

CIAT project linkages: Germplasm conservation SB-1, genomics SB-2, participatory research SW-3 for upland in hillsides PE-3 and cropping systems SW-2 for the savannahs. Provide improved germplasm to PE-1 and PE-2.

1A. Project Log-Frame 2004

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
Goal To add to the well being of the rice sector with emphasis on the resource poor rice farmers by increasing genetic diversity and the stability of high yielding varieties.	Increased rice production with farmers having more access to improved germplasm and information, and markets.	National production statistics	
Purpose To produce robust high yielding rice varieties requiring lower inputs, we will provide well-characterized progenitors and advanced materials with an ample genetic base as well as training to our partners.	Monitoring of yields of new varieties that were developed using our improved germplasm. Reductions in pesticide use and lower costs of production due to adoption of ICM practices leading to stable production and a cleaner environment.	Release of new rice varieties Annual reports. Publications. Impact assessment reports	Stability (internal and external) National policies favor adoption of new technology.
OUTPUT 1. Development of Improved Rice Genetic Resources	Rice populations with improved tolerance to biotic and abiotic stresses with good grain quality and physiological traits. Number populations and lines selected as well as the distribution of these for line development. Number of double haploid produced and used.	Project, CIAT, FLAR and NARS annual reports. Publications. Improved varieties released by partners.	Continued donor support. Maintaining multidisciplinary team
OUTPUT 2. Integrated Pest and Disease Management	Understanding components of resistance and virulence of rice blast, rhizoctonia, hoja blanca, crinkling disease, and other selected pathogens. Molecular markers associated and number of resistance genes for rice pathogens and pests. Crop management components developed. Using novel genes resistance to rice pathogens including hoja blanca and rhizoctonia.	Project, CIAT, FLAR and NARS annual reports. Publications. Pest and disease resistant varieties released by partners.	Continued donor support. Maintaining multidisciplinary team
OUTPUT 3. Education and Rice Cultivation as a Vehicle to Alleviate Poverty	Number of communities participating New varieties and small equipment for rice Number of workshops and scientists trained. Published reports of courses. Development of web pages	Project, CIAT, FLAR and NARS annual reports. Publications. Impact assessment reports CIAT's Rice Web page	Continued donor support. Maintaining multidisciplinary team

2. Project Inputs

- **Staff List**

Principal Staff	Allocation of time IP-4	Other	Affiliations	Location
Dr. Lee Calvert	70%		CIAT	CIAT HQ
Dr. Marc Chatel	100%		CIRAD/CIAT	CIAT HQ
Dr. Fernando Correa	100%		CIAT	CIAT HQ
Dr. Zaida Lentini	20%	80% SB-2	CIAT	CIAT HQ
Dr. Mathias Lorieux	50%	50% SB-2	IRD/CIAT	CIAT HQ
Dr. César Martínez	50%	50% SB-2	CIAT	CIAT HQ
Dr. Rafael Meneses	50%		IIA Cuba/CIAT	CIAT/Cuba
Dr. Gilles Trouche	50%	50% PE-3	CIRAD/CIAT	Nicaragua
Principal Staff positions in IP-4: 4.9 Associated projects 2.3			Total 7.2	
Dr. Carlos Bruzzone Works as a consultant	50%	50% (INIA)	INIA/CIAT	Peru

3. Research Highlights

The International Year of Rice

Rice is the first crop to receive the honor of a United Nation Year. It is because of the important of this crop throughout the world. In Latin America, there have been conferences and celebrations in support of the International Year of Rice. The principal theme of these events has been to look forward on how to continue to increase the productivity and the stability of rice production. We have discussed how to work together more effectively and share the products of our research. The scientist, extension agents, private companies, and public institutions have all expressed their willingness to develop closer working relationships. In this spirit, we can expect to continue the gains in productivity and to be part of the effort to eliminate hunger and poverty.

Using Chromosome Segment Substitution Lines to Unlock the Treasures found in Wild Species

Most modern crop varieties have undergone a genetic bottleneck associated with the process of domestication resulting in a restriction of the genetic options that are available to plant breeders. There is a larger pool of genetic variation available in landraces and wild relatives of crops, and we have been exploiting interspecific crosses to breeding for resistance to abiotic and biotic stresses. However, it is often difficult to utilize these natural sources of genetic diversity because of fertility barriers, linkage drag, the time and resources required to recover useful recombinants. To take advantage of the unexploited reservoir that exists in the wild relatives of cultivated rice (*Oryza sativa* L.), we started to develop interspecific introgression lines that will be of immediate use to breeders and will simultaneously serve to enhance our understanding of the “wild alleles” that contribute favorably to plant performance under drought stress. These lines are called Chromosome Segment Substitution Lines (CSSLs). The technology combined SSR marker genotyping and computer-aided selection of the lines and graphical genotyping. The set of CSSLs cover almost the entire genome of *O. glaberrima*. Two computer programs (CSSL Finder and GraphGenot) were designed for facilitate the analysis of CSS Lines. CSSLs are particularly valuable when complex, quantitatively inherited phenotypes are the breeding target. Because they represent inbred genetic resources that can be replicated by seed and distributed to collaborators working in different environments. Each set of CSSLs consists of a relatively small number of lines that can be evaluated in replicated trials. They are constructed to provide maximum power of statistical analysis because each line can be compared to all others or may simply be compared to the recurrent parent, making it possible to extract a great deal of valuable information from a relatively small number of lines crops.

Finding ways to control sheath blight of rice

In recent year, sheath blight of rice has become more prevalent and is causes significant losses in Latin America. The increase in incidence of the disease is associated with modern techniques of exploitation of the crop that favor the pathogen such as planting high yielding semi-dwarf cultivars, use of high nitrogen applications, rotation with soybean, and high seeding rates. Sheath blight, caused by the anastomosis group AG1-IA of the complex *Rhizoctonia solani*, but the genus *Rhizoctonia* has a wide number of species with characteristics of growth and plant symptoms similar to sheath blight, making it difficult any taxonomic classification, field identification, epidemiological studies, and management of the disease complex. A methodology to characterize the genetic structure and diversity of the sheath blight pathogen based on molecular markers was established, and fourteen genetic groups were identified in Colombia including species other than *Rhizoctonia solani*. Methodologies were developed to evaluate rice lines for their resistance to sheath blight. Tolerance to sheath blight was identified in a few varieties and in advance rice lines of *O. sativa*. Also tolerance to sheath blight was found in the wild species *O. rufipogon*, and this tolerance has been successfully transferred to the cultivated species. The next phase will be to use the information on the genetic diversity of sheath blight with the evaluatation methods. This will determine how universal is the tolerance and help define the breeding strategy for this disease. Even after tolerance is breed into new varieties, the farmers will still need to use good agronomic practices the reduce the plants susceptibility to the disease. Nevertheless, the widespread use of tolerant varieties will reduce disease losses and the need to use agro-chemicals on the crop.

Efficient use of water: a challenge for the future.
Although Latin America has the greatest amount of water per person, it is still a scarce resource. Nearly two-thirds of the rice cultivated in the region lacks adequate control of water. We have been working on developing rice for favored upland or aerobic environments. The yields of upland rice have significantly increased over the last decade in some cases approaches those of irrigated rice. These have been designated as dual purpose rice, and they do well in irrigated and aerobic environments. Our long experience with aerobic rice has put us in a good position to play a significant role in the Generation Challenge Program. We combine expertise in aerobic rice breeding, the use of molecular tools, and advanced interspecific crosses including the CSSL lines. Many of the wild species have good drought tolerance and are a valuable source of traits. While we may not produce a rice that grow like wheat, we can expect that work with this global challenge program, to produce in a more systematic way rice varieties with high yields that use water more efficiently.

Bullet Highlights

- More than 10 new varieties for irrigated and favored upland conditions by our partners.
- A new 2 hectares-field appropriate to receive 5,000 transgenic rice lines was set up. We now have 5 hectares available for transgenic rice cultivation.
- Phenotypic analysis has been collected data on more than 10,000 lines (more than 200,000 plants) tDNA mutants in our collaboration with Génoplante, France.
- A database in English (with partial information in Spanish) of all data relative to germination, flowering dates, and phenotypic observations was set up. This database can be used either for data browsing or as a working tool to facilitate data entering and compilation.
- SSR screening technology was optimized by setting up an agarose or Metaphor gel-based system for separation of PCR products.
- Good progress in the identification of interspecific lines with high yield potential, resistance to major diseases and grain quality. Over 10,000 lines were field tested in Santa Rosa and CIAT-Palmira resulting in 6174 plant selections.
- Transgenic Nipponbare plants carrying AcDs transposons were sent by Yale University and transplanted in biosafety greenhouses in CIAT-Palmira
- QTLs associated with traits of agronomic importance were identified in the Lemont/ *O.barthii* cross as well as in the *Oryza sativa* x *Oryza glaberrima* cross.

- The DREB sequence that increases tolerance to drought was successful transformed into rice.
- Several improvements were made in the development of Temporary Immersion System (RITA) for rice anther culture.
- Assessment of combinatory ability between red rice and rice was made for both greenhouse and field conditions. The biosafety studies are helping
- Two blast pathotypes affecting highly resistant cultivars were detected and corresponding genes conferring resistance identified.
- A gene conferring wide spectrum of blast resistance and derived from a wild rice species (*O. minuta*) *was* identified and used in breeding for resistance.
- Potential donors of stable rice blast resistance were identified from a diverse range of sources including commercial varieties, interspecific crosses and advanced lines.
- There was also good progress in the introgression of Pi1, Pi2, and Pi33 rice blast resistance genes into commercial rice varieties widely using both conventional screening and marker-assisted selection.
- QTLs associated with lesion type and disease leaf area affected in the highly resistant cultivar Oryzica Llanos 5 were detected for several blast isolates on rice.
- Rice lines originating in crosses, where the F_2 families show a higher number of blast resistant plants, and which showed a higher number of resistant sister lines, tend to give origin to more stable resistant lines in the advanced generations.
- The importance of involving more than one resistant parent in the triple crosses developed in breeding for durable blast resistance for high disease pressure environments.
- A molecular mark was associated with resistance to RHBV.
- The transgenic RHBV resistance materials continue to be advance and the mechanism of resistance was further characterized.
- Promising results of new early lines derived from composite population PCT-4\SA\1\1 and from inter-specific crosses for less favorable ecological areas.
- On-going Participatory Plant Breeding (PPB) schemes with several farmer groups in four areas of Nicaragua using PCT-18, PCT-4, PCT-11 and CNA-7 populations.
- Creation of three new site-specific narrow genetic base populations for Nicaragua.
- Validation Trials (Pre-launching) in Nicaragua of IRAT 366 (2004).
- Developing the structure and training needed to make PPB a sustainable for a long period of time.

4. Problems Encountered and their Solution

- Construction of the BAC library was delayed due to difficulties in developing sufficient material due to a very low seed set of the IRGC103544 accession. To overcome the problem, we have initiated a larger seed increasing campaign.
- Genotyping of the rice CSSL lines was really time-consuming due to lack of high throughput facilities. We have partially resolved the problem in developing a more versatile agarose gel-based system, but we still need more markers screening capacity.
- Germplasm distribution especially to non-FLAR members and seed companies needs to be resolved.

- Lack of clear guidelines for collaboration between the Rice Project and FLAR continues to generate too much noise and a stressful working environment.
- Recent reduction in core budget affected activities in breeding. Planting of breeding material was reduced in Santa Rosa and CIAT-Palmira.

5. Indicators: List Technologies, Methods & Tools

- **Varietal Releases**

NEW VARIETIES AND GERMPLASM

1. Variety Launching

1.1. Conventional Breeding

- **Brazil**

BRSMG CURINGA

"Variedade de Arroz para Plantio em Condições de Terras Altas e Várzeas"

✓ Launching: First semester 2004
✓ Origin: CIAT/CIRAD Line (CT13226-11-1-M-BR1)
✓ Intellectual property: CIAT/CIRAD and EMBRAPA
✓ Adaptation: Aerobic Rice Ecosystems (Cerrados and Várzea)
✓ An agreement between CIAT/CIRAD and EMBRAPA was made for seed production and corresponding royalties for the CIAT rice project.

- **Colombia**

Llanura 11

✓ Official registration and release by ICA-Colombia: First semester 2004
✓ Origin: CIAT/CIRAD Line (CT 11891-2-2-7-M or CIRAD/CIAT 409)
✓ Intellectual property: CIAT/CIRAD and CORPOICA
✓ Adaptation: Aerobic Rice Ecosystems (Savannas of the "Altillanura" region and the "Piedemonte" ecosystems). FEDEARROZ is very interested by the line because of its adaptation to the mechanized favorable conditions.
✓ Discussions took place between CIAT/CIRAD-CORPOICA and FEDEARROZ to reach an agreement for seed production by FEDEARROZ and corresponding royalties for the CIAT rice project.

1.2. Composite population breeding

- **Bolivia**

SR 99343: PCT-4\0\0\1>S2-1584-4-M-5-M-6-M-M

First Upland variety coming from the Composite Population PCT-4

✓ Official release: February 2005 (to be confirmed).
✓ Origin: CIRAD/CIAT (Upland *japonica* composite population PCT-4)
✓ Intellectual property: CIAT/CIRAD and CIAT Santa Cruz -BOLIVIA
✓ Adaptation: Small-farmer's and mechanized aerobic rice ecosystems.

2. Germplasm

2.1. Adaptation of aerobic germplasm in Central America

✓ Excellent adaptation of aerobic advanced and segregating lines
✓ Origin of the germplasm: CIAT/CIRAD (conventional and population breeding in Colombia)
✓ Intellectual property: CIAT/CIRAD

- ✓ Adaptation: Lines are evaluated and selected with and by framers (Participatory Variety Selection-PVS-). The selected lines show earliness, good yielding potential and resistance to diseases.
- ✓ This germplasm is highly praised because it offers the possible diversification of the actual cropping systems and also because of the reduction in costs production.
- ✓ The results are very relevant for the aerobic CIAT/CIRAD rice project and represent a valorization of the work done in Colombia.

2.2. New composite population

- **Chile and France**

PACQ-1: Site-specific population for the temperate climate ecosystem

- ✓ Origin: CIRAD/CIAT (Aromatic lines from CIRAD introgressed into the anaerobic *japonica* composite population PQUI-1)
- ✓ Intellectual property: CIRAD, CIAT and INIA Chile
- ✓ Adaptation: Anaerobic rice for the temperate climate ecosystem
- ✓ Population enhancement will focus on cold tolerance and aroma

- **Software**
  - Two computer programs (CSSL Finder and GraphGenot) were designed for facilitate the analysis of CSS Lines.
  - A database in English (with partial information in Spanish) of all data relative to germination, flowering dates, and phenotypic observations was set up. This database can be used either for data browsing or as a working tool to facilitate data entering and compilation.
  - A database on rice diversity was developed

- **Methods**
  - A methodology to characterize the genetic structure and diversity of the sheath blight pathogen based on molecular markers was established, and fourteen genetic groups were identified in Colombia.

6. Indicators: Publication List

- **Refereed Journal**

1. Aluko,G., C. Martinez, J. Tohme, C. Castaño, C. Bergman, J.H. Oard. 2004. QTL mapping of grain quality traits from the interspecific cross Oryza sativa x Oryza glaberrima. TAG 109:630-639.
2. Arrieta G., E. Sánchez, S. Vargas, J. Lobo, T. Quesada and A.M. Espinoza. 2005. The weedy rice complex in Costa Rica. I. Morphological study of relationships between commercial rice varieties and wild Oryza relatives and weedy types. Genetic Resources and Crop Evolution. Accepted (In press).
3. González R., R. Araya, M. Duque and D. Debouck. 2004. Wild common bean in the Central Valley of Costa Rica: ecological distribution and molecular characterization. Agronomía Mesoamericana 15: 145-153.
4. Larmande, P., Gay, C., Sallaud, C., Perin, C., Perez, P., Lorieux, M., Morel, J., Johnson, A., Ruiz, M., Courtois, B. & Guiderdoni, E. 2004. Nucleic Acids Research 01697.

5. Meneses, R., Reyes, L., Calvert, L., Triana, M., Cuervo, M., Duque, M. 2004. Identification of possible biotypes of Tagosodes orizicolus in different rice areas of Colombia. Rev. Integrated Pest Management. CATIE. Costa Rica.
6. Seebold, K.W., Datnoff, L.E., Correa-Victoria, F.J., Kucharek, T.A., and Snyder, G.H. 2004. Effects of silicon and fungicide on the control of leaf and neck blast in upland rice. Plant Disease 88:253-258.

- **Book Chapters**

1. Correa-Victoria, Fernando; Didier Tharreau, Cesar Martinez, Fabio Escobar, Gustavo Prado, Girlena Aricapa. (In Press). Studies on the rice blast pathogen, resistance genes, and implications for breeding for durable blast resistance in Colombia. Proceedings of the 3rd International Rice Blast Conference. 11-14 Septiembre 2002. Tsukuba, Japan p64. Kluwer Academic Publishers.
2. Correa-Victoria, Fernando. (In Press). EL ARROZ.... con énfasis en Venezuela. Mejoramiento para resistencia a plagas y enfermedades: Añublo del arroz (Pyricularia grisea) y Añublo de la vaina (Rhizoctonia solani). Eds: Orangel Borges y Elcio Guimaraes.
3. Lentini Z and A.M. Espinoza. 2004. Coexistence of weedy rice and rice in tropical America: gene flow and genetic diversity – In: J. Gressel (Ed.). "Crop Ferality and Volunteerism: A Threat to Food Security in the Transgenic Era?". Chapters XXIV. CRC Press. Boca Raton, FL (In press). 25 pp.
4. Trouche G. 2004. "The Participatory Breeding using Population Improvement in Rice: A New Methodology Adapted to the Needs of Small Farmers in Central America and the Caribbean. Chapter of book "Population improvement, an alternative to explore the genetic resources of rice in Latin America" Editor: Guimarães, Elcio. CIAT-CIRAD-Fundación DANAC.

- **Workshop and Conference**

46 publications, including oral presentations, poster (see Output 3)

7. Indicators: Training List

Thesis supervised

BSc.	4
MSc	4
PhD	1

number of interns

11 interns

number of visiting scientists

6 professionals from Nicaragua, Colombia and Venezuela

number of farmers trained
MIC course – CIAT, Colombia. 36 participants
MIC course – Nicaragua, 49 participants
Colombia – several farmers were trained on RHBV
Nicaragua – 175 farmers and 51 agronomists were trained

8. Indicators: Resource Mobilization List

- **List of Proposals Funded in 2004**
  - Generation Challenge Program. Sub-Project 3 "Gene Transfer and Crop Improvement", Cluster 2a 5: US$ 19,000
  - Generation Challenge Program. Sub-Project 1 "Global Genetic Diversity", Cluster 1 "Composite genotype sets": US$ 5,000
  - EMBRAPA/CIAT Cooperation fund. "Conferência Taller de Melhoramiento genetico do arroz na América Latina e Caribe" held in Goiânia-Brazil: US$ 15,000.
  - From CIRAD-Ca Calim Project Core budget: US$6,000.
  - International Rice Functional Genomics Consortium (Yale/CIAT). USDA and CIAT core funds. US$6,700.
  - High iron –zinc rice. CIDA,Canada. US$1,568.000/ six years starting 2005.
  - Génoplante. Project for phenotypic and characterization of a series of T-DNA mutants, for a total of US$61,000.
  - Challenge Program "Unlocking Genetic Resources in Crops for the Resource-Poor". Four projects for a total of US$67,000.
  - USAID – Development of a BAC library of the African rice species, *O. glaberrima* – US$14,000.

- **Projects Submitted in 2004**
  - Gene Flow Analysis for Environmental safety in the Tropics. CIAT – University of Costa Rica – Hannover University and BBA, Germany. Donor: BMZ. EURO 1,219,513. Submitted May 31, 2004. In Evaluation.
  - Precision transformation technology using heterologous recombination systems in crops. CIP-CIAT-IRRI-EMBRAPA- Berkeley University. Donor: Generation Challenge Program. US$740,000. Submitted May 15, 2004.
  - Proposal for the validation of new early lines in the Pacific area of Nicaragua submitted to FUNICA (accepted but not funded because of exhausted funds).
  - Join proposal "A strategy of Integrated Crop Management to reach the yield potential of rice in Latin America" to FONTAGRO Foundation.
  - Proposal " Producción sostenible y transformación local del arroz de secano en la región Atlántico Norte de Nicaragua": written, local partner has to submit to IDR (KR-2 funds)
  - Contribution to common proposals with CIPRES and the PPB-MA network to ACSUR and Norway: about 16,000 USD per year obtained for 2005 and 2006.

- Proposal to MAE Regional Funds of France for the elaboration and testing of a training module on Participatory Plant Breeding methods for NGO technicians and farmers.
- Four proposals were submitted to the CP Generation and two of them made it to the second round of selection. In the proposal *Exploring Natural Genetic Variation: Developing Genomic Resources and Introgression Lines for Four AA Genome Rice Relatives* "CIAT is the leading center with a value of US$900,000, whilst in the project EcoTILLING Consortium for Haplotyping and SNP Discovery in *Oryza*, *Sorghum*, and *Musa* IRRI is the leading center and we have budget of US$10,000.
- Project submitted to the Generation Challenge Program. Title: Exploring Natural Genetic Variation: Developing Genomic Resources and Introgression Lines for Four AA Genome Rice Relatives. Joint CIAT-IRD project. Total funding requested: US$877,200. In-Kind contribution: US$813,600. Total: US$1,690,800.
  Partners: Cornell University, Embrapa-CNPAF, WARDA, Fedearroz.

9. New Directions for 2005

Successful funded projects in the Biofortification and Generation Challenge Programs are leading to our greater participation in the both these Programs. For the Biofortification, we are increasing our activities in high iron rice and may also start testing Golden rice that contains vitamin A. As part of the Generation Challenge Program, we are increasing our activities on developing drought resistant rice. We have one project to enhance the utilization of four wild species with AA genomes. Rice and Biotechnology have also been invited to submit two additional projects to the Generation Challenge Program including one on screening mutant collections, which is part of functional genomics. There is also a possibility to collaborate with Japanese groups on Biofortification and screening of mutant collections. We also want to enhance our activities with farmer's groups and participatory research, and increase activities with our partners through networking.

MTP 2005-2007

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Outputs:

1. Enhancing Gene Pools
2. Integrated Pest and Disease Management
3. Education and Rice Cultivation as a Vehicle to Alleviate Poverty

Gains: Robust high yielding rice varieties requiring lower inputs will be developed. We will provide well-characterized progenitors and advanced materials with an ample genetic base as well as training to our partners. The focus will be on developing the capability to increase the number of desirable traits in varieties. This will lower unit costs giving farmers higher profits as well as maintain rice as an affordable food for the consumers.

Milestones and Indicators

2005

Output 1: Development of Improved Rice Genetic Resources

To increase the diversity in new rice varieties, 100 populations of interspecific crosses which incorporated key traits will be advanced two generations.

Genetic progress and gains for 20 populations enhanced by recurrent selection for different traits will be assessed.

Rice germplasm from our breeding activities will be evaluated by our partners in at least 11 countries. These populations will contain important agronomic traits including disease resistance, good yield potential, early vigor, water stress adaptation, etc.

To increase the nutritional value of rice, 200 advanced breeding lines will be evaluated for higher iron and zinc content.

Evaluation of existing germplasm and new crosses will be made to develop rice with better water use efficiency. The traits of interests will include earliness and tolerance to drought.

Gene flow studies will be published, giving policy makers more information to make regulatory decisions about transgenic rice.

Output 2: Integrated Pest and Disease Management

In five countries, studies to understand the dynamics of the rice blast pathogen will be conducted and the results will be used by breeders to develop rice varieties with durable blast resistance.

To better understand durable rice blast resistance, 225 RILs of O. llanos 5 will be evaluated using molecular markers. The outcome of these efforts will be to set up markers assisted selection (MAS) for rice blast.

To understand the genetics and set up MAS, the fine mapping of some genes involved in rice hoja blanca virus (RHBV) will be completed and published.

More than ten thousand rice lines will be evaluated for rice blast and RHBV resistance.

More than 100 isolates of sheath blight (Rhizoctonia spp.) will be characterized for virulence and genetic profiles.

Two rice populations will be analyzed using micro-satellite markers to identify sheath blight resistance genes.
Transgenic rice plants will be tested for resistance to sheath blight.

Output 3: Education and Rice Cultivation as a Vehicle to Alleviate Poverty

Two educational modules on rice management will be developed for the CIAT rice website
To rationalize pesticide use, two training courses in Integrated Pest Management will be conducted.
More than 40 rice lines will be tested with resource poor farmers using participatory methods in Central America.
To target the small farmers, two pamphlets on crop management will be printed.
A rice breeders network (Red Mega) will be initiated.
Training for more than 20 undergraduate and graduate students.
At least 5 publications in referred journals and 3 book chapters.

2006

Output 1. Development of Improved Rice Genetic Resources

MAS as a breeding tool will be tested for at least four disease and quality traits to determine its effectiveness versus costs.
Use identified sources of high iron and zinc to develop breeding populations with improved nutritional value.
From the interspecific populations one nursery with advanced lines with resistance to sheath blight will be sent to at least 10 countries for their evaluation.
Populations developed by recurrent selection that have resistance for rice blast, sheath blight, RHBV, and good grain quality will be sent to at least 10 countries for evaluation.
An impact study that monitors the use of the CIAT rice germplasm and the release of commercial varieties will be made and used to refine our rice breeding strategy.

Output 2. Integrated Pest and Disease Management

The fine mapping of genes involved in resistance to the sogata planthopper will be completed and published.
Rice lines with combinations of resistance genes that confer stable resistance to rice blast will be sent to at least 10 countries.
Control strategies for the mite *S. spinki* will be tested in Central America and the Caribbean region.
More than ten thousand rice lines will be evaluated for rice blast and RHBV resistance.
Transgenic plants will be tested for resistance to sheath blight.

Output 3. Education and Rice Cultivation as a Vehicle to Alleviate Poverty

The Red Mega rice breeders network will hold two workshops to select rice lines and exchange information.
Two new rice and sorghum varieties identified by resource poor farmers using participatory methods will be released in Central America.
Rice as one component in the agricultural community will be analyzed as a means to increase farmer’s incomes.
Training for more than 20 undergraduate and graduate students.
At least 5 publications in referred journals.
A book on rice productions for Latin America will be published.

2007

Output 1. Development of Improved Rice Genetic Resources

Depending on the outcome in 2006, a MAS breeding program will be implemented for at least 6 disease and quality traits.

The lines with multiple disease and quality traits that were selected by partners will become advanced lines and place into Red Mega international observation nurseries.

A new micro-spore anther culture method will be adopted if it proves more efficient than the current anther culture method.

Output 2. Integrated Pest and Disease Management

If MAS breeding for RHBV works, the number of lines evaluated by field methods will be reduced.

The results from the gene combinations for rice blast will be used to define region specific breeding strategies.

New genes or sources of resistance to rice blast should be identified and incorporated into new breeding populations.

The fine mapping of genes involved in resistance to sheath blight will be completed and published.

Output 3. Education and Rice Cultivation as a Vehicle to Alleviate Poverty

An impact study over the use and adoption of the varieties selected through participatory methods will be made to refine the participatory breeding strategy. Training for more than 20 undergraduate and graduate students.

Web and CD based training for IPM will be available. At least 5 publications in referred journals.

Users: Rice researchers especially in Latin America. Ultimate beneficiaries are the LA rice farmers most of whom are small farmers, and the resource poor consumer who are eating rice because it is available and affordable.

Principal Collaborators: France CIRAD, IRD & Genoplante, FLAR, IRRI, WARDA, Japan JIRCAS, Korea RDA, Brazil EMBRAPA, Colombia FEDEARROZ & CORPOICA, Peru INIA, Venezuela INIA & DANAC, Cuba IIA, Nicaragua INTA, Bolivia CIAT Santa Cruz, Chile INIA, Uruguay INIA, Argentina U. Corrientes & U. Tucumán, China, US Universities: KSU, Cornell, Purdue, LSU, U. Arkansas, Texas A&M and Yale.

CGIAR system linkages: Enhancement and Breeding (50%); Protecting the Environment (20%); Saving Biodiversity (15%); Transfer of Technologies (10%); Crop Systems (5%). Linked to IRRI and WARDA.

CIAT project linkages: Germplasm conservation SB-1, genomics SB-2, participatory research SW-3 for upland in hillsides PE-3 and cropping systems SW-2 for the savannahs. Provide improved germplasm to PE-1 and PE-2.

Project Log-Frame 2005-7

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
Goal To add to the well being of the rice sector with emphasis on the resource poor rice farmers by increasing genetic diversity and the stability of high yielding varieties.	Increased rice production with farmers having more access to improved germplasm and information, and markets.	National production statistics Impact assessment reports.	
Purpose To produce robust high yielding rice varieties requiring lower inputs, we will provide well-characterized progenitors and advanced materials with an ample genetic base as well as training to our partners.	Monitoring of yields of new varieties that were developed using our improved germplasm. Reductions in pesticide use and lower costs of production due to adoption of ICPM practices leading to stable production and a cleaner environment.	Release of new rice varieties Impact assessment reports Yields and areas of rice production Production practices and pesticide use.	Stability (internal and external) National policies favor adoption of new technology.
OUTPUT 1. Development of Improved Rice Genetic Resources	Number of crosses produced using CIAT germplasm. Number of lines screened by our partners and us. Advance lines and new varieties with improved tolerance to biotic and abiotic stresses with good grain quality and physiological traits. Number of double haploid produced and used. The development and implementation of MAS in the breeding program.	CIAT, FLAR and NARS annual reports. Publications. Improved varieties released by partners.	Continued donor support. Maintaining multidisciplinary team.
OUTPUT 2. Integrated Pest and Disease Management	Understanding components of resistance and virulence of rice blast, sheath blight, hoja blanca, crinkling disease, and other selected pathogens. Molecular markers associated and number of resistance genes for rice pathogens and pests. Crop management components developed. Using novel genes resistance to rice pathogens including hoja blanca and sheath blast.	CIAT, FLAR and NARS annual reports. Publications. Pest and disease resistant varieties released by partners.	Continued donor support. Maintaining multidisciplinary team.
OUTPUT 3. Education and Rice Cultivation as a Vehicle to Alleviate Poverty	Number of communities participating. New varieties and small equipment for rice. Number of workshops and scientists trained. The activities of Red Mega. The progressive development of the rice web pages The availability of educational materials on the web, Cds, pamphlets and books.	CIAT, FLAR and NARS annual reports. Publications. Impact assessment reports Monitoring the use of the Rice Web page.	Continued donor support. Maintaining multidisciplinary team.