CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

Annual Report 2006

Executive Summary

Project IP-4:

Improved Rice Germplasm for Latin America and the Caribbean

For Internal Circulation and Discussion Only

April 2007

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1. IP-4 Project Log Frame (2006)

PROJECT: **IMPROVED RICE FOR LATIN AMERICA AND THE CARIBBEAN**
PROJECT MANAGER: **FERNANDO CORREA**

	Outputs	Intended users	Outcome	Impact
Output 1: Enhanced gene pools				
Output Targets 2006 .	Enhanced gene pools and advanced lines with disease resistance to rice blast and rice hoja blanca complex that are high yielding with good grain quality for both irrigated and upland rice	Rice researchers, FLAR, and breeding programs throughout the region	Rice breeding methods and strategies for development, evaluation and selection of promising rice lines that result in varieties released by the rice sectors resulting in higher rice yields.	A robust rice sector will generate employment and maintain low rice prices for the consumers.

	Outputs	Intended users	Outcome	Impact
Output 2: Integrated crop, pest and disease Management				
Output Targets 2006 .	Characterization of the diversity of rice pathogens, resistance genes, and transfer of technology to partners	Rice pathologists and breeders	Better practices in place to reduce losses caused by pathogens as well as decreased use of agrichemicals.	The ecosystem will be less contaminated and the workers will be healthier.
	Integrated Pest, Disease, and Crop Management strategies adapted for at least 5 countries .	Rice scientists, extension agents and farmers.	Prerequisite for developing information based system as it confirms efficacy in local production systems	A more competitive rice sector with lower negative impact on the environment.

EXECUTIVE SUMARY

PROJECT IP-4: IMPROVED RICE FOR LATIN AMERICA AND THE CARIBBEAN

PROJECT MANAGER: FERNANDO CORREA

Project Description

Goal

To generate food security and employment associated with rice production with emphasis on improving the options for the small farmers.

Objective

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 information and training.

Target Ecoregion

Low and Mid Altitude Regions of Latin America and the Caribbean.

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.

	Outputs	Intended users	Outcome	Impact
Output 3: Intensification and diversification of rice systems for small farmers				
Output Targets 2006 .	Varieties including specialized high value rice (ethnic) and management practices (organic) developed for small rice farmers using participatory methods in two countries in Central America.	Small holders who produce rice and extension agents.	Better-organized small farmers. Increased yields and options that allow crop diversification including high value crops.	Improved livelihoods of small farmers. A dynamic and robust rice sector.

2. Achievements of 2006 Output Targets

Output 1

Output targets for the output on Enhanced Gene Pools were achieved on 100%.
The CIAT-ION nursery with 130 rice lines was distributed to different partners in Colombia, Nicaragua, Costa Rica, and Bolivia. Several sets of advanced rice lines were distributed to partners in the USA (Cornell University, Louisiana State University, U. of Arkansas, and RiceTec), WARDA, and University of South Africa. Rice lines from the biofortification project were sent to: Brazil (EMBRAPA-CNPAF, and University of Rio Grande Do Sul), Colombia, Cuba, Nicaragua, Republica Dominicana, Bolivia, Panamá, and WARDA.
In Bolivia, the first upland/aerobic commercial rice variety selected from the enhanced composite population PCT-4 (recurrent selection) was officially released in 2006 as the variety "ESPERANZA". The variety is adapted both to manual upland and mechanized aerobic rice ecosystems. In Chile, the first commercial variety, "RQuila 28", adapted to the temperate irrigated rice ecosystem, coming from the enhancement and selection of the population PQUI-1 was selected in 2006 and proposed for official release in early 2007. A total of 983 upland rice lines were multiplied and distributed to 25 Institutions from 12 countries.
Four additional commercial rice varieties were developed within the CIAT-FLAR consortium and released in different Latin American countries: ANAR 2006 (Nicaragua), IDIAP 54-05 and IDIAP 145-05 (Panamá) and CENTAURO (Venezuela).

Output 2

The Output Targets for the Output 2: Integrated crop, pest and disease management, were achieved on more than 90%.
This output considers the study of several rice pathogens including the rice blast pathogen (*Pyricularia grisea*), sheath blight (*Rhizoctonia solani*) and the new rice disease detected in Latin America, bacterial panicle blight (*Burkholderia glumae*). For each pathogen, significant advances were made in studying the pathogen diversity and in identifying resistance sources. For the rice blast pathogen, evolution studies allowed to identify potential mutants able to break

resistance gene combinations being used in the breeding program. The advanced detection of these mutants allows the identification of resistance genes that need to be incorporated in the new varieties to move ahead of future changes of the pathogen in natural populations (annual reports 2005-2006). Molecular markers associated to blast resistance genes were identified and implemented for marker assisted selection allowing the introgression of three blast genes into improved rice germplasm (see references). Lack of funding has not allowed the evaluation of large populations for the identification of rice lines carrying the three genes. Advanced lines with durable field blast resistance up to the eight generation were identified and are being multiplied to be given to our FLAR partner for their distribution to partners in the region. These lines can give origin to new varieties or be used as sources of stable resistance. Reliable screening techniques for the identification of resistance sources to the sheath blight pathogen under controlled greenhouse conditions were developed. Commercial rice varieties from Latina America were screened for resistance and resistance sources were identified. Rice populations (recombinant inbreed lines and double haploids) were screened and the information will be used to identify quantitative trait loci associated with resistance as part of a USA study funded by USDA. Characterization of the disease complex mite-fungus-bacteria affecting rice production in Central America and the Caribbean was initiated. A bacterial pathogen (*Burkholderia glumae*) was identified as the major cause of disease symptoms and responsible for economic losses (reference). The role of the mite seems to be more a way for spreading the bacterium. A reliable screening method to identify resistance sources to the bacterium is being developed under controlled conditions and preliminary results suggest that resistance genes to this pathogen are available. We initiated the screening of our germplasm bank as well as our elite and progenitors rice lines. All actual commercial cultivars planted were susceptible. Results will be confirmed under field conditions. Seed treatments using hot water and antibiotics suggest positive control of this pathogen in infected seeds, which is the main source for pathogen infection. Adoption of crop management practices by rice farmers in the region (lower seeding rates, hot water seed treatment, planting date, and adequate fertilization) to favor a healthier crop is also helping to reduce or minimize the presence of this disease complex. This research is being conducted as part of a FONTAGRO project and implementation and adoption practices are being conducted together with FLAR scientists working with different rice farmers in Central America. Activities within this output will continue during 2007.

Publications in Referee Journals:

1. Fuentes, J.L., Correa-Victoria, F.J., Escobar, F., Prado, G., Aricapa, G., Duque, M.C., and Tohme, J. 2006. Microsatellite markers linked to the blast resistance gene *Pi-1* in rice for use in marker assisted selection. Euphytica (accepted)
2. Jia, Y., Correa-Victoria, F.J., McClung, A., Zhu, L., Wamishe, Y., Xie, J., Marchetti, M., Pinson, S., Rutger, N., and Correll. J. 2006. Rapid determination of rice cultivar responses to the sheath blight pathogen *Rhizoctonia solani* using a micro-chamber screening method. Plant Disease (accepted)
3. Lopez-Gerena, J., Correa-Victoria, F.J., Prado, G., Tohme, J., Zeigler, R., and Hulbert, S. 2006. Mapping QTL affecting partial resistance and identification of new blast resistance genes in rice (*Oryza sativa*). Theor. Appli. Genet. (submitted)

Other publications:

1. Correa-Victoria, F.J. 2006. Improving Blast Resistance for Upland Rice in Colombia: a Challenging Task. 31st Rice Technical Working Group Meeting. The Woodlands, Texas, February 26-March 1, 2006.
2. Correa-Victoria, F.J. 2006. Identification of molecular markers for pyramiding rice blast resistance genes. Second Research Coordination Meeting. Nanjing, China, April 10-14, 2006.
3. Correa-Victoria, F.J. 2006. Avances en la investigación en enfermedades del arroz: *Pyricularia grisea.* II Congreso Brasilero de la Cadena Productiva del Arroz. VIII Reunión Nacional de Pesquisa de Arroz. EMBRAPA, Brasilia 26-28 de Abril, 2006. (Invited speaker).
4. Correa-Victoria, F.J. 2006. Situación del complejo acaro-hongo-bacteria en el arroz. Segundo Congreso Arrocero. San José, Costa Rica, Junio 29-30, 2006. (Invited speaker).
5. Correa-Victoria, F.J. 2006. Using rice differentials with known blast resistance genes for pathogen characterization and improving rice cultivars in Latin America. Rice Blast Workshop IRRI-JIRCAS. IRRI, Los Baños, Philippines, August 29-30, 2006.

Output 3

Selection of high performing well-praised rice varieties for different upland cropping systems and agro-ecological areas of Central America through participatory methods were achieved on more than 80%.
Two varieties in process of registration and three to be proposed for registration and release in 2007 in Nicaragua: two for low inputs upland cropping systems of the north-eastregion (Serviteca); one for the mechanized upland cropping systems of the north-pacific region (INTA); two very early upland lines for dry areas and/or new cropping systems (INTA). Farmers, NGO and extension technicians and NARS scientists trained on PCI approaches methods. Germplasm exchange and training course on PCI approaches with Guatemala, El Salvador and Costa Rica (germplasm in intermediate on-farm trials in Guatemala). No significant breeding work achieved on high value rice (just starting): 20%. Outputs on management practices: 20% (because of budget limitations, climatic and partnership constraints.
Another line derived from the cross Caiapo x *O. glaberrima* (African cultivated species) was identified trough participatory breeding by small farmers in Nicaragua as a variety and seed is being multiplied for commercial planting. Small farmers in Bolivia have identified a traditional variety called "azucena" as a potential variety for special markets.

Publications:

1. Trouche, G.; Narváez-Rojas, L.; Chow-Wong, Z.; Corrales-Blandón, J. 2006. Fitomejoramiento participativo del arroz de secano en Nicaragua: metodologías, resultados y lecciones aprendidas. Agronomía Mesoamericana (CR) 17(3): 307-322.
2. Chow W., Z.; Trouche, G. 2006. Informe anual de actividades en arroz. Proyecto fitomejoramiento participativo en arroz y sorgo CIAT-CIRAD/INTA. 17 p. 35 tab.
3. Trouche G. et al. 2006. Annual report for the research activity on Upland rice germplasm improvement for Central America.

3. Research Highlights 2006

- We have evidenced the usefulness of combining near-isogenic progeny analysis with rice genome information available in public databases to identify molecular markers highly linked to blast resistance genes in rice. Although a limited number of polymorphic markers can be expected when near-isogenic lines are used as progenitors, here we found six polymorphic markers in a region of only 13 cM surrounding the blast resistance gene *Pi-1(t)*. Additionally, two of these markers (RM1233*I and RM224) were closely linked to the gene. Our results support the utility of these DNA markers in MAS and gene pyramiding rice breeding programs addressing the improvement of blast resistance in rice cultivars; and eventually to map based cloning of the gene. The speed, simplicity and reliability of PCR based approaches make microsatellite analysis on agarose gels an attractive tool for marker-assisted selection in rice breeding programs aiming at developing durable rice blast resistant cultivars.
- We have demonstrated that polymorphic markers linked to resistance genes in near-isogenic populations, can also be expected to detect polymorphism and presence of linked genes in commercial rice cultivars with certain level of inbreeding.
- The Brazilian rice land race Tres Marias exhibiting stable blast resistance for many years in Brazil and Colombia carries at least one gene that confers resistance to the Colombian blast lineages SRL-4 and SRL-5. The resistance of the cultivar Tres Marias to the lineage SRL-6 was found very complex and did not follow a Mendelian segregation in the F_3 generation. QTL studies using molecular markers need to be conducted to elucidate the number of genes responsible for the stable resistance of the cultivar.
- The rice line 75-1-127 reported with wide spectrum of blast resistance to many blast populations of the world carries at least three different resistance genes and not only the Pi-9 gene derived from *O. minuta*. Resistance to blast in the rice line 75-1-127 is controlled by a dominant and a recessive gene to the blast genetic lineages SRL-6 and SRL-5 and by two dominant genes to the genetic lineage SRL-4.
- The blast resistance in the cultivar Oryzica Llanos 5 (durable blast resistance for more than 15 years) was found to have very complex inheritance. The durable broad-spectrum resistance in the rice cultivar Oryzica Llanos 5 is associated with multiple genes of major and minor effects that induce resistance to different blast isolates. Twenty-one QTL present in nine chromosomes were detected and associated with resistant traits in Oryzica Llanos 5. Most but not all of the QTL occurred in the same genomic regions of other genes that had been reported in the literature. None of the QTLs was effective against all blast isolates and all were isolate specific. One QTL mapped to a region on chromosome 9 where no blast resistance genes had yet been mapped. Another QTL near the bottom of rice chromosome 11 was found to be significantly associated with partial resistance.
- Advanced breeding lines (generation F_7-F_{11}) with transgenic-resistance to RHBV (comparable to Fedearroz 2000 and Colombia 1) combining high yield potential, good grain quality, tolerance to *Rhizoctonia* and characterized profile for strain resistance to pyricularia. These plants are ready to be evaluated by peers and to decide potential process for deployment to farmers. First product selection at completion, phase out, ready for decision on the fate for potential delivery to third parties.
- Transgenic lines carrying *DREB* genes. Hundreds of independent transgenic events carrying various transgenes for tolerance to abiotic stress (temperature, drought)

generated and characterized molecularly. The demonstrated competitive technical capacity for rice genetic transformation was reviewed by Japanese peer pioneer in development of gene technology in rice, recognition allowed CIAT to enter in new proposal in collaboration with JIRCAS, IRRI and CIMMYT and funded by MAFF Japan..

- Chloroplast and nuclear sequences selected and tested for genome and species characterization of *Oryza* allowing characterization of species composition and direction of gene flow in samples collected in farmers' fields in Colombia and Venezuela. High through-output methodology PCR-real time based for analysis of gene flow in rice at landscape level optimized. Set up international collaboration on experimental design and data collection for gene flow at landscape level that may allow adaptation of expert model systems for tropical conditions, applicable tool for biosafety decision process by competent authorities.
- Near-completion of a clean lab for handling and preparing rice samples for iron and zinc analysis, establishment of a methodology for running iron and zinc analysis in rice at CIAT, and establishment of base lines for iron and zinc. Validation of SNP markers to be used for the screening of rice genotypes having contrasting levels of iron content in the polished grains. Identification of rice cultivars having 2-3 times more iron than commercial milled rice bought by consumers

- Understanding of meiotic process of F1 hybrids between *O. sativa* x *O. latifolia* including abnormalities in spindle formation, chromosome segregation and cytokinesis leading to polyads formation, which give rise to unviable pollen and sterility, and chromosome elimination. Wide segregation for desirable traits including grain quality and high fertility was observed in F5 generation in crosses involving *O. latifolia*, and a large number of plant selections was made for further testing.
- Evaluation of about 13,000 breeding lines and identification of promising lines for CIAT-ION nurseries. Promising interespecific breeding lines with high yield potential, tolerance to main diseases and good grain quality were identified and included in the CIAT-ION nursery made available to NARs in 2006. Out of the 194 lines, 65 were from interspecific crosses. Two varieties for low inputs upland cropping systems in process to be registered by a private partner of the project (launching at mid-2007).
- Following convincing validation trials carried out in 2005 and 2006, future launching by the Nicaraguan agriculture research institute (INTA) of a very early line for upland areas with drought constraints and a line for favorable upland mechanized cropping systems
- Follow-up of the participatory plant breeding schemes with associated farmers and NGOs in two areas of Nicaragua. Creation of a national Participatory Crop Improvement (PCI) network in Nicaragua.

4. Major outcome of the Rice Project in 2006: Commercial Rice Varieties Released

Since the 1960s, commercial rice cultivars have been developed by conventional crossbreeding, often from breeding populations derived by crossing two inbred lines. This approach encourages inbreeding and so narrows the genetic base of breeding materials. Narrow genetic diversity is of major concern to breeders, geneticists and the agricultural community in general. In LAC, the

genetic diversity of rice cultivars depends on a small core of landraces. This finding led the rice project at CIAT in Colombia to direct its efforts toward broadening the genetic base in rice.

Wild species are valued as a unique source of genetic variation; however, they have rarely being used for the genetic improvement of quantitative traits. Since 1994 the CIAT Rice Project in close partnership with CIAT Biotechnology Unit has been characterizing and utilizing wild rice species to broaden the genetic base of cultivated rice in Latin America. The strategy in place make use of molecular maps in combination with backcrossing to elite breeding lines or commercial varieties to develop populations that are used to identify and transfer QTLs associated with traits of agronomic importance to cultivated rice.

Nearly 13,000 breeding lines in different stages of development were evaluated in Santa Rosa and Palmira; percentage of selected material varied depending on the type of cross combinations. About 1224 advanced lines were selected by participants from diverse NARs in a Breeder's Workshop held in Santa Rosa. Wide segregation for desirable traits including grain quality and a good number of plant selections were made for further testing in crosses involving different wild species of rice. Elite lines derived from crosses with *O. latifolia, O. glaberrima*, *O. barthii*, and *O. rufipogon* showed good field performance and high yield potential in replicated trials run by several partners including Fedearroz, our main local partner.

In 1996, a collaborative project between the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), CIAT and LAC NARS was established to develop and enhance at regional level, synthetic rice populations for the different rice ecosystems (upland, aerobic and irrigated) . The objective was to broaden the genetic base of Latin American rice by assessing genotype × environment interactions to identify specific potential parents and pooling them to create site-specific synthetic rice populations with a broader genetic base. Basic populations were improved using recurrent selection in centralized pre-breeding activities. Upland composite populations are observed, characterized and improved by recurrent selection in Colombia, and improved lines are distributed to national programs in the region for further testing.

The CIRAD-CIAT project set out to develop collaboration with rice breeders throughout LAC and took the lead in creating and sharing synthetic populations and providing training. In 1999, the Working Group on Advanced Rice Breeding (GRUMEGA by its Spanish acronym) was set up during a regional rice breeders' conference organized in Brazil by the Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), CIRAD and CIAT and sponsored by the Food and Agriculture Organization of the United Nations (FAO). The leadership in networking activities of the group is assumed by the rice projects of CIRAD-CIAT and EMBRAPA's Arroz e Feijão Center (**http://www.grumega.org**).

Lowland irrigated rice improvement is carried out in close collaboration with partners in the LAC region. In Colombia, the CIRAD-CIAT rice project started developing basic populations targeting the various lowland rice ecosystems present in LAC, in partnership with scientists in Colombia, Venezuela and Cuba for the tropical ecosystem; Argentina for the subtropics; and Chile and France for the temperate zone. The basic populations were shipped to regional partners and evaluated locally. Most of the cooperators used this material to develop site-specific

populations by introgressing additional variability to meet their specific breeding objectives. They then used these populations in their rice-improvement programs by recurrent selection.

In addition CIRAD and CIAT established in 2002 a new collaborative project in Nicaragua on participatory breeding of upland rice and sorghum for poor farmers in Central America. This project is developing and testing breeding schemes, including population improvement methods, in which farmers are fully involved, to develop varieties that are better adapted to the farmers' specific cropping conditions and needs. It is expected that participatory breeding methods and the genetic materials developed with this approach in Nicaragua will be applicable to other Central American countries.

Networking with LAC breeders (GRUMEGA). This is a framework for collaborative research built on five pillars: (i) capacity building, (ii) germplasm development and sharing, (iii) workshops for germplasm evaluation and selection, (iv) conferences to present results and advances, and (v) publications with and by collaborators. The IV GRUMEGA Conference was held in January 2006 in Chile and organized by INIA-Chile, CIRAD-CIAT and FAO. (**http://www.grumega.org**)

Regional Technical Cooperation Project (TCP). The TCP *"Capacitación en fitomejoramiento genético e intercambio de germoplasma para utilizar los recursos genéticos del arroz en América Latina y el Caribe"* involving 7 countries (Argentina, Bolivia, Chile, Cuba, Guatemala, Nicaragua and Dominican Republic) and CIRAD and CIAT was accepted and funded by FAO for 2 years, starting January 2006. In this framework a Breeders' Workshop and a breeding training course were organized in 2006 in Colombia and Cuba respectivelly.

The workshop 2006 was organized by CIRAD-CIAT and held in Villavicencio Colombia in August 2006. Sixty one rice breeders from 14 countries attended the workshop and selected upland and irrigated segregating and fixed lines. The participants selected a total of 983 and 1310 upland and irrigated lines respectively. These numbers show the importance for the region in having access to public genetic resources developed by international centers. The Training course 2006 was organized in Cuba to attend Central American and Caribbean rice breeders. CIAT and CIRAD staff were present as instructors.

The year 2006 was the 10th anniversary of the development of rice population breeding activities at regional level in Latin America and the Caribbean (LAC). Centralized (in Colombia) and decentralized (with LAC NARS) breeding activities, the adoption and inclusion of population breeding into LAC partners' breeding projects and the release of varieties are the main outputs of the sustained efforts made by the CIRAD-CIAT rice project to promote the use of a new breeding method in the region. Two commercial varieties were released in Bolivia and Chile for upland/ aerobic and temperate irrigated rice ecosystems respectively. Promising lines are in the pipeline for release in others countries. The collaborative project has established and nurtured a Working Group on Advanced Rice Breeding (GRUMEGA by its Spanish acronym) for collaborative research with national scientists based on capacity building, germplasm development and sharing, workshops for germplasm evaluation and selection, conferences, and joint publications.

With a strong involvement of local NGOs and farmers' organizations and using participatory crop improvement (PCI) approach and methods, the CIRAD-CIAT project in Nicaragua aims to take advantage of the diversified advanced lines and segregating synthetic populations recently developed by CIAT and CIRAD in Colombia as well as the new site-specific populations developed in-situ, in order to identify better-performing varieties matching the needs of the small and medium-scale upland rice growers. Research activities conducted during the last two years have permitted to identify well-performing and adapted lines for the existing upland cropping systems (manual as well as mechanized systems) and to give new variety options for the rice areas with increasing drought constraints. Among these lines, IRAT 364 and IRAT 366 will be released by the extension agency SERVITECA for small farmers in low inputs upland cropping systems; one variety for mechanized cropping systems and one early variety for areas with drought constraints will also be released by the national research institution during 2007. Moreover this research activity has generated other outputs concerning the development of methods; knowledge acquisition and capacity building, whose most relevant results for 2006 are the creation of a national PCI network in Nicaragua and the publication of a special issue on PCI experiences in Latin America in the Agronomía Mesoamericana journal.

In Central America, the majority of the rice area is cultivated in upland conditions. Because of its central geographic situation and its representativeness for the agro-climatic conditions and the upland rice cropping systems of the region, Nicaragua is a good platform for in-situ germplasm improvement and screening of new CIAT and CIRAD lines developed in Colombia for matching the needs of the Central America region. After a two-years phase for testing a large diversity of new exotic germplasm and starting new breeding schemes using synthetic populations, three regional field selection workshops were organized in 2005 and 2006 in close collaboration with INTA, where the breeders of public and private institutions were invited to chose the progenies and advanced lines which can be useful for their country. Main outputs of this regional strategy are the strengthening of the national rice breeding programs and a better access of more specific improved germplasm and elites lines.

As a result and main outcome of the Rice Project activities developed in collaboration with our Latin American Partners, the following rice varieties were released in the region during 2006:

In Bolivia, the first upland/aerobic commercial variety selected from the enhanced composite population PCT-4 was officially released in 2006 as **ESPERANZA**. The variety is adapted both to manual upland and mechanized aerobic rice ecosystems. This variety has the Pedigree CT8240-1-5-2P-M-1P/CT8008-3-12-3P-1X//CT9509-17-3-1-1-M-1-3P-M

In Chile, the first commercial variety, **RQuila 28**, adapted to the temperate irrigated rice ecosystem, coming from the enhancement and selection of the population PQUI-1 was proposed for official release in early 2007

In Salvador, the commercial variety **CENTA A-8** was released by ANAR. This variety came from the cross CT 11519/CT 11492 and Pedigree CT 122249-3-4-3-3P-1P

In Nicaragua, the commercial variety **ANAR 2006** was released by ANAR. Pedigree CT8240-1-5-2P-M-1P/CT8008-3-12-3P-1X//CT9509-17-3-1-1-M-1-3P-M

In Panamá, the commercial variety **IDIAP 54-05** was released by IDIAP. This variety originated form the cross CT9682-2-M-14-1-M-1-3P-M-1/CT10825-1-2-1-3-M//CT8222-7-6-2P-1X. The variety **IDIAP 145-05** was also released in the country. This variety originated form the cross CT8008-16-31-3P-M//CT9682-2-M-14-1-M-1-3P-M-1/CT11008-12-3-1M-4P-4P

In Venezuela, the commercial variety **CENTAURO** was released by FUNDARROZ, INIA and FLAR. This variety originated from the cross ECIA38-2-4-2-5-6/CT822-7-6-2P-1X/FB0007-3-1-6-1-M and Pedigree FL00984-8P11-2P-2P-M-M

5. Publication List

Refereed Journal

1. Flórez-Ramos C.P., Z. Lentini*, M.E. Buitrago, and J. Cock. 2006. Somatic Embryogenesis and Plantlet Regeneration of Mango (*Mangifera indica* L.). *Acta Horticulturae* (In Press)
2. Ruiz J.J., Z. Lentini*, V. Segovia, M. Buitrago, C. Flórez, and J. Cock. 2006. *In vitro* Propagation and Regeneration of *Solanum quitoense* (Lulo) Plants and their Use as Elite Clones by Resource Farmers. Somatic Embryogenesis and Plantlet. *Acta Horticulturae* (In Press).
3. Ceballos*, H., M. Fregene, Z. Lentini, T. Sánchez, Y.I. Puentes, J.C. Pérez, A. Rosero and A.P. Tofiño. 2006. Development and Identification of High-Value Cassava Clones. Acta Horticulturae 703:63-70.
4. Fuentes, J.L., Correa-Victoria, F.J., Escobar, F., Prado, G., Aricapa, G., Duque, M.C., and Tohme, J. 2006. Microsatellite markers linked to the blast resistance gene *Pi-1* in rice for use in marker assisted selection. Euphytica (accepted)
5. Jia, Y., Correa-Victoria, F.J., McClung, A., Zhu, L., Wamishe, Y., Xie, J., Marchetti, M., Pinson, S., Rutger, N., and Correll. J. 2006. Rapid determination of rice cultivar responses to the sheath blight pathogen *Rhizoctonia solani* using a micro-chamber screening method. Plant Disease (accepted)
6. Lopez-Gerena, J., Correa-Victoria, F.J., Prado, G., Tohme, J., Zeigler, R., and Hulbert, S. 2006. Mapping QTL affecting partial resistance and identification of new blast resistance genes in rice (*Oryza sativa*). Theor. Appli. Genet. (submitted)
7. Trouche, G.; Narváez-Rojas, L.; Chow-Wong, Z.; Corrales-Blandón, J. 2006. Fitomejoramiento participativo del arroz de secano en Nicaragua: metodologías, resultados y lecciones aprendidas. Agronomía Mesoamericana (CR) 17(3): 307-322.
8. Trouche, G.; Hocdé, H.; Aguirre-Acuña, S.; Martínez-Sanchez, F.; Gutiérrez-Palacios, N. 2006. Dinámicas campesinas y fitomejoramiento participativo: el caso de los sorgos blancos (Sorghum bicolor, L. Moench) en la region Norte de Nicaragua. Agronomía Mesoamericana (CR) 17(3): 407-425.

Book Chapters

1. Calvert L.A. and Z. Lentini. 2007. Rice Hoja Blanca Virus. *In:* Characterization, Diagnosis and Management of Plant Viruses. Vol. 4: Grain Crops and Ornamentals. Govind P. Rao, Claude Bragard and Benedicte S.M. Lebas (Editors). Stadium Press ILLC, Texas, USA. ISBN 1-933699-34-5. p: 85-99.
2. Marc Châtel, Yolima Ospina and Gilles Trouche. 2006. Impact of the rice synthetic population breeding project for Latin America and the Caribbean. In: France and the CGIAR. Delivering Scientific Results for Agricultural Development. Chapter 1: Scientific Partnerships. Producing more and better food. Publication coordinated by Daniel Rocchi, Liaison Officer at the CGIAR Secretariat in Washington.Washington, U.S.A. CGIAR, p.44-47.

Workshop and Conferences

- Lentini, Z*. 2006. Biotecnología y Riesgos Fitosanitarios *Invited Key-note lecture*. 2do Curso Internacional sobre Riesgos Fitosanitarios para la Agricultura Colombiana. Cali, Colombia December 2006. Funded by MADR Colombia.
- Coordination and Execution of Course: Capacitación para el Fortalecimiento de la capacidad institucional del Ministerio de Ambiente, Vivienda y Desarrollo Territorial y Autoridades Ambientales Regionales en materia de Biotecnología y Bioseguridad Ambiental de OGM con énfasis en Plantas Transgénicas. Abril 26, 27, y 28 de 2006. Funded by Colombia GEF/WB Biosafety Project.
- Trouche, G.; Hocdé, H.; Aguirre S. 2006. Sélection participative des sorghos au Nicaragua : approche et dispositifs. *In:* Lançon J., Weltzien E., Floquet A. Eds. Gestion du partenariat dans les projets de sélection participative. Actes de l'atelier Recherche 14-18 Mars 2005, Cotonou, Benin: 159-173.
- Lancon, J.; Bertrand, B.; Clément-Demange, A.; Hocdé, H.; Nouy, B.; Trouche, G. 2006. What determines the stakeholders'participation in plant breeding programs? Cases studies in the South. *In:* Lançon J., Weltzien E., Floquet A. Eds. Gestion du partenariat dans les projets de sélection participative. Actes de l'atelier Recherche 14-18 Mars 2005, Cotonou, Benin: 179-193.
- Taller de selección de material genético de arroz de secano y de riego. Villavicencio-Colombia. August 15-18, 2006. 61 participants from 12 countries (Bolivia; Colombia; Costa Rica; Cuba; Dominican Republic; France; Guatemala; Madagascar; Nicaragua; Panama; Peru and Venezuela)
- Correa-Victoria, F.J. 2006. Improving Blast Resistance for Upland Rice in Colombia: a Challenging Task. 31st Rice Technical Working Group Meeting. The Woodlands, Texas, February 26-March 1, 2006.
- Correa-Victoria, F.J. 2006. Identification of molecular markers for pyramiding rice blast resistance genes. Second Research Coordination Meeting. Nanjing, China, April 10-14, 2006.
- Correa-Victoria, F.J. 2006. Avances en la investigación en enfermedades del arroz: *Pyricularia grisea.* II Congreso Brasilero de la Cadena Productiva del Arroz. VIII

Reunión Nacional de Pesquisa de Arroz. EMBRAPA, Brasilia 26-28 de Abril, 2006. (Invited speaker).

- Correa-Victoria, F.J. 2006. Situación del complejo acaro-hongo-bacteria en el arroz. Segundo Congreso Arrocero. San José, Costa Rica, Junio 29-30, 2006. (Invited speaker).
- Correa-Victoria, F.J. 2006. Using rice differentials with known blast resistance genes for pathogen characterization and improving rice cultivars in Latin America. Rice Blast Workshop IRRI-JIRCAS. IRRI, Los Baños, Philippines, August 29-30, 2006.

6. List of proposals funded in 2006, dollar value of contract and donor

- Gene Flow Analysis for Environmental safety in the Tropics. CIAT – University of Costa Rica – Hannover University and BBA, Germany. Donor: EURO 450,000 (2005-2007).
- Development and evaluation of drought-tolerant rice transgenic plants. GCP SB3 USD 70,000 (2005-2006)
- The Latin America: Multi-country capacity-building for compliance with the Cartagena Protocol on biosafety. PDF-B: Development of PAD (Project Appraisal Document). Donor: GEF-World Bank. USD 260,000 (Nov 2005-April 2007)
- Latin America: Multi-country capacity-building for compliance with the Cartagena Protocol on biosafety (Brazil, Colombia, Costa Rica, Peru). USD 5 million. Donor: GEF-World Bank
- Impacto ambiental de la adopción del arroz resistente a las imidazolinoas en sistemas productivos contrastantes de América Latina (AL). INIA-UCV-CIAT. USD 420,000. Donor: Fontagro.
- Capacitación en fitomejoramiento genético e intercambio de germoplasma para utilizar los recursos genéticos del arroz en América Latina y el Caribe TCP/RLA/3102 (A) USD 340,000.00. FAO
- High iron and zinc rice lines. AgroSalud. CIDA-Cananda US$230,000.
- Interspecific bridges to get full access to genetic diversity found in O. glaberrima: GCP , US 300,000 total; about US$ 80,000 for CIAT. To get started in 2007.
- Cenicafe. Technical assistance to the Coffee Genome funded by MADR: US30,000.
- Identification and expression analysis of genes important for iron translocation to the rice grain , hp+ us 15,000.
- Reducción del uso y desarrollo de resistencia a plaguicidas en el cultivo del arroz y fríjol en Colombia, Venezuela y Ecuador. FONTAGRO. US$ 224,000 (2006-2008)
- Manejo del complejo acaro-hongo-bacteria, nuevo reto para arroceros centroamericanos. FONTAGRO. US$ 360,000 (2006-2008)
- Identify and use candidate genes and other molecular markers linked to quantitative trait loci which control milling quality and resistance to sheath blight disease. USDA National Research Initiative Competitive Grants Program. CIAT US$ 47,000 (2005-2007).
- Phenotype evaluation of mutant collection for sheath blight resistance within the commissioned research project PI: Dr. Mathias Lorieux/Dr. I. Manabu (2006-2007). US$ 8,000
- Rice breeding for disease resistance and grain quality in Cuba. IAEA. US$ 30,000 (CIAT US$ 3,750). Within a Project on Pyramiding of mutated genes contributing to crop quality and resistance to stress affecting quality. Project for 15 countries and several crops (US$ 750,000 for five years).

7. Problems encountered and their solutions

- In July 2006, CIBIOGEM (Mexico National Biosafety Secretary) indicated the impossibility of Mexico to participate in implementation of the project entitled: The Latin America: Multi-country capacity-building for compliance with the Cartagena Protocol on biosafety. USD 5 million. Donor: GEF-World Bank. The decision was communicated to the World Bank, and modifications of activities were jointly adjusted without affecting the outcome of the multi-country project.
- The main problem encountered for 2006 was the elimination of funding from the Colombian Government to the Rice Project and the reduction of core budget assigned to the Project by CIAT. Special Projects were funded during 2006 that will help to cover part of the gap in funding but will not be enough for future budget reduction expected to be implemented for 2007-2008. Special projects do not generally fund costs of personnel, which do not solve all the problems of budget reductions at the Center
- Transaction costs continue to be too high. It is very hard to keep up with breeding, coordination and supervision of diverse activities, and field work due to too many meetings, travel and paper work. Even my support team feels overloaded. We have tried to more carefully divide and assign responsibilities among support staff and field workers to do our job without sacrificing efficiency, quality and quality of life.
- As last year this year we managed to keep going our core breeding activities by using other sources of funding, especially from AgroSalud, and Cenicafe.
- The stability and sustainability of the Rice Project continues to be a major concern. We have to be more creative and original in approaching the Latin American rice sectors to obtain additional funding for our core activities. There are sectors that actually are not contributing to funding research activities but that are willing to contribute if an adequate mechanism is proposed to them.

8. Staff List (2006)

Principal Staff	Allocation of time		Affiliations	Location
	IP-4	Other		
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	20%		IIA Cuba/CIAT	CIAT/Cuba
Dr. Gilles Trouche	100%		CIRAD/CIAT	Nicaragua/CIAT
Principal Staff positions in IP-4: 5.1 Associated projects 1.8				
Dr. Carlos Bruzzone Works as a consultant			(INIA)	INIA/CIAT Peru