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Executive Summary

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

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 which will reduce the production costs, help protect the environment, and make rice locally available at a reasonable price.

Outputs:

1. Enhanced Gene Pools
2. Rice pests and genetics of resistance characterized
3. Education and rice cultivation used as vehicles 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

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. Interactive training for rice researchers and extension agents will be available through as E-learning tools. 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. A new Rice Breeders network with both public and private organizations will be started for regional collaboration.

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. The rice breeder networks will become a major vehicle for 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.

2007

It is expected the SNPs will be the preferred type of molecular marker and additional traits will be incorporated into the breeding program. The use of markers will allow us to develop more populations and eliminated most materials at the F2 stage. RHBV and rice blast will be two of the principal uses of markers. National plans for competitive rice will be encouraged. More emphasis will be given to integrated crop management through the Learning to Innovate initiative. Small framers will be targeted with rice as food security mixed with higher value crops for income.

Users: Rice researchers 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-1.

1A. IP-4 Project Log Frame (2005-2007)

Project: **Improved Rice for Latin America and the Caribbean**
Project Manager: **Lee Calvert**

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
Goal Germplasm of beans, cassava, tropical forages, rice, and their wild relatives collected, conserved, enhanced, and made accessible to NARS and other partners.	Sufficient number of accessions (of beans, cassava, and tropical forages), representing genetic diversity, conserved and managed *ex situ*. Strategies and guidelines for *in situ* management of biodiversity of beans, cassava, and tropical forages have been developed and tested with users. Accessible rice germplasm meets NARS' standards in terms of productivity, stability, agronomic traits, and user needs. Techniques and relevant information for more efficient and reliable germplasm improvement are accessible to users.	CIAT's germplasm bank inventories. Partners' technical reports. Annual reports.	
Purpose To increase rice genetic diversity and enhance gene pools for higher, more stable yields with lower unit production costs that reduce prices for consumers and decrease environmental hazards.	Evaluations of yield potential (interspecific, wide, and elite crosses, and recurrent selection). Continued use of improved germplasm by NARS. Monitoring rice production practices and markets. IPM practices in place for stable production and cleaner environment. Rice lines selected with desired gene traits. Potential sources for high levels of biotic and abiotic stress resistance.	Databases. Project, CIAT, and NARS annual reports. Publications. Promotional activities (conferences, training, workshops, and field days).	Stability (internal and external). National policies favor adoption of new technology.
Outputs 1. Rice gene pools enhanced. 2. Rice pests and genetics of resistance characterized. 3. Education and rice cultivation used as vehicles to alleviate poverty.	Pathogen and pest variation and source of resistance identified. IPM strategies. Workshops. Training courses. Farmer surveys.	Project progress report Publications. Project progress and workshop reports.	Continued support from CIAT, CIRAD, and FLAR. Continued adequate funding. Recommendations adopted by NARS and implemented by farmers.

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
Output 1: Enhanced gene pools Rice improvement, using conventional breeding and gene pools and/or populations with recessive male-sterile genes. Evaluation of savanna upland rice lines in Latin American countries. Developing upland rice for smallholders. Advance and evaluate interspecific gene pools. Introgress new plant type genes into LAC's gene pools. Use anther culture and *in vitro* culture to enhance gene pools.	13 rice populations developed with improved tolerance of soil acidity; resistance to blast, RHBV, and *T. orizicolus*; good grain quality; early maturity. Number of field trials planted and lines selected. Populations distributed to NARS for line development. 14 populations developed; 12 populations in process; 4 populations yield tested and/or molecular characterized. Partners: WARDA, CIRAD, EMBRAPA, Cornell U. 433 crosses made; tropical irrigated (226), temperate (155), upland (52). Number of selected lines. Double haploids: interspecific crosses (386), accelerated breeding populations (815), somaclones (3758 in Venezuela; 4440 in Colombia).	Project progress report. Field visits and evaluations in testing sites. Breeding populations distributed throughout LAC. Breeding populations in storage and field. Best lines and QTLs identified. Double haploids in storage. Publications.	Continued support from CIAT, CIRAD, and FLAR. Adequate funding and timely release of budget. Favorable climate. Continued financial support for anther culture laboratory. Crosses, field support, and operational costs provided by FLAR.
Output 2: Integrated pest and disease Management Characterized interactions of host-plant resistance to rice blast, sheath blight, and grain discoloration. Characterization and use of partial and complete resistance for controlling rice blast. Characterization of interactions within the host plant, rice *hoja blanca* virus, and *T. orizicolus* complex. Foreign genes as novel sources of resistance to rice *hoja blanca* virus and *Rhizoctonia solani*. Characterization of interactions among host plant, *Polymyxa graminis*, and rice stripe necrotic virus causing *entorchamiento*.	Virulence spectrum and genetic structure of rice pathogens. Molecular markers associated and number of resistance genes. Sources of complete, complementary, and partial resistance. Rice lines with diversified resistance to RHBV and *T. orizicolus*. Understanding components of resistance to the RHBV complex. Crop management components developed. Transgenic lines with RHBV-viral genes with reduced symptoms produced and evaluated.	Pest and disease resistant varieties released by partners. Collection of rice pathogens. Database of resistance sources. Crosses made among resistance sources. F7 lines with stable blast resistance combining genes Pi-1 and Pi-2. Rice genome map with blast resistance genes mapped. Rice progress report. Publications. Resistant germplasm selected under artificial conditions.	Rice crosses and populations developed by breeders. Biotechnology Unit identify molecular markers associated with resistance. Continued collaboration with FLAR. Continued adequate funding from Colombia and Rockefeller. Continued support and adequate funding from CIAT, CIRAD, and FLAR. Continued funding from Colombia, Rockefeller, and COLCIENCIAS. Permission for field testing of transgenic plants granted. Continued support and adequate funding.

Narrative Summary	Measurable Indicators	Means of Verification	Important Assumptions
	Transgenes introgressed into commercial cultivars. Novel genes for multicomponent resistance to rice pathogens used. RSNV and vector complex characterized. Germplasm evaluation methods developed.		
Output 3: Education and rice cultivation as vehicles to alleviate poverty Participatory development of rice for poor communities in marginal areas. FLAR–CIAT collaboration. Collaborator training and information.	Community-based projects. New equipment for small rice systems. Number of scientists trained. Workshops. Published reports of courses. FLAR annual report. Publications and Web pages.	Increased production in marginal areas. Number of communities participating. Rice progress report. CIAT's Web page.	Special funds continue. Recommendations adopted by farmers.

2. Project Inputs

- **Staff List**

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	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

- **Budget 2005**

PROJECT IP4: Improved Rice for Latin America and the Caribbean

SOURCE	AMOUNT US$	PROPORTION (%)
Unrestricted Core	248,381	30%
Restricted Core: European Commission	392,340	48%
		0%
Sub-total	**640,721**	**78%**
Special Projects[1]	178,324	22%
		0%
Total Project	**819,045**	**100%**

1. This value does not include the salaries of the scientist from CIRAD and IRD, which is an in kind restricted core contribution to IP-4.

3. Research Highlights

Participatory Rice Breeding: Building capacity and developing varieties for small upland rice producers

Rice is a crop mainly produced by small farmers, and in Latin America these farmers are facing many challenges. They tend to have the least amount of infrastructure and machinery and since most are upland rice farmers they are more dependent on rainfall. With the advent of the Central American Free Trade Agreement, these farmers must compete with subsidized rice. In 2002, the CIAT-CIRAD started participatory rice breeding in Nicaragua in collaboration with INTA. These activities involve local groups of expert-farmers and use appropriate participatory breeding approach and methods. Already many workshops, field days and courses have been held and this is helping to strength the local organizations. Through changes in cultural practices, these farmers are increasing their yields. At the same time, the farmers are involved in the process of evaluation and selection of rice lines that fit their needs and in the short span of this project several varieties are about to be released. These varieties are more adapted to the local cropping systems and have characteristic which include drought tolerance, good yield potential, good grain quality and they mature early. This last trait is important, because it allows the farmers more options on the date of planting, more likelihood of escape drought and options to rotate with a second crop, and this helps increase their income. Moreover, this research has empowered the small farmers through the development of methods to solve local problems, knowledge acquisition and capacity building. There is a demand to upscale these activities.

Durable resistance to rice blast

Hot spot breeding for rice blast has led to the development of rice varieties that have more durable resistance to rice blast. The genetic basis of the high level of durable resistance to rice blast in the cultivar Oryzica Llanos 5 is being characterized in collaboration with Kansas State University in two Recombinant Inbred Lines (RILs) from a cross between the susceptible cultivar Fanny and O. Llanos 5. A linkage map was constructed using 250 molecular markers: SSR, RFLP and RGAs. Eleven loci, distributed on chromosomes 1, 2, 3, 4, 5, 6, 8, 9, 11, and 12, were associated with the resistance of the cultivar. As a whole, the observed durable resistance in Llanos 5 is the result of a combination of quantitative and qualitative resistance genes. Fedearroz 50 that is a highly popular variety that was released in 1998. This variety has been grown on approximately 50% of the rice production area in Colombia. It is also being grown in Venezuela, Costa Rica and Panama. It has remained resistant to rice blast and it has similar combination of quantitative and qualitative resistance genes. A combination of three quantitative resistance genes was shown to confer stable resistance for 5 year under very high rice blast pressure. We now have a much better understanding of what it takes for a rice plant to remain resistant to rice blast and the tools to assist breeders in developing these combinations. Already the work has had impact in lowering pesticide use and increasing yields in those varieties that have this complex durable resistance.

Understanding the Genetics of Resistance to Rice Hoja Blanca Virus

Plant resistance to Rice Hoja Blanca Virus (RHBV) is a combination of resistance to the virus and to the planthopper vector *Tagosodes orizicolus*. Since the virus cannot be mechanically inoculated, it is difficult to separate the components that are most important for resistance to the virus. Crosses were made between Fedearroz 2000 X WC366 and this focuses on the resistance to the virus. Another cross was made between Fedearroz 50 X WC366 that focuses primarily on the resistance to the insect. The combination of the information learned from the genetic and molecular analysis of the segregating population will be used to understand the plant/vector/virus interaction. To date, several potential QTLs have been identified for resistance to RHBV and *T. orizicolus*. In the both crosses the short arm of chromosome 4 has a significant association with resistance to RHBV. In this region, two candidate genes have been identified. One is a gene that is associated with resistance to the brown planthopper in Asia and the other is a gene involved in gene silencing which is a known mechanism of resistance to viruses. In addition, there is a QTL on chromosome 7, that has a very strong association with resistance to *T. orizicolus*. This association is only found in the cross of Fedearroz 50 with WC366. These associations are strong enough that micro-satellites used in this study could serve in a system of marker aided selection for these traits. The development of Molecular Assisted Selection as a Breeding Tool is a priority for the CIAT rice project.

Scaling up analysis gene flow analysis from rice into weedy rice at landscape under farmers' commercial conditions

Red rice (*Oryza sativa* L.) is a weed that infests most rice growing areas throughout the world. This weed shows a high similarity with cultivated rice varieties in the early growth stages. It has a wide range of characteristics, including competitive ability, tillering capacity, flowering date, seed shattering and dormancy, pigmentation of several plant parts in particular of the pericarp that make it a problem that is difficult to control. The presence of red rice both reduces the yield and the millers reduce the price they pay based on the percentage of red rice in the harvested seed. The objective of this study is to assess the impact of specific traits on biodiversity (genetic structure of recipient population) due to gene flow over time at the landscape level in countries that harbor land races, weedy/wild species of these two crops. In the case of rice, herbicides are used by farmers to control weedy rice. Herbicide resistant rice varieties had been released in several agroecosystems sympatric to natural environments that harbor native wild relatives of rice. This mutagenesis (not transgenic) derived herbicide resistance (imidazolinone resistance, Clearfield®) had been bred into elite local materials and released as improved varieties in Central America and Colombia. It is easy to trace herbicide resistance to evaluate the unintended transfer of traits deployed in the crop by cross-pollination to the sexually compatible weedy rice complex. The herbicide is used as a form of chemical control for positive selection in the rice fields, and the wild *Oryza* relatives found in natural environments in the crop contact zones act as the indicators of neutral selection. This model will give information on impact of resistance genes that may affect fitness of derived hybrids, invasiveness, population dynamics and genetic structure of the corresponding wild/weedy. This information is useful for *in situ* conservation of rice diversity. Protocols and methodologies using molecular markers will be established for assessing gene flow at landscape level (rate and direction) allowing comparison to those under controlled conditions. Finally, information will be used to develop guidelines for environmental safety and co-existence of different types of agriculture systems in the Neotropics.

Identification and Molecular Characterization of Two Wild Rice Accessions Collected in Colombia

Wild relatives of rice were collected in Salahondita and Santa Rosa, Villavicencio, Meta and were shown to be *O.* latifolia a tetraploid species (CCDD). After several backcrosses to *O. sativa*, it was possible to recover fertile plants having introgressed traits from the wild progenitor. In some plants these introgressed traits were the consequence of additional chromosomes. These hybrid plants represent a very valuable genetic resource for genetic and breeding purposes. The presence of bivalents at diakinesis in F1 plants could be indications of recombination between genomes of different species. Chromosome behavior was abnormal in F1, BC2 and BC3 progenies, and there was a high amount of plant sterility. Polymorphic markers were identified which were used to assess introgressions from the wild progenitor. Preliminary results showed that *O. latifolia* may be a potential source of resistance to rice blast, rice hoja blanca virus and *Tagosodes oryzicolus*.

Rice Composite Population Improvement

The CIRAD/CIAT rice collaborative project concentrates on broadening the genetic base of rice through composite population improvement using a recurrent selection combined with conventional breeding methods. Recurrent selection adds another methodology to develop improved varieties but is not intended to replace others breeding methods. Basic composite populations are developed, shared and enhanced with regional partners in Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Guatemala, Nicaragua and Venezuela. In Colombia, basic upland composite populations are enhanced using two recurrent selection-breeding methods: mass and S_2 progenies evaluation. At each step of enhancement, fertile plants are selected for the development of segregating lines and progeny selection using the conventional pedigree method. The most advanced upland lines are shared with LAC partners through the CIAT-ION nurseries and are locally screened and selected. The most promising lines are evaluated at countries' regional yield trials. The first upland rice commercial variety coming from population breeding will be released by Bolivia in January 2006. In addition, that are several candidate advanced lines are in the process of becoming varieties in different countries. The partners in these activities are members of the "Working Group on Advanced Rice Breeding" (GRUMEGA its Spanish acronym) which promotes collaboration in research, capacity building and the development of the rice sector.

Bullet Highlights

- High through-output methodology PCR-real time based for analysis of gene flow in rice at landscape level optimized
- Advanced breeding lines with transgenic-resistance to RHBV combined with high yield potential, good grain quality, tolerance to *Rhizoctonia* and characterized reaction profile to pyricularia selected in the field
- Hundreds of independent transgenic events carrying various transgenes for tolerance to abiotic stress (temperature, drought) generated and characterized molecularly
- Improved methodology for increased green plant regeneration of doubled haploids plants from rice anther culture using desiccation and subculture treatments available
- The blast pathogen has evolved defeating all major resistance genes present in the rice cultivars Oryzica Llanos 5 and Fedearroz 50; however, a high level of partial resistance is maintained in the two cultivars due to the presence of several minor or QTL resistance genes.
- Avirulence frequency studies allowed the identification of blast resistance genes that confer a wide spectrum blast resistance. The gene Pi-9, which came from the wild species *Oryza minuta* was effective against most blast isolates tested.
- 211 Latin American rice cultivars have been classified into 9 different groups with complementary blast resistance genes, which can be used for designing genetic crosses aiming at combining R genes that can confer durable blast resistance
- Several accessions of the African rice species *O. glaberrima* and a wild rice from Colombia have been found as potential donors of new blast resistance genes
- The Brazilian rice land race Tres Marias exhibiting stable blast resistance for many years in Brazil and Colombia carries at least three different resistance genes

- 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*
- The durable broad-spectrum resistance in the rice cultivar Oryzica Llanos 5 is associated with multiple genes of major and minor effects. A total of 58 QTLs mapped to nine chromosomes. And some of these QTLs mapped in regions where there are not previously reports of resistance genes.
- Two rice relatives were collected and shown to be a tetraploid species (CCDD) belonging to *O. latifolia*. After several backcrosses to O.sativa, it was possible to recover fertile plants having introgressed traits from the wild progenitor. These hybrid plants represent a very valuable genetic resource for genetic and breeding purposes.

4. Problems Encountered and their solutions

- After 10 years of excellent support there was no funding from the Colombian Government to the Rice Project. This reduction in funding has been partially offset by successful fundraising from other sources including CIDA- Biorfortification project, two Fontagro projects, and an FAO-TCP project.
- After approval of BMZ gene flow project 2nd phase, the rice collaborator from the UCR (Costa Rica) indicated in April 2005 that could not collaborate because it was committed with another partner. First steps to establish a new and efficient collaboration with INIA and UCV, Venezuela, was sought and obtained. New germplasm collection of weedy/wild rice plants were collected jointly with Venezuelan collaborators in natural environments and rice fields to achieve objectives originally set for UCR. The evaluation of these materials will start on January 2006 jointly with the training of a M.Sc. Student from Venezuela.

5. Indicators: List Technologies, Methods & Tools

- **Varietal Releases**

Colombia
Aceituno ACD 25-28
Official Release: September 2005
Origin: Selected line from the recurrent population
Intellectual Property: CIAT-CIRAD, DANAC
Adaptation: Irigated and favorable upland rice

Bolivia
Esperanza
Official Release: September 2005
Origin: Selected line from the upland recurrent population PCT-4 Intellectual
Property: CIAT-CIRAD, CIAT-Bolivia and ASPAR
Adaptation: Upland rice (Mechanized and manual)

Brazil
BRSMG Curinga

Official Release:	September 2005
Origin:	Line CT13226-11-1-M-BR1 from conventional crossbreeding
Intellectual Property:	CIAT-CIRAD, EMBRAPA, EPAMIG
Adaptation:	Savannas (“Cerrados”) and favourable upland (“Varzeas Úmidas)

BRSMG Seleta

Official Release:	September 2005
Origin:	Intellectual Property: CIAT, EMBRAPA, EPAMIG
Adaptation	Irrigated rice

6. Indicators : Publication List

- **Refereed Journal**

1. Delgado, H.; Châtel, M.; Ospina, Y.Llanura 11, nueva variedad de arroz para el ecosistema de sabana de la Altillanura colombiana. Fitotecnia colombiana. Órgano de la associación colombiana de fitomejoramiento y producción de cultivos. Vol 4 No 2 Julio-Diciembre 2004. ISSN 0123-1286. p. 8-11.
2. C.P. Flórez-Ramos, Z. Lentini, M.E. Buitrago, and J. Cock. 2005. Somatic Embryogenesis and Plantlet Regeneration of Mango (Mangifera indica L.). Acta Horticulturae (In Press)
3. J. Ruiz, V. Segovia, Z. Lentini, M. Buitrago, C. Flórez, and J. Cock. 2005. In vitro Propagation and Regeneration of Solanum quitoense (Lulo) Plants and their Use as Elite Clones by Resource Farmers. Somatic Embryogenesis and Plantlet Regeneration of Mango (Mangifera indica L.). Acta Horticulturae (In Press).
4. Dakouo, D. ; Trouche, G. ; Bâ, M. ; Neya, A. et Kaboré K.B. 2005. La lutte génétique contre la cécidomyie du sorgho, Stenodiplosis sorghicola, une contrainte majeure à la production du sorgho au Burkina Faso. Cahiers d’Agriculture, 14 vol. 2, p.201-208.
5. CPMartinez, SJCarabali, JBorrero, MCDuque and J.Silva.2005. Genetic progress towards grain quality in rice(O.sativa) through recurrent selection. In: Population improvement: Away of exploiting the genetic resources of Latin America. Elcio P. Guimaraes(ed). FAO, Rome.2005:277-297 p.
6. Thaura Ghneim, Alejandro Pieters, Iris Pérez Almeida, Gelis Torrealba, César P. Martínez, Mathias Lorieux and J.Tohme. 2005. Venezuela joins the global efforts for breeding water-saving and drought tolerant rice. Plant Breeding News, Cornell Univ. Clair Heresy(ed).
7. Fuentes, J.L., Correa-Victoria, F.J., Escobar, F., Prado, G., Aricapa, G., Duque, M.C., and Tohme, J. 2005. Microsatellite markers linked to the blast resistance gene Pi-1 in rice for use in marker assisted selection. Plant Breeding (submitted).
8. Lopez-Gerena, J., Correa-Victoria, F.J., Prado, G., Tohme, J., Zeigler, R., and Hulbert, S. 2005. Mapping QTL affecting partial resistance and identification of new blast resistance genes in rice (Oryza sativae). Theor. Appli. Genet. (submitted).

- **Book Chapters**

1. In Guimarães E.P. (ed.). 2005. Population improvement: A Way of exploiting the rice genetic resources of Latin America. Rome, Italy: FAO, 350 p.
   The book chapters are on-line at: http://www.fao.org/docrep/008/y5843e/y5843e00.htm and in PDF format at: ftp://ftp.fao.org/docrep/fao/008/y5843e/y5843e00.pdf
2. Châtel M., Ospina Y., Rodríguez F., Lozano V.H. 2005. Cirad/Ciat rice project: Population improvement and obtaining rice lines for the Savannah ecosystem. In Guimarães E.P., (ed.). Population improvement: A Way of exploiting the rice genetic resources of Latin America. Rome, Italy: FAO, 237-253.
3. Guimarães E.P., Châtel M. 2005. Exploiting rice genetic resources through population improvement. In Guimarães E.P., (ed.). Population improvement: A Way of exploiting the rice genetic resources of Latin America. Rome, Italy: FAO, 3-17.
4. Hernaiz S., Alvarado J.R., Châtel M., Castillo D., Ospina Y. 2005. Improving irrigated rice populations of the temperate climate in Chile. In Guimarães E.P., (ed.). Population improvement: A Way of exploiting the rice genetic resources of Latin America. Rome, Italy: FAO, 129-143.
5. Marassi M.A., Marassi J.E., Châtel M., Ospina Y. 2005. Exploiting the genetic resources of rice in Argentina through population improvement. In Guimarães E.P., (ed.). Population improvement: A Way of exploiting the rice genetic resources of Latin America. Rome, Italy: FAO, 113-127.
6. Ospina Y., Guimaraes E.P., Châtel M., Duque M.C. 2005. Effects of selection and of recombinations on an upland-rice population. In Guimarães E.P., (ed.). Population improvement: A Way of exploiting the rice genetic resources of Latin America. Rome, Italy: FAO, 331-350.
7. Pérez Polanco R., Châtel M., Guimarães E.P. 2005. Acquiring a basic understanding of rice population improvement for use in Cuba. In Guimarães E.P., (ed.). Population improvement: A Way of exploiting the rice genetic resources of Latin America. Rome, Italy: FAO, 205-220.
8. Lentini Z and A.M. Espinoza. 2005. Coexistence of Weedy Rice and Rice in Tropical America: Gene Flow and Genetic Diversity. Chapter 19. p: 303-319. In: J. Gressel (Ed.). "Crop Ferality and Volunteerism: A Threat to Food Security in the Transgenic Era?". CRC Press. Boca Raton, FL.
9. Trouche G., 2005. Participatory rice breeding, using population improvement: A new methodology adapted to the needs of small farmers in Central America and the Caribbean.. In : Population improvement: A way of exploiting the rice genetic resources of Latin America. Rome, Italie, FAO, p. 95-109.
10. CPMartinez, SJCarabali, JBorrero, MCDuque and J.Silva.2005. Genetic progress towards grain quality in rice(O.sativa) through recurrent selection. In: Population improvement: Away of exploiting the genetic resources of Latin America. Elcio P. Guimaraes(ed). FAO, Rome.2005:277-297 p.
11. Thaura Ghneim, Alejandro Pieters, Iris Pérez Almeida, Gelis Torrealba, César P. Martínez, Mathias Lorieux and J.Tohme. 2005. Venezuela joins the global efforts for breeding water-saving and drought tolerant rice. Plant Breeding News, Cornell Univ. Clair Heresy(ed).

- **Workshop and Conference**

7. Indicators : Training List

- **Thesis Supervised**

BSc. 8
MSc. 5
PhD. 3

- **Number of Interns**

8 interns

- **Number of Visiting Scientist**

1 scientific from Mexico
20 scientifics from Colombia
4 scientifics from Japan
1 scientific from France
2 scientifics from Brazil
3 scientifics from USA

- **Workshops and Congresses**

-Biosafety and Rice Improvement Workshop. 3 participants from Costa Rica and 4 participants from Mexico
-Biosafety in Centers of Biodiversity, GEF/ World Bank. Cali. October 24-26, 2005.
-Biosafety Course (Corpoica) within the Workshop Biotechnology Tools, genomics and proteomics for plant breeding. CIAT, Cali, Colombia.
III Congreso Internacional del Arroz, La Habana-Cuba.
- Annual meeting of the Mesoamerican PPB Network, Zamorano, Honduras.
-Regional training workshop on upland Rice Breeding for Central America. Posoltega, Nicaragua
- Workshop on PPB methods. Somoto, Nicaragua.
- Plant & Animal Genome XIII. San Diego, Ca USA.
- 10 Congreso Nal.Fitomejoramiento, Palmira, Valle.
- LI Reunión Anual PCCMCA, Panamá.
- 5th International Rice Genetics Symposium.IRRI, Manila, Philippines.
- IX ICABR International Conference on Agricultural Biotechnology, Ravello (Italy)
- XIII Congreso Latino Americano de Fitopatología (ALF). Cordoba, Argentina. (Invited speaker).
- Encuentro Red de Biotecnologia Agroalimentaria. REDBIO/FAO Maracay, Venezuela.
- XXVI Congreso ASCOLFI. Bogotá, Colombia.
- III Seminario Regional Agrociencia y Tecnología, Siglo XXI. Villavicencio, Meta.

Number of Visiting Students

158 Students from Colombia (Quindio, Tunja, Manizales, Caldas and Palmira)

8. Indicators : Resource Mobilization List

- **List of Proposal Funded in 2005**

- Delivery of Transgenic Rice Cultivars to Seed Producers and Farmers in Tropical America. US$ 300,075. (2001-2005). Donor: The Rockefeller Foundation
- Gene Flow Analysis for Environmental safety in the Tropics. CIAT – University of Costa Rica – Hannover University and BBA, Germany. Donor: EURO 450,000 (2005-2006).
- 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$ 17,000 (2005-2006).
- Phenotype evaluation of mutant collection for sheath blight resistance within the commissioned research project PI: Dr. Mathias Lorieux. US$ 4,000
- Desarrollo de una estrategia para la obtención de resistencia durable a Pyricularia grises en arroz en el cono sur FONTAGRO. US$ 125,000 (CIAT US$ 12,500; 2003-2005)
- 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).
- CIDA, Canada. Agrosalud, High iron and zinc rice lines. US$235,000
- GCP-Unlocking genetic diversity SP1 and SP2. US&4,500
- GCP- Evaluation of T-DNA mutants to drought stress. US$ 3,000
- GCP-Exploring natural genetic variation: developing genomic resources and introgression lines for four AA genome rice relatives. US$ 4,500
- CIAT-Yale Univ. Consortium: Screenhouse and field evaluation of Ac/Ds mutants. USDA. US$ 4,000.
- HP- Rice crop. Identification and expression analysis of genes important for iron translocation to the rice grain.US$200,000 Two years project starting in 2006. PI. Dr. Janette Palma Frett. Universidade Rio Grande do Soul. Porto Alegre. Brazil.

- **Projects Submitted in 2005**

- Biosafety in centers of biodiversity: Building technical capacity in Latin America for safe deployment of transgenic crops. GEF-World Bank. USD 5 million. PDF-B (pre-proposal) approved August 2005. USD 260,000 (November 2005-July 31, 2006)
- Development and evaluation of drought-tolerant rice transgenic plants. GCP SB3 USD 70,000 (submitted March 2005).
- Identification of QTLs conditioning sheath blight resistance in rice. ICGEB (International Center for Genetic Engineering and Biotechnology) trhough COLCIENCIAS. US$ 105,000 (The project after being selected by COLCIENCIAS for Colombia, was not funded by ICGEB in Italy)

9. New Directions for 2006

- To start a CIAT rice regional nursery in Central America
- To develop with GRUMEGA or INGER a Latin America and Caribbean nursery of advanced lines from Breeding Programs throughout the region
- To expand rice participatory breeding activities outside of Central America
- To test using Marker Aided Selection as a breeding tool.
- Blast populations will continue being analyzed for their genetic structure and virulence spectrum to determine the potential changes of the pathogen that would lead to resistance breakdown.
- Identification of new blast resistance genes will continue and will be based on characterization of wild rice species and populations developed from crosses with the cultivated species.
- New studies on the inheritance of the sheath blight tolerance and identification of QTLs associated with it will be initiated in 2006 as part of a RiceCap project in rice funded by USDA.
- To evaluate the development of fungicide resistance by populations of the blast and sheath blight pathogens in rice in Colombia and Venezuela. We expect to determine what fungicides are not effective in order to reduce their use.
- To work with Panama, Costa Rica, Nicaragua and Colombia on the combating losses due to the newly introduced mite S. spinki.