

# Annual Report 2007

## SBA-4: RICE



**For Internal Circulation and Discussion Only**

**March 2007**

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# **Annual Report 2007**

## *Executive summary*

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# 1 CIAT – SBA 4 RICE

## NARRATIVE PROJECT DESCRIPTION

### *Rationale & Changes*

#### **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

#### **Research Outputs**

Our research is organized around three major outputs

- 1) Enhanced gene pools
- 2) Integrated crop pest and disease management
- 3) Intensification and diversification of rice cropping systems for small farmers

#### **Rationale**

There are opportunities for growth in the rice sector because land and water are more abundant in Latin America than in other rice growing regions. The rice sector faces risks because there is a trend for more open markets and many countries subsidize rice production. Most rice producers are small to mid size farmers and the governments in this region tend not to subsidize rice production. The Rice Project focuses on strengthening the rice sector in the low and mid altitude regions of Latin America and the Caribbean. Our activities focus on problems that are locally important and especially in the area of pest and diseases many of these constraints are unique to Latin America and the Caribbean. Our rice breeding activities are for both irrigated and upland rice.

We concentrate on developing materials with broad genetic diversity that incorporates a range of grain quality traits and resistance to the pest and diseases common in this region. To increase the genetic diversity we work with interspecific crosses, composite populations and are developing biotechnology methods that allow the incorporation of traits more efficiently. These activities are generating both segregating populations and advanced lines which are transferred to partners through either bilateral agreements or networks including FLAR, GRUMEGA and INGER. Our partners are then able to select advanced lines or make their own selections from the segregating populations. These materials also serve as a source of parents in the breeding activities of our partners.

Unlike Asia, most of the rice in Latin America is planted by direct seeding. Since many small farmers do not have irrigated infrastructure we are increasing our research on rice that has better tolerance to water stress and / or has increased efficiency in water use. This is a global effort that is being coordinated through the Generation Challenge Program.

We have been developing upland rice breeding populations and advanced lines for many years. The tendency in Latin America has been a decline in total area of upland rice but an increase in yields in those areas that remain in production. Improved varieties have made excellent impact in the upland rice ecosystems. Jointly with the Biotechnology Research Unit and in collaboration with JIRCAS (Japan) gene technology is being explored as an alternative to incorporate increased efficiency in water use for the irrigated rice ecosystems targeting reduction of water consumption.

For the small farmers jointly with our partners we put in place participatory variety selection and breeding schemes in different agro systems of Central America. Early maturity, vigorous, high yielding varieties with adequate grain quality are some of the traits selected by farmers which gives their families the food security needed to experiment and adopt higher value crops. The recent activities to develop rice with higher levels of iron and zinc is being funded by CIDA Canada in collaboration with Harvest Plus and should lead to the development of naturally biofortified varieties that will provide better nutrition for both the rural and urban rice consumers.

To sustain yields preventing the pressure of pests and diseases we work in collaboration with our partners to disseminate Integrated Crop Management practices. FLAR has been active in promoting Integrated Crop Management Practices. With water becoming a more expensive and/or scarce resource and the need to produce rice at competitive prices we are working with FLAR and other partners to develop a comprehensive set of management guidelines to reduce inputs while increasing yields. These activities are information intensive and require local support to be successful.

### **Significant Changes**

While the output targets for 2007 remain the same the CIAT rice project is developing closer ties with both IRRI and WARDA. Part of the Output Target Integrated Crop and Pest Management information developed and available in print and electronic media in 2007 is the translation of documents from the IRRI Rice Knowledge Bank. In the area of genetic resources CIAT and IRRI will increase our activities for INGER in Latin America and the Caribbean. We have also agreed to the development of a common database for our genetic resources. Locally GRUMEGA is developing a nursery that will include many of the best varieties throughout Latin America. Another area of change is the increase in cooperation between the FLAR integrated crop management activities and the integrated pest management activities of CIAT as well as in the breeding activities. In the area of Interspecific crosses we are shifting our focus to *O. latifolia* which is a species that is native to the Americas.

During 2007 the core resources for the rice project have been significantly reduced. These changes are reflected in the consolidation or elimination of several of the Output Targets. The 2007 Output 2 target Characterization and development of markers for 6 major rice blast resistance genes has been incorporated into the 2008 Output 1 target Implementation of Marker Aided Selection techniques for quality traits RHBV and Rice Blast in varietal development.

The 2008 Output 2 target Advanced sources of Rhizoctonia resistance available for at least five countries of LA has been eliminated and activities in this area have been reduced The rice project has decided to integrate the participatory rice breeding activities which were being reported in 2008 Output 3 target Varieties and management practices developed for small rice farmers using participatory methods in 6 countries in LAC with the Output 1 in 2008 Integrated regional collaboration for the use and development of rice genetic resources through networking will result in at least 10 new varieties This output was previously reported for 2009 The marker aided selection Output 1 target has been moved from 2008 to 2009

### **CG System Priorities**

The Rice Project promotes the conservation and characterization of the relatives of rice Red rice which is a major weed is also being characterized both to understand the origin of this pest and to consider using it as a new source of genetic diversity for selected traits The following species *O glaberrima* *O rufipogon* *O barthi* *O glumacpatula* *O meridionalis* and most recently *O latifolia* were crossed with cultivated rice (*O sativa*) in efforts to increase the biodiversity of rice varieties and introduce traits of importance to Latin America The Rice Project develops breeding populations and advanced lines with traits that include high yield good grain quality early vigor strong tillers tolerance to water stress rice blast Rhizoctonia rice hoja blanca virus and the plant hopper *T ornilcolus* More recently in collaboration with IRRI we have started enhancing the nutritional quality of rice by developing lines that are higher in iron and zinc This output is reflected in the CIAT project SB 2 The pest and disease traits that are incorporated into the new varieties are helping the farmer to reduce the use of pesticides Using integrated crop and pest management is central to producing a sustainable agro ecological system The efforts to develop rice with better water use efficiency benefits the rice farmers with the least amount of infrastructure and should lead to the reduction of water in the irrigated systems

### **Impact Pathways**

The Rice Project focuses on strengthening the rice sector in the low and mid altitude regions of Latin America and the Caribbean Our research is organized around three major outputs 1) Enhanced gene pools 2) Integrated crop pest and disease management 3) Intensification and diversification of rice systems for small farmers

### **Output 1 Enhanced Gene Pools**

This output is concerned with the characterization of genetic resources and how to use them efficiently

The Future Harvest (CGIAR) rice genetic resources are held in IRRI WARDA and CIAT We are collaborating to ensure that this important public good becomes characterized and catalogued in a manner that makes it more accessible to the community of rice researchers INGER is a network which facilitates access to these materials

We maintain many activities with other advanced research institutions and these activities contribute to bring recent technologies to the regional partners. These generate knowledge and technologies that include functional genomics, marker aided selection, transgenic rice, gene flow studies, biosafety and biofortification. Many of these activities are housed in the Biotechnology Research Unit and Agrobiodiversity Project of CIAT.

The CIAT contribution to regional varietal development has included populations that were derived from both *O. sativa* and other relatives. We attempt to develop populations with a high degree of diversity yet include many important traits of agronomic importance. The parents of these populations normally include germplasm from our sister Future Harvest centers. CIRAD has also been a source of parental materials. We also have been in the forefront of new methods for rice breeding. The two principal methods are Recurrent Selection and Marker Aided Selection. Recurrent selection is an activity that has been promoted through GRUMEGA. During the last 10 years, it has held many Rice Breeder Workshops and many local partners have populations and advanced rice lines from these activities. This year, the second rice variety that was developed by recurrent selection was released in Bolivia by CIAT Santa Cruz and ASPAR.

We are a member of FLAR and most of the FLAR germplasm is developed using some of the CIAT germplasm. FLAR includes some of the strongest rice research institutions in Latin America and this is a valuable source for Germplasm Enhancement as well as other forms of collaboration.

The Regional Rice partners are responsible for the release of varieties, which is the main impact of Output 1. A very high percentage of the new rice varieties contain CIAT germplasm. Many of the varieties were developed into advanced lines before they were selected by our partners. The need for germplasm is highly variable and depends on the amount of rice production in a given country. In general, the less rice that is produced, the more these programs need advanced materials. The larger rice programs use germplasm and segregating populations to make their own selections.

## **Output 2 Integrated Crop Pest and Disease Management**

The breeding for resistance activities that are part of this output are integrated with the activities of Output 1 and achieve impacts through the same mechanisms and partners.

The characterization of the pest and diseases are an essential part of this output. This work is often done in collaboration with ARI or national partners. An example of the collaboration is the analysis of why the variety Llanos 5 has maintained stable (durable) resistance to rice blast for more than 15 years. This study was conducted with Kansas State University and has elucidated that both major and minor genes are contributing to the stable resistance. This information is being used in the breeding activities and in the development of molecular markers for this disease. A molecular analysis of resistance to rice hoja blanca and its vector are also being done.

The counterpart of the plant resistance is the diversity of the pathogens and pests. We have conducted extensive analysis of the diversity of the rice blast fungus. Similar characterization is being done for the causal agent of sheath blight. This can help determine which varieties could be deployed to mitigate losses or applications of pesticides.

The management of pest and diseases cannot be separated from crop management. FLAR is active in promoting Crop Management practices that are helping to increase the yields and lower the cost of rice production. We are working to combine IPM with the Crop Management to maximize the benefits. These activities depend on extension activities and high levels of collaboration. We have initiated in 2006 a project to study in selected rice pathogens the development of resistance to fungicides. The objective is to develop management strategies that mitigate the probability of pathogen resistance to fungicides through the judicious use of the pesticides. This should lead to lower pesticide use which benefits the farmers and environment.

### **Output 3 Intensification and diversification of rice cropping systems for small farmers**

This activity includes participatory rice breeding and the main mechanism is working with farmer organizations. The small farmers generally have the least amount of land, equipment, irrigation systems, and credits (infrastructure) and need upland or aerobic rice varieties that use water and fertilizers efficiently. This activity integrates the advances in breeding methodology (recurrent selection), the use of diverse germplasm including the interspecifics and in the future the high iron and zinc rice lines using participatory methods to focus on the needs of the small rice farmers. These activities help the farmers by developing their organizational skills and can aid in their eligibility for credits and other assistance. These farmers need to be aware of other opportunities to include other crops into their agro ecosystems especially high value crops. Rice is a food security crop that also contributes to the farmer's income.

This output involves the training activities of the project. Many of these activities are integrated with the Outputs 1 and 2. CIAT has been a source of training for many of the scientists in the rice community and we continue to play a role in the development of rice researchers, extension agents, and students in LAC. Access to information is extremely important for a competitive rice sector and this is an area in which more resources need to be devoted. The CIAT site strives not to duplicate information that is on other sites but to be a resource to help find the most useful information.

### **International Public Goods**

The International Treaty on Plant Genetic Resources for Food and Agriculture is an international agreement governing many of the world's most important crop diversity collections. The treaty will ensure that this diversity, which is critical for the rice crop improvement, will remain in the public domain. In the area of germplasm, CIAT has decided to place most of its elite lines into this system. To do this, we will use the database format of IRRI and these should become part of the Future Harvest genetic resources.



Most of the technologies including database management programs breeding methodologies rice lines which are developed at CIAT enter into the public domain as international public goods

One of the most relevant and important outputs of the CIAT Rice Project is the development and deployment of interspecific rice lines derived from crosses between wild rice species and cultivated rice. Most of our partners and NARs in LAC are not in a position to carry out this type of breeding work since they lack the expertise resources and funding to do it. Besides they are more concerned with the development of improved lines to address production problems that impinge on today's rice production but not on broadening the genetic base of rice or on problems for which no sources of genetic resistance are known.

### **Partners**

IRRI and WARDA are CGIAR institutions working on rice and with whom we collaborate in germplasm exchange and on problems of global importance. The Generation Challenge Program and INGER are two of the major joint activities.

We have an alliance with CIRAD and IRD of France which is vital to our research activities. Two CIRAD scientists and one IRD scientist hold joint appointments with the CIAT rice project and contributed extensively to activities in Output 1 and Output 3.

To increase our impact we are a member of FLAR. This network includes members from fourteen countries. FLAR is a partnership of the private and public sectors for the international research of rice. Its mission is to generate new technologies to allow the Latin American rice sector to become more competitive profitable and efficient with low environmental impact practices that propitiate lower unit costs and as a consequence lower rice prices to consumers. It generates both genetic resources (contributing to Output 1) and technology transfer of integrated crop management practices (contributing to Output 2 and 3).

The AgroSalud Project (housed in SB 2) is aiming at increasing the iron and zinc content in the rice grain includes partners throughout the region.

Brazil EMBRAPA & IRGA Colombia FEDEARROZ CORPOICA U Nacional U del Tolima & U de Antioquia Peru INIA Venezuela INIA IVIC FUNDARROZ & DANAC Cuba IIA Nicaragua INTA Costa Rica CONARROZ SENUMISA INTA & U Costa Rica Guatemala ARROZGUA Mexico Consejo Mexicano del Arroz Bolivia CIAT Santa Cruz ASPAR & CONARROZ Dominican Republic IDIAF Chile INIA Panama U de Panama Uruguay INIA Argentina INTA CIB FIBA U Corrientes & U Tucuman are national institutions and we have activities many of which are carried out using the networks of FLAR GRUMEGA INGER and Biofortification. Many of these institutions develop rice varieties while other are more involved in the transfer of technologies to the rice farmers.

Universities including KSU Cornell Purdue LSU U Arkansas Texas A&M U Missouri Rutgers and Yale. We have collaborative projects and students that work on research of mutual interest. IAEA collaborates in the use of induced mutations for crop improvement.

**Project Funding**

**Budgeting 2005-2009**

<b>Year</b>	<b>2005 (actual)</b>	<b>2006 (estimated)</b>	<b>2007 (proposal)</b>	<b>2008 (plan)</b>	<b>2009 (plan)</b>
US Dollars (millions)	2 621	2 450	2 017	1 946	1 920

## 2 CIAT SBA 4 PROJECT LOG FRAME (2007 2009)

PROJECT IMPROVED RICE FOR LATIN AMERICA AND THE CARIBBEAN  
PROJECT MANAGER

	Outputs	Intended users	Outcome	Impact
<b>Output 1 Enhanced gene pools</b>				A robust rice sector will generate employment and maintain low rice prices for the consumers. The expansion of the genetic base of rice is leading to yield stability and better adaptability for abiotic and biotic stresses.
<b>Output Targets 2007</b>	Advanced lines arising from interspecific crosses and recurrent selection will have been widely distributed and tested in more than 11 countries throughout the region.	IIAR and rice breeding programs throughout the region.	These interspecific crosses and current selection population will be a major basis for expanding the genetic diversity of cultivated rice in LAC.	
<b>Output Targets 2008</b>	Integrated regional collaboration for the use and development of genetic resources through networking will result in at least 10 new varieties.	IIAR GRUMFGA INGLR LAC and Rice breeding programs throughout the region.	Increase interactions and efficiency of Rice Breeding Programs throughout LAC.	
<b>Output Targets 2009</b>	Implementation of Marker Aided Selection techniques for quality traits (RHBV and Rice Blast) in varietal development.	IIAR and Rice breeding programs throughout the region.	Rice breeding strategies for evaluation and selection of promising rice lines that result in more and better varieties released to the rice sector at a faster rate.	

**CIAT SBA 4 PROJECT LOG FRAME (2007 2009)**

**PROJECT** IMPROVED RICE FOR LATIN AMERICA AND THE CARIBBEAN  
**PROJECT MANAGER** FERNANDO CORREA (CESAR MARTINEZ AS OF 02/2008)

	<b>Outputs</b>	<b>Intended users</b>	<b>Outcome</b>	<b>Impact</b>
<b>Output 2 Integrated crop pest and disease Management</b>				Advanced techniques to develop resistant varieties faster and better management practices will lower the use of agrochemical and mitigate contamination to the farmers and environment. The farmers will be able to produce rice at a lower cost.
<b>Output Targets 2007</b>	Control strategies implemented for the pest and diseases completely eradicated with the assistance of <i>Spiral</i>	Rice scientists, extension agents and rice farmers	The use of pest management practices to reduce losses caused by the complex of <i>Spiral</i> and diseases	
<b>Output Targets 2008</b>	Identification of rice hoja blanca and planthopper resistance genes	Rice pathologists and breeders	The development of rice varieties with increased resistance to rice hoja blanca virus and <i>T. c. l.</i>	
<b>Output Targets 2009</b>	Implementation of strategies to prevent development of fungicide resistance in rice pathogen	Rice scientists, extension agents, rice farmers and fungicide agronomists	Implementation of strategies for controlling and managing problems associated with the development of resistance to fungicide	

**CIAT SBA 4 PROJECT LOG FRAME (2007 2009)**

**PROJECT IMPROVED RICE FOR LATIN AMERICA AND THE CARIBBEAN**  
**PROJECT MANAGER FERNANDO CORREA (CESAR MARTÍNEZ AS OF 02/2008)**

	<b>Outputs</b>	<b>Intended users</b>	<b>Outcome</b>	<b>Impact</b>
<b>Output 3 Intens fication and diversification of rice systems for small farmers</b>				More competitive rice production so that the sector thrives even when faced with more open markets. This will lead to a dynamic and robust rice sector that improves the livelihood of small farmers.
<b>Output Targets 2007</b>	Integrated Crop and Pest Management information developed and available in print and electronic media	Rice scientists extension agents and rice farmers	The information will be used in participatory farm groups as well as other rice farmers to reduce the yield gap and intensify farming systems. Also a large volume of scientific literature will be published.	
<b>Output Targets 2008</b>				
<b>Output Targets 2009</b>				

### **3 Research highlights**

- Two mapping populations were evaluated for their sheath blight reaction using two different greenhouse screening methods. Preliminary QTL analysis using more than 100 microsatellite markers identified several QTLs on at least 7 rice chromosomes. Several of the QTLs identified are similar to other previously mapped QTLs.
- We have corroborated the presence of the bacterial panicle blight in Panama, Costa Rica, Nicaragua, and Colombia. Our studies have provided convincing evidence of the association of this bacterium to the disease symptoms observed in all these countries. Bacterial panicle blight has the potential to become a major constraint to rice production in Latin America. We have identified potential sources of resistance to the disease, which will probably offer good management alternatives in the near future.
- Among 3189 lines analyzed, 38 and 32 were found to reliably meet or exceed the iron 6.8 ppm target range and the zinc 22.25 ppm target range for milled rice, respectively. In collaboration with Harvest Plus, it was determined that NIRs technology can be successfully used to estimate iron and zinc content in rice grain.
- In close collaboration with US Universities and RiceTec, high yield QTLs identified from *O. rufipogon* were verified to have a yield enhancing impact when introgressed into Jefferson.
- Collaborative work by FLAR/CIAT showed that large panicles alone do not automatically result in high yield. High spikelet fertility and lodging resistance are required. Additionally, dark green leaf color could be an important secondary trait for yield.
- The web page of the GRUMEGA network (<http://www.grumega.org>) was launched, and a breeding network Red Mega was also established with FAO support.
- A systematic morphological, phenological, and molecular analysis of 154 accessions of wild *Oryza* species from diverse environments in Venezuela was carried out in collaboration with Venezuelan scientists.
- Further work done in relation to RHBV and *T. oryzae* confirmed that in Fedearroz 50 and Fedearroz 2000 there is a QTL associated with resistance to RHBV on the short arm of chromosome 4. In Fedearroz 2000 there is a QTL associated with resistance to RHBV on chromosome 5. In Fedearroz 50 there is a QTL associated with resistance to *T. oryzae* on chromosome 7.
- After five years of work in Nicaragua, the PVS strategy succeeded in identifying four high performing lines that will be released by our Nicaraguan partners in 2008, covering a wide range of production systems in Nicaragua.
- Ten varieties were released by our partners in Colombia, Venezuela, Costa Rica, and Bolivia, Chile, and El Salvador.

#### 4 Project Outcome

##### **Output 1 Enhanced gene pools in IP 4 and OUTPUT2 in SB 2 Genomes modified genes and gene combinations used to broaden the genetic base of crops (rice )**

Where was the achievement of the output/output target documented? Poster presented at the Rice Technical Working Group Meeting Enhancement of yield through chromosomal introgressions from *Oryza rufipogon* 2008 Anna McClung Shanon Moon Georgia Eizenga Susan Mc Couch 32nd Rice Technical Working Group Meeting San Diego California February 18 21 2008 Another paper to be presented at the PCCMCA meeting **AVANCES DEL PROYECTO AGROSALUD EN EL CULTIVO DE ARROZ SANTA CRUZ BOLIVIA** R Taboada<sup>1</sup> J Virue<sup>1</sup> V H Callau<sup>1</sup> C Martine San Jose Costa Rica Abril 14 19 2008

Who used/adopted or was influenced by the output? Identify the kinds of people or entities affected and their location by country USDA Dale Bumpers National Rice Research Center Texas A& M University Cornell University University of Arkansas Rice Tec Rice Program of CIAT Santa Cruz and ASPAR Bolivia and INTA Nicaragua How was the output used or adopted? What was the nature of the influence of the output? The introduction of selected wild QTLs into commercial varieties/elite lines has the potential to enhance the performance of rice varieties It was demonstrated that specific *O rufipogon* introgressions confer superior performance for an array of agronomic and yield related traits In the case of Bolivia two inter specific breeding lines derived from the cross *Oryzica3 X O rufipogon* have gone through two years of field evaluations in farmer s fields showing superior performance compared to available commercial varieties in Bolivia and are being considered for release Another breeding line from the cross *Cuapox O glaberrima* went through a participatory breeding selection with farmers in Nicaragua and is being considered for varietal release by INTA

What is the magnitude (in terms of for example geographic coverage or reach of intended user groups) of the outcome relative to the intended recommendation domain? In the case of wild QTLs from the cross Jefferson x *O rufipogon* rice breeding programs in USA will benefit from this discovery as well as RiceTec(hybrid rice company) based in Texas is considering to introgress these QTLs into their hybrids In the case of Bolivia farmers growing rice under irrigated and rainfed conditions will benefit along as small resource farmers growing rice under upland conditions in Nicaragua

What is the evidence for the outcome? Specifically what kind of data were collected or study was conducted? Who collected the data and/or conducted the study? If not included in the outcome evidence what is the evidence that shows that the outcome is derived from the output/output target? Anna McClung Shanon Moon Georgia Eizenga and Susan Mc Couch collected yield and agronomic data on 70 NILs planted in comparison with three commercial varieties and one hybrid in four locations in Texas and Arkansas in replicated yield trials in 2007 In the case of Bolivia Roger Taboada Juana Viruez and V H Callau collected yield and agronomic data in regional yield trials planted in different rice growing regions in Bolivia during 2006 and 2007 In Nicaragua Gilles Trouche(CIRAD) Zildghen Chow Lazaro Narvaez Jose Corrales and Marlon Ortega from INTA conducted and collected the data via participatory breeding

## **5 Publications**

Nandakumar R Rush MC and **Correa Victoria FJ** 2007 Association of *Burkholderia glumae* and *B gladioli* with Panicle Blight Symptoms on Rice in Panama Plant Disease 91 767

**Correa Victoria FJ** Perez CR y Saavedra E 2007 Anublo bacterial de la panícula del arroz *Burkholderia glumae* ARROZ 57(468) 26 32

Fuentes JL **Correa Victoria FJ** Escobar F Prado G Aricapa G Duque MC and Tohme J 2007 Microsatellite markers linked to the blast resistance gene *Pt 1* in rice for use in marker assisted selection Euphytica (accepted 28 June 2007 DOI 10.1007/s10681-007-9497-0)

**Correa Victoria FJ** 2007 Identification of resistance gene combinations conferring durable blast resistance in Colombia Phytopathology 97 S24

Jia Y **Correa Victoria FJ** 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 91 485 489

**Calvert LA** Cuervo M Lozano I Villareal N and Arroyave J 2008 Identification of three strains of a virus associated with cassava plants affected by frogskin disease Journal of Phytopathology (In press)

McCouch SR M Sweeney Jimming Li Hui Jiang M Thomson E Septiningsih J Edwards P Moncada Jinhua Xian A Harris Tom Tai **Cesar Martinez J Tohme** M Sugiono Anna McClung Long Pin Yuan San Nag Ahn 2007 Through the bottleneck *Oryzifipogon* as a source of trait enhancing alleles for *O sativa* Euphytica 154 317 339

Cesar P Martinez J Borrero J Tohme Myriam C Duque Silvio James Carabalí James Silva 2007 Variedades de arroz con mayor valor nutricional para combatir la desnutricion en America Latina Revista ASIAVA 76 5 9

Alvarez A Fuentes JL Puldon V Gomez PJ Moral L Duque MC Gallego G and Tohme J 2007 Genetic diversity analysis of Cuban traditional rice (*Oryza sativa* L ) varieties based on microsatellite markers *Genet Mol Biol* 2007 vol 30 no 4 p 1109 1117 ISSN 1415 4757

Pantoja A Triana M Bastidas H Garcia C and Duque MC 2007 Damage by *Tibraca limbativentris* (Hemiptera Pentatomidae) to rice in Southwestern Colombia J Agric Univ P R 91(1 2) 11 18 (2007)



Nandakumar R Rush M C and **Correa Victoria F J** 2007 Association of *Burkholderia glumae* and *B. gladioli* with Panicle Blight Symptoms on Rice in Panama Plant Disease 91 767

Larmande P Gay C **Lorieux M** Perin C Bouniol M Droc G Sallaud C Perez P Barnola I Biderre Petit C Martin J Morel J Johnson A Bourgis F Ghesquiere A Ruiz M Courtois B Guiderdoni E (2008) Oryza Tag Line a phenotypic mutant database for the Genoplante rice insertion line library Nucleic Acids Res 36 D1022 D1027

Torres EA and Geraldı IO 2007 Partial diallel analysis of agronomic characters in rice (*Oryza sativa* L.) Genetics and Molecular Biology 30 (3) 605 613

Red de Mejoramiento Genetico de Arroz en America (Red MeGA) Development of the Estatutos y Reglamento para la Creacion y el Funcionamiento de la Red MeGA

Slide Show Mejoramiento Genetico de Arroz Seleccıon Recurrente utilizando Androesterilidad Genetica un nuevo Metodo de Seleccıon

### **Refereed journal articles**

McCouch S R M Sweeney Jimming Li Hui Jiang M Thomson E Septiningsih I Edwards P Moncada Jinhua Xian A Harris Tom Tai **Cesar Martinez J Tohme** M Sugiono Anna McClung Long Pin Yuan San Nag Ahn 2007 Through the bottleneck *O. rufipogon* as a source of trait enhancing alleles for *O. sativa* Euphytica 154 317 339

**Trouche G** Aguirre Acuna S Hocde H Obando Solis R Gutierrez Palacios N Chow Wong Z Valorisation de la diversite genetique du sorgho par des approches de selection participative au Nicaragua Valorisation of the genetic diversity of sorghum through methodologies of participatory breeding in Nicaragua Cahiers Agricultures Numero special Agrobiodiversites In press

Vom Brocke K **Trouche G** Zongo S Bitie A Barro Kondombo C Weltzien E Chantereau J Creation et amelioration de populations de sorgho a base large avec les agriculteurs au Burkina Faso Cahiers Agricultures Numero special Agrobiodiversites

**Lentini Z** 2007 Estimating Likelihood and Exposure Environmental Biosafety Research 5 (4) pp 193 195

**Lentini Z D** Debouck A M Espinoza and R Araya 2007 Gene flow analysis into wild/weedy relatives from crops with center origin/ diversity in tropical America Environmental Biosafety Research 5 (4)

## **In books**

**Calvert L** 2008 Tenuiviruses In Compendium of Wheat Disease Second Edition Eds Bill Bock Published by The American Phytopathological Society St Paul Minnesota USA (In Press)

**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

**Correa Victoria Fernando** 2007 Using rice differentials with known blast resistance genes for pathogen characterization and improvement of rice cultivars in Latin America P 123 In A differential system for blast resistance for stable rice production environment Ed Y Fukuta C M Vera Cruz and N Kobayashi JIRCAS Working Report No 53 123p

**Correa Victoria FJ** 2007 Algunas consideraciones Proteccion quimica de los cultivos Ventana al Campo 3 4 8

## **Online publications**

**Correa Victoria FJ** 2007 The rice Tarsonemid mite *Steneotarsonemus spinki* Smiley RiceCAP Fact Sheet 4 pages [www.ricecap.uark.edu/outreach\\_downloads.html](http://www.ricecap.uark.edu/outreach_downloads.html)

Web Page Development <http://www.grumega.org>

## **Posters**

Luisa F Fory Mabel Morales Alicia Velazquez Kihany Arcia Andres E Blanco Eliana Gonzalez Myriam C Duque and **Zaida Lentini** 2007 Gene flow and introgression analysis from rice into wild/weedy relatives in center of diversity in tropical America VI Encuentro Latinoamericano y del Caribe de Biotecnologia Agropecuaria REDBIO 2007 Vina del Mar Chile October 22 26 2007

Eliana Gonzalez Luisa F Fory Kihany Arcia Andres E Blanco Aida Ortiz Iris Perez Myriam C Duque and **Zaida Lentini** 2007 Genetic diversity analysis of weedy rice and wild oryza species collected in crop natural ecosystems contact zones VI Encuentro Latinoamericano y del Caribe de Biotecnologia Agropecuaria REDBIO 2007 Vina del Mar Chile October 22 26 2007

Manuel Quintero Luisa Fory Eddie Tabares **Cesar P Martinez** and **Zaida Lentini** 2007 Transgenic rhbv resistance and breeding selection of advanced lines in the field VI Encuentro Latinoamericano y del Caribe de Biotecnologia Agropecuaria REDBIO 2007 Vina del Mar Chile October 22 26 2007 \*

**Sanabria Y Carabali J Giraldo O Martinez C Tohme J** Using molecular markers SSR to search wild introgressions from a relative tetraploid species in the diploid *Oryza sativa* L VI Encuentro Latinoamericano de Biotecnología Agropecuaria REDBIO/2007 Vina del Mar – Chile 22-26 Octubre 2007

**Giraldo O X\* Quintero C Plata G Rodriguez F Borrero J Martinez C P y Tohme J** 2007 **Identification of SNPs Markers for Biofortification in Rice** VI Encuentro Latinoamericano de Biotecnología Agropecuaria REDBIO/2007 Vina del Mar – Chile 22-26 Octubre 2007

**Sanabria Y Olaya C Carabali J Martinez C Tohme J** Eliminación cromosómica como estrategia para la recuperación de la fertilidad en híbridos interespecíficos de arroz II Simposio Latinoamericano de Citogenética y evolución Palmira – Valle Agosto 2007

**Sanabria Y Carabali J Olaya C Martinez C Tohme J** Cruzamientos interespecíficos entre una especie de arroz tetraploide (*Oryza latifolia*) y el diploide (*Oryza sativa*) X congreso colombiano de fitomejoramiento Pasto – Nariño Junio 5-7 2007

**Sanabria Y Carabali J Giraldo O Martinez C Tohme J** Introducción de genes de una especie de arroz tetraploide (*Oryza latifolia*) en cultivares diploides (*Oryza sativa*) por medio de cruzamientos IV Congreso Colombiano de Botánica Medellín – Antioquia Abril 2007

Castilla Lozano Luis Armando( **FEDEARROZ**) **Martinez Cesar P** Evaluación de líneas interespecíficas de arroz (*Oryza* sp) a la inoculación con bacterias fijadoras de nitrógeno *Azotobacter chroococcum* y *Azospirillum ananense* en un suelo típico haplustalf de la meseta de Ibagué Colombia XVII Congreso Latinoamericano de la Ciencia del Suelo León Guanajuato México Septiembre 17-21 2007

Pericles de Carvalho F Neves Priscila Zaczuk Bassinello Orlando Peixoto de Moraes Jaime R Fonseca Jose Almeida Pereira Jose Luiz Viana De Carvalho Marilia R Nutti **Cesar Martinez** Helena Pachon 2007 Germplasm identification and development of upland rice cultivars with high zinc contents Zinc Crops 2007 Improving Crop Production And Human Health Maio 24-26 2007 Istanbul Turquia

### **Oral presentations**

**Correa Victoria FJ** 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 FJ** and Martinez C 2007 Breeding rice cultivars with durable blast resistance in Colombia 4<sup>th</sup> International Rice Blast Conference Changsha China Oct 9-14 2007 (**invited speaker**)

**Correa Victoria F J** 2007 Identification of resistance gene combinations conferring durable blast resistance in Colombia APS Annual Meeting San Diego CA July 27 August 2

McClung A M Groth D E Oard J H Utomo H Moldenhauer K A K Boza E Scheffer B Jia Y Liu G **Correa Victoria F** and Fjellstrom R G 2007 Development and characterization of RiceCap QTL mapping population for sheath blight resistance ASA Meeting New Orleans LA Nov 3 9 2007

**Lentini Z** 2007 Gene flow analysis in centers of origin and diversity VI Encuentro Latinoamericano y del Caribe de Biotecnología Agropecuaria REDBIO 2007 Vina del Mar Chile October 22 26 2007

**Lentini Z** 2007 Development and evaluation of transgenic rice in tropical America University of Tokyo Japan July 12 2007

**Lentini Z** 2007 Environmental safety of crops with center origin/ diversity in tropical America NIAS Tsukuba Japan July 11 2007

**Lentini Z** 2007 Development of Drought tolerant rice via transgenesis JIRCAS Tsukuba Japan July 9 2007

**Lorieux M** 2007 MapDisto a free user friendly program for computing genetic maps Computer demonstration given at the Plant and Animal Genome XV conference Jan 13 17 2007 San Diego CA URL <http://mapdisto.free.fr/>

**Martinez Cesar P** 2007 Development of high iron and zinc rice lines to combat malnutrition in Latin America and the Caribbean 2nd Annual Harvest Plus and AgroSalud BIOFORTIFICATION MEETING 11 –14 November 2007 Brazil

**Martinez Cesar P** Jaime Borrero J Tohme Myriam C Duque Silvio J Carabali y James Silva 2007 Desarrollo de germoplasma de arroz con mayor valor nutricional para combatir la desnutricion en America Latina *X Congreso Colombiano de Fitomejoramiento San Juan de Pasto – Junio 5 7 2007*

**Martinez C P Borrero J** Carabali J Duque M C Correa F Sanabria Y Giraldo O Silva J 2007 Contribucion de las especies silvestres en el mejoramiento del arroz cultivado de America Latina X Congreso Colombiano de Fitomejoramiento San Juan de Pasto – Junio 5 7 2007

**Jaime Borrero C** and **Cesar P Martinez** 2007 Contenido de hierro y zinc en arroz integral y pulido en algunos países de America Latina y el Caribe XII Congreso Colombiano de nutrición y dietética Armemá Quindío 2 3 y 4 de Agosto de 2007

**Cesar P Martinez** 2007 Development of high iron and zinc rice lines to combat malnutrition in Latin America and the Caribbean HARVEST PLUS RICE CROP TEAM/BIOFORTIFICATION MEETING 2 – 6 November 2007 Thailand

**Martinez Cesar P** 2007 Evaluation of Drought Tolerance of Transformed Upland Rice at CIAT Kick off Meeting of the MAFF Funded Project JIRCAS TSUKUBA JAPAN JULY 9 11 2007

**Mathias Lorieux** 2007 Exploring Rice Diversity An update on wild introgression populations and related tools Generation CP ARM Benoni – Sept 2007

**Gutierrez Andres Gonzalo Cesar Pompilio Martinez Olga Ximena Giraldo Joe Tohme and Mathias Lorieux** 2007 Desarrollo y evaluacion de lineas de introgresion interespecificas de arroz (*Oryza sativa* L.) X Congreso Colombiano de Fitomejoramiento San Juan de Pasto – Junio 5 7 2007

**Martinez Cesar P Helena Pachon Jaime Borrero** 2007 Cultivos basicos biofortificados para abordar deficiencias nutricionales y la inseguridad alimenticia nutricional en Latinoamerica y el Caribe Conference presented at the 5th Rice Producers Meeting Santa Cruz Bolivia October 12 2007

### **Workshops**

Training on Advanced Rice Pathology Palmira Colombia November 26 30 2007 10 participants from the Minister of Agriculture from Panama

Training course on Rice breeding Project TCP/RLA/3102 (A) Chillan – Chile January 22 25 del 2007 30 participants from several NARs

Training course on Rice Breeding Project TCP/RLA/3102 (A) Managua Nicaragua May 27 – 31 2007 30 participants from different NARs

Lentini Z 2007 America Latina Construccion de Capacidad Multi Pais en Biosseguridad (Brasil Colombia Costa Rica y Peru) Centro Internacional de Agricultura Tropical CIAT Cali Colombia Miercoles Junio 13 2007 Funded by GEF World Bank

Lentini Z 2007 Workshop on Knowledge Generation for Biosafety Risk Assessment and Management June 14 15 2007 CIAT Cali Colombia Funded by GTZ Germany

### **Conferences and workshops**

**Correa Victoria F J** 2006 Situacion del complejo acaro hongos bacteria en el arroz Segundo Congreso Arroceros San Jose Costa Rica Junio 29 30 2006 **(invited speaker)**

**Correa Victoria F J** and Martinez C 2007 Breeding rice cultivars with durable blast resistance in Colombia 4<sup>th</sup> International Rice Blast Conference Changsha China Oct 9 14 2007 (**invited speaker**)

**Correa Victoria F J** 2007 Identification of resistance gene combinations conferring durable blast resistance in Colombia APS Annual Meeting San Diego CA July 27 August 2

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Martinez Cesar P Helena Pachon Taller Biofortificacion con diferentes Instituciones del sector salud y nutricion La Habana Cuba Agosto 20 21 2007

### **In Proceedings Scientific Meetings**

**Lentini Z** 2007 Gene flow analysis in centers of origin and diversity VI Encuentro Latinoamericano y del Caribe de Biotecnología Agropecuaria REDBIO 2007 Vina del Mar Chile October 22 26 2007

**Lentini Z** 2007 Development and evaluation of transgenic rice in tropical America University of Tokyo Japan July 12 2007

**Lentini Z** 2007 Environmental safety of crops with center origin/ diversity in tropical America NIAS Tsukuba Japan July 11 2007

**Lentini Z** 2007 Development of Drought tolerant rice via transgenesis JIRCAS Tsukuba Japan July 9 2007

### **6 List of proposals funded in 2007, 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 2008)
- Impacto ambiental de la adopcion del arroz resistente a las imidazolinonas en sistemas productivos contrastantes de America Latina (AL) INIA UCV CIAT USD 420 000 Donor Fontagro (2007 2010)

**MAFF Funded Project Promotion of Research Targeting Stable Supply of Global Food Japan US\$ 300 000/year 3 years**

- AgroSalud High iron and zinc rice lines CIDA Canada US\$ 258 000/year

## **List of Partners**

- COLCIENCIAS Colombia
- CONAGRO CALESA IDIAP MAG Panama
- CNPAF EMBRAPA Brazil
- DALE BUMPERS NATIONAL RICE RESEARCH CENTER USA
- FEDEARROZ Colombia
- INTA Nicaragua
- INIA Venezuela
- INIA Peru
- IRRI Philippines
- IAEA Austria
- Louisiana State University USA
- SENUMISA CONARROZ Costa Rica
- USDA USA
- University of Arkansas Texas A &M U Cornell U and Yale U USA
- WARDA Benin
- CIBIOGEM UNAM Mexico
- University of Costa Rica Costa Rica
- ICA Corpoica Institute von Humboldt Colombia
- UCV IVIC INIAP Venezuela
- CONAM INIA Peru
- EMBRAPA Brazil
- University of Hanover BBA University of Braunschweig Germany
- ETH Switzerland
- PRI University of Wageningen The Netherlands
- JIRCAS Japan
- CIAT Santa Cruz ASPAR and Mision Alianza Noruega Bolivia
- Instituto Investigaciones del Arroz Cuba
- IDIAF Dominican Republic
- IDIAP Panama
- Harvest Plus Rice
- CIRAD IRD Genoplante France
- INIA Chile

## **List of proposals submitted in 2007 value and donor**

Germoplasma mejorado de Arroz de Riego de Amplia Base Genetica y Nuevas Caracteristicas de Interes MADR Colombia Total US 246 944

Introgresion asistida por marcadores de genes de resistencia al virus de la hoja blanca en lineas elites de arroz MADR Colombia Total Col\$ 627 7 millions

## 7 Principal and Support Staff

- **Principal Staff**

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 Cesar Martinez	25%	50% SB 2	CIAT	CIAT HQ
Dr Gilles Trouche	50%	50 % PE 3	CIRAD/CIAT	CIAT HQ

Principal Staff positions in IP 4 4 9 Associated projects 2 3 Total 7 2

Dr Carlos Bruzzone 50% 50 % (INIA) INIA/CIAT Peru  
Works as a consultant

- **Support Staff**

Jaime Borrero Genetics  
Myrian Cristina Duque Biometry  
Fabio Escobar Biotechnology/Pathology  
Ivan Lozano Virology  
Yolima Ospina genetics  
Gustavo Prado Pathology  
Manuel Quintero Tissue Culture  
James Silva Biometry  
Silvio James Carabali Genetics  
Jaime Lozano Genoplant  
Jairo Barona Database  
Eddy Tabares Transformation

## 8 M Sc Thesis

- Olga Higuera FEDEARROZ  
Supervisor Fernando Correa  
University Universidad Nacional de Colombia  
Title Correlation of blast resistance selected in early generations (F2 F3) and stability of resistance in advanced generations
- Mabel Morales BSc Identificacion y Caracterizacion de especies de los complejos *Oryza sativa* y *Oryza officinalis* Tesis en Curso Universidad Javeriana Bogota Colombia Graduated January 2007



- Alicia Milena Velasquez B Sc Rastreo de flujo de genes en campos comerciales de arroz utilizando marcadores moleculares y resistencia a herbicidas Tesis en Curso Universidad Javeriana Bogota Colombia Graduated Decemeber 2007
  - Kiliany Andrea Arcia Moreno M Sc Tesis Caracterizacion de especies silvestres del genero *Oryza* colectadas en condiciones naturales y campos de arroz en el Estado Portuguesa Venezuela Tesis en Curso Universidad Nacional Sede Palmira
  - Andres Eloy Blanco M Sc Tesis Caracterizacion de especies silvestres del genero *Oryza* colectadas en condiciones naturales y campos de arroz en el Estado Guarico Venezuela Tesis en Curso Programa sandwich Universidad Nacional Sede Palmira/ Universidad Central de Venezuela Maracay Venezuela
  - Francisco Amella MSc Thesis Inheritance of the rice panicle size (*Oryza Sativa* L.) Thesis research finished but statistcal analysis of data is on going Universidad Nacional of Colombia Sede Palmira
- Olga Ximena Giraldo Ms Thesis Identification of SNPs Markers for Biofortification in Rice Research activities on –going Universidad Nacional de Colombia Palmira
- Natalia Labrin MSc CATIE Costa Rica Estudio de la resistencia en variedades de arroz (*Oryza sativa* L.) venezolanas al virus de la hoja blanca (Degree completed Feb 2007)

#### **Others Students**

- Enrique Bravo PhD U of Valle Colombia The complete nucleotide sequence of the genomic RNA of Bean common mosaic virus strain NL4 (Degree to be completed March 2008)
- Monica Fernandez BSc U Nacional de Palmira Colombia
- Herminio Paredes Universidad Nacional Palmira 6 months training in rice agronomy
- Liliana Gil Universidad Javeriana Bogota 6 months training in molecular markers associated with rice blast

## **9 Problems encountered and their solutions**

- We are developing two Projects funded by FONTAGRO. At the time the Projects were developed, the Rice Pathology section had operational funds which were offered as our matching funds to the funds of the FONTAGRO Projects. Today our section has no operational funds and several charges including technical and research support were charged to the FONTAGRO Projects in 2007 affecting the normal budget execution and with the risk that FONTAGRO could not accept the financial report. No solutions were given to this problem which will continue in 2008.
- Two well known, experienced and respected scientists will be departing in 2008, reducing drastically our critical mass of scientists. This fact has already increased the level of anxiety and concern in our rice people. CIAT management has made some commitments to fill these positions with post doctoral fellows. However, there will be some lead time for the new scientists to get established and be productive. Therefore, there is a risk that the productivity of the Rice Product Line could be affected.
- Core funding for the Rice Product Line is still not clear and is not adequate. As a matter of fact, we lost the administrative assistance position in 2007 which has created some logistic problems for us. A possible solution could be to bring more money through special projects. However, our senior staff, research assistants and technicians are over committed and over work. Human Resources is calling our attention because our people are not getting due rest on time.
- Future activities of the Rice Anther Culture laboratory are uncertain since this laboratory lost all its financial support in 2007. Activities will depend on third financial support.

### **Indicators**

#### **List of technologies, methods and tools**

- Two sheath blight greenhouse screening methods named micro chamber and mist chamber were improved for reliable phenotyping of rice mapping populations for the identification of QTLs controlling sheath blight resistance.
- Five rice mapping populations with more than 250 advanced lines are available for phenotyping and identification/corroboration of new QTLs controlling sheath blight resistance.
- A laboratory and greenhouse method including morphological characteristics, pathogenicity tests and use of PCR specific primers was developed for the identification of the bacterial panicle blight pathogen *Burkholderia glumae*.
- A greenhouse screening method to evaluate and identify potential sources of tolerance to the bacterial panicle blight pathogen was developed and used for screening more than 200 Latin American rice cultivars and advanced breeding lines.

- Six potential sources exhibiting high tolerance to the bacterial panicle blight pathogen *Burkholderia glumae* were identified in greenhouse inoculations for field testing and use in breeding for resistance
- In collaboration with Harvest Plus it has been shown that NIRs technology can be successfully used to estimate iron and zinc content in rice grain
- A marker assisted selection program for resistance to RHBV and *Torytocolus* is being established

**Rice Varietal Improvement Ten varieties for commercial rice production were released in the region by our partners from germplasm developed by the CIAT FLAR breeding programs**

ESPERANZA Upland rice variety in Bolivia coming from population breeding was released in Bolivia for both manual and mechanized rice ecosystems

RQUILIA 23 First irrigated rice variety coming from population breeding in Chile adapted to the temperate rice ecosystem

Fedearroz 174 and Fedearroz 60 were released by FEDARROZ in Colombia for irrigated and favored upland conditions

Cetauro was released for irrigated conditions by FUNDARROZ in Venezuela

Coprosem 304 and Improarroz 420 were released by COPROSEM and IMPROARROZ respectively for irrigated and favored upland conditions in Colombia

Palmar 18 and Cabuyo were released by SENUMISA for irrigated/favored upland conditions in Costa Rica

CENTA –A8 was released by CENTA El Salvador for irrigated favored upland conditions

**Special Project**

- FAO Regional Technical Cooperation Project (TCP/RLA/3102)  
Capacitacion en Fitomejoramiento Genetico e Intercambio de Germoplasma para utilizar los Recursos Geneticos del Arroz en America Latina y el Caribe  
The Regional TCP Project involves 6 Countries Argentina Chile Cuba Guatemala Nicaragua and Dominican Republic and 3 International Institutions FAO CIAT and Cirad

**Liaison Officer**

- **Liaison between FAO (regional LAC Office and Rome Headquarters) CIAT and Cirad**

Funding by FAO of a Regional TCP Project

Implementation of the proposed activities (Breeders Workshops and Training courses)

- **Inter institutional liaison between CIRAD and CIAT +**

Implementing new research activities linking Population Breeding and Eco physiology (3 weeks visit of a Cirad Scientist at CIAT and field experiment at Villavicencio Colombia)

Implementation of a rice population breeding project in France (Camargue) targeting the development of aromatic varieties

New Cirad Scientist to be posted at CIAT in mid 2008 to reinforce the actual

### 10 Summary Budeet prepared by Finances

#### **ACTUAL EXPENDITURES 2007**

#### **Outcome Line SBA-4 Rice**

SOURCE	Rice Program		Total US\$	( / )
	HQ+LAC	Biotech		
Unrestricted Core	134 845	222 140	356 985	7 /
Restricted Core C E	342 502		342 502	7 /
<b>Sub total Core</b>	<b>477 347</b>	<b>222 140</b>	<b>699 487</b>	<b>14 /</b>
<b>Restricted</b>				
Special Projects	1 515 514	1 628 741	3 144 255	65 /
Generation Challenge Program		323 550	323 550	7 /
<b>Sub Total Restricted</b>	<b>1 515 514</b>	<b>1 952 291</b>	<b>3 467 805</b>	<b>72 /</b>
<b>Direct Expenditures</b>	<b>1 992 861</b>	<b>2 174 431</b>	<b>4 167 292</b>	<b>86 /</b>
Non Research Cost	314 817	343 500	658 317	14 /
<b>Total Expenditures</b>	<b>2 307 678</b>	<b>2 517 931</b>	<b>4 825 609</b>	<b>100 /</b>

<sup>(1)</sup> Exclud ng Non Operational expenses Phase out and F xed Assets adjustment