RICE PROGRAM INTENSIVE REVIEW

ACHIEVEMENTS

(Presented to the Program Committee of CIAT Board of Trustees)

CIAT INTERNAL PROGRAM REVIEW

December 4-6, 1989, Cali

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CONTENT

I. RICE PROGRAM ACHIEVEMENTS

Robert S. Zeigler

Rice Program achievements may be assessed at two different levels. At the most specific level, individual scientific and technical accomplishments may be examined for their validity, quality and contribution to the overall knowledge base of rice in the region. From a broader perspective the achievements of the Program as a whole may be assessed in terms of their impact on rice in the region and the likelihood of this impact continuing. In this document the latter approach is selected, since in the accompanying document "Summary of Recent Research Advances", the first approach is adequately covered.

From a broad perspective, the achievements of the CIAT Rice Program may be examined using several distinct criteria. First, has the Program reached the goals and met the objectives as stated in its earlier stages? That is, has the Program had the desired impact for which it presumably was created? If so, has the Program been able to formulate the necessary shifts in strategy dictated by changes in its working environment? In particular, has the Program recognized and addressed those changes caused by the very impact generated from the Program's success? Finally, has the Program been able to implement at an operational level the mandated strategic shifts and operational strategies?

The questions will be addressed separately in the following sections. Fist it will be shown that the desired IMPACT from the initial strategies of the Rice Program have, indeed, been achieved. Second, the STRATEGIC SHIFTS mandated by this success will be outlined, together with

brief illustration of how the need for change was identified. Third, activities illustrating that the Program has been capable of IMPLEMENTATION OF STRATEGIC SHIFTS will be presented.

Using the above set of criteria the scientific achievements of Program scientists will not be summarized as such in this section. This is consistent with the concept of a "development oriented research institution", in that the research is evaluated in light of its relevance to and impact upon development. In this context the scientific achievements are viewed as the means to reach the "development oriented" goals, rather than as ends in themselves. However, given that CIAT is by definition a research institution, the caliber, results, and scientific standards of the research must be considered in a summary of Program achievements. Therefore, this general "Achievements" chapter is followed by very brief summaries of the principal scientific advances realized by the different sections over the past several years (Achievements and Constraints by Section). These summaries may serve as a guide for the interested reader to pursue topics further in "Rice Program: Summary of Recent Research Advances (1986-1989)"

IMPACT

The original objectives of the CIAT Rice Program remain the same since its origins with CIAT: to contribute to increased rice production in Latin America in order to benefit rice growers and, in particular, consumers. The strategy adopted and followed through the 1970s to the mid 1980s was essentially two-pronged: (1) Develop technologies for increased productivity; and, (2) Develop human resources at national program level to assure local adaptation and adoption of the technologies. The operational strategies

were, first, focus on highly favored irrigated production systems by adapting the new semi-dwarf, input responsive, high yielding rice germplasm developed in Asia by IRRI. Second, train young national program scientists in the basics of rice improvement and production agronomy.

Improved germplasm:

The success of these strategies has been truly impressive. In Table 1 the importance of modern varieties in Latin American rice production during the period 1985-87 is shown. Eighty one per cent of irrigated area (2.5 million hectares) is planted to modern varieties based on germplasm from the CIAT Rice Program. In terms of production **82% of irrigated production**, which corresponds to **56% of total Latin American production, comes from CIAT-based lines.** Much of this impact came out of the fruitful CIAT-ICA collaboration.

In monetary terms, CIAT impact can be illustrated based on 82% of the 9.8 million tons (paddy) of irrigated production coming from CIAT materials. The value of this, given a paddy price of US$250/ton is US$2.01 billion. Attributing 19% of this to variety (Rubinsteinn, 1984), CIAT's most direct contribution, gives approximately US$382 million per year. If national program contributions to the varietal component are assumed to be 50%, then direct **CIAT impact** from irrigated rice varieties alone is **US$191 million** per year. Indeed, the Program's impact has been overwhelmingly through the adoption of its improved materials.

This kind and level of impact in the irrigated sector will certainly continue. During the period 1985-1988 from CIAT developed germplasm **31 rice varieties in 11 countries** have been **released** for irrigated and favored uplands. In Central America, of the 41 lines in the last stages of testing prior to release, 33 are originally from CIAT.

The steady growth in Latin American rice production following the introduction of modern varieties can be seen in Figure 1. The initial 3.5% annual growth rate in rice production (1966-1977) was roughly split evenly between significant growth in area and yield. However, in the last decade area growth has ceased to be significant, with the entire 2.6% annual production growth rate attributed to yield increases (FAO Tapes).

The influence of the growth of rice production on consumer well being can be seen in Table 2. The real retail price of rice has fallen steadily in important rice consuming countries. This trend has been accompanied by steadily rising rates of rice consumption and real income. The effects of the recent economic crisis in the region has not been included in these figures, but it seems reasonable to expect that as consumers are squeezed for purchasing power, a cheap and nutritious food like rice would become more important.

Human resource developmentt:

The success of the Program strategy on assisting in the development and strengthening of national programs has been similarly positive. By the late 1980's over **400 rice researchers had received professional training at CIAT**, primarily in the areas of **production agronomy and breeding.** In addition, over **two hundred other researchers** and extentionists have been trained in **in-country courses.**

This training effort has had a surprising longevity in the national programs. For example, of the 80 scientists from Central America having received training at CIAT over half are still working within their programs. Most of the remainder are in the rice private sector, thus still contributing.

Given this level of training, strong national programs, at least from the perspective of human resources, should predominate in the region. A survey of national rice programs structure and activities conducted by the CIAT Rice Program in 1988 gave this expected result. Programs were found to have experienced (half the staff with greater than 8 years experience) and well educated (80% with agric. engineer level or higher) staff.

The breeding work now being carried out by the national programs is assuming ever increasing importance in the region. These programs in the aggregate now make more rice crosses than CIAT. This is producing concrete results in that half the varieties released in the region over the last several years have come from national crossing programs, albeit depending on CIAT and IRRI materials for parents. (A more detailed summary of the results of the survey can be found in the February 1989 Proceedings of the 7th IRTP Latin America Conference:Zeigler and Cuevas, pp. 34-54). This strong base has stimulated the growth of the International Rice Testing Program (IRTP)-Latin America (a germplasm exchange and testing network of national program scientists funded by UNDP, administered globally by IRRI, and in this region based at CIAT, with an IRRI-CIAT liaison scientist coordinator).

[It would be misleading to paint too optimistic a picture of the NARDS situation. While there is strength within the system, there is erosion as well. In recent years, substantial decline in the capabilities within several important programs has occurred. These include Peru, Panama, Nicaragua, and several countries in the Caribbean.]

From the above summaries, it is clear that the Rice Program has had significant and substantial impact in Latin America.

This impact has been consistent with its goals and follows directly from the strategies adopted to meet those goals.

STRATEGIC SHIFTS

During the 1980s it became clear that a number of strategic shifts were in order. Although these shifts were products of an evolution in thinking over a period of almost a decade, they may be grouped as responses to the following perceived needs: (1) Assure the sustainability of the production advances achieved in the irrigated sector; (2) Extend production gains to regions yet to experience impact; (3) Respond to changing real national program needs. The strategic shifts stemming from these concerns will be presented in groups corresponding to the concerns.

Sustainability of Irrigated Production Gains:

The sustainability of irrigated rice production began to be of concern in the early 1980s when high yielding varieties planted over large areas in some Latin American countries suffered serious losses due to the rice blast disease and the rice hoja blanca virus. In 1985 concerns were raised over very high production costs of irrigated rice in many countries in the region (CIAT analyses; see 6th IRTP Conf. Proc., 1986). In particular, use of pesticides and herbicides was becoming widespread and in many cases indiscriminate. Furthermore, in most areas the yield potential of modern varieties was not being expressed. During this same period it was becoming clear that the genetic base of the modern irrigated varieties grown in the region was very narrow, with almost all sharing a major portion of parentage as IR8, and virtually all having cytoplasm from this same variety.

Some of the principal conclusions from analyses of this situation were: (1) Modern high-yielding varieties bred in

and for the most favored conditions lacked tolerance to many pests and diseases. This became a problem when these varieties were grown under less favored conditions;
(2) Different regions had widely differing germplasm needs;
(3) The information required to develop pest, disease, and crop management practices for the region was not available;
(4) Where information was available, it was not reaching farmers. From these conclusions and the above observations the following shifts in strategies were suggested:

(1) Incorporate resistance and tolerance to the principal insects, diseases and abiotic stresses in the region;

(2) Shift from a highly favored site to a "hot-spot" breeding site approach;

(3) Characterize and distribute germplasm according to the requirements of a region (rather than uniform nurseries to all countries in the region);

(4) Develop a concept of integrated crop management, with special emphasis on integrated pest management (IPM).

(5) Diversify the genetic base of rice germplasm in the region.

(5) Develop a basic understanding of the nature of regionally important noxious organisms.

Impact in New Areas:

In the early 1980s, with impact assured in irrigated sector, the extensive upland areas were first considered for possible attention. It was clear that some areas were more likely to benefit than others (e.g. the high rainfall acid

soil uplands compared to the drought-prone acid soil uplands). However, rice production even under the moisture favored environments was typically unsustainable. Other environments considered for attention were those irrigated environments with low temperatures at the beginning and end of the growing season.

The strategic shifts emerging from these observations were:

(1) Develop germplasm suited to the diverse constraints of the acid soil high rainfall uplands;

(2) Develop sustainable cropping systems which include rice for the high rainfall acid soil uplands;

(3) Consider germplasm needs for environments with production limited by temperature extremes.

Changing National Program Needs:

With the increasing role played by national programs in generating breeding lines it became apparent that support in this area was required from CIAT. Training needs clearly were shifting in that most scientists were already experienced in the basics of applied rice research.

Institutional linkages within countries were generally found to be weak. Similarly the means to develop priorities based upon an understanding of the rice (and agricultural) sector was found to be lacking. This latter point extended to the CIAT Rice Program, as well.

From these conclusions the following strategic shifts were suggested:

Rather than concentrate on developing fixed lines for direct release by national programs:

(1) Provide germplasm that will be useful as parents for generating locally adapted lines; and,

(2) Develop methodologies which may be used by national programs in strengthening their breeding capacities;

Rather than concentrate on training at CIAT for entry-level scientists from national programs:

(3) Concentrate training for young staff at the country level, taking advantage of local skilled personnel;

(4) Offer advanced research experience at CIAT for mid-career scientists;

For institutional linkages, priority development and sector analysis:

(5) The CIAT Rice Program would adopt the strategy of assisting in developing institutional linkages to address production and technology transfer problems;

(6) A legitimate role of the Rice Program would be to foster an understanding of socioeconomic issues relevant to rice within the agricultural sector.

Considering the fundamental nature of most of the above highlighted strategic shifts, it is clear that the Rice Program is able to asses changing situations within its mandate and identify plausible modifications in its strategies to address them.

IMPLEMENTATION OF STRATEGIC SHIFTS

The implementation of the strategic shifts indicated in the above section will be addressed as they were presented. However, it should be kept in mind that the new thrusts are not independent. Also, while not specifically included under "Strategic Shifts", a fundamental implication of the shifts is a requirement to develop strong cross-program linkages within CIAT and among other international institutions. Concrete steps in this area have been taken as indicated by:

- Strong collaboration with the Biotechnology Research Unit in the areas of rice anther culture and RFLP mapping;

- Development of pilot projects in training trainers in the Dominican Republic and Ecuador with the Training and Communications Support Program;

- Implementation of a collaborative project between the Rice Program and the Tropical Pastures Program in the area of rice-pastures associations and rotations.

- Participation in the Rockefeller Foundation International Program on Rice Biotechnology.

- Initiating a process by which CIAT, IRRI, WARDA, IITA, and eventually, IRAT, can establish a coherent global strategy for rice research.

Sustain Irrigated Production Gains:

- Sources of resistance and screening methods have been developed for a number of constraints specific to the

region. These include rice blast, the hoja blanca virus, and its planthopper vector (Sogatodes oryzicola), iron toxicity, cold, and grain quality limitations.

- The Sta. Rosa farm in the Llanos Orientales of Colombia has been developed as a hot spot screening site. As of 1985, it has become the principal site for breeding, selection, and characterization of materials, particularly for blast resistance. The site has also permitted the Program to begin to understand the dynamic blast pathogen population, and factors behind resistance breakdown.

- Germplasm is now characterized according to regional needs (as specified by national programs) and distributed accordingly.

- Rice anther culture has been adopted as a breeding and research tool for the CIAT Rice Program to facilitate germplasm diversification and genetic characterization activities.

- A recurrent selection breeding program has been established for both upland (cytoplasmic male sterility developed by the Program) and irrigated breeding populations.

- Crosses to bridge genetically and cytoplasmically very distinct upland and irrigated populations have been made and progeny entering second round of recombination.

- Germplasm from diverse sources (particularly improved African uplands) have been introduced into CIAT irrigated breeding pools. A variety with African

parentage and cytoplasm from this pool was released in Colombia as a highly blast and hoja blanca resistant variety.

- Collaborative basic research projects have been initiated with advanced institutions in the US and Europe (e.g. Cornell University, University of Hawaii, and Purdue) to specific issues relevant to regional problems.

- Research towards management of rice crop production constraints is conducted in an integrated manner (multidisciplinary). A Rice Entomology/IPM section was opened in 1989. Collaborative research plans developed with national programs emphasize the inter-related nature of most constraints.

- A germplasm data base has been designed and is being loaded with the last 15 years' data on crossing and line performance. From the understanding emerging from analyses of line performance over environment, breeding activities of CIAT and national programs will be more sharply focussed.

Impact in New Areas:

- A detailed study of of the rice production distribution and description of rice growing environments of the region is underway with the AESU.

- Cold-tolerant lines incorporating good grain quality have been developed for use by national programs in the southern cone.

- Development of rice germplasm adapted to the soils and biotic stresses of the acid soil high rainfall uplands, incorporating input response, lodging resistance, and excellent grain quality, has been under way for seven years. Lines from this project incorporating the desired traits have reached advanced testing level in Colombia and Brazil, and perform extremely well.

- The acid soil upland materials have been combined with acid soil tolerant tropical grass and legume combinations developed by the CIAT TPP, and tested under a range of possible association and rotations. The results indicate that this combination will contribute to sustainable intensified crop-pasture exploitation of the vast savanna regions of Latin America.

National Program Needs:

- A detailed survey of the national rice research programs was conducted in 1988 to assess their human resource endowment and activity spectrum.

- The characterized germplasm as distributed according to local needs is being used in crossing programs as sources for desirable traits in a high-yielding background.

- The Rice Program has adapted a simplified crossing method for use by national programs to greatly improve their crossing efficiency.

- Anther culture has been applied to specific needs of countries (e.g. Chile and S. Brazil). An economic

analysis suggests for which types of national programs the tool will prove useful.

- A network (CRIN, with headquarters in the Dominican Republic) to address the specific research, coordination and training needs of the Caribbean was initiated in 1986;

- Training activities are shifting towards more in-country activities. Ten introductory courses in rice production have been conducted in-country over the last several years, taking advantage of local expertise when possible;

- A "training trainers" model is being tested in conjunction with the TCSP at the Dominican Republic CRIN headquarters;

- Collaborative research plans, based on diagnostics and prioritization of problems, have been developed and implemented in a number of countries. A detailed census of Colombian rice production has been carried out in partnership with ICA and FEDEARROZ. The methodology developed for this is currently being applied in Venezuela.

CONCLUDING REMARKS

In view of the already substantial impact the Program has had, the question of the need for further international investment in rice for Latin America should be addressed. There is ample justification for the investment. Some principal arguments are directly related to the strategic shifts indicated above, falling within the technical and national program spheres.

Within the technical sphere, future Program activities are essentially directed towards sustainability. That is, sustainability of production gains in the irrigated sector and developing technology for sustainable production increases in areas not having received the same level of benefit from research as the irrigated sector. Future directions of the CIAT Rice Program in the irrigated sector will be oriented towards addressing the areas the that have not had substantial technical input (integrated crop, pest, and disease management; broaden genetic base etc.) in order to sustain rice production gains.

Recognizing that enormously important areas of rice production have yet to experience an expansion in productivity driven by new technology, the Program will develop technology for those areas with good production potential. To achieve sustainable gains in productivity, the Program must approach this from a perspective of developing rice-based or rice-driven systems.

The foundation of basic research required, the region-specific nature of both issues, and the general applicability of the concepts of integrated crop and pest management suggest that within these areas of inquiry a comparative advantage clearly lies with an international program oriented towards regional needs.

There are two points within the area of "Changing Needs of NARDS" which argue for a continued strong international presence in rice in the region: Recurring erosion of programs, and growing private sector financing of NARDS research. The regrettable phenomenon of rising and falling research capabilities due to shifting economic and political conditions is a reality likely to be with the region for quite some time. This being the case, it is essential that there be an institution within the region capable of

contributing the necessary support for rebuilding national research capabilities when the need arises.

A growing change in the national research arena is the increasing role played by the private sector in financing and conducting rice research. While a welcome and necessary relief from the terrible financial constraints limiting the programs, this presents a quandary for researchers and policy makers. The tendency for the private sector (be it growers, seed producers or millers) is that it will fund research directed towards more short-term goals. Similarly, assuming the organizations have a strong presence in the present system, they will be unlikely to support research that threatens the status quo. Thus, research directed towards bringing new areas into production or increasing the productivity of a group not currently important is unlikely to be funded and, therefore, carried out. How will long-term future needs be addressed? Who will assume risky, "long-shot" research? Who will explore the likelihood of expanding the sector, and beneficiaries of research? It would seem that such areas of the "common good" will have to remain in the public sector, and most likely at the international level.

From the activities implemented, as summarized above, it can be seen that the CIAT Rice Program has met the challenge of adapting to the dynamic rice research and production environment of Latin America. This adaptation, and the promise it holds of maintaining and, indeed, increasing the already impressive impact made by the Program, is perhaps the most significant achievement of last five years.

TABLE 1. MODERN SEMI-DWARF VARIETIES IN LATIN AMERICA 1985 - 1987.

	AREA		PRODUCTION [A]	
	TOTAL (10^3 HA)	% MV	TOTAL (10^6 T)	% MV
IRRIGATED	2505	80.9	10.6	81.8
UPLAND	5057	9.5	7.2	19.3
TOTAL	7562	33.1	17.7	56.3

[A] PADDY; CIAT ESTIMATES BASED ON FAO AND NATIONAL PROGRAM DATA.

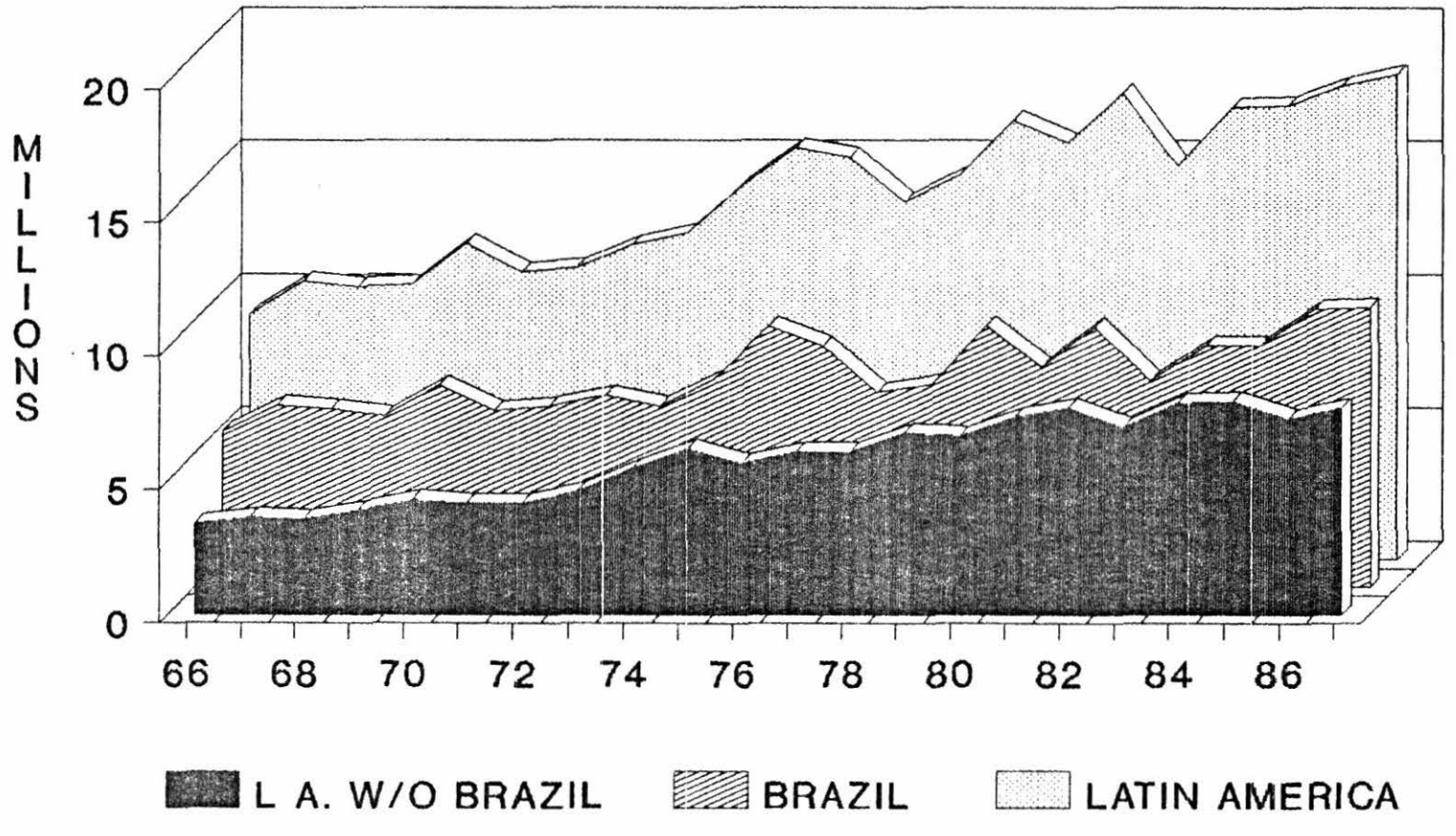
TABLE 2. RICE PRICE AND CONSUMPTION COMPARED TO INCOME GROWTH.

		% ANNUAL GROWTH RATES		
			RICE	
COUNTRY	PERIOD	PER CAPITA REAL INCOME	RETAIL PRICE	PER CAPITA CONSUMPTION
BRAZIL	1973-87	1.8	- 3.0	1.0
COLOMBIA	1960-84	1.9	- 3.4	4.1
ECUADOR	1970-87	3.3	- 1.0	NS
PARAGUAY	1968-83	4.0	- 1.2	2.3
VENEZUELA	1965-86	1.8	NS	2.2

SOURCE: CIAT RICE PROGRAM.

RICE PRODUCTION 1966/87

LATIN AMERICA (Metric Tons)



Breeding: Subtropical, Central America and anther culture.

C. P. Martínez

Main achievements in this section during the last four years can be summarized as follows:

1. The successful implementation of anther culture in rice as a breeding tool to complement traditional breeding methods; this technique is being used in various ways by our program. A study guide was prepared explaining the methodology adapted at CIAT based on previous work by Chinese scientists. This work was done in close collaboration with CIAT's Biotechnology Research Unit.

2. Development of cold tolerant lines with good grain quality for Chile. This material is showing good adaptability to diverse conditions in Chile, Brazil, Cuba and France (IRAT); about 55 breeding lines were nominated by the national rice program of INIA, Chile to the International Rice Cold Tolerance Nursery distributed by IRRI. Anther culture was instrumental in developing these lines.

3. Screening for cold tolerance. Several methods to screen for cold tolerance at the germination and seedling stages were developed.

4. Studies on the effectiveness of white belly selection in segregating populations suggested some maternal (cytoplasmic) effects; the cultivar used as mother could have an influence on the type of selection response observed. An audiotutorial unit on rice grain cooking, eating and milling quality was prepared.

5. Breeding activities in Central America. Breeding work done in Panama in collaboration with the national rice program of IDIAP and the College of Agriculture of the University of Panama resulted in the release of two varieties: Panama 1048 and Panama 1537; the national rice program of CENTA (El Salvador) released the variety CENTA 5 which they selected out of the breeding material they carried to El Salvador from Panama; a breeding line P 3831 F3-RH38-8-1M-J182 (from the Panama collaborative project) is being multiplied by CEDIA for release in Dominican Republic.

   The national rice program of ICTA in Guatemala released two varieties from this section: ICTA-Motagua and ICTA-Quirigua.

6. From the breeding work done on Sogatodes - Hoja blanca virus resistance two varieties, namely Oryzica Llanos 4 and Oryzica Llanos 5 were released in Colombia.

7. Use of anther culture to produce doubled-haploid lines for RFLP analysis was started; this is done in collaboration with CIAT's Biotechnology Unit.

Some of the existing constraints I see can be summarized as follows:

1. Lack of strategic planning and focus in research in many national programs, specially in Central America.

2. Excessive traveling commitments reduce our time to conduct some needed research projects.

3. Lack of adequate funding in many national programs affects continuity in research efforts.

4. It is very difficult for many rice scientists in most national programs to get good access to rice literature.

5. Regarding constraints within CIAT's rice program, on several occasions I have found budgetary restriction on supplies, services and overtime.

6. Frequently the work load is extremely heavy, exacerbated by recent staff turnover, compromising our ability to initiate pressing projects.

IRRIGATED AND FAVORED UPLAND RICE BREEDING PROGRAM: Achievements and Constraints

E. P. Guimaraes

The main achievements during the last four years can be summarized as:

1) More than 30 varieties were released for irrigated and rainfed lowlands in 11 countries in Latin America, based on CIAT rice germplasm;

2) The level of resistance to blast, the major disease in rice, was increased in the lines distributed to the national programs;

3) The genetic background of Latin American varieties has been increased with the development of lines with germplasm from Africa;

4) Genes for resistance to hoja blanca virus present in japonica lines were introduced into more useful background (Colombia just released two varieties with these genes);

5) The choice of Santa Rosa Experimental Station, situated in Villavicencio-Colombia, a high disease pressure site (hot spot), has been one of the key points to select lines with higher level of resistance to diseases. This site has been linked into a shuttle breeding scheme which includes Palmira and national program breeding sites, when appropriate.

6) Breeders from national programs have been included more directly in selections and planning crosses for their

environments via breeders workshops and individual invitations.

7) A mechanism for characterizing lines for dispatch for a wide range of characters has been implemented.

The main constraints to the Program are :

1) Santa Rosa Experimental Station is located 25 km from Villavicencio and has very limited flexibility in terms of vehicles;

2) Communications with CIAT and Villavicencio are very difficult (we have been using a radio);

3) The infrastructure for machine and seed storage is limited.

Acid Soils Savanna Breeding.

The following are major achievements in this breeding section:

1. Characterization of rice germplasm originated mainly from Africa, Brazil, and Southeast Asia for tolerance to acid soils and responsiveness to inputs. These materials were later used as parental sources for the breeding program for acid soils.

2. Development of high-yielding acid tolerant materials that combine good grain quality, lodging resistance, and disease and insect resistance. These cultivars have been demonstrated to fit nicely fit various cropping systems of savannas/cerrado conditions (e.g. in association with pastures and in rotation with soybeans).

3. Development of "upland dwarfs" cultivars that possess deep root system, earliness, and Fe toxicity tolerance. The "upland dwarfs" would serve as a bridging-gap for the upland X irrigated crosses in order to broaden genetic base of the irrigated program. The deep-rooted semi-dwarf cultivars, however, are also useful in production areas where water is in short supply - such as in Cuba and Coastal Peru.

4. Development of a simplified crossing methods in rice that allow national programs to save costs and resources.

5. Development of a field-screening methodology for iron toxicity that allow rapid screening and evaluation of materials. This method provides uniformity of Fe distribution in the field which in turn minimizes escapes.

6. Development of a genetic male sterile line adapted to acid soils.

7. The male-sterile mutant, obtained from the irradiation treatment is being used in the recurrent selection/ population improvement to facilitate natural cross-pollination in rice.

I feel that the following constraints interfere with or slow down my research activities:

1. Restricted budgets for supplies, services and over-time.

2. The weekly flight of the CIAT plane to Villavicencio is poorly managed.

3. Communication between CIAT-Palmira and CIAT-Santa Rosa is extremely difficult.

4. Poor maintenance of vehicles at Santa Rosa

DEVELOPING SUSTAINABLE RICE-PASTURES SYSTEMS: ACHIEVEMENTS AND CONSTRAINTS

José I. Sanz S.

The project "Developing sustainable Rice-Pastures Systems" started early this year and a series of exploratory experiments were planted in different sites of the Colombian acid savannas during May to July. The results of this first year's work are very encouraging.

1) Around 1.2 T rice production are necessary to break even in rice monoculture in the studied areas. To cover completely the costs of the pastures establishment in association with rice, some 0.8 T extra rice production are needed.

2) Rice after a 10 year B. decumbens has higher yields (1.3 T without N and 3.5 T with 80 kg N/ha) than after native savanna (1.0 T without N and 2.0 T with 80 kg N/ha). Pastures reestablished spontaneously.

3) Rice yields following a grass-legume pasture (B. decumbens + P. phaseoloides) were 3.0 T without N, 3.5 with 80 kg/ha, and 4.5 T with 80 kg N/ha (weed control in latter yield plots). The contribution of the legume to rice yield is high, even without applied N. Pastures reestablished spontaneously.

4) When rice was grown in a sandy soil (>40% sand) with water stress at the reproductive stage, yields were twice as much (2.4 T) when an early plow was carried out (burning the savanna followed by one pass of light disk at the end of the

previous rainy season), in comparison to a late plow treatment (conventional land preparation before planting).

5) Rice yields in both a monoculture and associated with two different pastures mixtures were similar (1.8-2,5 t/ha) when grown in large plots (1 ha each with 3 replications). In the case of the associations there is the benefit of well established pastures mixtures established at rice harvest time, and ready to be grazed immediately.

6) An increase in rice spacing (34 or 51 cm between rows) and seed rate from 60 to 90 kg/ha does not translate into increased yields.

7) A. gayanus in association with rice (30 days after) and with fertilization for rice (80 N, 50 P, 100 K, 300 dolomitic Lime kg/ha) yielded more dry matter at rice harvest than A. gayanus grown alone with conventional pastures fertilization (20 P, 20 K, 200 dolomitic lime kg/ha). S. capitata was mixed with A. gayanus and in the association with rice its growth (dry matter) was reduced in comparison to the pastures alone, but the number of plants was not affected.

8) B. dictyoneura + C. acutifolium and A. gayanus + S. capitata were sown at different dates with rice. The first association had a good establishment only when sown simultaneously whereas the second established well when sown simultaneously or 30 days after sowing the rice crop.

9) Diverse methods and machinery for land preparation as well as types, quantities and placement of fertilizers should be investigated as an important alternative for weed management.

These early results are showing that productivity can be significantly increased in acid savanna soils. This higher level of productivity and the association with a highly productive pasture suggest that it can be made sustainable. To ensure that it is sustainable it is important that both the short and long term implications of these systems are known and understood.

CONSTRAINTS

One postdoctoral fellow, a technician, 2 field workers and after September a research assistant are the permanent team in charge of the project. Only one vehicle was available for all the work and for the use of the postdoctoral fellow. Personnel, transport as well as lack of communication from the savanna sites to Santa Rosa Station i.e. lack of a radiotelephone in the vehicles were the main control constraints to the project during this year.

Shortage of machinery at Santa Rosa Station available to the project was a constraint during this year and would increase if point (9) above is implemented as it should be.

RICE GERMPLASM EXCHANGE 1985-89

ACHIEVEMENTS

Federico Cuevas-Perez

1. A new germplasm exchange system was implemented. The new approach is based on the distribution of observational nurseries, defining different line subsets according to combination of tolerances to stresses defined by network members. Under this system, network trials enter the germplasm evaluation system of national programs from its onset, i.e. preliminary trials, thus facilitating their integration with national objectives and reducing their chances of becoming parallel trials. The voluntary nature of the network is reinforced by allowing network members to define the type of lines they want and can evaluate.

2. Breeders' workshops, a mechanism to improve interactions among breeders working with similar problems, were incorporated within the network. Four workshops were organized within the period, contributing to develop the feeling of membership to the network among breeders working in Tropical South America, Central America and Mexico and the Caribbean.

3. Discussion panels were organized within existing regional meetings, integrating the network with existing research efforts. The participation of rice researchers in meetings of the Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos Alimenticios (PCCMCA) and the Irrigated Rice Meeting of Southern Brazil was supported. The insertion of

activities of the germplasm exchange network within activities with a broader focus contributed to develop the feeling on the need for multidisciplinary approaches.

4. The Steering Committee for the network became structured and functional during the period. Representatives from the different rice growing zones of Latin America meet to discuss and approve network policies and workplans.

5. A method to estimate the value of germplasm evaluations done under "hot spots" to the rest of the region was developed. The method used long term network data, demonstrating the usefulness of collaborative evaluations. The location used by CIAT Rice Program for selection Santa Rosa Station, was found to predict very well disease reaction in Central America.

6. A survey to determine technical and organizational resources available for rice research in Latin America was conducted. The results suggested well staffed programs doing research on breeding and cultural practices. Subregional differences in personnel stability and relative importance of the two major research areas were observed. These data supported the Program efforts to better define research strategies for the future.

7. The grain appearance variables translucency and milling recovery were identified as the most important varietal traits region wide. The breeding behavior of translucency (white belly) was studied and the type of crosses and generation of selection for its improvement were identified.

8. A screening method for improved precision in milling evaluations was developed. A combination of the proportion of whole grains recovered after milling and the number of fissured grains after artificial moisture stress was used. The new method is expected to improve the predictability of milling evaluations conducted by network coordination.

CONSTRAINTS

1. The demonstration that the network is a collaborative effort between the international centers and national programs is not always easy. The utilization of the network solely as a means to distribute materials generated by international centers is no longer advisable given the strength of national breeding programs.

2. The need for timely distribution of information for a dynamic network is constrained by the limited resources devoted to produce printed materials for the center as a whole. Network personnel has to be assigned to fill this gap.

3. More formal scientific publications are also delayed by the slow review process. Information dissemination is not encouraged under the present structure.

4. The network coordinator is an IRRI employee. Having several bosses reduces the time available to do productive work.

RICE PATHOLOGY: ACHIEVEMENTS AND CONSTRAINTS

Fernando Correa

Research Achievements

Rice Hoja Blanca virus (RHBV)

1. Development of a massive field screening method to evaluate rice breeding lines for resistance to the hoja blanca virus (RHBV).

2. A careful technique for creating vector colonies and mass-rearing vectors to be used in the field screening methodology has been developed.

3. Identification of resistance sources to RHBV.

4. Incorporation of RHBV resistance into released commercial varieties.

5. Characterization of the resistance-susceptibility to RHBV in resistant donors.

- Plant age and virus dosage involved in resistance expression; no evidence for "races".

6. Isolation of the rice hoja blanca virus made possible the production of antiserum against the virus to be used in ELISA tests to detect virus in both infected plants and planthopper vectors (with VRU). Potential vectors, an important component of the vector population are also detected easily using the ELISA technique.

7. The vectoring ability in Sogatodes oryzicola was found to be under single recessive gene control with important epidemiological implications.

8. An integrated RHBV management is being developed together with the entomology section to be implemented in target countries.

GRAIN DISCOLORATION

1. Bacterial pathogens instead of only fungi (as often reported in the literature) were found to commonly cause grain discoloration and sheath rot of rice in Latin America.

2. Two fluorescent (Pseudomonas fuscovaginae, P. syringae pv. oryzicola) and two non-fluorescent (P. avenae, P. glumae) have been identified as the main bacterial causal agents of sheath and grain discoloration of rice. These species were shown to be seed transmitted and have a wide host range.

3. Characterization of the four species using a large number of bacteriological tests have identified them as the same pathogens reported in some Asian and European countries causing sheath rot and grain discoloration in rice.

4. P. fuscovaginae was shown to be widely distributed in Latin America and is probably the principal pathogen causing sheath rot and bacterial grain discoloration in the area. It was demonstrated that this pathogen moves with international germplasm seed.

5. A careful technique for the isolation, purification, inoculation and identification of bacterial pathogens associated with grain and sheath discoloration has been developed.

6. A rapid and simple selective culture medium to distinguish the four Pseudomonas species has been developed.

7. A heat treatment to eradicate pathogenic Pseudomonas spp. from contaminated seeds was found and is used as a regular treatment for all in coming and out going rice seeds at CIAT.

RICE BLAST

1. A field screening methodology for evaluation of rice lines for blast resistance has been developed and implemented in Santa Rosa, a "hot spot" screening site.

2. Studies on the pathogenic variation of Pyricularia oryzae, the blast pathogen, indicate that our breeding lines are being exposed to a great variability of the fungus in Santa Rosa, giving more reliable results on our selections for resistance.

3. Controlled inoculations in the greenhouse indicate that commercial varieties with broken resistance still show a great accumulation of resistance genes useful for breeding purposes.

4. Strategies based on gene rotation, or gene pyramiding to control rice blast seem to be feasible according to the pathogenicity studies.

5. More stable resistance to blast shown to be developed when selections are made through several generations in a "hot spot" screening site like Santa Rosa.

6. Lines with high levels of blast resistance shown to be more stable under blast epidemic areas than lines with lower levels of resistance.

7. Partial resistance (low level of disease severity) shown to be ineffective under high blast pressure.

8. Stability of resistance to blast is associated with small lesion type.

9. Cultural measures such as low seeding rates, low nitrogen fertilization and irrigation water management have great potential together with development of resistant varieties for the control of rice blast.

10. Chemical seed treatment retards onset of blast epidemics under favorable environment for blast development.

11. Integrated blast management concepts based on varietal resistance, cultural measures and chemical control developed are being merged with similar agronomic and entomological concepts.

CONSTRAINTS

1. Shortage of high level support staff (MSc level) which would substantially expand the amount and level of work that could be accomplished by the section.

2. Budgetary restrictions in overtime. Required for greenhouse and field care over weekends (birds etc.).

3. Insufficient labor support for field activities.

4. Very cramped laboratory space, given the diversity of projects that must be undertaken.

RICE ENTOMOLOGY/IPM: ACHIEVEMENTS AND CONSTRAINTS

Achievements

1. First approximation on IPM for Colombia;

2. Identification of new rice pests;

3. Refinement of sampling techniques and Action Thresholds (AT) for most important pests;

4. Integration of agronomic practices, (Nitrogen levels and water control) with insect management (Integrated Crop Management);

5. Characterization of rice resistance to S. oryzicola (RHBV vectors) feeding damage;

6. Development of a field technique to detect potential S. oryzicola vectors;

7. Base-line data on arthropods affecting rice in new areas (acid-soils);

8. Base line data on rice-pasture associations on savanna acid soils;

9. Initiated trials to develop action thresholds in other countries;

10. Establish rice pests collection.

Constraints

1. Transportation (Vehicles)
2. Lack of collaborators (Entomologists in National Programs
3. Lack of information on rice pests present on most countries

INTEGRATED CROP MANAGEMENT: ACHIEVEMENTS AND CONSTRAINTS

Albert Fischer

Achievements:

1. Established the basis for integrated crop and weed management work.

2. Strengthened the integration with other crop protection disciplines.

3. Developed an approach for the prediction of losses from red rice competition.

4. Characterized growth, morphology, and competitivity of different red rice accessions with respect to cultivated rice.

5. Established the resistance of Echinochloa colonum accessions, to propanil in farms repeatedly treated with this herbicide.

6. Conducted work on planting systems and on crop/insect response to nitrogen as part of the rice-pasture project on savanna acid soils.

7. Participated in the following projects of international collaboration;

   - Plan to improve the irrigated rice breeding program in Rio Grande do Sul, Brazil (1987).
   - National plan for the development of rice production in Chile, (1986, 1987).

- Collaboration plan between the Rice Research Institute of Cuba and CIAT.
- Plan to reduce red rice economic damage in Rio Grande do Sul, Brazil (1985).

Constraints:

Transportation for off-station work.

ECONOMICS SECTION CONTRIBUTIONS, 1987-89

L. R. Sanint

I. Production Studies.

A. Baseline data for Latin America by regions, countries and rice producing systems. Data on production, area and yields from 1960 onwards.

B. Brazil:

(i) Comparative advantages among the various rice systems in the country (upland, irrigated, varzeas; division among tenants and renters, large and small farmers). Ph.D. Thesis of a student at Vicosa, oriented by economist at Embrapa/CNPAF and the CIAT Rice Program economist. In progress. Deadline: Spring 1990.

(ii) Social Benefits and Costs of Rice Research in Brazil. Ph.D. Thesis, J. Ernstberger, with orientation of CIAT's Rice Program Economist.

(iii) Upland rice production in Brazil: characteristics. In: Teixeira, S.M. and L.R. Sanint: Arroz de Sequeiro. Agroanalysis, Vol. 12, No. 9, 1988. Also, by the same authors: Arroz em Minas Gerais: Situacao Atual e Implicacoes para a Pesquisa. Informe Agropecuario, Vol. 14 (161), 1989.

C. Colombia:

The First National Rice Census of Colombia, conducted by Fedearroz-ICA-CIAT in 1988.

In-depth characterization of rice technologies by regions, systems, tenure, size, etc. Survey of farmers on statistically significant sample from Census. Measurement of economic and agronomic inefficiencies through maximum likelihood production function estimators. In progress.

D. Costs of Production:

Analysis for several L.A. countries (Brazil, Ecuador, Venezuela, Colombia, Dominican Republic) for irrigated rice, 1988-89.

II. Consumption Studies

A. Cross sectional household budget analysis: food expenditures, caloric and protein intake of major food items and groups of foods. Brazil: ENDEF 1976 data, in J. Ernstberger thesis.

Colombia: DANE 1985 urban data Rice Economics. Comparisons with 1981 National Survey results. All food items. Consumption and expenditure shares by regions and income groups. Demand functions and elasticities.

B. Time Series Rice Demand Estimation. Econometric estimation of demand functions for rice in Brazil, Colombia, Ecuador, Paraguay, Peru and Venezuela. Trends in real and relative prices of rice with respect to major carbohydrates in the diets. Elasticities.

C. Market Integration: price formation and market signals among regions and vertical flows from producers to intermediaries to consumers in Colombia. In progress. M.S. student at CIAT from Wageningen (Netherlands).

D. Milling of rice in the Andean Group Countries. Collaboration in a Fedearroz study for JUNAC. 1988.

III. Collaborative Rice Research Projects:

A. Contributed with socio-economic component to these interinstitutional projects in: Colombia, Ecuador, Venezuela and Panama. Major aspects include diagnosis of rice sector, production constraints and setting up monitoring mechanisms among producers for analysis of technology diffusion and flow.

B. Diagnosis of the rice sector: a previous step from the collaborative program, where this might be difficult to accomplish for various reasons:

Brazil, in collaboration with CNPAF. In progress. Central America: the agricultural policy environment of the six countries. Constraints and limitations of rice production and consumption. 1987. The Caribbean: rice sector needs with emphasis on mechanization aspects in the Dominican Republic, Haiti, Guyana and Surinam, with CIAT/CRIN economist at the Dominican Republic.

THE CARIBBEAN RICE IMPROVEMENT NETWORK: ACHIEVEMENTS

Jorge L. Armenta Soto

1. Germplasm evaluation, selection, distribution, and germplasm workshop

A total of 2924 lines have been evaluated and 901 selected from nurseries of IRRI-CIAT (IRTP) and National Rice Programs. A total of 118 sets of observational nurseries have been distributed among CRIN member countries, according to priority constraints.

A Rice germplasm selection workshop was held in Dominican Republic (1989), 14 rice scientists from seven countries and the CIAT Rice Program attended, 743 lines were evaluated and 353 were selected.

2. Training

A total of 194 technicians have been trained; 30 during 1987, 47 and 117 during 1988 and 1989 respectively. A Cascade Training Pilot Project has been initiated to test methodologies for developing training skills. This has been introduced into three rice production technology courses and two workshops on training to trainers.

One hundred twelve technicians have been trained in both production technology and teaching skills. One trained technician has given a 40 hour course to 10 colleagues. Cascade course participants have themselves developed seven educational units on rice production which they will use as training tools for technicians and farmers.

Two trained technicians advised 24 farmers via demonstration plots and field days, and impacted with an average range of yield increase of 38.1 to 53.5%.

3. Technology transfer

This activity is aimed to validate updated technologies of National Rice Programs (NRP) and International Centers, for subsequent in-country adoption. These kind of activities were conducted in three sites of Dominican Republic (D.R.), results are as follows:

3.1 For a group of 10 farmers, with IRRI design PT-3 power tiller a complete land development (straight levees and land leveling) was accomplished, an average yield of 6418 kg/ha and a benefit-cost relationship of 1.83 was obtained.

3.2 For two independent farmers from North Central and Eastern Regions yield increases of 117% and 94% and benefit-cost relationships of 3.34 and 2.82 was respectively obtained.

4. Small Agricultural Machinery

A (PT-3) power tiller, a reaper (RE-2) and a thresher (TH4) was introduced from IRRI to D.R.

4.1 Evaluation. The efficiency of the PT-3 in a single plowing was of 1.0 ha/14.3 hours; leveling of one hectare was accomplished in eight hours. Cutting one hectare was done in 4.5 hours and threshing for 5000 kg required eight hours.

4.2 Development. A prototype power tiller was developed by CRIN, a single plowing of one hectare

required 16 hours; relevant adjustments have to be made for its improvement. A board leveler (for land leveling) was also designed and fabricated for the PT-3 and Yanmar Japanese power tillers.

5. Regional Conference

Thirteen rice scientists from six Caribbean countries participated in a monitoring visit to rice field of Trinidad and Guyana, in this country a technical meeting was held and six regional papers were discussed.

6. Documentation exchange

A total of 149 books on various aspects of rice research and production were distributed among CRIN member countries (an average of 19 per country). Page of contents service, Rice in the Caribbean Newsletters and the International Rice Research and Seed Health Newsletters from IRRI are being regularly distributed.

7. In-Country Activities

The most relevant activities up to date are; germplasm evaluation and documentation exchange, training in service and courses at CIAT, IRRI and mostly CRIN headquarters, validation technologies, assistance, evaluation and development on small agricultural machinery, surveys on seed industry, machinery needs, rice milling industry, regional conference and workshops on seed and training to trainers.

Constraints

1. Communications with the countries
2. Languages and dialects diversity

3. Little data feedback from germplasm trials by the National Rice Programs
4. In country political problems
5. Assorted priorities among member countries (Importers VS Exporters, Small VS Big size of farms)
6. Productivity expectations of CRIN staff
7. CIAT administrative support