Workshop on

The Development of Strategies to Improve Rice Production in Latin America, Cali, 1977

October 31 to November 3, 1977

0552

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL, CIAT

Workshop on

The Development of Strategies to Improve Rice Production in Latin America

October 31 to November 3, 1977

C O N T E N T S

1. Program ....

2. Foreword. Dr. Alexander Grobman ....

3. Introduction ....

4. I. Country Reports ....

5. II. Obstacles for the Increase of Rice Production in Latin America ....

6. III. National Capabilities ....

7. IV. Objectives and Strategies for the CIAT-based Rice Program ....

8. Appendix 1: Restraints to Regional Rice Production in Relation to CIAT Research Priorities, by P.R. Jennings ....

9. Appendix 2: Agronomic Aspects of Rice Production in Brazil, by Dennis Johnson ....

10. Appendix 3: Survey on Rice Production Technology Gaps in Latin America ....

11. Appendix 4: List of Participants ....

WORKSHOP ON THE DEVELOPMENT OF STRATEGIES TO IMPROVE RICE PRODUCTION IN LATIN AMERICA

P R O G R A M

October 31, Monday

08:00-08:30	Registration
08:30-08:45	Welcome - Dr. J.L. Nickel
08:45-09:00	Objectives of Workshop - A Grobman

1. EVALUATION OF THE RICE PRODUCTION AND THEIR CROP SYSTEMS IN THE REGION

09:00-09:30	Restraints to Regional Rice Production in Relation to CIAT Research Priorities - P.R. Jennings
09:30-09:45	Coffee Break

PRESENTATION OF REPORTS

Chairman: K.O. Rachie

09:45-10:35	Brazil - D. Johnson
10:35-10:50	Discussion
10:50-11:10	Colombia and Venezuela - M.J. Rosero
11:10-11:25	Discussion
11:25-11:45	Peru and Bolivia - J. Hernández
11:45-12:00	Discussion
12:00-12:20	Argentina and Paraguay - W. Jetter
12:20-12:35	Discussion
12:35-14:00	Lunch
14:00-14:20	Ecuador - L. Johnson
14:20-14:35	Discussion

14:35-14:55	Guyana and Surinam - H. Weeraratne
14:55-15:10	Discussion
15:10-15:25	Coffee Break
15:25-15:45	Central America - E. Espinosa
15:45-16:00	Discussion
16:00-16:20	Caribbean Countries - J.M. Cordero
16:20-16:35	Discussion
17:30	Cocktails

November 1, Tuesday

2. GENERAL DISCUSSION ON PROBLEMS AND RESEARCH LIMITING THE INCREASE OF RICE PRODUCTION IN THE REGION

Chairman: H. Kauffman

08:30-10:30

2.1 Problems of Irrigated Rice

a. Regional or Watershed Level

a.1 Water Supply

a.2 Water Management

Drainage and Irrigation Sche

b. Farming Practices

b.1 Water Management at Farm Le

b.2 Land Preparation

b.3 Planting Systems

b.4 Fertilization

b.5 Weed Control

c. Varieties

c.1 Breeding

c.2 Network Cooperation in Testi

c.3 Seed Production

	d. Phytosanitary Problems
	e. Socio-economic Problems
10:30-10:45	Coffee Break
10:45-12:30	2.2 Problems of Rainfed Rice
	a. Regional or Watershed Level
	a.1 Water Supply
	a.2 Water Management
	Drainage and Irrigation Scheme
	b.. Farming Practices
	b.1 Water Management at Farm Level
	b.2 Land Preparation
	b.3 Planting Systems
	b.4 Fertilization
	b.5 Weed Control
	c. Varieties
	c.1 Breeding
	c.2 Network Cooperation in Testing
	c.3 Seed Production
	c.4 Seed Distribution
	d. Phytosanitary Problems
	e. Socio-economic Problems
12:30-14:00	Lunch
14:00-16:00	2.3 Problems of Upland Rice
	a. Farming Practices
	a.1 Water Supply at Farm Level
	a.2 Land Propagation
	a.3 Planting Systems

a.4 Fertilization

a.5 Weed Control

b. Varieties

b.1 Breeding

b.2 Network Cooperation in Testing

b.3 Seed Production

b.4 Seed distribution

c. Phytosanitary Problems

d. Socio-economic Problems

November 2, Wednesday

3. DISCUSSION OF NATIONAL CAPABILITIES IN FURTHERING RICE RESEARCH AND DEVELOPMENT PROJECTS AND THEIR INTERRRELATION WITH THE CIAT RICE PROGRAM

Chairman: A. Grobman

08:30-12:30 3.1 Analysis of Institutional Limitations

a. Organization

b. Manpower

c. Policy

d. Budget

Coffee Break

3.2 Development Projects and their Type

3.3 Research and Network Project

Discussion

12:30-14:00 Lunch

14:00-17:00

4. DISCUSSION OF OBJECTIVES AND STRATEGIES FOR THE CIAT BASED RICE PROGRAM

November 3, Thursday

08:30-12:00 Field Visit CIAT/ICA

Rice Experiments

- M. Rosero
- L. Johnson
- G. Villegas
- H. Weeraratne
- C. Martínez

18:00 Cocktails and Dinner

FOREWORD

Rice is undoubtedly one of the most important staples in human nutrition in Latin America. No less than one third of the calories taken in daily, on the average come from rice, an essential ingredient of the diets of people in tropical Latin America. While average yields of rice have risen in the region as a whole at a rate of 2.5% per year, rates of population growth are higher. However, enormous land resources capable of sustaining rice production at least double the present level have been identified, especially in South America. At present South America is in a self-supply position switching periodically from a net exporting to a slight deficitary situation depending on the years. Mexico and the Caribbean area are in a chronic short supply situation that is deteriorating at a fast pace. Central America has experienced a great increase in production and is at present nearly self-sufficient in rice.

CIAT, in collaboration with ICA, has been active in rice research, with the backstopping of IRRI through basic germplasm, breeding material, and technical support. Since 1967, a series of introductions from IRRI first (IR-8 and IR-22), and of various produced by the CIAT/ICA program later (CICA-4, CICA-6, CICA-7, CICA-9, and line 4440), have rapidly expanded the rice area in Colombia, Venezuela, Ecuador, Paraguay, Cuba, and Central America and Mexico, resulting in dramatic increases in yields and total production in all those countries. Simultaneously, independent rice breeding achievements in Peru, Dominican Republic, Brazil, and Surinam, primarily, have produced similar results in those countries, and in the case of Peru and Surinam, in other countries as well through varietal exports to Cuba and Central America, respectively.

In May 1977, the CIAT's Board of Trustees approved a resolution requesting CIAT management to convene a rice workshop to be held at CIAT during 1977, with the purpose of assessing the present status of rice production in Latin America, research accomplishments, institutional capabilities and limitations, rice production development programs in the different countries, present limitations to rice production, opportunities for area and yield expansion of rice, and what would be the role of CIAT, as viewed by representatives of national rice programs in the context of their own research and development activities, to further research and training leading to higher levels of rice production in Latin America.

A workshop was thus organized under the title "DEVELOPMENT OF STRATEGIES TO IMPROVE RICE PRODUCTION IN LATIN AMERICA", and was held at CIAT from October 31 to November 3, 1977. In preparation for the meeting, and because of the large rice production and area devoted to rice in Brazil, as well as its future rice potential, a special study on the production of rice in Brazil was commissioned to Dr. Dennis Johnson, on the "AGRONOMIC ASPECTS OF RICE PRODUCTION IN BRAZIL". Dr, Peter Jennings of CIAT was also asked to prepare a background paper entitled "RESTRAINTS TO REGIONAL RICE PRODUCTION IN RELATION TO CIAT RESEARCH PRIORITIES". These articles are attached to this report as Appendices.

The present report summarizes information given by the participants, both verbally as well as in written reports requested from them in advance of the workshop. It also includes recommendations based on discussions and summarized by working groups, which were later presented to the entire group of participants for possible modifications and inclusion in the present text.

The editing of the present report, as well as its preparation in final form was ably done by Dr. Fernando Monge of CIAT.

Alexander Grobman

Associate Director General
(International Cooperation)
CIAT

CENTRO INTERNACIONAL DE AGRICULTURA TROPICAL, CIAT

Workshop on

The Development of Strategies to Improve Rice Production in Latin America

October 31 to November 3, 1977

INTRODUCTION

The main objective of this workshop was to get first hand information on the status of rice production in Latin America and of problems as perceived by the countries, which are obstacles to its improvement. On the basis of this information, the countries would make recommendations to CIAT to be analyzed by CIAT's administration and Board of Trustees in order to establish guidelines and policies for future work in this commodity.

The meeting was conducted in a deliberately informal manner. Two papers, one by Dr. Peter R. Jennings on the "Restraints to Regional Rice Production in Relation to CIAT Research Priorities", and one by Dr. Dennis Johnson on "Agronomic Aspects of Rice Production in Brazil", were the only formal presentations, while the rest of the meeting was conducted as round table discussions and thus, a mechanism to capture this information was deviced. For each session a rapporteur was appointed who took notes and summarized the discussion. At the end of the meeting, rapporteurs met for a working luncheon where the various reports were commented.

This final report combines the rapporteurs' partial report In addition, results of a survey conducted during the meeting c some basic statistics of rice production in each country represented, are also included as Appendix 3. It should be noted, however, that these statistics may be only approximate since th are not based on official documentation.

I. Country Reports

A. Ecuador

Rice production in Ecuador comes from some 21,000 small farms, averaging in size from 3 to 4 ha. There are two main planting seasons: the dry season from May to December and the rainy season from January to April. Various planting systems are used, but the most common is that of summer ponds made during the dry season (?4,000 ha) with yields averaging 3.6 t/l Some 80,000 ha are seeded during the rainy season, with yields reaching 2.5 t/ha.

Some 28,000 ha are planted to irrigated rice during the dr season, with yields of 3 t/ha. However, with modern varieties and adequate technology, a few outstanding farmers have obtain as much as 5 to 7 t/ha. There is a great potential for increa ing the area planted to irrigated rice, especially in the regio of Guayas (800,000 ha).

The areas where upland rice is grown have fertile soils an high rainfall. In the lowlands there are 47,000 ha planted to rice and in the high, sloping areas, 12,500 ha.

About 10 percent of the rice-growing areas of Ecuador is completely mechanized whereas 70 percent has only intermediate mechanization. In areas where summer ponds are done during the dry season, machinery is not used and no research is on this system being done. The use of chemical products, especially fungicides, is increasing; the same is true for applications of nitrogen fertilizer and the use of certified seed.

Farmers now know the improved varieties, and 47,000 ha are seeded with these while 20,543 ha are seeded with local varieties, especially in the areas where puddling during the dry season is used. Surinam varieties occupy 5,246 ha.

It has been observed that average yields have not improved in Ecuador since 1966, in spite of the fact that they could be as high as in Colombia.

There is a great potential for developing extensive areas for rice growing, and floating varieties could be very successful in flooded areas.

B. Guyana and Surinam

Rice production in these two countries is primarily export oriented. Approximately 90 and 60 percent of the total production in Surinam and Guyana, respectively, are exported to the European Common Market. About 45,000 families are engaged in rice production in Guyana, but only a few families do so in Surinam. In Guyana 45,200 and 67,800 ha are planted to rice under irrigated and semi-irrigated conditions, respectively, yielding an average of 3.1 and 2 t/ha, respectively. In Surinam only 30,000 ha are planted under irrigation, with average yields of 4 t/ha. In both countries, temperature and rainfall are high (2500-3000 mm).

Wet tillage and sowing pregerminated seeds under well-puddles conditions area practiced in 40 percent of the total area in Guyana. The remaining are is cultivated under dry land preparation and rainfed conditions.

Wet tillage is practiced in Surinam and pregerminated seed is seeded directly in well-puddled land.

In both countries, rice production is highly mechanized. Quality standards for export require a non-chalky, slender, extra-long grain.

Major production constraints are confined to Guyana, where helminthosporiosis and blast are the major diseases. Salinity is encountered in coastal regions and damage caused by Aluminum toxicity is frequent.

BG79, Stanbonnet and two locally developed varieties cover the entire cultivated area in Guyana. Early-maturing varieties are preferred.

Surinam has developed highly productive semi-dwarf varieties that represent a slight deviation from the common improved type and lack early vigor. Increased production is being pursued as national priorities in both countries, and they plan to double the present area cultivated to rice. Surinam bred varieties have been exported and are in use in Panama, Central America and Ecuador.

Lack of qualified and trained scientific staff, together with the added disadvantage of severely limited facilities impedes all aspects of rice research in Guyana. There are six people working on breeding, pests, diseases, soils, agronomy and quality testing. Two breeders and a chemist are engaged in rice research in Surinam.

CIAT participation is desirable in:

a. Breeding projects for the development of suitable upland varieties having drought tolerance

b. Breeding projects for the development of better yielding, nitrogen-responsive varieties combining resistance to blast and tolerance to hostile soil conditions

c. Investigations to determine the factor limiting nitrogen responsiveness to a maximum of 60 kg/ha.

Guyana welcomes segregating populations as well as advanced breedings lines.

C. Central America and Panama

Rice growing is very important in the six countries that make up this area, with small variations from one country to another. Per capita rice consumption is high in Panama and Costa Rica, average in Nicaragua and low in the rest of the countries.

In 1975 there were 288,000 ha planted to rice in this area, with low yields per unit area (2 t/ha), which range from 1.3 to 3.1 t/ha. Except for Nicaragua, where 60 percent of the cultivated area is irrigated, the countries depend entirely on

All the countries have certain problems in common such as weeds, insects, disease and soil problems; and because of this national research programs follow common objectives.

Farmers have readily accepted improved varieties, which are only good for three to four years when their disease resistance breaks down. The most common varieties are CICA 4, CICA 6, IR 22, CR 1113, IR 100d and some introductions from the United States such as Bluebonnet and Starbonnet and Surinam bred or locally adapted varieties of that origin as the Nilo series from El Salvador.

There is a good potential for developing new areas for rice cultivation. The potential area for irrigated rice is estimated at 200,000 ha, mostly in Guatemala, Honduras and Nicaragua. In Panama and Costa Rica about 50,000 ha could be planted to upland rice because there is high rainfall in these countries.

Collaborative technical work coordinated by the Programa Cooperativo Centroamericano de Cultivos Alimenticios (PCCMCA) has established the following general objectives:

1. To develop high-yielding varieties
2. To improve crop technology
3. To produce sufficient certified seed to meet the regional demands
4. To carry out extension work

Some improved varieties have been obtained in Central America among these are CR 1113, Tikal-2, X-10, and IR 100d, by government workers and Nilo 1 and 3 by private workers.

The rational use of agricultural inputs has increased, and efforts are being made to become self-sufficient in the production of certified seed for this area. The principal sources of germplasm are the rice breeding programs of ICA, CIAT, IRRI, and Surinam.

Some suggestions for CIAT are:

1. To supply segregating material in early generations
2. To improve varieties for favored upland conditions
3. To strengthen the training program
4. To provide technical assistance for the national programs when they require it and aid in the evaluation of local programs
5. To provide certain required equipment

D. Caribbean Region

It is impossible to make generalizations about this area because of the differences in political organization, language and customs. Nevertheless, rice consumption in this region is high.

Puerto Rico has some 3,000 ha under rice cultivation while Jamaica has cooperative projects with CIAT and grows 5,000 ha of rice. The main rice producers in this area are Cuba and the Dominican Republic.

In the Dominican Republic rice is the second most important crop in relation to area and production, and it is the principal crop consumed domestically.

The agronomic basis of the agrarian reform program is rice, and 50 percent of the rice-growing area is supervised by this program. Nevertheless, it is necessary to import 15 to 20 percent of the country's rice needs.

Almost all the rice is grown under irrigation (80,358 ha) and 90 percent is transplanted. Average yield is 3 t/ha. Improved varieties are grown on 25 percent of the area, yilding an average of 4.3 t/ha. However, the expansion of such varieties to other areas is hindered by problems of water and weeds, as well as certain policies. Within the short term, it will be possible to add 35,000 ha to the total rice-growing area when large and small dams are constructed. The rice program has developed varieties such as Juma 57 and 58, IR5 and IR6 through the selection of introductions and native material. Yet, because of a strong ratooning yield performance some older farmer rice selections are still widely grown, and their seed is grown and certified by the Ministry of Agriculture. Low national productivity is essentially due to agronomic problems, not varieties. For this reason, more emphasis is being placed on the training of technicians in rice production, irrigation methods and agronomic research.

Recommendations to CIAT:

1. To offer practical training in rice production
2. To conduct research on soil management, fertilization, weed control, land preparation and water management
3. To formulate plans for rice production and alternatives

The report on Cuba is based on a summary made by Cuban technicians.

The rice program in Cuba has been under way since 1957, when work began with introductions of genetic material from abroad. About 200,000 ha are under rice cultivation, yielding an average of 2.2 t/ha. This whole area is under irrigation and cultivation is mechanized. From 90 to 95 percent of the total cultivated area is under government control; the rest belongs to a few private farmers.

About ten years ago, Cuba imported IR 8, which was planted on 90 percent of the area under cultivation. Today CICA 4 and Nylamp are planted on 50 percent and Sinaloa on the ohter 50 percent.

The problem with Pyricularia has increased; and rather than depending on varietal resistance, they continue to apply insecticides to control Sogatodes.

The headquarters of the rice program is located near Havana and is staffed by highly trained technicians. Various varietal improvement programs are being carried out in order to find a source of resistance to Pyricularia and hoja blanca. By using certified seed, they have eradicated red rice. They also have a good extension service.

Their irrigation system (connecting channels) and drainage system are advanced. They can irrigate 200 ha/man/day. Direct seeding is used.

Although the government subsidizes rice production, they have to import rice to meet the domestic demand; and although they would like to become self-sufficient, they do not want to become exporters.

Low yields are due to agronomic problems and diseases such as Pyricularia. Well-leveled fields with good irrigation give better yields.

They would like CIAT's collaboration on the following aspects:

1. Sending of genetic material
2. Training in Colombia for young men presently studying agronomy in Persia and other countries

Mexico

In Mexico rice is the third most important crop after maize and wheat. Rice consumption is low (9 kg/person) but there are campaigns trying to increase its use to replace maize in the Mexican diet since there is a deficit of this crop.

Mexico is self-sufficient in rice production and even produces some reserves, which cannot be exported because of their high production costs. Three different planting systems are used: irrigated (25%), transplanted (10%) and upland (60%). In total, 250,000 ha are dedicated to rice growing in fifteen states; average national production is 2.9 t/ha. Yields fluctuate from one region to another.

There are various experimental centers conducting research on rice in different areas of the country, but only three of them have breeding programs. Their general objectives are high yields, resistance to Pyricularia, tolerance to alkalinity and drought, and plant types with intermediate growth habit and good-quality grain. There are some 14 technicians working in rice. Seeding of segregating materials are rotated in several parts of the country.

Emphasis has been placed on the efficient utilization of fertilizers.

Recommendation for CIAT:

1. To supply segregating material in early generations
2. To train technical and intermediate personnel
3. To develop varieties tolerant to drought

E. Brazil

Brazil is the sixth largest producer of rice in the world.

Between 1952 and 1956, Brazil tripled the area sown to rice, and at present they are self-sufficient. Basically, the rice-growing area is located in the southern and mideastern parts of the country; the principal system used is upland rice.

The principal objectives of rice cultivation in Brazil are: subsistence on small farms without mechanization and upland rice in intercropping systems.

Upland rice yields range from 1,000 to 1,500 kg/ha whereas irrigated rice yields are 3,500 kg.

The production increase was due to the increase in area sown to upland rice.

A common irrigation method is based on increasing the water level of rivers; this method is used on small farms where transplanting is done at the beginning of the rainy season.

In the Amazonian region, west of Belém, there is a large-scale project under way for irrigating rice by constructing channels; the operation will be mechanized.

Variety IR 22 is sown in 70 percent of the rice-growing areas and the Surinam type in the other 30 percent. Several crops can be produced during the year for a total yield of up to 10 t/ha/yr. The variety Apwra yields 4 t/ha but gives only one harvest per year.

In tropical Brazil there are regions that are suitable for cultivating irrigated rice, but the high cost of irrigation does not render it profitable.

The firms that are conducting research in Brazil are Comp. de Investigaciones Sao Paulo, Instituto de Rio Grande do Sul and the new National Rice Center.

Brazil's future potential increase in production lies in planting additional lands with rice.

Recommendations for CIAT;

1. To establish a breeding program for upland rice with assistance from CIAT and the Nationa Rice Center and to develop cultivars resistant to bl st
2. To determine whether droughts in the Central Plateau region make it unfeasible to increase rice production in this area
3. To conduct research on cultural practices for small farmers
4. To intensify the seed program

5. To carry out zoning, with the aid of CIAT
6. To determine areas suitable for irrigated rice, with assistance from CIAT and IRRI

F. Colombia

Rice is a major component of the Colombian diet and the second most important crop after coffee.

During the last fifteen years, Colombia has been totally self-sufficient. In 1961 it produced 308,000 tons of glazed rice for a population of 15,500,000 and a per capita consumption of 19.1 kg. In 1975 the consumption rate for a population of 24,000,000 was 29 kg per capita.

In Venezuela rice is a staple food; per capita consumption is 17 kg. During the last fifteen years, production has been unstable: in 1975 the country was self-sufficient whereas in 1976 it had to import.

Comparative Area and Production in Colombia

	Irrigated			Upland		
Year	Area	Production	kg/ha	Area	Production	kg/ha
1972	170,620 ha	882,760	5.2	103,200 ha	160,520 t	1.5
1977	246,100 ha	1,265,200	5.1	95,000 ha	152,000 t	1.6

Comparative Area and Production in Venezuela

Year	Area	Production	Mean
1971	112,626 ha	153,038 t	1.3 kg/ha
1977	179,213 ha	474,000 t	3.1 kg/ha

Area Distribution of Rice in Venezuela

	1974			1975	
	Area	Production	Kg/ha	Area	Production
Irrigated	32,960 ha	154,032 t	4.6	41,930	203,322
Rainfed	84,329 ha	142,032 t	1.68	71,618	159,006

Varieties: in Venezuela the area sown with IR 22 decreased between 1974 and 1975 and that with CICA 4 increased.

In 1976 Colombia reduced the area because of high production costs, low prices for paddy rice and unfavorable government policies applied to the surplus from the previous year. This reduction in production made it necessary to import 42,000 tons early in 1977. In 1977 Venezuela obtained a surplus rice production.

Colombia can increase the area planted to rice on the Atlantic Coast.

Venezuela has established a national plan to increase the food production area in order to stabilize production and improve the infrastructure.

Good financing is another system for increasing production.

Research in Colombia:

ICA, FEDEARROZ and CIAT have four research centers and 12 rice specialists. In Venezuela there are only two specialists in rice at the Fondo Nacional de Investigación Agropecuaria.

Recommendations for CIAT:

1. To continue collaboration with ICA with regard to research and multiplication of seed

2. To extend distribution of regional trials to upland areas
3. To cooperate with EONAIAP in training

G. Peru

Rice is considered to be a strategic crop in Peru. It occupies third place in area and fifth in the economy. After Brazil and Colombia, Peru is the third largest rice producer in Latin America.

The main rice-growing area is on the coast. Of a total of 134,000 ha, 107,000 are under irrigation.

The estimated production of 134,000 ha is 655,000 tons of paddy rice; per capita consumption is 35.5 kg/yr in 1977.

Trade is a State monopoly and prices are predetermined.

Average yields are 5,000 kg/ha; but the Camana Valley, with 4,100 ha, produces yields of 8,170 kg/ha whereas only 1,600 to 1,800 kg/ha of upland rice are obtained in the jungle.

In the northern part of the jungle, there are 17,000 ha that yield 5,000 kg/ha.

By 1982 a total of 680,000 tons of paddy rice are required for a per capita consumption of 35.5 kg, which means that production based on the present area would have to increase 100 kg/ha since cultivation cannot be expanded in the coastal area.

There is a great potential for upland rice production in the jungle area of Peru, where future area expansion is predicted.

In 1942 introductions of rice varieties from Burma into Peru, accounted for what FAO considered the first large rice yield increase in the world. During the 40's and 50's, Peru had the second largest yield and relative rice production increase in the world. This was also a consequence of improvement in fertilizer use, populations and water management.

By the early 70's new high-yielding rice varieties derived from selections made in Peru of crosses sent from IRRI took over and allowed considerable yield expansion. Varieties that dominate areas at present in Peru are Naylap, also one of the leading varieties in Cuba, and Inti.

H. Bolivia

There is a total of 160,000 ha planted to rice in the entire country, mainly in the state of Santa Cruz.

In 1975-76 there was a surplus of rice; however, it was difficult to export because the grain was medium sized. For this reason long-grain varieties were introduced from Colombia and Argentina.

Yields in Santa Cruz and Cochabamba are 1.8 kg/ha. The planting systems used are flooding after slashing, with two to three years per zone per crop. Large-scale farmers have mechanization with upland rice.

The main problems are weeds, followed by pests, diseases and drought.

The Centro de Acopio of EMA is located in Buena Vista.

I. Argentina

In 1976-77 the area planted to rice was 105,000 ha, representing a 10 percent increase in comparison to the previous

The rice-growing area is located between 25 to 32° longitude and 55 to 60° latitude.

A total of 250,000 tons of paddy rice per year are consumed; per capita consumption for 25,000,000 inhabitants is 10 kg of paddy rice. Production is 370,000 tons.

The most important varieties are Fortuna (45% for domestic consumption) and Bluebonnet-50 (45%); the rest are medium-length grain varieties. There is a surplus of production, but the internationally accepted quality is Bluebonnet-50.

As of August 30, 1977, they had exported 130,000 tons of whole-grain rice.

An increase of 135,000 ha, planted to Bluebonnet-50 for exportation, is expected, without government aid. Fortuna is preferred for national consumption.

CICA 4 was distributed but was unsuccessful because of the grain quality. CICA 9 is a good variety although its quality is not ideal. IR8-41 is promising because it yields more than Bluebonnet-50 under adverse conditions. Le Bonnet could be used in Entreríos because it is early maturing as compared to Bluebonnet-50.

All operations are commercial, mechanized and irrigated; there is no upland rice and fertilizers are not used.

The only machinery lacking is land levelers, and there are no drying or storing capabilities.

Problems in Argentina are red rice because it affects export quality, water weevils and physiological disorders (straighthead).

J. Paraguay

The area planted to irrigated rice is 21,000 ha and 15,000 ha to unfavored upland rice. Varieties are similar to those planted in Argentina. By 1980, there will be an estimated 30,000 ha planted to irrigated rice. Most of the production is destined for national consumption; only a small part of Bluebonnet-50 is exported. The area sown to Furtuna has remained the same while that of Bluebonnet-50 has increased.

The upland rice area in Paraguay increased drastically in 1976-77 through the planting in northeastern Paraguay of over 10,000 ha by Brazilian colonists, using their own seed and technology. Thus, in only one year, an unplanned increase of 50% in area planted to rice took place. Upland rice sells at lower prices at the mills, but has a lower cost of production as well.

II. OBSTACLES FOR THE INCREASE OF RICE PRODUCTION IN LATIN AMERICA

A. Problems of Irrigated Rice

- Water Supply and Management

1. In Latin America, there is adequate water (or an excess of it) during the rainy season. More often the problem is water control during the rainy season whereas during the dry season addition of water becomes necessary a saturated root zone and for weed control purposes.
2. Rivers and lakes in Latin America have an abundance of water. A problem, however, is little communication be-

tween personnel at Ministries of Agriculture and those in hydraulics departments.

3. Most Latin American countries have infrastructural problems, such as, deficient legislation on the use of water, irrigation districts, etc. which result in inequities in the distribution of water for various crops, and in higher overall costs for water.

4. Specific suggestions for research:

   - To carry out a joint CIAT-national programs study on water consumption in rice, as well as on the use of residual water for crops complementary to rice.
   - To carry out with national governments a comparative study on production costs.
   - To establish pilot experiments in order to lower the cost of water. CIAT could be the leader on this type of activity.

5. Conclusion:

   a. CIAT should carry out research on water management
   b. It should focus on lowland tropical floodplains
   c. Training on water management is a generalized need
   d. CIAT and IRRI should become more active in water control, public policy, design, and investment activities by widening the professional disciplines and agencies participating in conferences, short courses, research, and training. The agricultural biological research would then be better related with the infrastructure development and operation.

- - -

- Farming Practices

1. Planting Systems

Discussion centered around direct seeding versus transplanting. Transplanting has the advantage of controlling red rice. However, one of its major drawbacks is the cost of labor. Thus, there is a general trend towards direct seeding in most of the countries. As an example, in Brazil, transplanting has gone down practically to zero, and in Mexico, although it is recognized that transplanting is more expensive (about 50% higher) there are still about 20,000 ha transplanted. Direct seeding is rapidly advancing, however, because similar yields (6 t/ha) are obtained with both methods.

2. Weed Control

Direct seeding requires more weed control. Appropriate land preparation, levelling and good water management, facilitate weed control. Besides, herbicides can be used.

The major problem, however, is red rice. Transplanting is the only method for complete control of red rice. However, it was pointed out that, in Cuba, red rice was eliminated by a combination of clean seed, puddling, and applications of Gramoxone before flooding.

3. Fertilization

Because of the variable nature of soils and water supply in rice fields in Latin America, and the high demand of N of the rice crop, agronomists should work appropriate fertilization schemes for rice under various conditions. Special attention should be devoted to P fertilization for rice in acid soils. Varieties capable of high yields under conditions of acid soils, low N uptake should be developed.

In addition to N, Zn and S are very important, sometimes even more important than P. Ammonium sulphate, rather than urea, can be used to correct S deficiencies, but acidity of the soil will increase.

In the utilization of N, there is an interaction with solar radiation and temperature. This aspect should be studied by CIAT.

4. Recommendations to CIAT:

Planting Systems

1. To disseminate CIAT-developed technology for seed production and controlling red rice with the use of transplants
2. To control red rice in direct seeding, research should be done on a combination of factors:
   a. Flooding
   b. Wet tilling
   c. Use of chemical products
   d. Use of antidotes
   e. Leveling
   f. Varieties - with intermediate growth habits
   g. Use of pure seed
   h. Hand weeding

period of rice growth. Occasionally puddling is essential to increase water-holding capacity.

Favorable Dryland: Areas which are growing dry-land rice on unbunded fields that are flat or gently sloping with annual rainfall of 1,500 mm or more with at least 250 mm of monthly average rainfall in each of the growing months and rainless days during reproductive and ripening stages not exceeding 10 days. In those areas, water-holding capacity of soil is good to excellent with no severe soil fertility problems that cannot be corrected by fertilizer application.

Unfavorable Dryland: Dryland rice grown on unbunded field with varying slopes and with annual rainfall of less than 1,500 mm and monthly average rainfall of less than 250 mm in each of the growing months and rainless days during reproductive and ripening stages exceeding 10 days. In thos areas, water-holding capacity of soil is poor to very poor with varying degreees of soil problems (some soils can be amended with fertilizers and others cannot be amended by fertilizers such as highly acid soils with high aluminum saturation).

3. As to the promise rainfed rice may have for Latin America, it was stated by Dr. Jennings that upland rice per se involves high risks. However, risk may be reduced by bunding to retain rain water or flooding, in which case this rainfed system may hold promise. This would be a move fro strictly upland to rainfed rice.

4. The case of Brazil is a particular one in that a "veranico" (15 to 25 days of drought) takes place at the time of flowering, thus lowering production up to 70%. This happens in about four million hectares.

5. The potential for irrigation in Brazil is up to 20 million hectares. The problem, however, is that these regions are located very far from urban centers, thus increasing the cost of transportation. This, in fact, is only a possibility for a distant future.

6. In central Panama, precipitation is definitely low. In Ecuador, 24,000 ha are cultivated in ponds and this system is likely to expand. In Colombia, it would be feasible to go from upland to rainfed in the Atlantic Coast region, whereas in the Eastern Plains (Llanos Orientales) a system of bunding could be used provided Al-resistant varieties are developed.

7. Varieties. It is already known that converting to rainfed from upland increases yields. The strategy would be to start with level lands first. But what additional requirements are needed for varieties to be adapted to rainfed conditions?

   The varieties developed by CIAT/ICA are well adapted to rainfed conditions. In Central America, they have been widely adopted. Nevertheless, blast severity increases. In addition, the newer varieties developed by CIAT/ICA are deliberately taller which makes them more competitive with weeds.

CIAT/ICA varieties, however, would not be appropriate for acid soils. If Al- and Fe- resistant varieties are to be developed, this work should be done on acid soils under upland conditions. In some countries, such as Thailand, there are already some materials tolerant to acid conditions, so that transferring these characteristics to improved varieties should not be too difficult.

It was pointed out that photoperiod sensitivity would also be an important characteristic to consider in breeding this type of materials. Finally, it was recognized that CIAT has capabilities to carry out this work.

B. Upland Rice

1. Initially, the economic aspects of upland rice were discussed. Upland rice is more economical to produce than irrigated rice in countries such as Brazil and Paraguay, and probably in others as well, due mainly to the high cost of fuels used for pumping water.
2. Soil fertility aspects should be considered, especially, in the case of unfavored upland rice. Actually, the two basic factors for analyzing upland rice are 1) water availability and 2) soil fertility.
3. Socio-economic aspects as related particularly to colonization programs are also of primary importance. As an example, in 22 years the population of Peru will be around 33 million which will force the use of dry lands for rice production. The population of Latin America as a whole will double in 20 years.

4. Throughout the discussions, the importance of upland rice in countries such as Brazil, Mexico, Panama, Bolivia, Peru, Paraguay, Guatemala, Ecuador, has been established. It was, therefore, suggested that CIAT helped national programs in defining potential areas for upland rice production.

5. As a summary of what CIAT can do in relation to upland rice, it was restated that it is likely that CIAT's future contribution would do little for unfavored upland, whereas CIAT could add significant contributions to favored upland rice conditions.

6. Seed Production

Seed production seems to be a problem for all Latin American countries. All of them, however, have some sort of a seed production program with the exception of Bolivia that requested help from CIAT to establish such a program.

7. Plant Protection Problems

The most important diseases as expressed by the participants, were: *Pyricularia*, *Helminthosporium* and *Rhynchosporium*. In all countries, various chemicals are being used for controlling these diseases.

It was pointed out by Dr. Ou, that efforts are being made to obtain resistant varieties even when fertilized with high doses of N. For *Pyricularia* control, good management of the crop is essential in addition to the use of chemicals.

In relation to Rhynchosporium, a new method is being developed at IRRI through artificial inoculation. It appears that the cutting method used to inoculate bacteria may be used for Rhynchosporium.

Bolivia apparently does not have serious disease problems in rice, whereas in Argentina, Helminthosporium attacks are quite severe.

8. Planting Systems

The general opinion was that direct seeding is more advantageous because of the high cost and dependency of labor availability. Transplanting should be used for seed production programs only, mainly to avoid the red rice problem.

9. Fertilization

The main problem stated was that of increasing the efficiency of N utilization. Studies were suggested to determine appropriate quantities, times, and forms of application. Problems with some micronutrients, especially S, Zn, and Fe, were also mentioned as being important in several countries.

10. Weed Control

This was cited as one of the most important problems in rice cultivation. Whereas for irrigated rice, land preparation, water management, transplanting, use of pre-germinated seed are important practices that help control weeds, for upland rice, the development of taller varieties with fast initial growth to dominate weeds appears to

11. As a socio-economic problem, it was pointed out that in Bolivia 20 - 30 thousand families migrated from the highly populated Altiplano to enter rice cultivation. These migrants clear the forest and alter hydrological conditions. A similar situation was mentioned in relation to Panama.

12. Concern was expressed as to the present existence and future possibility of rice production in Latin America. Thus, it was suggested that CIAT and National Rice Programs take some action in trying to stimulate consumption to avoid drastic price drops and the subsequent discouragement of the producer.

13. New uses of rice may be investigated and diffused. In Mexico, for example, bakeries are using mixed flour containing 75% wheat flour, 20% rice flour, and 5% soybean flour, apparently with excellent results.

III. NATIONAL CAPABILITIES

A. Analysis of Institutional Limitations

Argentina

1. Institution: The Instituto Nacional de Tecnología Agropecuaria (INTA) is in charge of all agricultural research including rice.

2. Experiment Stations: The experiment station at Corrientes is the most concerned with rice.

3. Technical Personnel: 2 agronomists for varietal improvement and cultural practices; 1 entomologist and 1 economist (30% time in rice).

4. Budget: Derived from a 2 percent tax on exports.
5. Extension: System of extension agencies with regional agronomists. In addition, CREA groups operate by taking successful farmers to visit with groups of 8 - 10 fellow farmers and exchange experiences with the help of an agronomist.
6. Activities: Varietal improvement, production, seed multiplication and distribution, direct contact with farmers, conferences.
7. Expectations from CIAT: 1) Training; 2) Some laboratory equipment and machinery; 3) Improvement in seed production and quality.

Colombia

1. Institution: Instituto Colombiano Agropecuario (ICA); CIAT; and Federación de Arroceros (FEDEARROZ).
2. Experiment Stations: Most concerned with rice are, Palmira, Montería; Nataima, Villavicencio, Bucaramanga.
3. Technical Personnel: ICA operates on an interdisciplinary goup basis; thus, about 28 technical personnel are directly or indirectly involved in rice. Of these, 12 are full time in rice; 14 are part-time. Two scientists are at Ph.D. level, 12 have an M.S. degree, and 14 Ing. Agr. (B.S. level).
4. Budget: ICA has Col.$ 4.4 million, and FEDEARROZ has Col.$ 3.0 million, for a total of Col.$ 7.5 million (approx. US $ 200,000.00).
5. Extension: In addition to some extension activities carried

jointly with ICA and some training activities. At present, some 500 agronomists have been trained.

6. Activities: 1) Production of varieties resistant to Piricularia and hoja blanca; 2) Research on acid, infertile soils of the Eastern Plains (Llanos Orientales); 3) Seed production, plant pathology, entomology. No research is being done on upland rice. Activities are limited to testing materials.

7. Expectations from CIAT: To strengthen even more the collaborative work ICA-CIAT-FEDEARROZ.

Mexico

1. Institution: Instituto Nacional de Investigaciones Agropecuarias (INIA). The Rice Program is part of the Cereals Unit which deals with wheat, barley and oats, in addition to rice. The program is organized into 12 regions with a head of each regional program. There is a head of the entire unit and a coordinator of the National Rice Program.

2. Experiment Stations: The 12 regional programs are located as follows: 2 in the N.W.; 2 in the Central region; 1 in Tamaulipas; and 7 in the S.E. In the NW, rice is direct-seeded with irrigation; in the Central regions, it is planted for the SE.

3. Technical Personnel: 15 proffesionals -- 12 Ing. Agr. and 2 M.S. one of whom is pursuing a Ph.D. degree in the Phillipines.

4. Budget: Total budget for rice is Mex. $ 6.0 million (5 million from INIA plus 1 million from the Colegio Superior de Agricultura de Tabasco), approx. US $ 333,000.oo. Sixty percent of this budget is devoted to upland rice.
5. Extension: No specific information.
6. Activities: The following varieties have been developed: 3 varieties for irrigation and transplanting, 7 varieties for irrigation and direct seeding, and 2 varieties for uplandcultivation.
7. Expectations from CIAT: The main concern is training. Two persons have already been trained by CIAT; next year they want to send four.

Peru

1. Institution: Programa Nacional de Investigaciones en Arroz, Centro Regional de Investigación Agropecuaria (CRIA-II), Vista Florida, Lambayeque.
2. Experiment Stations: For regional centers -- 3 for irrigated rice, and one for upland (Chiclayo, Chira, Tulumayo and Tingo María).
3. Technical Personnel: 16 scientists with university degrees.
4. Budget: Information not available.
5. Extension: 34 extension agents, 5 regional specialists, 2 national specialists, 6 professionals to study production costs and prices. Total: 47 professional staff plus 123 intermediate level technicians.

6. <u>Activities</u>: Production of foundation seed and certified seed by EPSA (seed production agency). Outstanding results have been obtained with 4 new cultivars, Maylamp, Chancay, and Inti. Promissing varieties are SRI Malasia 1 and PNA 46-25-1-3-1. Working towards developing varieties that would have high oil content in the rice bran.
7. <u>Expectations from CIAT</u>: Production training, and joint research projects.

<u>Ecuador</u>

1. <u>Institution</u>: Instituto Nacional de Investigaciones Agropecuarias (INIAP) runs all agricultural research including rice.
2. <u>Experiment Stations</u>: Most concenred with rice is the Boliche Exp. Station.
3. <u>Technical Personnel</u>: Breeding: 1 MS, 3 Ing. Agr., 2 trainees, 1 technician. Seed Production: 1 Ing. Agr., 1 trainee, 1 technician. Entomology: 1 Ph.D., 1 Ing. Agr., 1 trainee, 1 technician. Weed Control: 1 Ing.Agr., 1 trainee. Soils: 1 MS, 1 Ing. Agr., 1 trainee, 1 technician. Economics: 1 MS, 1 trainee. Total exclusively in rice: 1 Ph.D., 3 MS, 7 Ing. Agr., 7 trainees, 4 technicians.
4. <u>Budget</u>: One million sucres/year (approx. US $ 4000,000.00/yr).
5. <u>Extension</u>: Programa Nacional de Arroz y Control de Piladoras is in charge of extension (fomento) activities. There are 8 agencies with a total of 12 Ing. Agr., 1 chemist, 1 industrial engineer, and 1 economist.

6. Activities: 52 percent of the area is planted with improved varieties from INIAP. They consider they have appropriate technology for irrigated rice, but need more work on upland and pond cultivation technology. Seed multiplication of INIAP varieties is done by a specialized, semi-private agency.
7. Expectations from CIAT: Their main source for training has been CIAT and CIAT-assisted in-country training at INIAP. They would like CIAT to train 10 persons per year for all their personnel needs.

Panama

1. Institution: Instituto de Investigaciones Agropecuarias (IDIAP).
2. Experiment Stations: Three regions: Chiriquí, Azuero, and Panama. There is a plant pest and disease laboratory.
3. Technical Personnel: 1 Entomologist, 1 phytopathologist, 1 breeder, 3 Ing. Agr. for weed control and fertilization.
4. Budget: No specific budget allocated to rice.
5. Extension: No specific information.
6. Activities: Weed control and fertilization of upland rice, varietal development and seed production. They have released Line-9 which is resistant to Piricularia and lodging, and Line-15. They need about 150,000 cwt. of seed per year. They have had severe budget limitations for rice research.
7. Expectations from CIAT: CIMMYT has trained some personnel

for Panama in the past. CIAT trained one person in rice, and they expect more. All heads of division should be trained by CIAT. They also hope for 3-6 week in-country courses on rice production for larger groups.

Dominican Republic

1. Institution:
2. Experiment Stations: Juma Experiment Station devoted to rice.
3. Technical Personnel: 8 Ing. Agr., 11 technicians, 3 Chinese consultants and one CIAT consultant.
4. Budget: Information not available.
5. Extension: 57 technicians (agrónomos) in rice plus 62 technicians (agrónomos) in agrarian reform. One hundred additional technicians to be trained.
6. Activities: Varietal improvement and training. Courses of 10 weeks duration are given, 80% of the time being practical work. Their goal is to increase production 40% in 4 years. They have collaboration from the Universidad Católica de Santiago mainly for economic studies. Successful varieties released are Juma 57 (IR8 x Nilox 1) and Juma 58 (IR8 x Toño Brea 91). Record production: 11 t/ha. On seed production they need 50,000 cwt. per year.
7. Expectations from CIAT: Continued assistance in training.

Guatemala

1. Institution: ICTA
2. Experimental Stations: One in the Atlantic Coast and another one on the Pacific.
3. Technical Personnel: 4 Ing. Agr. and 8 technicians.
4. Budget: US $ 100,000.00. Rice program is small because rice is a minor crop in Guatemala.
5. Extension: No specific information.
6. Activities: 1) Try to organize a rice growers federation; 2) Training; 3) Irrigation work. Seed production program is just starting. Seed imported in 1977 included Bluebonnet-50, CICA-4 and CICA-6.
7. Expectations from CIAT: Technical support being obtained from ICA/CIAT, IRRI and PCCMCA.

Bolivia

1. Institution: Instituto Boliviano de Tecnología Agropecuaria (IBTA).
2. Experiment Stations:
3. Technical Personnel: 1 MS, 1 trainee.
4. Budget: US $ 50,000.00.
5. Extension: 7 technicians.
6. Activities: Rice research is minimal. Their policy states rice as a priority crop to be developed. They wish to stabilize upland rice production. They are working on a feasibility project to irrigate 180,000 ha of which 60,000

would be dedicated to rice. Thirty technicians have been trained. Three in-country courses have been given by CIAT. No seed production program exists. Basic seed has been distributed on a limited basis. One technician for seed production is being trained. As far as varieties, Bluebonnet-50 is used, CICA-4 and CICA-6 are recommended, and other varieties of IRRI and CIAT are being tested.

7. Expectations from CIAT: 1. To elaborate a rice production plan with the help of CIAT: 2. A zoning plan to establish areas best suited.

Honduras

1. Institution: Ministry of Agriculture.
2. Experiment Stations: Guaibas, site of Rice Program.
3. Technical Personnel: No reliable data available. Fifteen scientists under training will be coming back with MS degrees and one with Ph.D.
4. Budget: No specific budget for rice. Total research budget US $ 600,000.00.
5. Extension: Information not available.
6. Activities: Breeding and cultural practices. Trying to establish an Agricultural Research Institute. Seed most generally used is Bluebonnet, CICA-4 and 6. Under testing are CICA-9, line 4440, 2 lines from IRRI and one from the US (early, 90-95 days).
7. Expectations from CIAT: Training in production and in breeding.

Brazil

1. Institution: EMBRAPA

2. Experiment Stations: National Centers, State Centers and Institutes, Research Units, Universities. Main station for rice is Goiania.

3. Technical Personnel: 21 scientists -- 4 Ing. Agr., 14 MS, 3 Ph.D. In addition, 3 MS, and 2 Ph.D. are being trained. Next year, it is planned to have 32 scientists in Goiania.

4. Budget: Total for rice US $ 2 million (1.2 million at Rice Center and 0.8 million in other regions) without including administration.

5. Extension: Through Brazilian extension system, EMBRATER.

6. Activities: Production of basic seed has US$ 25 million. 14% of Brazilian arable land is devoted to rice. They have 2.5 million persons employed one way or another in the rice industry. Consumption is 45 kg/person/year with a total of 7 million metric tons consumed annually.

7. Expectations from CIAT: 1. Training: 20 persons have been trained by CIAT in rice and 12 more in extension; they need this activity be continued and expanded. 2. They need help from CIAT in defining a philosophy of rice production and research -- where to place emphasis. 3. They request advanced segregating material for their breeding program, suited to four different regions of Brazil.

Venezuela

1. Institution: FONAIAP and CIAR (Centro de Investigación

Agropecuaria Centro Occidental, located at Calabozo).

2. <u>Experiment Stations</u>: In two main locations for rice, Calabozo and Araure.

3. <u>Technical Personnel</u>: 2 Ing. Agr. -- one in breeding and one in agronomy, and 1 Ing. Agr. in seed certification. Exodus to private enterprise.

4. <u>Budget</u>: Poses no problem.

5. <u>Extension</u>: Ministerio de Agricultura y Cría (MAC) is in charge. Research and Extension are separate.

6. <u>Activities</u>: 19,000 tons of certified seed per year. Materials from CIAT, IRRI and Mexico mainly. Work on soil fertility, planting rates, weed control, use of chemicals. Field days and workshops. Control of rodents and birds needs more attention. Irrigated rice yields are much higher than those for upland; thus, little emphasis is placed on the latter.

B. <u>Development Projects</u>

Mr. Manuel González del Valle, agricultural officer of the Inter-American Development Bank, Bogotá office, gave a brief explanation on the Bank's policies for considering projects to be financed. These must be viable projects backed by a policy decision on the part of the country whereby the project is considered of high priority.

Mexico

Mexico is in the process of transferring rice production from the irrigation districts in the dry regions of the North West, and will concentrate on development projects for rice in the South West -- Chiapas, for example. Six million hectares for rice may be developed in the more humid regions of Mexico under upland conditions.

Panama

Little is being planned for the immediate future. Opening of the Darien area may create new opportunities for rice production.

Brazil

150,000 hectares of new land in the Rio Sao Francisco basin are being devoted to irrigated rice. By 1980, they expect to develop 3 million hectares of rice between upland and irrigated, in total. The Amazonian highway will open much land for resettlement. Rice is the first crop planted by settlers, followed by other cash crops, rice itself, under upland conditions, and pasture. An untold number of rice hectares may be planted under these conditions.

Venezuela

Venezuela is developing one million hectares, for the cattle industry with rice being part of it. The Orinoco delta project covers 300,000 ha which also includes rice land. There is also a project for drying and storage facilities for rice with a capacity of 200,000 metric tons, nearing completion at 14 locations in the country. At present Venezuela is self-sufficient in rice production.

Bolivia

Project Rositas will develop 180,000 ha with 160,000 ha being for rice. Also, colonization projects are opening up new land.

Ecuador

Water control and irrigation projects are being carried out in the Guayas River basin covering approximately 30,000 ha -- Babahoro (7,000 ha), Daule (4,000 ha), Milagro (7,000 ha), other sites (12,000 ha).

Colombia

Colombia is mostly making use of facilities presently available. The Atlantic Coast, however, has vast possibilities for expansion of irrigated rice, as does the Amazonian basin area.

IV. OBJECTIVES AND STRATEGIES FOR THE CIAT-BASED RICE PROGRAM

1. Various representatives made suggestions on the role of CIAT:

CIAT should concentrate on broadly-based problems and leave local problems to NP.

Stressed need for:

- Training
- Breeding material for irrigated rice
- More basic research (e.g. on sterility in F2 in certain cross) which national programs are not equipped to undertake
- Enter into upland rice research
- Play useful role in organizing workshops at CIAT whic result in an interchange between members of national programs (a catalytic or "brokerage" function).

2. The problem of upland rice research was the focus of much discussion. It was agreed that CIAT should become involve in research on upland rice but a carefully chosen ecologic limit to the research was necessary to avoid those unfavorable upland areas where the prospect of any significant improvement is limited.

3. There is a clear need for a more universally accepted and better understood classification of rice production system and areas. Much confusion arose because of different interpretations. CIAT could help in this, especially, as this information is critical to planning its strategies.

4. The following characteristics are considered important:

   1. Total rainfall per year.
   2. Rainfall per month during growing cycle

3. Frequency and length of drought stress periods
4. Water holding capacity of soil
5. Slope of land
6. Degree of toxicity and soil fertility problems

There was a consensus that CIAT should not focus on those areas which did not satisfy the minimum requirements with respect to those criteria.

5. In terms of research strategy there are two principal problems:
   - Blast disease
   - Drought tolerance

Acid soils were mentioned as important in many areas.

The Palmira site is not adequate for screening for these and if CIAT is to effectively examine favored upland rice production, additional site(s) will be needed.

6. If CIAT does start to address the upland problems, the basic varietal research must continue. As new diseases emerge and new strains of existing diseases arise, CIAT must have the material and breeding capability to respond.
7. Considerable interest was expressed by NP in receiving early segregating material from IRRI/CIAT (F2-3) so that selection can be done in areas where there is drought stress and blast problems.
8. Blast was regarded as a universal problem and continued efforts to find horizontal resistance are needed. A sustained effort by CIAT with selection of early segregating

lines in Np was indicated. But in some cases NP do not have the capacity to screen large numbers of early segregants. In this case CIAT should do more of the early screening.

9. All participants expressed concern with water control especially related to the overhead investments, but it was not clear what role CIAT could paly in this area.

10. The session concluded with a discussion of the basic data the representatives had submitted. The inconsistencies and definitional problems reflected a basic need for a more careful evaluation of actual and potential areas of the different rice production systems.

11. A synopsis of the session in relation to CIAT's role:

    1. Training must be extensive to provide rice production systems
    2. Conferences and workshops at CIAT help in the interchange of ideas
    3. Breeding and agronomic work must continue
    4. CIAT should expand its capacity to include favorable upland rice areas addressing tow specific problems
        a. Tolerance to short periods of drought stress
        b. Blast
    5. Another site(s) will be needed for this
    6. A basic lack of information impedes selection of research strategies, and this should be rectified.

12. <u>Socio-Economic Issues Raised during the Plenary Session</u>

12.1 Throughout the session the lack of <u>baseline data</u> was evident. This is an important barrier to selecting research strategies. For each country some attempt should be made to assemble,

a. The present areas of rice production under each of the systems

b. The potential areas

c. The number of producers

d. The distribution of rice producers by area grown

e. The location of different size groups by type of environment (are small producers located in worse/better ecological zones?)

f. Costs of production for different systems

12.2 An important issue is the distribution of the social benefits to different groups. The type of research strategy followed has implications for:

a. The relative income gains of producers and urban economics

b. The rate of rural - urban migration

c. Employment in rural areas

d. Improving nutrition

12.3 The need to identify the magnitude and distribution of benefits which would flow from alternative strategies.

12.4 The magnitude of production increases which would follow from remaining policy constraints (especially credit, price, and exchange rate policies).

12.5 The socio-economic implications when trying to avoid short periods of drought stress through:

- Seeking better adapted varieties
- Changing cultural practices
- Investment in improved water control

12.6 The economic importance of grain quality for gearing additional production to export markets.

APPENDIX 1

RESTRAINTS TO REGIONAL RICE PRODUCTION IN RELATION TO CIAT RESEARCH PRIORITIES

Peter Jennings
CIAT

INTRODUCTION

The purposes of this paper are to define the major restraints to rice production in this hemisphere and to use this information to guide CIAT in the definition of its rice research priorities and activities.

I have accepted this assignment recognizing that this paper represents only the opinion of one person. It cannot, nor should not, be considered as anything more than a focus for discussion. Nevertheless, I foresee two potential areas of difficulty in any attempt to define CIAT's role in rice research. The first is that representatives of national programs, the clients for CIAT's product, will identify a series of problems of local concern, many of which lie outside of the capacity of CIAT to undertake. The second, is the danger of scatterization or the diffuseness of trying to be all things to all people. The CIAT rice program, despite some scope for growth, will remain relatively small. It can continue its successful tradition only by restricting carefully its activity to major regional needs.

It is not difficult to prepare a list of restraints to rice production. They are numerous and come in many forms. Some are major, others are minor. Some are local, others are regional in scope. A few are simple, but most are complex, involving many interrelated problems.

Consequently, I have listed several guidelines which might be useful in determining which of the restraints should be considered as targets for the CIAT program.

a. The restraint must be important. Its removal must markedly increase production or the efficiency of production.

b. The restraint must be regionally broad in importance, not peculiar to one country or area.

c. The restraint must be solvable. There must be a reasonable chance of removing it.

d. The restraint must be one that CIAT is best equipped to tackle as opposed to one better pursued by IRRI, national programs, or developed country institutions.

e. The restraint must fall with CIAT's capacity as defined by available resources and the physical environment.

BACKGROUND

I wish to summarize some of the background relating to Latin American rice as it pertains to production restraints of interest to CIAT. There are three general comments of importance. Firstly, rice culture is relatively uniform throughout the hemisphere. Discounting minor exceptions, the crop is uniformly directly seeded, it is basically all of the indica type of rice, there are similar quality preferences, and there is general uniformity of the disease and pest complex.

Secondly, the Americas are abundantly endowed with the natural resources necessary for rice production. Compared to other major land masses water and fertile land exist in massive quantities, and sunlight and climate are favorable. Consequently, natural resources are not a limiting restraint to production. Therefore, it is not essential to seek production growth from marginal lands having limited scope for high productivity.

Thirdly, irrigated rice yields are extremely high throughout the Americas by Asian standards. Five t/ha is a realistic goal for national averages and the favored upland areas should average 3 t/ha. This provides a potentially huge competitive advantage over Asia and Africa. Despite these yields and unlimited production potential, rice has not become the dominant cereal in the Americas. Nevertheless, neither wheat nor maize, the other major cereals, are in a position to markedly alter local consumption patterns or sustain a substantial export posture. Except for the southern cone wheat yields, production potential, and adaptability are limited. Most countries are dependent upon the world market for their wheat at great expense to national economies. Maize, the other cereal that might be considered as capable of sustaining development in Latin America has similarly dim prospects. National yields are very low and there is no evidence of rapid improvement in productivity or production.

I consider these three factors: uniformity of culture, abundant natural resources, and the highest proven productivity of rice among the staple cereals to combine to place rice in a position of potential dominance. Clearly, Latin America could produce an essentially infinite supply of rice.

The fact that the hemisphere does not produce, say, 100 million tons annually indicates there are major restraints other than natural resources and yielding ability.

We shall now attempt to define what they are, in order of priority, in relation to CIAT's role in rice research.

MAJOR RESTRAINTS TO PRODUCTION

A. The Political Arena

I believe that we neglect one crucial element in our discussions of rice production. I refer to the professional politicians who adopt and finance the programs recommended by technical professionals. Political leadership must have an understanding of the process of rice development including its potential and requirements. Commitment to specific production programs can only follow an understanding of what is possible. All of us as representatives of national programs or research centers are aware of cases in which viable scientific solutions have been frustrated by political professionals. On the other hand, we rarely have given professional politicians a sound understanding of the rice development process to permit adoption of a strategy for production. How can we maximize political consensus behind a policy based on sound scientific knowledge? What are the national and international consequences of alternative policies? Do we understand the trade-offs important to any political decision maker faced with two or more strategies relating to increased rice production? I believe that we are guilty of talking to ourselves. We pride ourselves on our technical knowledge but ignore the political side of production.

As production scientists we are concerned about the enormous difference between actual and potential regional production given the favorable environment, natural resources and technology. We might agree that the best way to close this gap would be to find the relatively low price at which local consumption is increased and then saturated as occurred recently in Colombia. Prices must not be so low as to put efficient producers in a noneconomic position. If the price of rice is competitive with corn, wheat and, perhaps, feed grains consumption patterns will change in favor of rice. Once saturation is reached, the mechanism to continue expansion of production would be through implementation of policies to stimulate export of surplus production.

This may be a reasonable strategy for many Latin American nations to ensure production expansion. Most countries have low consumption rates of 10 to 30 kg/person/year while having the capacity to increase production to double consumption. Others have the production capacity to export surplus. Do we have the base information necessary to present the strategy to political decision-makers? What about the details of price supports, competition with other cereals, consumer-producer tradeoffs, potential markets, the competitive position with rice offered from other world suppliers, the level of quality demanded by importers, and so forth?

To summarize, I view the political-economic restraint to be paramount at present. Alleviation of the restraint will require specialized study, acquisition of much background data and formulation of alternative strategies for different national programs.

B. Farming Practices

In my view, the second most critical restraint to rice production is the complex of farming practices we call agronomy, specifically: water control, land preparation, seeding methods, weed control, and fertilizers. Let us look at one example. I would not be surprized if weeds depress yields more than all diseases and insects lumped together. Yet, we tend to pay more attention to blast, *Helminthosporium*, *Rhyncosporim*, sogata, sheath blight and so forth. Why the relative lack of emphasis on weeds? It is because weed control is complex and inextricably tied to water control, land preparation, seeding methods and fertilizer practices. Similarly, improved efficiency of nitrogen application, important in today's farming, is only possible by simultaneously looking at water, weeds, and variety.

This area of unsatisfactory farming practices is so broad and location-specific that I want to focus in somewhat more precisely on three major sectors crying for attention:

a. Favored upland: defined as upland rice grown on flat, fertile soils with a high water table and abundant rainfall. The Central American area is the prime example with present yield potential of 2 to 4 t/ha. The greatest need here is to devise techniques to convert this favored upland into rainfed rice.

b. Rainfed: defined as yields with levees depending upon rainfall for water, characterized frequently by periodic flooding or drought. Ecuador is one of the many examples of such areas. The need here is to devise low-cost water control schemes and the cultural practices to convert existing rainfed rice in the trial and error manner that L. Johnson and A. Díaz have followed in past years at CIAT. This area holds the most potential for improving the production of small rice farmers.

c. Irrigated rice: Even Colombia, which enjoys a national average of 5.3 t/ha in this sector, is a case where there is strong opportunity for improvement in productivity and in the efficiency of production defined as cost/ton. However, the limiting factor again is much more agronomic than varietal.

I offer a final opinion on research methods in farming practices. We have seen that water, land preparation, weed control, and seeding and fertilizer practices are interrelated. It follows, therefore, that research along project lines, such as an herbicide trial or a nitrogen rate and timing study, are of limited value. Infinitely better is an integrated program approach not individual projects, dealing simultaneously with all the major variables in a trial and error manner with minimal attention to the normal concerns of plot size, randomization and replication.

C. Disease Resistance and Plant Breeding

The third, and final, major restraint to production, in my view, is varietal improvement. I consider it to be less crucial than the previous two because so much has already been achieved in yielding ability in modern varieties. Breeding continues to be CIAT's strong area. A few national programs have have breeding competence but most do not and, probably, cannot for the forseeable future. Thus it remains important to continue the CIAT tradition and strengthen the network for international testing.

The problem in breeding is to close the gap between potential and actual yields (largely through improved farming practices with modern varieties) and to stabilize actual yield potential. The problem is not to deliberately seek higher yield potential. Whatever scope for this exists is better pursued at IRRI than at CIAT. There is some room for improvement of plant type for the favored upland and the rainfed sectors through selection for stronger vegetation vigor and slightly taller varieties such as CICA-9 and line 4440.

The stability of yield is basically a problem of stable resistance to *Pyricularia*, our only widespread pathogen capable of epidemic consequences. Losses incited by *Pyricularia* are substantial in some areas. Added to this are costs for chemical control, reduced prices for damaged grain, and foregiven yield wherever farmers are restrained from aiming at maximum productivity because of the threat of blast.' This implies a loss even if the disease does not occur. Finally, failure to obtain stable resistance forces the release of new varieties every year or so. This strains research capability and the ability of the seed industry and farmers to change varieties. Taking these points together blast is a significant problem characterized by the explosive potential to destroy a farmer's crop.

OTHER RESTRAINTS

I deliberately excluded an array of other problems which will be mentioned repeatedly during this workshop including seed production, low temperature tolerance, modified floating rices, mineral nutrition stresses in relation to varietal tolerance, *Rhyncosporium*, sheath blight, and other pathogens and pests. In my view, these and many others are legitimate problems but they are either localized in impact, minor in priority ranking, impossible to attack at CIAT, or receive attention at IRRI. A partial solution to many of these problems is available in the international germplasm testing program originating from IRRI.

Finally, there remains the one problem area that most concerns CIAT administration, its Board, and its donors. Similarly, our Brazilian colleagues will raise it forcefully, I suspect.

I recognize the pressures to become involved in this area and that my evaluation will not meet with universal acceptance. Nevertheless, my opinion is based on considerable experience and reflection and is one which finds sympathy among the members of the CIAT rice program. I refer now to the question of the unfavored upland rice sector. To sustain a rational discussion of this subject requires a clear definition of this area. Misunderstanding of the distinctness of the two types of mechanized upland rice existing in the Americas has confused our ability to define potential and priorities. Unfavored upland rice is that sector grown on infertile soils, with neither a high water table nor rainfall exceeding about 250 mm/month, where water stress is the factor holding yields to extremely low levels. This characterizes the bulk of Brazilian upland rice which is fundamentally different from the type found in Central America or the minor amount found in slash-and-burn hillside agriculture. Despite the huge area and the massive contribution it makes to total Latin American rice production, I do not rate <u>unfavored</u> upland rice as a crucial area in which CIAT should have a direct role. Let me explain my reasons for this opinion.

a. There is low probability of improvement in the present yield averages of slightly over 1 ton/ha with existing or expected technology.

b. Given that water deficiency is the basic problem and that no simple solution is possible, a research effort would require a disciplinary team of no less than 6 senior scientists. Anything less would be inadequate. Even so, I would rate as low the prospects for substantial progress after 10 years of work.

c. The CIAT environment does not permit work on any phase of the problem. Research necessarily would have to be conducted in the area of the problem.

d. About 20% of IRRI's multimillion dollar budget is devoted to upland rice and IITA makes an added investment.

e. In the Americas the problem is basically unique to one country where it is firstly a useful means to open land to pastures and other crops and secondly a rice enterprise *per se*.

While I have reservation about research investment on unfavored upland rice, it is clear that decisions regarding this sector are those of the national program concerned. I only wish to add that Brazil has enormous unexploited potential to produce highly productive irrigated rice in the Matto Grosso and along the upper reaches of the San Francisco River. In summary,my view is that CIAT should not accept a mandate to conduct research on unfavored upland rice and that its resources would be more profitably invested in the three production restraints discussed above.

THE CIAT ROLE IN RELATION TO RESTRAINTS

Economics

National programs, growers organizations, national planning boards and professional politicians are not devising or implementing production strategies commensurate with technology generation or potential production capacity. There appears to be a lack of policy incentives for sustained production growth of a magnitude to increase local consumption and exportation. Most producing nations seem content to deal with fluctuating short-term shortages and surpluses. Goals are often limited to the vague concept of national self-sufficiency. National policy is clearly a national responsibility. However, the data base in relation to price supports, credit, investment in research and extension, marketing, export, and other ingredients for the development of national strategies is inadequate. There is a positive role here for an economist of the CIAT rice team. The primary responsibility would be the accumulation of data and the definition of alternate long range policies in collaboration with national programs for their presentation to professional politicians. An added benefit would be feedback to the biological scientists of information relating to breeding and agronomic research. Even modest progress in this area has enormous potential to stimulate production, internal consumption and export. Social science support would address the one element most frustrating to biological scientists concerned with rice production.

Farming Practices

I assign high priority to general agronomy in the CIAT rice program because crop management deficiencies constrain yield more than the varieties. The major activities begging attention include:

a. Training. Whereas most national programs have limited need for training in the details of rice breeding, all would profit from greatly expanded training in crop management, in techniques of evaluation of international nurseries, and in breeder and foundation seed multiplication procedures. Emphasis should be placed on techniques to convert favored upland to rainfed, and rainfed to irrigated rice.

b. Integrated Research. With particular reference to rainfed and irrigated rice, ways must be found to bring actual farm yields closer to the potential of existing varieties and to effect economics in farming practices through research on the complex of water management, land preparation and levelling, weed and red rice control, fertilzer rates and timing and, in certain cases, on the reduction of mineral nutrition stresses. This research must be tied closely to training since cultural practices are strongly location specific.

c. Consultancies. I expect a growing demand from national programs for CIAT assistance in the formulation of rice production programs, an area in which CIAT has had little capacity. Given that much of the difficulty in most countries lies in land and water management and that the diffusion of available technology is slow, outreach activity in the broad area of farming practices is a powerful mechanism to improve national yields. I visualize a CIAT capacity to mount a team of specialists in varietal evaluation, cultural practices, pest control, economics and in-country training to respond to requests for assistance in national production campaigns.

These activities and others unmentioned constitute too much responsibility for a single agronomist. The ideal posture would be two cultural practice specialists, one dealing largely with training, the second with international needs, and both cooperating on research.

Disease Resistance

CIAT must avoid the danger of the genetics of disaster that accompanies many successful breeding programs which produce a relatively small number of varieties heavily adopted over a broad area. Our area planted to modern dwarf varieties is growing and could reach several million hectares in future years. The wide deployment of a narrow genetic base is dangerous.

The CIAT rice program requires a plant protection input to ensure the obtention of stable resistance to *Pyricularia* and to monitor the disease/pest situation in Latin America to undertake resistance breeding for other pathological stresses as need arises The specific need is clearly in the area of *epidemiology*. A related requirement is a blast testing area where the disease is guaranteed. Since Palmira is unsatisfactory for this purpose, the development of land at the new CIAT farm in Santander de Ouilichao might be the ideal solution.

The plain fact is that no variety having stable blast resistance has ever been developed and that no research program is grappling effectively with the Pyricularia problem. Experience indicates that vertical gene resistance derived from apparently "high resistant" donors through a pedigree system is ineffective. We need a concerted assessment of the alternative strategies identified at a recent IRRI workshop on the blast disease. The three most powerful strategies are:

a. Gene Pyramiding. The accumulation in one variety of a complex of distinct major and minor resistance genes. Some work is in progress at CIAT.

b. Multiline Varieties. Synthetic mixtures of similar lines each differing in reaction to specific races. CIAT is exploring this concept but without the necessary pathological backstopping.

c. Horizontal (Field) Resistance. Quantitatively inherited resistance that does not have a 1:1 relationship with virulence genes in the pathogen. My feeling is that this strategy is the most promising. The weakness at present is in methodology. The strategy implies fundamental changes in current breeding practice. Breeding for horizontal resistance requires avoidance of vertical genes, use of "susceptible" varieties as parents, elimination of seedling tests, discard of the pedigree selection system, and the use of a high volume, polycrossing system.

SUMMARY

I have identified three restraints to rice production that I consider to be most important in the Americas:

a. Involvement with the political-economic component of agricultural production.

b. Research and training in farming practices for the favored upland, rainfed and irrigated sectors.

c. Disease resistance with special emphasis on blast.

To meet this challenge the ideal composition of the CIAT rice team would be:

2 Agronomists

1 Breeder

1 Economist

1 Germplasm Specialist

1 Pathologist

APPENDIX 2

AGRONOMIC ASPECTS OF RICE PRODUCTION IN BRAZIL

Dennis Johnson

Assistant Professor
Department of Geography
University of Houston
Houston, Texas 77004

A paper presented at the Workshop

"DEVELOPMENT OF STRATEGIES TO IMPROVE RICE PRODUCTION IN LATIN AMERICA"

CIAT, Cali, Colombia
October 31-November 3, 1977

Brazil ranks as the largest non-Asian rice producer and the sixth largest in the world. Production in 1976 was estimated to have exceeded 9 million tons. The majority of the rice is grown in the South and Central-West Regions.

The objectives of this survey are to present an analysis of current rice production with special emphasis on upland rice and to suggest ways in which production can be increased.

Rice is grown in Brazil under 4 major production systems: (1) upland cultivation, in upland areas without irrigation; (2) _várzea_ or non-irrigated floodplain cultivation, where soil moisture is present and serves as a supplement to rainfall; (3) natural irrigation, in riverine and estuarine locations where partial water control may exist; and (4) controlled irrigation, in locations where total water control exists.

Rice is cultivated for 3 main purposes. One, it is a subsistence crop of small farmers, with little or no mechanization and generally in consortium with other food crops. Subsistence cultivation is most common in the North and Northeast Regions; it involves production systems of upland cultivation, várzea cultivation and natural irrigation. Two, rice is cultivated as a first crop in land clearing on the agricultural frontier. New lands are subsequently used to pasture livestock or to grow other field crops. This production purpose is most common in the Central-West and North Regions and exclusively involves the upland production system. Third, rice is grown as a commercial crop with modern technology and mechanization. Commercial cultivation is prevalent in the South and Southeast Regions; and, to a lesser degree, in the Central-West Region. Controlled irrigation and upland cultivation are the involved production systems.

Brazil grows 3 types of rice cultivars. One, traditional cultivars that generally are low-yielding but possess other qualities that are desirable such as grain type, hardiness or nonshattering grain. Two, Brazilian-bred cultivars that have been developed over the last 40 years for irrigated and upland cultivation. These cultivars have higher yields, but suffer from susceptibility to rice blast and are not, in the case of upland cultivars, drought resistant. Three, introduced foreign cultivars. Most often these are grown under controlled irrigation; they are high-yielding, but are also susceptible to rice blast and commonly have grain characteristics that are less acceptable to the Brazilian consumer.

About 75% of Brazil's rice production comes from upland and <u>várzea</u> cultivation; the remaining 25% from controlled and natural irrigation. The respective contributions of <u>várzea</u> cultivation and natural irrigation are minor.

In recent years rice yields under upland conditions have ranged from about 1,000-1,500 kg/ha, while yields of rice grown on <u>várzeas</u> are on the average slightly higher. In contrast, yields under controlled irrigation have reached levels of 3,500 kg/ha in Rio Grande do Sul. Even higher yields have been realized in the limited areas of natural irrigation in the Amazon estuary.

Increases in rice production in Brazil over the past 25 years have been accomplished by expanding the cultivated area of upland rice on the agricultural frontier, and through an increase in productivity of irrigated cultivation. Extensive potential areas exist for upland rice cultivation that can be developed at low cost. Further increases in production of irrigated cultivation is hindered, in the South Region, by outdated technology in the old areas of rice production and a lack of additional land suitable for irrigation. Extensive areas exist in tropical Brazil that could be developed for controlled irrigation, but the high costs of constructing irrigation works and supplying water would make such investments only marginally economic in terms of current rice prices. Given such circumstances, further increases in Brazilian rice production, to meet the growing demand of a burgeoning population and an increase in per capita consumption, can most easily be realized through an improvement of upland rice production. The future situation with regard to rice production in Brazil is of concern to some economists who forecast a deficit of rice in the country by 1980.

Major obstacles to increasing the production of upland rice lie with cultivars that are low-yielding, susceptible to rice blast and have little drought resistance. Regarding the latter, drought is a serious problem in parts of the Central-West, Southeast and South Regions where short rainless periods (veranicos) occur during the regular rainy seasons. Major obstacles of irrigated rice are cultivars that are susceptible to rice blast and high development costs for establishment of irrigation works. Yields of irrigated rice have alread been increased to near maximum levels in the South Region.

Obstacles common both to upland and irrigated rice include inadequate sources of selected or certified seed for growers who wish to plant better cultivars, and an outdated or inefficient milling industry, resulting in a high percentage of broken grains that diminishes the market value of the harvest.

In order to increase rice production it is recommended that Brazi establish a long-term upland rice breeding program to develop new culti vars that have grain types acceptable to the domestic market and are a so high-yielding, resistant to rice blast, resistant to drought and to rant of poor soils. Such a program could increase rice field yields t about 2,000 kg/ha. Two parallel but complementary breeding projects a required. One, to serve the needs of the subsistence farmer who pract manual harvesting and consortium cropping and does not use artificial tilizer or chemical control of plant parasites. Two, to aid the comme cial farmer who employs advanced technology and mechanization for large-scale production.

Another major recommendation regarding upland rice improvement involves the study of agroclimatic crop zonation to determine the geographic areas affected by the veranico and its probable frequency and duration. Investigations should also be undertaken to improve agronomic practices and increase utilization of várzeas and natural irrigation sites that are particularly well-suited to small farmers.

An essential element of rice development strategies in Brazil is a thorough understanding of existing production systems, that by their very existence are successful, and consideration of the farmers who are directly part of those systems. A first step to the improvement of any rice production must be the identification of constraints to such improvements at the farm level; whether agronomic, social or economic, and the possible solution of those problems within the context of overall goals. Ultimately, the success or failure of rice development, or any agricultural development for that matter, rests with the farmers themselves and their adoption of new cultivars or new technologies. If the objectives of rice improvement in Brazil are defined in terms of what is feasible and acceptable to the growers, rather than what appears to be glamorous or noteworthy to others, the problems of rice production can be solved.

- - - -

APPENDIX 3

SURVEY ON RICE PRODUCTION TECHNOLOGY GAPS IN LATIN AMERICA

A brief survey on the gaps in technology of rice production was carried out on the third day of the "Workshop on Development of Strategies to Improve Rice Production in Latin America". Participants from 12 major producing regions or countries (except Cuba) were requested to identify and assign a numerical rating to specific constraints they considered of major importance in their regions. Respondees included the following:

Country/Region	Respondee
Argentina	Wolfgang Jetter
Bolivia	Carlos V. Díaz-Bowles
Brazil	José F.V. Moraes
Caribbean	José M. Cordero M.
Central America	Ezequiel Espinosa
Colombia	Cesar Martínez
Ecuador	José Matamoros
Guyana/Surinam	Hector Weeraratne
Mexico	Leonardo Hernández-Aragón
Paraguay	Wolfgang Jetter
Peru	Victor Torres La Jara
Venezuela	Anibal Rodríguez H.

Materials Covered

The questionnaires covered nine major areas and 29 specific problems. In addition, problem areas not covered in this listing were described. The relative importance of specific constraints were rated on a scale of four categories:

1 = Very important and urgent

2 = Important but not urgent

3 = Secondary importance

0 = Not important

These evaluations are compared in Table 1 in terms of rating and as weighted means based on production (tons per annu In the latter case it was necessary to assign a numerical rati to "0" to allow computation. Since numerical ratings are inve sally related to importance/urgency the number "5" was uniform substituted for "0".

Hectareage

Respondees were also requested to provide their most rece information on rice hectareage in their region/country as foll

Country/Region	Hectares (1000) Irrigated	Upland	Total Ha (1000)	Percen Upland
Argentina	105	-	105	0
Bolivia	-	70	70	100
Brazil	650	4,069	4,719	86
Caribbean (exc.Cuba)	100	20	120	17
Central America	20	268	288	93
Colombia	280	95	375	25
Ecuador	30	90	120	75
Guyana/Surinam	150	-	150	0
Mexico	61	114	175	65
Paraguay	21	15	36	42
Peru	105	25	130	19
Venezuela	90	60	150	40

The Results

The cumulative valuations on the relative importance of different problem areas show concerns in several specific areas as shown below:

		Weighted Rating	Respondees 1	2	Ratings 3
A.	*Kinds of Rice*				
	2. Irrigated	1.15	7	5	-
	4. Upland favored	1.56	5	-	3
	5. Upland unfavored	1.64	4	1	2
B.	*Water*				
	1. Water supply	1.24	6	3	1
	2. Management	1.22	5	6	1
	3. Drainage/Irrigation	1.20	6	6	-
C.	*Farming Practices*				
	3. Weed control	1.22	8	2	-
	4. Fertilization	1.31	3	6	-
	5. Mechanization	1.46	6	3	1
D.	*Diseases*				
	1. Blast	1.31	7	2	-
	3. *Helminthosporium*	1.67	2	3	-
E.	*Varieties*				
	1. Breeding	1.28	6	4	1
	2. Network testing	1.22	7	4	-
	3. Seed production	1.31	6	4	-
G.	*Socio-economics*				
	1. Technology adoption	1.31	6	5	-
	2. Profitability	1.43	4	5	-

H. Training

1. Research	1.28	6	4	-
2. Production	1.18	8	4	-
3. In Service	1.40	5	4	1

Other Problems

Several other problems were mentioned in addition to those specifically listed in the questionnaire. These are listed separately by country/region below:

Country/Region	Problem	Importance Rating
Argentina	"Chinches"	2
	"Gorgojamiento"	1
	Harvest/drying	2
	River irrigation	2
Bolivia	Harvesting	1
	Seed production	1
Brazil	*Elasmopalpus lignosecus*	1
	Program evaluation	1
Caribbean	*Rhynchosporium*	2
	Waterweevil	2
	Stink bug	2
	Industrialization	2
	Processing	2
Central America	Copper toxicity	2
	Rhynchosporium	1
	Marketing	1
	Rodents	2
	Birds	2
Colombia	*Rhynchosporium*	3
	Integrated insect control	2
	Hydrellia sp.	2
	Marketing	1
	Government policies	1

Ecuador	Communications	1
Mexico	Dams and bunding	2
	<u>Rhynchosporium</u>	2
	Stink bug	1
	Communications	1
	Extension	1
Paraguay	"Straighthead"	2
	"Chinches"	3
	"Gorgojamiento"	3
	Organizing cooperation	2
Venezuela	<u>Rhynchosporium</u>	1
	"Acaros"	2
	Rats	1
	Migratory birds	1

- - - - -

Table 1. Results of the Survey on Rice Production Technology Gaps in Latin America on 2nd November 1977.

	Rating Frequency 1	2	3	Weighted Rating
A. Kinds of Rice				
1. Deep Water	1	1	2	4.53
2. Irrigated	7	5	-	1.15
3. Rainfed	4	4	1	2.13
4. Upland - "Favorable"	5	-	3	1.56
5. Upland - "Unfavorable"	4	1	2	1.64
B. Water and Irrigation				
1. Water Supply	6	3	1	1.24
2. Water Management	5	6	1	1.22
3. Drainage and irrigation	6	6	-	1.20
C. Farming Practices				
1. Land Preparation	4	6	-	1.99
2. Planting System	2	5	1	2.30
3. Weed Control	8	2	-	1.22
4. Fertilization	3	6	-	1.31
5. Mechanization	6	3	1	1.46
D. Diseases				
1. Blast (*Pyricularia*)	7	2	-	1.31
2. Sheath Blight	-	3	4	2.53
3. *Helminthosporium*	2	3	-	1.67
4. Hoja Blanca	3	-	4	4.33
5. Bacterial Leaf Blight	-	2	4	2.65

E.	Varietal Improvement				
	1. Breeding	6	4	1	1.28
	2. Network Testing	7	4	-	1.22
	3. Seed Production	6	4	-	1.31
F.	Insects				
	1. Sogatodes	3	3	2	2.90
	2. Stem Borers	1	4	5	2.36
	3. Armyworm	6	4	-	3.46
G.	Socio-Economic				
	1. Technology Adoption	6	5	-	1.31
	2. Profitability	4	5	-	1.43
H.	Training				
	1. Research Scientists	6	4	-	1.28
	2. Production Specialists	8	4	-	1.18
	3. In-Service Training	5	4	1	1.40

APPENDIX 4

WORKSHOP ON THE DEVELOPMENT OF STRATEGIES TO IMPROVE RICE PRODUCTION IN LATIN AMERICA

October 31 to November 3, 1977

P A R T I C I P A N T S

MANUEL ALVAREZ RICO
Instituto Colombiano Agropecuario,
I. C. A.
Apartado Aéreo 7984
Bogotá, D.E.
COLOMBIA

FRANCISCO A. ANDRADE E.
Instituto Nacional de Investigaciones
Agropecuarias, I.N.I.A.P
Apartado 7069
Guayaquil, ECUADOR

PAULO S. CARMONA
Instituto Riograndense do Arroz,
I. R. G. A.
Caixa Postal 1927
90000 - Porto Alegre, Riogrande do Sul
BRASIL

MANUEL H. CARRERA A.
Ministerio de Agricultura
y Ganadería,
Apartado 10094
San José, COSTA RICA, C.A.

PETER R. JENNINGS
Departamento de Fitopatología
Ministerio de Agricultura y
Ganadería,
San José, COSTA RICA

WOLFGANG JETTER
I.N.T.A. Estación Experimental
Agropecuaria - Corrientes,
Casilla Correo 57
3400 Corrientes, ARGENTINA

DENNIS JOHNSON
Department of Geography,
University of Houston
Houston, Texas 77004
U. S. A.

LOYD JOHNSON
Centro Internacional de Agricultura
Tropical, C.I.A.T.
Apartado Aéreo 67-13
Cali, COLOMBIA

HAROLD KAUFFMAN
The International Rice Research
Institute, I.R.R.I
P.O. Box 933
Manila, PHILIPPINES

ROLANDO LASSO GUEVARA
Instituto de Investigación Agropecuaria
de Panamá, I.D.I.A.P
Apartado 58
Santiago de Veraguas, PANAMA

DARIO LEAL MONSALVE
Instituto Colombiano Agropecuario
"La Libertad",
Apartado Aéreo 2334
Villavicencio, Meta
COLOMBIA

CESAR P. MARTINEZ R.
Instituto Colombiano Agropecuario,
I. C. A.
Apartado Aéreo 233
Palmira, Valle
COLOMBIA

JORGE E. MATAMOROS C.
Instituto Nacional de Investigaciones
Agropecuarias, I.N.I.A.P
Casilla 7069
Guayaquil, ECUADOR

FERNANDO MONGE
Centro Internacional de Agricultura
Tropical, C.I.A.T
Apartado Aéreo 67-13
Cali, COLOMBIA

JOSE FRANCISCO VALENTE MORAES
EMBRAPA - Centro Nacional de Pesquisa
Arroz, Feijão,
Km. 04 - BR 153
Caixa Postal 179
74.000 - Goiânia, Goiás
BRASIL

RODOLFO MORENO G.
Instituto Nacional de Investigaciones
Agrícolas, I.N.I.A
Apartado Postal 6-882
México, D.F., MEXICO

JOSE I. MURILLO
Ministerio de Agricultura y Ganadería,
Apartado 10094
San José, COSTA RICA

JAIME NAVAS A.
Instituto Colombiano Agropecuario,
I. C. A.
Apartado Aéreo 151123
Bogotá, D.E.
COLOMBIA

JOHN H. NEWTON
Tate & Lyle Technical Services Limited
Cosmos House,
No.1 Bromley Common
Bromley, Kent
ENGLAND

JOHN L. NICKEL
Centro Internacional de Agricultura
Tropical, C.I.A.T.
Apartado Aéreo 67-13
Cali, COLOMBIA

S. H. OU
The International Rice Research
Institute, I.R.R.I
P.O. Box 933
Manila, PHILIPPINES

FRANCISCO PAZ ANTELO
Centro de Investigación Agricola
Tropical, C.I.A.T.
Casilla 247
Santa Cruz, BOLIVIA

WALTER RAMIRO PAZOS M.
Instituto de Ciencia y Tecnologia
Agricolas, I.C.T.A
5a. Avenida 12-31, Zona 9
Edificio El Cortez
Guatemala, GUATEMALA

KENNETH O. RACHIE
Centro Internacional de Agricultura
Tropical, C.I.A.T.
Apartado Aéreo 67-13
Cali, COLOMBIA

GERMAN R. RICO
Estación Experimental de Calabozo
No. 14, Bancos de San Pedro
Km. 28 Carretera Nacional Via San
Fernando de Apure,
Calabozo, Guárico
VENEZUELA

BENJAMIN RIVERA C.
Programa Arroz,
Instituto Colombiano Agropecuario,
I. C. A.
Apartado Aéreo 206
Montería, Córdoba
COLOMBIA

JOSE MAURICIO RIVERA
Departamento de Investigación Agropecuaria,
Secretaría de Recursos Naturales
Boulevard Miraflores,
Tegucigalpa, HONDURAS

Sede de Trabajo:
Estación Experimenta
Guaymas
Rdo./Dirección Agric
Regional #3
San Pedro Sula, HOND

JORGE ESTEBAN RODAS
Instituto Agronómico Nacional
Ministerio de Agricultura y Ganadería
Caacupe, PARAGUAY

MANUEL RODRIGUEZ G.
Instituto Nacional de Investigaciones
Agrícolas, I.N.I.A
Apartado Postal 6-882
México 6, D.F., MEXICO

RUBEN ANIBAL RODRIGUEZ H.
CIARCO - FONAIAP,
Estación Experimental Araure
Carretera Araure - Barquisimeto Km.5
VENEZUELA

MANUEL ROSERO
Centro Internacional de Agricultura
Tropical, C.I.A.T.
Apartado Aéreo 67-13
Cali, COLOMBIA

JOSE ROLANDO RUBI
Secretaría de Recursos Naturales,
Programa Inv. Agropecuaria
Tegucigalpa, D.C., HONDURAS

GRANT M. SCOBIE
Department of Economics and Business,
North Carolina State University
Raleigh, North Carolina 27607
U. S. A.

WERLY MACHADO DE SOUZA
Instituto Agronômico de Campinas,
Av. Barão de Itapura No. 1481
Caixa Postal [illegible]
13.100 - Campinas, S[illegible]
BRASIL

[illegible]ional [illegible]ricultura

HOWARD A. STEPPLER
Agronomy Department,
MacDonald College
Ste. Anne de Bellevue
Quebec, CANADA

HERNANDO A. SUAREZ
FEDEARROZ,
Apartado Aéreo 52772
Bogotá, D.E.
COLOMBIA

NGUYEN VAN TAN
EMBRAPA/University of Wisconsin,
Caixa Postal 179
74.000 Goiania, Goias
BRASIL

VICTOR HERNAN TORRES LA JARA
Ministerio de Alimentación,
Avenida Salaverry s/n.
Ministerio de Trabajo, 10o. Piso
Lima, PERU

CARLOS A. VACA DIEZ
Centro de Investigación Agricola
Tropical, C.I.A.T.
Calle Ñuflo de Chavez No.40
Casilla 247
Santa Cruz, BOLIVIA

GUSTAVO VILLEGAS
Centro Internacional de Agricultura
Tropical, C.I.A.T.
Apartado Aéreo 67-13
Cali, COLOMBIA

HECTOR WEERAK[illegible]
Centro Internacion[illegible] Agricultura
Tropical, C.I.A.T.
Apartado Aéreo 67-13
Cali, COLOMBIA

JORGE ESTEBAN RODAS
Instituto Agronómico Nacional
Ministerio de Agricultura y Ganadería
Caacupe, PARAGUAY

MANUEL RODRIGUEZ G.
Instituto Nacional de Investigaciones
Agricolas, I.N.I.A
Apartado Postal 6-882
México 6, D.F., MEXICO

RUBEN ANIBAL RODRIGUEZ H.
CIARCO - FONAIAP,
Estación Experimental Araure
Carretera Araure - Barquisimeto Km.5
VENEZUELA

MANUEL ROSERO
Centro Internacional de Agricultura
Tropical, C.I.A.T.
Apartado Aéreo 67-13
Cali, COLOMBIA

JOSE ROLANDO RUBI
Secretaría de Recursos Naturales,
Programa Inv. Agropecuaria
Tegucigalpa, D.C., HONDURAS

GRANT M. SCOBIE
Department of Economics and Business,
North Carolina State University
Raleigh, North Carolina 27607
U. S. A.

DERLY MACHADO DE SOUZA
Instituto Agronomico de Campinas,
Av. Barão de Itapura, No.1481
Caixa Postal 28
13.100 - Campinas, Sao Paulo
BRASIL

PETRUS SPIJKERS
Centro Internacional de Agricultura
Tropical, C.I.A.T
Apartado Aéreo 67-13
Cali, COLOMBIA

HOWARD A. STEPPLER
Agronomy Department,
MacDonald College
Ste. Anne de Bellevue
Quebec, CANADA

HERNANDO A. SUAREZ
FEDEARROZ,
Apartado Aéreo 52772
Bogotá, D.E.
COLOMBIA

NGUYEN VAN TAN
EMBRAPA/University of Wisconsin,
Caixa Postal 179
74.000 Goiania, Goias
BRASIL

VICTOR HERNAN TORRES LA JARA
Ministerio de Alimentación,
Avenida Salaverry s/n.
Ministerio de Trabajo, 10o. Piso
Lima, PERU

CARLOS A. VACA DIEZ
Centro de Investigación Agricola
Tropical, C.I.A.T.
Calle Ñuflo de Chavez No.40
Casilla 247
Santa Cruz, BOLIVIA

GUSTAVO VILLEGAS
Centro Internacional de Agricultura
Tropical, C.I.A.T.
Apartado Aéreo 67-13
Cali, COLOMBIA

HECTOR WEERARATNE
Centro Internacional de Agricultura
Tropical, C.I.A.T.
Apartado Aéreo 67-13
Cali, COLOMBIA