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# International Rice Testing Program

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# Report of the Monitoring Tour to the southern region of South America

## March 6 - 20, 1978

COOPERATION

Centro Internacional de Agricultura Tropical

THE INTERNATIONAL RICE RESEARCH INSTITUTE 1960

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## INTRODUCTION

The International Rice Testing Program (IRTP) was initiated at the beginning of 1975 to form a network of scientists to evaluate rice germplasm over a broad range of agroclimatic conditions and cultural systems.

The United Nations Development Programme (UNDP) provided the International Rice Research Institute (IRRI) with funds to initiate and coordinate the project with national programs and other international centers.

In Latin America, the IRTP was formally begun in 1976 with the support of IRRI and the Centro Internacional de Agricultura Tropical (CIAT). Through this program, rice technicians of national programs can share and evaluate the best entries of each country in their own environmental conditions. In this way, we can accelerate the development, evaluation and the distribution to the farmers of a continuous flow of improved varieties with good adaptation to a wide range of agroclimatic conditions.

The IRTP for Latin America, for 1977, involved 96 sets of six specific nurseries which were distributed in 19 countries. Nurseries included yield nurseries for early, medium and deep water irrigated varieties (VIRAL-P, VIRAL-T and VIRAL-F, respectively, yield nursery for upland conditions (VIRAL-S), and sheath blight and salinity observational nurseries (VIAVAL and VIOSAL, respectively).

Most of the material included in these nurseries were improved lines from the IRRI Genetic Evaluation and Utilization Program (GEU) and from the national programs of several Asian countries.

In 1977, IRRI also distributed to several South American countries these other nurseries: Observational Nurseries for Irrigated (IRON) and Upland (IURON) conditions, the Yield Nursery for Upland conditions (IURYN) and the International Rice Blast Nursery (IRBN).

Each year the IRTP arranges Monitoring Tours to enable rice scientists from various countries to:

1) Observe the performance of the materials in the international nurseries,

2) Become familiar with rice production systems and research activities at other national and regional programs of the area, and,

3) Know the entomological, pathological and agro-ecological problems limiting rice production so that these can be solved through the regional exchange of knowledge and promising materials.

The 1978 Monitoring Tour focused on the rice culture of the southern region of South America, including Argentina, Bolivia, Brazil, Paraguay and Peru (Fig. 1). Five scientists representing the national or regional programs of Argentina, Brazil and Peru, and four scientists from IRRI and CIAT participated in the Monitoring Tour (Appendix 1). The technicians from the national programs of Bolivia and Paraguay cancelled their participation on the complete tour, but accompanied the team in their respective countries.

## RICE PRODUCTION AND RESEARCH IN THE FIVE COUNTRIES VISITED

Table 1 shows the rice areas, production and yields in the five countries visited by the team. The yields in lowland conditions, except in Peru, are low mainly due to using low productivity varieties, the incidence of diseases and in-


Figure 1. Localities and institutions visited during the Monitoring Tour to five countries in the southern region of South America.

Table 1. Rice area, production and yields in five countries of South America.

| Country | Area (1000 ha) | | | Production (1000 ton) | | | Yield (t/ha) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Lowland | Upland | Total | Lowland | Upland | Total | Lowland | Upland | Total |
| Argentina* | 105.0 | - | 105.0 | 370.0 | - | 370.0 | 3.5 | - | 3.5 |
| Bolivia** | - | 60.0 | 60.0 | - | 118.0 | 118.0 | - | 1.9 | 1.9 |
| Brazil*** | 714.2 | 5201.2 | 5915.4 | 2437.9 | 6187.2 | 8625.1 | 3.4 | 1.2 | 1.4 |
| Paraguay* | 22.5 | 15.0 | 37.5 | 56.3 | 24.0 | 80.3 | 2.5 | 1.6 | 2.1 |
| Peru* | 106.7 | 27.0 | 133.7 | 592.3 | 47.0 | 639.3 | 5.5 | 1.7 | 4.7 |
| TOTAL | 948.4 | 5303.2 | 6251.6 | 3456.5 | 6376.2 | 9832.7 | 3.6 | 1.2 | 1.6 |

* Growing season 1976-77

** Growing season 1975-76

*** Data are for 1977. A combined system of irrigated and upland culture is reported under Upland Area and Upland Production (8.5 and 5.0% of total upland, respectively). (Information supplied by EMBRAPA).

sects — such as blast in Brazil and the stink bug in Argentina —, and to the deficiency of crop technology related to weed control and fertilization in Paraguay.

Under upland conditions, yields are low mainly due to the lack of varieties resistant or tolerant to blast and brown leaf spot diseases, to insects such as Elasmopalpus and stem borers, and to droughts that seriously affect production, especially in Brazil.

In the following sections, the rice production situations and the observations made by the team are presented in detail for each of the countries visited.

## ARGENTINA

### Status of the crop

#### General aspects

Only irrigated rice is cultivated in Argentina. Production is concentrated in the northeastern section of the country, between latitudes 32° and 25° South and longitudes 55° and 60° West. This section includes the provinces or departments of Corrientes, Entre Ríos, Santa Fe, Formosa and Chaco. Fifty percent of the rice planted in the country is in Corrientes.

Actual production of rice in Argentina (Table 1) meets the domestic demand, which for 1977, was estimated at 250,000 tons of paddy rice for the country's average per capita consumption of 5 kg of white rice. The surplus (120,000 tons) is destined for export.

Rice production in Corrientes is on a commercial scale. Eighty-one percent of the private producers have farms larger than 400 hectares and 84 percent of the producers renting land have areas of less than 400 hectares. Producers of the region have the necessary machinery for preparing the land and pumping irrigation water. The majority of the private producers and those renting more than 200 hectares have their own combines. More than 70 percent of the producers own their own dryers and 31 percent have their own mills.

## Production systems

The rice production system in Argentina is the direct-seeded and irrigated type and is completely mechanized from seeding to harvesting. Land preparation and seeding are made on dry soil. The dry seed is sown with a drill in rows or broadcast. After seeding, dikes are built to provide the first irrigation for germination. Ten days after germination a second irrigation is provided to the crops and ten days later the permanent flood is established. The rice fields are drained between 45-50 days after germination for 4-6 days to prevent the incidence of straight head and serious attacks from the water weevil (Lissorhoptrus oryzophilus).

The main sources of water are the rivers Paraná, Paraguay, Bermejo and Pilcomayo. Underground sources are also utilized, especially in the state of Entre Ríos. Other sources of water for irrigated rice are the lakes and swamps which are abundant in the region.

Weed control and fertilization are not practiced in Argentina because of the rotation system that the farmers employ. This system involves the seeding of rice for 1 or 2 years, after which the land is used for beef cattle grazing for 3 to 6 years. This system does not allow weeds to build up and the organic matter is maintained or increased with the natural grass.

The harvest is made mechanically with the same combines used for harvesting wheat.

## Varieties grown

The varieties cultivated most are Fortuna (long grain), Bluebonnet 50 (long grain) and Itapé (medium grain). The variety Fortuna was introduced from Brazil approximately 30 years ago. Afterwards, the National Rice Program of the Instituto Nacional de Tecnología Agropecuaria (INTA), in Corrientes, further selected and purified this material. In the 1976-77 season Fortuna was planted on 45 percent of the rice area and the production is for domestic consumption. In the same season, Bluebonnet 50, a variety introduced from the United States, was seeded on 35 percent of the total rice area. Most of its production is destined for export. The variety Itapé was grown on 10 percent of the area with its production concentrated in the state of Entre Ríos.

Limiting factors

The main problems of rice production in Argentina are:

a) Rice water weevil (L. oryzophilus)

b) Stink bugs of the stem (Tibraca limbativentris) and of the grain (Oebalus spp. and Mormidea spp.)

c) Straight head

d) Brown leaf spot (Helminthosporium oryzae)

e) Red rice

f) Deficiency in production of certified seeds

g) Lack of varieties with high yield potential and good grain type

## Visits and Observations

In Corrientes, the monitoring team was received by officials of the Estación Experimental Agropecuaria (EEA) of INTA. The group saw field experiments established by the rice program and the laboratories of the Entomology and Natural Resources groups of that station. The group also visited two commercial rice/cattle farms — Santa Ana Ñu and Las Tres Marías — to observe work at the producer level.

The monitoring team also was received by the Governor of the Province of Corrientes; the team members discussed the purpose of their visit to the rice-producing zones of the state (Fig. 2).

### Estación Experimental Agropecuaria (EEA)

The Director of the EEA welcomed the group and briefly explained the research activities under way at this station.

The EEA covers an area of 1000 hectares of which 600 are utilized for the production and investigation of irrigated rice and the remainder, for cattle ac-

Figure 2. Members of the Monitoring Group discuss the activities of the IRTP with General of Division Luis Carlos Gómez, Governor of the Province of Corrientes, Argentina.

tivities. The station is at an altitude of 56 meters, at latitude 27° 39' South and longitude 58° 46' West. The site has an average annual temperature of 21.7°C and average annual precipitation of 1250 mm. Soils are alluvials of a planosolic type with sandy texture, medium in organic matter and with a pH of 5.5-6.0.

In addition to rice work, the station does research with cattle, natural resources (mainly soil survey and classification), production economics and comparative studies with varieties of cotton, peanuts and soybeans.

The EEA staff consists of 15 researchers and 10 extension agents. The Rice Improvement Program is directed by two of these scientists and they receive help and collaboration from personnel of other disciplines, principally the sections of Entomology and Soils. The extension personnel are charged with transferring the technology to the farmers of the region.

The Rice Program has a national scope from its headquarters at EEA. Its central objective is the selection of high-yielding varieties, with resistance to lodging, diseases and insects, with early maturity (120-130 days) and with good milling and cooking qualities. The program is also responsible for purifying and multiplying genetic and basic seed of commercial varieties and promising lines. Other related activities include research, in collaboration with the Entomology Section, on the biology and control of insect pests of rice like grain stink bugs (Oebalus spp. and Mormidea spp.), stem stink bug (T. limbativentris) and the rice water weevil (L. oryzophilus).

Appendix 4 presents a list of the experimental projects in the Rice Program and visited by the monitoring team.

Production of basic seed. Fields for the production of basic seeds of the varieties Fortuna INTA, Bluebonnet 50 INTA and line IR 841-63-5-18 were observed. The lots were seeded mechanically in furrows, at densities of 160, 150 and 130 kg/ha of seed, respectively. Water in the plots was 20-30 cm deep. The lots were not fertilized and did not receive treatments for weed and insect control.

The field of Fortuna (7 hectares) was well-developed and free of diseases but showed damage (15-20%) typical of the stem borer, but which was caused by T. limbativentris. Also, several areas were affected by straight head. The yield of this field was estimated to be 4.5 ton/ha (Fig. 3).

Figure 3. H.E. Kauffman (IRRI) and other members of the Monitoring Group listen to a description of seed multiplication of the variety Fortuna INTA at the Experimental Station of Corrientes, Argentina.

The field of line IR 841-63-5-18 (4 hectares) showed satisfactory development although it was flooded to a water depth that was somewhat affecting its growth (Fig. 4). Weedy areas with barnyard grass (Echinochloa colonum), known as Capin in Corrientes, were also observed. Light symptoms of straight head were detected. Plants had a height of 90-100 cm with good panicle exertion and long grains. The yield was estimated to be 5-5.5 ton/ha.

The development of the field of Bluebonnet (9 hectares) was not uniform and attacks of T. limbativentris were observed.

IRTP nurseries. Of the IRTP for Latin America nurseries, at this station were observed the VIAVAL, the VIRAL-P and the VIRAL-T, all sent from CIAT in 1977. The nurseries were seeded at the end of December (1977); at the time of this visit the nurseries were 67 days old (booting stage). The material showed severe damage from the rice water weevil, such as retarded growth and foliar yellowing, and symptoms of leaf miner damage. Several plants were pulled and it was possible to observe pupae and larvae similar to those of L. oryzophilus; however the entomologist of EEA identified them as belonging to the genus Neobagus.

Figure 4. W. Jetter, Director of the Rice Program at the Agricultural Experiment Station in Corrientes, Argentina, explains the principal characteristics of rice line IR 841-63-5-18 in this seed multiplication plot.

In the VIAVAL, the local check IR 841-63-5-18 was highly susceptible to the rice water weevil. In the VIRAL-T various levels of tolerance to damage of the rice water weevil were detected; line IR 2823-399-5-6 was most resistant and line IR 2071-586-5-6-3, seeded in an adjacent plot, was most susceptible. These observations are very important since they indicate that there is a varietal resistance to this insect which is a limiting factor for rice production in Argentina.

In the VIRAL-P, several lines (BR-51-46-1-C1, IET 2881, IET 3127 and CICA 7) were observed with good performance (Appendix 5).

Experimental trials. Among the national trials of the INTA Rice Program, the following were observed:

a) Comparative yield trials with 8 promising semidwarf lines, selected from segregating materials introduced from CIAT, in comparison with 3 commercial varieties. Some of the lines were superior to the commercial varieties Fortuna and Bluebonnet 50.

b) An experiment of the Official Network of Territorial Trials (ROET), which included 13 varieties of definite or provisional registry from official and private nurseries, in comparison with INTA varieties. Fortuna and Bluebonnet 50 were superior to the 13 varieties.

c) A fertilization trial with line IR 841-63-5-18, with two levels of nitrogen (0 and 50 kg/ha) and two of phosphorus (0 and 50 kg/ha). No differences were observed between plots with either 0 or 50 kg/ha of nitrogen, but a response was observed to the phosphorus.

d) A preliminary trial for controlling the rice water weevil. The plot treated with granular Furadan (5 percent), was better developed than the control plot.

The management given the different experiments and the fields for seed purification and multiplication was good and conclusive results should be assured. These will contribute to increasing the production and productivity of rice in the country in the near future.

Entomology. Agronomist Rafael M. Trujillo, the INTA entomologist at EEA, informed the group on research activities related to biological studies and control of insects affecting the production of rice in Corrientes. Among insects under study are grain stink bugs which seriously affect yields and milling quality. Recommendations have been made to farmers for cultural and chemical control. The biology and chemical control of T. limbativentris have also been studied. Evaluations of yield losses indicate that 1 or 2 stink bugs/$m^2$ cause losses of 20 percent and 6/$m^2$ can cause losses of 40-50 percent. The minimum level for their chemical control has been determined to be 1 or 2 stink bugs/$m^2$. This insect causes damage principally by disrupting vascular circulation at the last internode, causing no grains to form in the panicles.

New pests of rice have been identified such as the nematodes Meloidogyne arenaria, which affects the plant root, and Aphelenchoides sp., affecting the leaf, the mite Schyzotetranychus oryzae, and Sogata reported in 1975 in a 3 $m^2$ area of a commercial crop at Corrientes. In 1976 and 1977 no new incidences of Sogata were reported. In early 1978 several insects attracted by light from an urban sector of Corrientes were collected. These were first thought to be Sogata, but later observations showed them to be different from Sogatodes oryzicola in appearance, size and color. Later identification of these insects by Fulvia García, entomologist at ICA, Palmira, Colombia, showed them to be of the order Homoptera, family Delphacidae, and completely different from S. oryzicola.

Soils. Agronomist Adolfo Capurro, soil specialist at INTA, provided the monitoring team with detailed information about studies in soil survey and classification in the rice zones of Corrientes, Formosa, Misiones, Entre Ríos, Santa Fé and Chaco. The potential area with soils suitable for rice growing totals some 2 million hectares in the Province of Corrientes and 1.5 million hectares in Formosa.

## Santa Ana Ñu Farm

Santa Ana Ñu is a farm of 9300 hectares owned by Mr. Ernesto Meabe. It is in the district of Loreto, department of San Miguel, in Corrientes. About 500 hectares are planted to rice annually. During the 1977-78 season, 380 hectares were seeded to Fortuna and 100 hectares to Bluebonnet. The rest of the farm is used for beef cattle.

A very efficient system of gravity irrigation is used on the rice land with the water coming from the Paraná river. The production is completely mechanized, from preparing the land to harvesting and drying of the rice. Direct seeding is done on dry soil, at rates of 170 and 150 kg of seed/ha for Fortuna and Bluebonnet, respectively. No fertilizers are used nor are weeds or insects controlled. These factors are not limiting because of the good land rotation system; rice is grown one year and for the next three years the field is in native graze for cattle grazing.

Several fields of Fortuna were observed, all in good condition and ready for harvest. Fields of that variety already harvested had yielded 4.5 ton/ha. In some fields, red rice was present and some areas were affected by straight head. The Bluebonnet variety had already been harvested and had averaged yields of 3.9 ton/ha.

The rice is dried using a column dryer with a capacity of 11.5 ton/4 hours. Grain moisture is lowered 5 percentage points with air heated to 110°C.

Las Tres Marías Farm

This farm which is 10 kilometers from the EEA of INTA is owned by Mr. Alexander Cook. It covers 1600 hectares of which 200 are in irrigated rice and the rest devoted to cattle production. Irrigation water comes from the Paraná River.

Rice has been grown on this farm since 1947 and Fortuna and Bluebonnet are the varieties now produced. The land rotation used consists of rice for two years and cattle grazing for the next four years. Several fields of both Fortuna and Bluebonnet were seen and were in healthy condition. The potential yields were estimated to be 3.5-4 ton/ha.

Formosa

In the Porvince of Formosa, on the way to Paraguay, the team interviewed the Secretary of Agriculture. This official stressed his interest in seeing rice production increased in his province. The region has some 1.5 million hectares of level land suitable for rice. He specifically asked for technical assistance to develop an irrigation infrastructure that would utilize natural ditches to conduct water from the Paraguay River.

## BOLIVIA

### Status of the crop

#### General aspects

Only upland rice is grown in Bolivia. During 1975-76, 60,000 hectares of rice were grown in the northeastern region of the State of Santa Cruz, in the Provinces of Santisteban, Ichilo and Sara, where annual precipitation varies from 1200 to 1800 mm. Seventy percent of Bolivia's production is in this region. In the 1975-76 season Bolivia's rice production met the domestic demand of 32,000 tons and provided a surplus of 75,000 tons; the surplus was not exported due to the poor milling quality. National rice consumption is low (14 kg per capita annually), but this could be increased if better distribution were available to the different areas.

Fifty percent of the rice is produced on small farms (1-3 hectares). The production system used by small farmers is that of manual upland. The remainder of the production comes from mechanized upland systems on larger farms. These producers have all necessary machinery for rice cultivation, from preparing the land to harvesting.

#### Production systems

Manual upland system. In this system the natural forests are cleared, and burned and then the rice is seeded (Fig. 5). Seeding is done by hand, placing 3 to 8 seeds in each hill, at distances of 40 x 40 cm. Weeds are controlled by hand, but some farmers use herbicides. No fertilizers are applied. Some producers apply insecticides to control stink bugs (T. limbativentris) or other insects, in cases of severe infestations. Harvesting is also done manually, by cutting each panicle with a knife (Fig. 6). The small farmers employ this production system

**Figure 5.** Area prepared for manual seeding of upland rice in Santa Cruz, Bolivia.

for two or three crops and then move to other areas because of the invasions of weeds and the low fertility of the soil.

Mechanized upland system. This system is totally mechanized, from land preparation to harvest. Planting is in furrows with a seeder at distances between

**Figure 6.** Manual harvesting of upland rice by small farmers at San Pedro, Santa Cruz, Bolivia.

furrows of 35-40 cm when a cultivator is to be used for weeding and 17-20 cm when herbicides are used. The majority of the farmers make at least one soil insecticide application for controlling stink bugs, and two applications are made if infestations are severe. No fertilizers are applied in this system and harvesting is done by combines.

Varieties grown

Rice varieties utilized by farmers in both production systems are of the Indica type, including Dourado, Pico Negro, Colorado and 90 "días" (all local varieties) and Bluebonnet 50 and Dawn (introduced varieties). Some farmers are also planting CICA 6 with satisfactory results.

Limiting factors

The principal problems of upland rice production in Bolivia are these:

a) Disease incidence, especially rice blast (*Pyricularia oryzae*), brown leaf spot (*H. oryzae*), leaf scald (*Rhynchosporium oryzae*), narrow brown leaf spot (*Sphaerulina oryzina* or *Cercospora oryzae*) and bacterial blight (*Xanthomonas oryzae*).

b) Insect incidence, especially stem borers (*Diatraea* sp. and *Elasmopalpus lignosellus*), stink bugs (*Neobaridia amplitarsis* and *T. limbativentris*) and armyworms (*Spodoptera* spp. and *Mocis* sp.). Other insect pests recently identified include *S. oryzicola* and *Rupella albinella*.

c) Weed incidence

d) Deficiency of fertilization

e) Lack of harvesting machinery

f) Lack of personnel trained in breeding and production

g) Drought problems

## Visits and Observations

### Saavedra Agricultural Experiment Station (EEAS)

The Rice Program of the Center for Tropical Agricultural Research (CIAT) of Santa Cruz — a national institution — is located in the Saavedra Agricultural Experiment Station, 65 km northeast of Santa Cruz. The site is at latitude 17°10' South and longitude 63°10' West, at an altitude of 320 meters. It has an average annual temperature of 23.9°C and average annual precipitation is 1205 mm.

Seed production. Upland rice research was begun in 1950 with the introduction of some materials. The varieties Dourado, Bluebonnet, Bluebelle, Pico Negro and Dawn were recommended to farmers. Since 1974, the program has evaluated semidwarf materials from IRRI and CIAT. Three promising lines have been selected from IRRI (IR 2042-178-1, IR 1529-430-3 and IR 1140-147-3-2) and three from CIAT (CICA 6, Line 4440 and CICA 9), all of which are now in seed multiplication.

Cultural practices. The program has defined that, for manual upland production, the appropriate seeding distances are 20 x 40 cm using 25 to 30 kg of seed/ha, and for the system of mechanized upland planting in furrows, should be 17-20 cm with chemical weed control practices and 35-40 cm with manual or mechanical weed control, using 50 to 70 kg of seed/ha.

IRTP nurseries. The monitoring team visited IRTP nurseries (IRBN and VIRAL-S) established at the EEAS. Blast resistance was observed in several lines of the IRBN (50 days of age); the susceptible control had an infection level of 5 to 6. Among 10 drought-tolerant lines from IRRI, the outstanding ones were IR 4422-165-2, IR 3880-13 and IR 3941-25-1.

The VIRAL-S materials were 84 days old at the visit; most of the lines were in the boot stage and some had begun flowering. Outstanding materials were IR 3880-13, BPI 76-9/Dawn and line 4444 (see Appendix 5). On the majority of the lines symptoms similar to bacterial blight were observed; selections most affected were IRAT 13, IR 2061-522-6-9 and Dourado. The variety CICA 8 and the selection 4440-10 (sister to CICA 8), seeded in plots adjacent to the VIRAL-S, were well-developed and had minor incidence of bacterial blight.

Experimental trials. The monitoring team visited several experiments established by the Rice Program at the EEAS, including seed multiplication, varietal comparisons and associations of maize and rice.

Multiplication fields for seed of the lines IR 2042-178-1, IR 1529-430-3, IR 1480-147-3-2 and the variety CICA 9 were all in the flowering stage and were seriously affected by drought; CICA 9 showed the best performance.

In the varietal comparison trial — including 10 materials from IRRI, four from CIAT, three from the U.S.A. and one local material — performance was irregular because of the drought and very much lower than that at the Portachuelo substation (see next section). Several lines had symptoms similar to bacterial blight.

In the maize/rice association trials, both crops were well-developed and the rice (Bluebelle) did not show water deficiency symptoms. Associations of these two crops is a very common practice among small farmers of the region (Fig. 7).

Figure 7. Experiments of rice/maize associations on the Saavedra Experiment Station, Santa Cruz, Bolivia.

Portachuelo Experimental Substation

At this substation, the monitoring team visited trials for seed production, comparisons and adaptation of varieties, seeding densities and insect control systems.

Seed production. Seed production lots of Bluebonnet 50 and CICA 6 were nearing harvest. Although the lots had suffered 20 days of drought, their development was good (Fig. 8). Both varieties had moderate incidence of brown leaf spot and sheath blight and light symptoms of blast were detected. Potential yields of 3.5 ton/ha for Bluebonnet 50 and 3 ton/ha for CICA 6 were estimated.

Varietal trial. In the varietal comparison trial, having the same materials as the trial at the EEAS, several lines were observed to be better than the local check; best materials were IR 2035-353-3-2, IR 1529-430-3, IR 2053-206-1, IR 2043-104-3, BPI 76-9/Dawn, line 4440, and varieties CICA 4 and CICA 6. The other lines were susceptible to brown leaf spot, were not well-developed and the grain was affected by fungi. Bluebonnet 50 and several lines had symptons similar to those of bacterial blight.

In the seeding density trial, no marked differences were observed between the levels used (20, 40, 60, 80 and 100 kg of seed/ha).

Figure 8. Seed multiplication of CICA 6 under upland conditions at Portachuelo, Santa Cruz, Bolivia.

Regional trial at San José

The team visited a regional trial of varieties of the Rice Program at San José, 60 km north of Saavedra. This trial, which utilized the same material planted at Portachuelo, was on a farm owned by Mr. Abel Surita, a small farmer in that region. The regional trial was under the supervision of the local extension agent Agronomist Cleto Siles, who has the responsibility of transferring crop production technology to farmers of this region. At the visit, the experimental lots were ready for harvest. The better performing materials, in order of superiority, were: line 4440, IR 2035-353-3-2, IR 2042-178-1, IR 1529-430-3 and IR 2043-104-3. CICA 9 was not well-developed and was very susceptible to brown leaf spot. Infections of blast, brown leaf spot, leaf scald, bacterial blight, narrow brown leaf spot and sheath blight were detected.

Adjacent to the varietal trial, the team saw a trial for the transfer of technology, in which four technology levels were tested with three rice varieties (Bluebonnet 50, CICA 6 and Bluebelle). The technologies were:

- Technology of the farmer: manual seeding at 40 x 40 cm with 12 to 15 kg of seed/ha and manual control of weeds.
- Minimal technology: manual seeding at 20 x 20 cm with 30 kg of seed/ha, manual control of weeds and chemical control of insects.
- Intermediate technology: manual seeding at 20 x 20 with 30 kg of seed/ha, chemical and mechanical control of weeds, chemical control of insects and fertilization.
- Advanced technology: mechanical seeding in furrows at 30 cm with 60 kg of seed/ha, chemical and mechanical control of weeds, chemical control of insects and fertilization.

The plots of Bluebelle had been harvested. The plots of CICA 6 and Bluebonnet with intermediate technology were superior to the same plots at all other technologies.

The farmer's crops of Bluebonnet 50 and Dourado were also observed. Both were well-managed and free of weeds. Growth of both varieties was excessive with plant height varying between 150 and 160 cm.

Other observations

In the San Pedro area wild rice (Oryza latifolia) was seen along the roadsides. Plants were about 2 meters high and the panicles were free of diseases.

Along the way to San Pedro, the team spoke with a farmer Mr. Celestino Sotará who claimed his yields from Bluebonnet and Dourado were 2.7 ton/ha on lands in the first crop and 1.4 to 1.8 ton/ha on lands in the second and third planting.

San Pedro is a rural settlement region with colonizing families to whom the government has given 30 hectares of land per family in order to promote the agricultural development of the area. Rice is one of the main crops for these small farmers andfor this reason activities of the Rice Program should be emphasized in this region.

## BRAZIL

### Status of the crop

General aspects

In Brazil, rice production represents the third place in area cultivated for crops, and in many states, it is the principal source of agricultural income.

Rice is grown in all the states of the country, but commercial production is concentrated in the east-central, south-central and southern regions of the country. In the northeastern section, the only large-producing state is Maranhão. Ninety-five percent of the 1977 production (8.6 million tons grown on 5.9 million hectares) came from the states of Rio Grande do Sul, Mato Grosso, Goiás, Minas Gerais, São Paulo, Paraná, Maranhão and Santa Catarina. In Río Grande do Sul and Santa Catarina, irrigated rice predominates; in all the other states, upland rice is prevalent (Table 2). Annual per capita consumption in Brazil was 45 kg of milled rice.

Table 2. Area and rice production in Brazil in 1977.*

| Cultural systems and states | Area (ha) | Production (ton) | Yield (kg/ha) |
|---|---|---|---|
| Upland** | | | |
| Mato Grosso | 1,546,663 | 2,095,558 | 1,354 |
| Goiás | 780,000 | 620,472 | 795 |
| Minas Gerais | 708,883 | 635,955 | 897 |
| São Paulo | 356,000 | 399,000 | 1,037 |
| Paraná | 564,070 | 904,865 | 1,604 |
| Maranhão | 753,608 | 1,137,609 | 1,509 |
| Total | 4,709,224 | 5,793.459 | |
| Irrigated*** | | | |
| Rio Grande do Sul | 566,000 | 2,105,000 | 3,719 |
| Santa Catarina | 148,164 | 322,950 | 2,247 |
| Total | 714,164 | 2,437,950 | |
| Otros | 501,032 | 432,791 | 863 |
| TOTAL | 5,924,420 | 8,664,200 | 1,462 |

* Source: José Francisco Valente Moraes: Arroz de Sequeiro. CNPAF/EMBRAPA. 1978.

** Average yield of upland rice was 1224 kg/ha.

*** Average yield of irrigated rice was 3413 kg/ha.

Production systems

Generally, 80 percent of the total production area is in upland rice, 12 percent is irrigated rice and the other 8 percent is a combination of the two systems. The percentage contribution of these cropping systems to total production is estimated at 67, 28 and 5 percent, respectively.

Upland rice. For the most part, upland rice in Brazil could be considered as unfavored upland, that is, upland rice production under drought and low-soil fertility problems.

Rice competes with soybeans for fertile lands; consequently, rice is the crop chosen for planting when new lands are being opened on less fertile soils. This is the case on the Cerrados (Fig. 9) where the major part of the rice is produced in the states of Goiás, Mato Grosso, Maranhão and Minas Gerais. In the Cerrados area Latosolic soils predominate, especially the yellowish-red and dark red Latosols that make up 52 percent of the area. These soils are deep, highly weath-

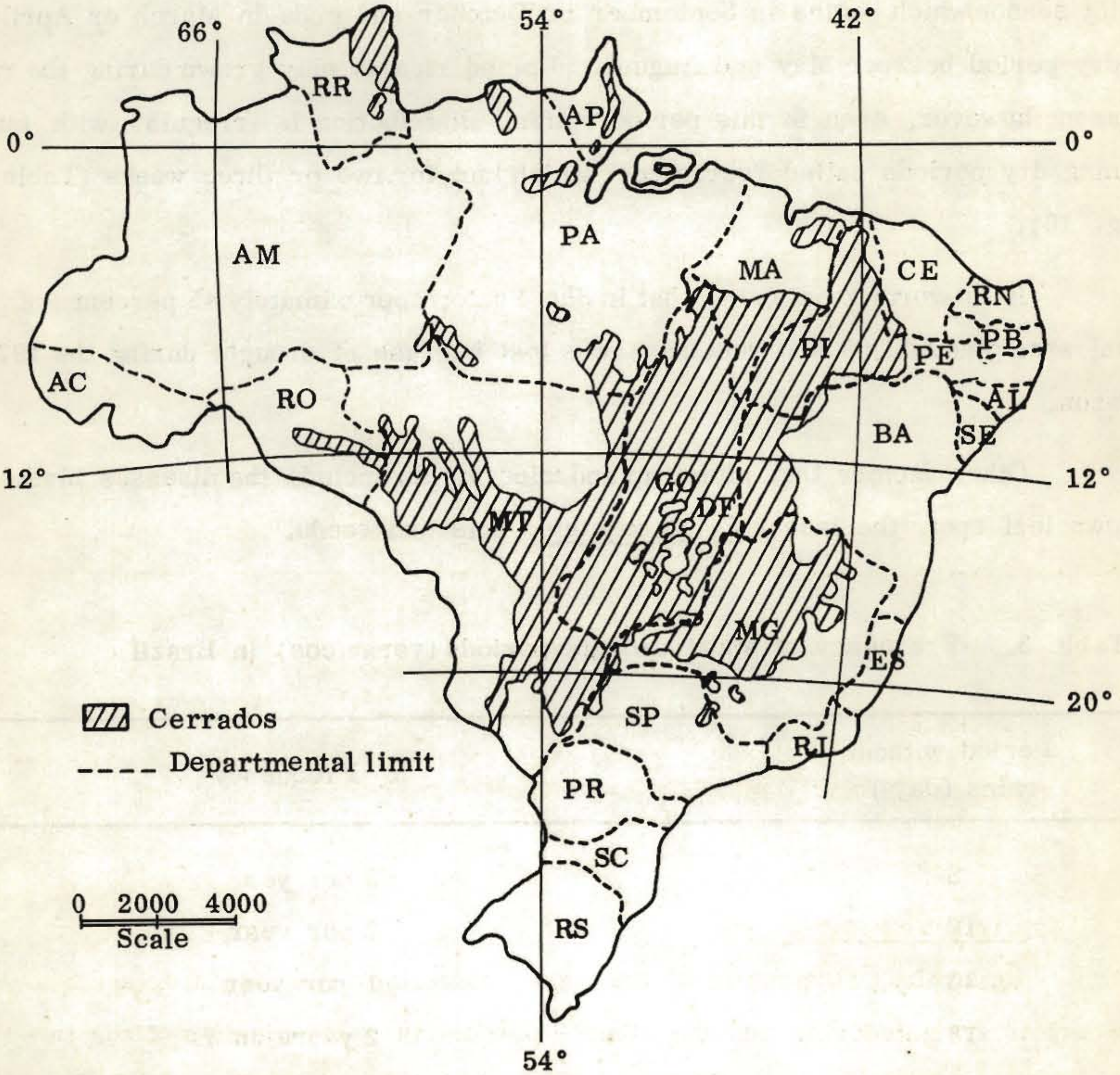


Figure 9. Present distribution of "Cerrados" in Brazil.

ered and have low fertility and a high content of aluminum. In this same region there are also quartziferous soils, hydromorphic laterites and Podzolic and other Latosolic soils. All, with the exception of the Podzolics, are of low fertility.

The rainfall pattern of the region is possibly even more important than the soil fertility because it determines the stability of production and prevents farmers from utilizing available technology. Rainfall distribution is irregular in the area, except in Paraná, the Amazonia region of Maranhão and the northern region of Mato Grosso, where rainfall is adequate for crop needs.

The central region of Brazil has two well-defined climatic periods: one rainy season which begins in September or October and ends in March or April and a dry period between May and August. Upland rice is only grown during the rainy season; however, even in this period rainfall distribution is irregular, with intervening dry periods called "veranicos" which last for two or three weeks (Table 3, Fig. 10).

It is worth mentioning that in São Paulo, approximately 45 percent of the total area planted (365,000 hectares) was lost because of drought during the 1977-78 season.

Other factors that affect upland rice yields include the diseases blast and brown leaf spot, the insect E. lignosellus, ants and weeds.

Table 3. Frequency of short drought periods (veranicos) in Brazil.

| Period without rains (days) | Frequency |
|---|---|
| 8 | 3 per year |
| 10 | 2 per year |
| 13 | 1 per year |
| 18 | 2 years in 7 |
| 22 | 1 year in 7 |

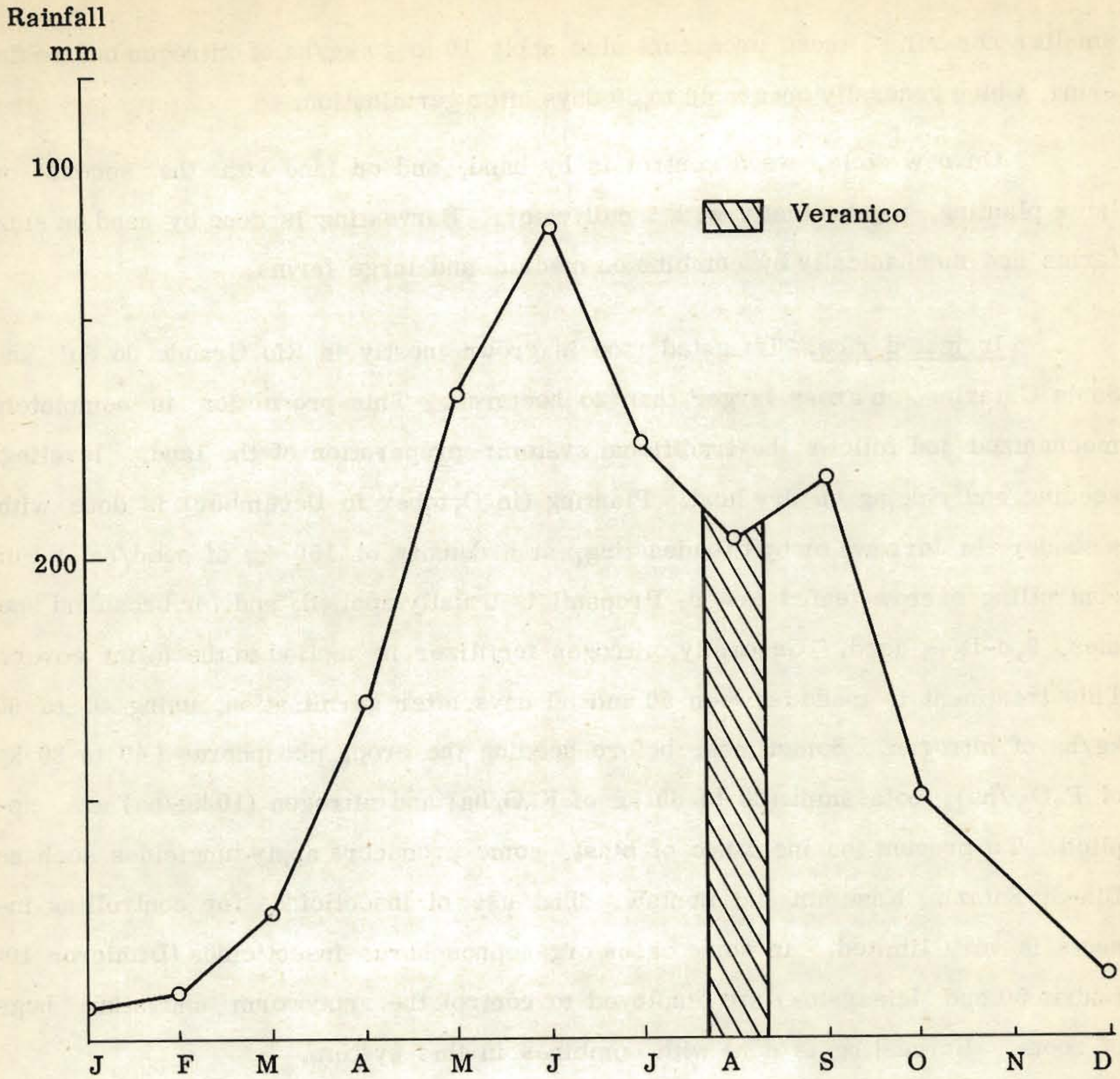


**Figure 10.** Occurrence of "Veranicos" in the central part of Brazil.

Upland rice is grown on small (2 to 20 hectares), medium (21 to 100 hectares) and large farms (101-800 hectares). Small farmers do all the work of cultivation manually or with animals; the technological level employed is low, harvesting is done by hand and the production is consumed at the farm. Cropping at the medium and large scales is mechanized, from land preparation to harvesting.

In the latter cases, seeding is done with seeders-fertilizer applicators, in furrows 30 or 60 cm apart with planting densities of 25 to 35 kg of seed/ha. At the time of land preparation, lime and phosphate are applied as soil amendments. A smaller number of these producers also apply 10 to 20 kg/ha of nitrogen before flowering, which generally occurs 40 to 50 days after germination.

On new soils, weed control is by hand, and on land with the second or later planting, mechanically with a cultivator. Harvesting is done by hand on small farms and mechanically by combine on medium and large farms.

Irrigated rice. Irrigated rice is grown mostly in Rio Grande do Sul and Santa Catarina, on areas larger than 20 hectares. This production is completely mechanized and follows the traditional system: preparation of the land, leveling, seeding and ridging on dry land. Planting (in October to December) is done with a seeder in furrows or by broadcasting, at a density of 150 kg of seed/ha. For controlling narrow-leafed weeds, Propanil is usually applied, and for broadleaf species, 2,4-D is used. Generally, nitrogen fertilizer is applied to the foliar cover. This treatment is made between 50 and 60 days after germination, using 40 to 60 kg/ha of nitrogen. Sometimes, before seeding the crop, phosphorus (40 to 80 kg of $P_2O_5$/ha), potassium (30 to 60 kg of $K_2O$/ha) and nitrogen (10 kg/ha) are applied. To prevent the incidence of blast, some producers apply fungicides such as Bla-S, Kitazin, Kasumin and Benlate. The use of insecticides for controlling insects is very limited. In some cases organophosphorus insecticides (Dimicron 100, Endrin 50 and Metasystox) are employed to control the armyworm and stink bugs of roots. Harvesting is done with combines in this system.

The rotation system employed in the Rio Grande do Sul involves planting of rice during the first year and cattle pasturing during the next two years.

Varieties grown

The principal varieties grown under upland conditions in 1977-78 were IAC 47, IAC 25, IAC 1246, Batatais, Bico Ganga, Dourado and other native Indica varieties.

In Rio Grande do Sul the principal varieties utilized for irrigated production during the same period were Bluebelle, EEA 404, EEA 406, IRGA 407, Bico Torto, EEA 405 and CICA 4; Bluebelle occupied more than 50 percent of the total area seeded in this state (520,000 hectares).

## Visits and observations

The monitoring group visited the central offices of EMBRAPA in Brasilia; CNPAF and its research and rice production projects in cooperation with Agrovet and the Secretary of Agriculture in Goiânia; the Agronomic Institute of Campinas and the Experimental Fields of rice at Campinas; the Rice Experiment Station of IRGA in Porto Alegre; commercial production fields at Camaquã and the cooperative projects of rice research of UFPEL/EMBRAPA, in Pelotas (Appendix 4).

## EMBRAPA

The Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) is a public corporation of national status, connected to the Ministry of Agriculture. The corporation was legally created in December 1972 and has administrative and financial autonomy. EMBRAPA is responsible for coordinating and promoting agricultural research throughout the country. Its activities are directed to the establishment of a cooperative system at the national scale, in cooperation with the states, universities and private enterprises. EMBRAPA has several national and regional research centers which are classified as follows:

- Eleven national research centers for the following agricultural products or enterprises: wheat; rice and beans; maize and sorghum; cassava and fruits; cotton; soybeans; dairying; beef production; rubber; and swine and goats.

- Three regional research centers: the Cerrados Center, in the Federal District; the Semiarid Tropic Center, in Pernambuco; and the Humid Tropic Center, in Pará.

- A Center for Technology and Processing of Agricultural Products, in Rio de Janeiro.

- Three centers of complementary services: one each for Genetic Resources and Basic Seed Production, both in the Federal District and the Center for Survey and Conservation of Soils, in Rio de Janeiro.

- Twenty-five research units at the state and territorial scale, located in principal production zones.
- Nine state agricultural research companies located in Minas Gerais, Espírito Santo, Goiás, Santa Catarina, Río de Janeiro, Pernambuco, Bahia, Ceará and Maranhão.
- Three integrated agricultural research programs in São Paulo, Paraná and Río Grande do Sul.

EMBRAPA has established a cooperative system of international research with the object of obtaining human and financial resources to develop Brazilian agricultural production. The corporation collaborates with the following entities: BIRF, BID, IICA, USAID, FAO, CIMMYT (Mexico), ICRISAT (India), CIAT (Colombia), IRRI, (Philippines), CIP (Peru) and the governments of Western Germany, Australia, Canada, France and Japan.

CNPAF

The National Center for Research in Rice and Beans (CNPAF) is located in Goiânia, Goiás, at latitude 16°40'21" South and longitude 49°15'29" West. The site is 764 meters above sea level and has an average maximum temperature of 29.4°C and an average minimum temperature of 15.2°C. Average annual rainfall is 1487 mm.

At CNPAF, 23 professionals (5 agronomists (B.S.), 15 at the M.S. level and 3 at the Ph.D level) work in rice research. Fifteen professionals work with beans (1 at the B.S., 13 at the M.S. and 4 at the Ph.D. levels).

With regard to professional training, the center has a primary objective of preparing 80 percent of the personnel for the doctoral level. The National Program for Rice has several research projects in CNPAF, Capivara and Agrovet. Appendix 4 shows the experiments that were in progress in the 1977-78 season.

The principal objective of the Breeding Program is to obtain high-yielding varieties with resistance to drought, blast, brown leaf spot, leaf scald and to insect pests, especially Elasmopalpus.

The program also does research on cultural practices, especially methods and densities of seeding, fertilization and chemical control of weeds, diseases and insects.

The program initiated an international cooperation project in 1975 with the introduction of IRRI nurseries. In 1976, nurseries from the cooperative IRRI/CIAT program were introduced. During the present season nurseries under evaluation were the IRON, IURON, IURYN and IRBN of IRRI and the VIRAL-S, VIRAL P and the VIRAL-T of the cooperative IRRI/CIAT testing program. In addition, the program has germplasm of some 5000 lines and varieties of rice of either national origin or introduced from more than 30 countries.

IRTP nurseries. At CNPAF, the monitoring team visited the IRBN and IURON from IRRI, which were seeded in infection beds (Fig. 11). Most of these materials showed resistance to blast while the susceptible controls had infection levels of 4 to 5. In the infection beds the team also observed one of the program's nurseries for evaluating promising materials for their reaction to leaf scald. In the IURON, the majority of the lines had good performance but some were highly susceptible to blast (for example, ASD 7). Appendix 5 presents the selections that were most promising.

Figure 11. Evaluation of genetic material for resistance to blast in infection beds at CNPAF, Goiânia, Brazil.

Experimental trials. In the experimental field comparative yield trials were observed under upland conditions. In these trials were 8 late and 5 early varieties, most of which came from the Agronomic Institute of Campinas. Susceptibilities of the materials to brown leaf spot and to leaf scald varied from moderate to high.

In this same trial, the majority of the varieties were severely affected by drought. One of the objectives of the experiment was to measure losses from blast. Most of the early varieties were highly susceptible, and in particular, the variety Batatais which showed 90 percent rotting damage of the panicle neck. Among this group of materials, the variety IAC 25 was outstanding, presenting tolerance both to drought and blast. Among the late varieties, the long-grained IAC 47 variety was outstanding for its tolerance to drought and blast.

A field of segregating lines, composed of progenies of crosses made for lodging resistance, showed high susceptibility to blast, brown leaf spot and leaf scald as well as severe symptoms of drought damage.

Another experiment was visited in which scientists were investigating the treatment of seeds with chemical compounds versus different planting densities, to offset attacks of Elasmopalpus.

In all of the trials observed at this location, experimental management was excellent; the incidence of drought conditions and of diseases provided very appropriate conditions for selecting promising material.

The Capivara Field of CNPAF

IRTP nurseries. In the Capivara Field of CNPAF the monitoring team observed the VIRAL-S from IRRI/CIAT and the IURYN-77 from IRRI, which were both at the flowering stage (Fig. 12).

In the VIRAL-S, lines IRAT 13, IR 36, IR 3880-13, MRC 172-9 and the local check (IAC 25) were outstanding; the other materials were highly susceptible to leaf scald and some lines were highly susceptible to blast. Generally, performance of the majority of the lines was not satisfactory for upland conditions.

**<u>Figure 12.</u> Agronomist José Hernández (Peru) shows professionals of CNPAF certain anomalies in the IRTP nurseries seeded at that location.**

In the IURYN-77, most lines were highly susceptible to leaf scald. Only a few lines were superior in performance (Appendix 5).

One field of the variety IAC 47 planted for seed production was observed in the tillering stage. The lot was planted under upland conditions with 50 cm between the furrows. The crop was completely free of weeds and the variety showed good performance.

<u>Pilot Project — Secretary of Agriculture/EMBRAPA</u>

The group visited a pilot project for irrigated rice production at a farm 45 km from Goiânia. The project is under the direction of the Secretary of Agriculture, in collaboration with professionals from EMBRAPA's Rice Program at Goiânia. The project was initiated in 1977 and involves 6 agronomists and 8 field assistants who are in charge of supervising the rice crops, from land preparation of lots through harvesting. This type of project will be enlarged to train personnel and produce basic seed, which is one of the main priorities for improved irrigated and upland rice production in most of the producing states.

This particular project will be for 350 hectares of which 120 are now under production. The central object is to transfer technology of irrigated rice production from Minas Gerais to Goiás.

The variety being grown in the project was IR 22, which exhibited good performance. Lots were observed which were near harvest (115 days of age). The plants were 110 cm high and showed only light symptoms of leaf scald and sheath blight and no symptoms of blast. The planting had been seeded at a density of 100 kg of seed/ha and fertilized with 300 kg/ha of 5-32-14 plus minor elements.

Other trials under way included varietal comparisons versus different levels of nitrogen applied, in order to provide the best recommendations to farmers.

The Agrovet Experimental Field

IRTP nurseries. At this location the monitoring team saw the IRRI/CIAT VIRAL-P and VIRAL-T as well as the IRON-77 of IRRI.

Growth of most of the materials in the VIRAL-P was irregular, possibly because of the poor soil conditions. These nurseries were planted between October 15 and November 5, 1977, and therefore were nearly ready for harvest. Harvest time for most of the lines in the VIRAL-P had already passed; diseases observed were leaf scald, brown leaf spot, and in some lines, blast symptoms.

Better performance was observed among the lines of the VIRAL-T, although moderate symptoms of brown leaf spot and blast were present on foliar areas; no blast symptoms were seen on the panicle necks. Most of the lines in the IRON were flowering and exhibited good performance. Generally, the experiments were well-managed and the results will be very useful in selecting improved varieties.

Instituto Agronômico de Campinas (IAC)

Dr. Lourival Carmo, the Director General, welcomed the monitoring team to this facility and briefly explained its activities.

The IAC was established in 1887 by the Emperor Don Pedro II. The Institute is dedicated to basic and applied research on plants, soils, the climate and cultural methods.

Research on agricultural problems is done in well-equipped laboratories, screenhouses and insect-rearing facilities, with the objective of rapidly increasing crop productivity. The scientific team working at this center is evaluating more than 500 trials.

The Institute has eight divisions under which the departments for crops and basic disciplines function. Work is done on cotton, rice, coffee, sugar cane, citrus, beans, fruits (peaches, cherries and grapes), vegetables and soybeans. A commission has the responsibility of coordinating the crop research projects and execution of the trials is done by the professionals.

The Institute has an adequate budget which now is 10 million dollars. The major part of the research efforts (90 percent) is directed to applied research. The Institute has contributed to a rapid change of the agricultural production structure in São Paulo — from coffee in monoculture to a diversification of basic crops.

The Institute has a total of 2500 employees among which are 223 agronomists, 18 at the M.S. level and 50 at the Ph.D. level.

The Rice Program of the Institute is located at the Experimental Station in Campinas, occupying an area of 700 hectares. The site is at latitude 22°05' South and longitude 47°05' West, at an altitude of 669 meters. Average annual temperature is 20.6°C and average annual precipitation is 1385 mm. In addition to this station, work is done on 17 other regional experiment stations in a network covering the entire state.

The Rice Program has been directed by Agronomist Derly Machado de Souza since 1963. The program has five full-time professionals and they receive help from personnel in three other disciplines. The principal objective of the program is to select, through hybridization, varieties for upland conditions that are resistant to drought, blast, brown leaf spot and sheath blight. The program has also begun research to select varieties for irrigated conditions, since the state government is acquiring land for this system of cultivation. Presently, 95 percent of the area planted to rice in São Paulo is under the upland system.

The germplasm bank is composed of 5000 lines or varieties. Panicles of these materials are stored in a cool room at a temperature of 11°C and at relative humidity of 35 percent. Under these conditions, the germplasm can be guaranteed to remain in good condition for more than 10 years.

Appendix 4 shows the different experiments visited by the monitoring team at the Experimental Station in Campinas.

IRTP nurseries. Nurseries observed were the VIRAL-P and the VIRAL-T, seeded November 17, 1977. Performance of the varieties in the VIRAL-P was satisfactory. Many lines were superior or equal to the local check (Appendix 5). The material was nearly ready for harvesting and problems of blast or brown leaf spot were not observed on any lines (Fig. 13).

The VIRAL-T had several lines that were very superior to the local check, among them, the selections BR 51-74-6 and BR 4 of Bangladesh and the lines BG 374-1 and BG 375-1 of Sri-Lanka.

**Figure 13.** D.M. de Souza (Brazil) observes the VIRAL-P and VIRAL-T nurseries planted under irrigated conditions at the IAC.

Experimental trials

The monitoring team observed the behavior of promising material from the Rice Program (252 lines), which was seeded in infection beds for evaluation of resistance to blast; materials were being compared with IAC 162 (susceptible check) and Tetep (resistant check) (Fig. 14). The trial materials included the varieties CICA 9 and CICA 7; CICA 9 had a blast infection grade on the foliage of type 6 to 7 (equal to IAC 162), while CICA 7 showed type 1 infection (equal to Tetep).

Materials introduced from IRRI were also being evaluated in these infection beds for cultivation under upland conditions. The trial also included the varieties Salumpikit and IAC 25, which showed drought tolerance.

Under greenhouse conditions scientists were studying the differentiation of blast races present in the region and in other rice zones of the country, so that differential varieties could be utilized. Under similar conditions promising materials were being evaluated for resistance to brown leaf spot and sheath blight, using a spore suspension as the inoculant. Checks being used for the brown leaf spot

Figure 14. Agronomist Derly M. de Souza (Brazil) explains to Dr. J. O'Toole, of IRRI, the techniques utilized at IAC to evaluate genetic material for blast and drought.

experiment were the varieties Saturno and Dawn (resistant and susceptible, respectively).

The team also visited a varietal comparison trial under upland conditions which was seeded in furrows 30 and 60 cm apart. The material in the trial was seriously affected by drought, blast, brown leaf spot and leaf scald (Fig. 15). The drought period that affected the trial had lasted 20 days at the time the plants were at the stage of maximum tillering. Most of the upland varieties were severely affected by the drought. A few upland varieties and some improved lines were recovering well, but potential yields were estimated to be very low. The plants 60 cm apart showed better tolerance to the drought, compared to those 30 cm apart. The variety Batatais showed a yellowing and rolling of the leaves, but the cause could not be determined. The symptoms resembled those caused by hormonal herbicides, however, no herbicides had been applied to this field.

Near the experimental lot of the varietal comparisons, a rice crop (5-6 hectares) belonging to small farmers was observed. The variety planted was IAC 120 (tall and with a long grain). The crop was in good condition as the field was in a low area with high moisture; this situation is considered to be a crop of favored upland rice. The potential yield was estimated to be 2.3 ton/ha (Fig. 16).

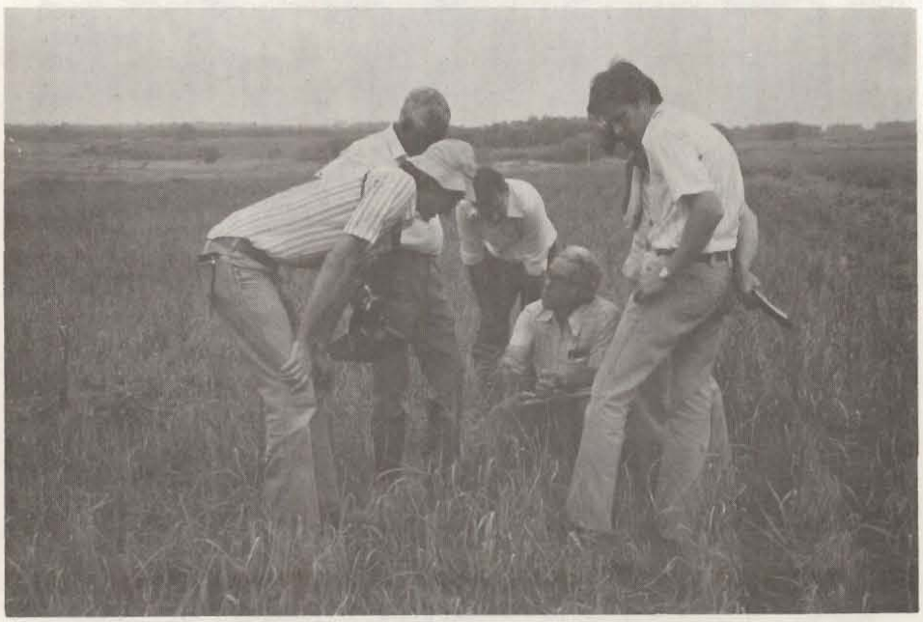

Figure 15. The Monitoring Group observes problems from drought and diseases at IAC, Campinas, São Paulo, Brazil.

Figure 16. Small farmers' upland rice crops of the variety IAC 120 at Campinas, São Paulo, Brazil.

Plots of promising semidwarf lines (mostly introductions) were visited which were at the stage between tillering and first flowering. Most of the lines had irregular performance. None of the dwarf varieties had sufficient vegetative growth to permit their setting seed, indicating that this type of material is not adequate for upland conditions. It was concluded that for upland culture in Brazil, varieties of intermediate or tall stature are required (Fig. 17).

Figure 17. D.M. de Souza (Brazil) explains to M. Rosero (IRRI), J. Hernández (Peru), J.C. O'Toole (IRRI) and P.S. Carmona (IRGA-Brazil) problems of dwarf varieties under upland conditions in Brazil.

Among the work being done for irrigated conditions was a trial comparing promising selections from the program and six introduced varieties. The team visited this experiment. One outstanding material was line P 899-55-6-4-6-1B which will be named as a variety in 1978. Also observed was line IR 841-63-1-9-33 which was made available as a variety resistant to blast two years ago, but became susceptible in 1977.

The management of the diverse experiments under irrigated conditions was excellent and very marked differences could be detected among the materials under study.

<u>Seed production</u>. The team visited several plots for seed multiplication of commercial varieties and promising introduced lines, under irrigated conditions. Among the materials seen were CICA 8, line 4440 selection 10. Both materials were flowering and their performance was satisfactory.

It is important to note that the majority of the varieties cultivated under upland conditions in Brazil have been developed by IAC. Among the principal ones are IAC 554, IAC 1246, IAC 47, IAC 25 and IAC 1391.

The selections IAC 5130, IAC 22, IAC 5067, IAC 164, IAC 165, IAC 5128, IAC 5032 and IAC 1131 are being evaluated as promising materials for upland conditions. The program hopes to select one or two of these varieties over the next two or three years for commercial production.

The breeding strategy and the results obtained by the Rice Program, under the direction of Agronomist Souza, ought to be shared with other programs. The crosses that have been made and their progenies give some idea of their applicability (Fig. 18). The germplasm base introduced by the material has good adaptation.

<u>The Instituto Rio Grandense do Arroz (IRGA)</u>

The monitoring team was received by the directors of the Institute, in Porto Alegre. IRGA is an institute for research in irrigated rice production in the state of Rio Grande do Sul and is under the Secretary of Agriculture.

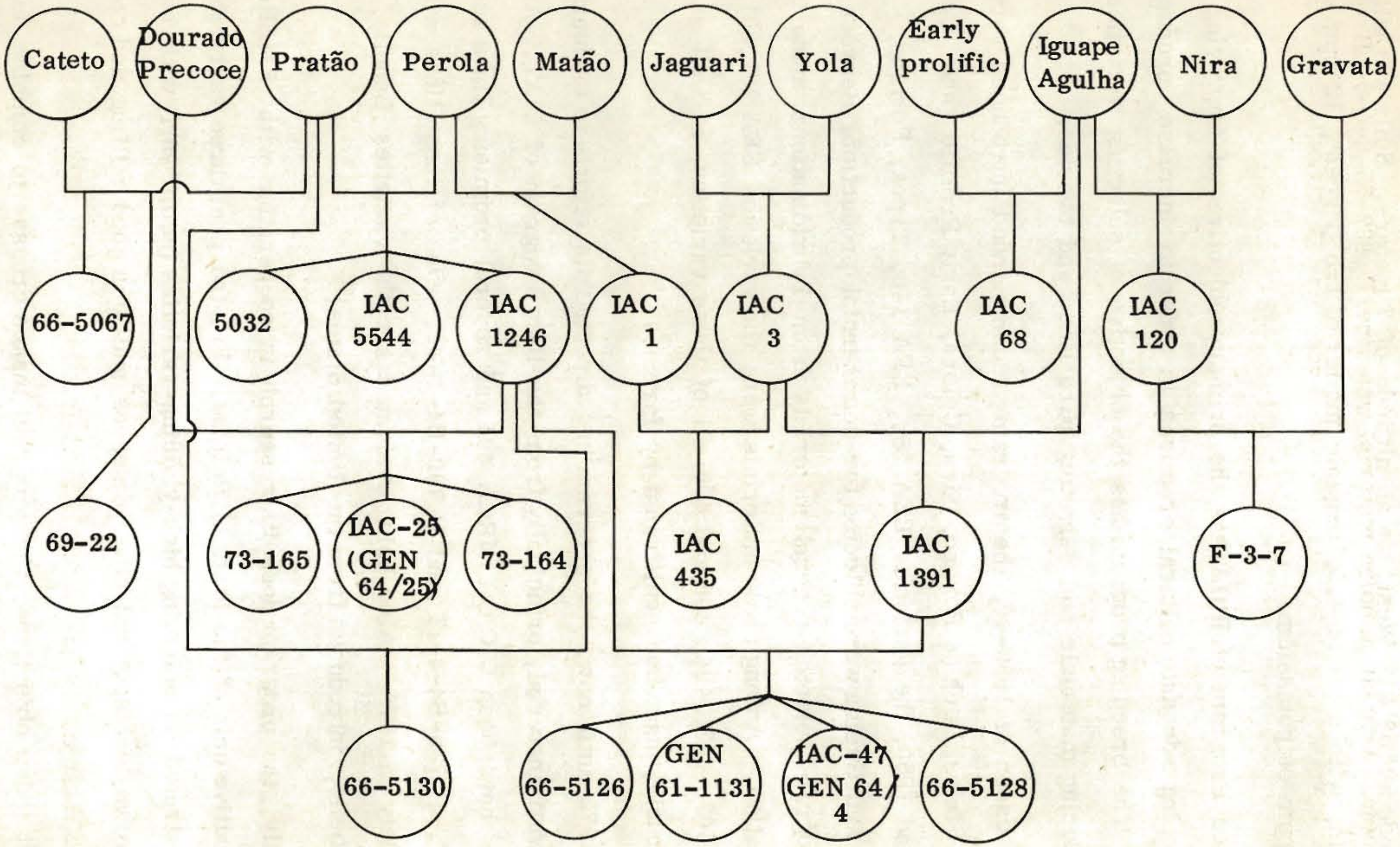


**Figure 18.** Pedigree history of IAC upland varieties.

The Experimental Station of IRGA at Porto Alegre was founded in 1939. The station has an area of 700 hectares and is located at latitude 29°55'30" South and longitude 50°58'21" West, at an altitude of 7 meters. Soils are silt-clay, of alluvial origin, with a pH of 4.5, organic matter of 1.5 percent, 12 ppm of phosphorus and 30 ppm of potassium.

The Rice Program of IRGA has the primary objectives of improving varieties and developing adequate cultural practices in order to increase productivity per unit area. The breeding program has the objective of selecting varieties by means of introducing materials and selecting pure lines and hybrids.

In the season of 1939-40, the program recommended introduced varieties from the United States, such as Rexoro, Nira, Caloro, Early Prolific and Colusa. Between 1942 and 1950, the varieties EEA 388, EEA 140, Tapes, Fortuna, Japonés, Blue Rose and Guaiba were selected for commercial production. Between 1959 and 1966 the program selected several materials from hybridizations made in the experimental station. Among these materials were the varieties EEA 201, 301, 302, 303, 304, 401, 402, 403, 404, 405 and 406; all of these varieties, as well as those mentioned previously, have been cultivated by farmers.

From 1972 until now, the program has directed its efforts to evaluating introduced semidwarf material, principally from the Rice Program of CIAT. Among the introductions have been CICA 4, IRGA 404 and several promising lines such as P 793-B4-38-1T, P 798-B4-4-1T and P 790-B4-4-1T. One of these lines will be named as a variety in 1978. Also being evaluated are the varieties Labelle, Lebonnet and Bluebelle, introduced from the United States.

Presently, the program does its research in cooperation with EMBRAPA, through the executive unit of the State in Pelotas. For the past three years, the program has concentrated on selecting high-yielding varieties (semidwarf) with resistance to blast, brown leaf spot and other diseases and with good milling and cooking qualities.

To meet these objectives, the program makes crosses to combine desirable characteristics from semidwarf varieties or lines introduced from CIAT or IRRI, with blast resistance from the parents Tetep, Dissi Hatiff, Carreon and C46-15.

The program is studying approximately 400 introductions and 4000 segregating lines, which have combinations of semidwarf plant type, good grain characteristics and blast resistance. From this material, the program hopes to select at least four varieties for delivery to farmers in 1980.

The introduction of varieties or pure lines from IRRI has not given satisfactory results consistent with the IRGA Rice Program's objectives. This is mainly because of the diversity of climatic, edaphic and agronomic conditions existing in Rio Grande do Sul that are different from those at IRRI.

The cooperative project of IRGA and EMBRAPA has great importance for the Rice Program because it allows planting (between May and October) of segregating or promising materials at other experimental centers under EMBRAPA's direction. For example, the crosses that EMBRAPA makes in the UEPAE at Pelotas can be replicated in the IRGA Experiment Station. Seeding of segregating material from IRGA can be advanced in one generation by means of its planting at EMBRAPA's UEPAEs, where there are no low temperature problems during the period between May and October.

<u>IRTP nurseries.</u> The VIRAL-P and the VIRAL-T were seeded October 28, 1977. Performance of the varieties in the VIRAL-P was irregular; some varieties showed little growth and others were inferior to the local check. IR 36 exhibited the best behavior. In the VIRAL-T, the majority of the varieties showed yellowing and little growth because of an excess of rain during the planting period. Line BR 4 and the varieties IRGA 406 and CICA 9 were superior to the rest of the varieties (Fig. 19).

<u>Experimental trials</u>

The monitoring team visited infection beds for the evaluation of introduced segregating and promising materials for blast resistance; materials were in the seedling stage. Tetep was being used as the resistant check and the susceptible checks were Bluebelle and Fanny. Part of the segregating material was resistant and the susceptible varieties had infection levels of 7 to 8 (Fig. 20).


**Figure 19.** Yield nurseries of early varieties (VIRAL-P, 1977), planted at the IRGA Experiment Station, Porto Alegre, Brazil.

Also visited was a varietal comparison trial with different seeding dates which was designed to compare the performance of introduced varieties or promising lines with that of varieties of the program (Fig. 21).

In the $F_2$ segregating material, composed of 112 populations, good genetic variability was observed. The field of germplasm, composed of 500 lines introdu-

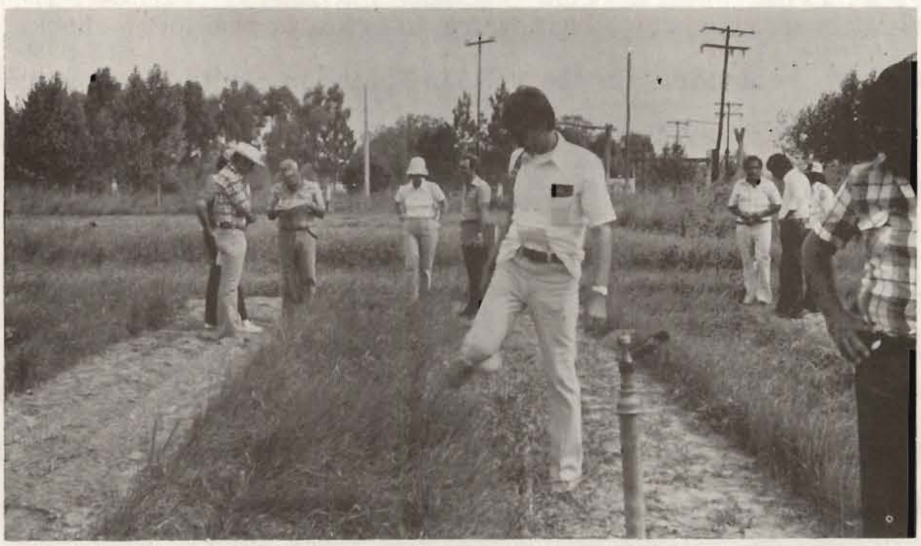

**Figure 20.** J.C. O'Toole (IRRI) and other members of the Monitoring Group observe genetic material under evaluation for blast resistance at IRGA.

Figure 21. P.S. Carmona, Coordinator of the IRGA Rice Program, explains the cultural practices employed in yield trials.

ced and selected by the program, was at the maturity stage. A large number of materials was observed with good plant type and long grains.

The preliminary and advanced yield trials were planted with two levels of nitrogen, to determine the yield of promising materials and their response to nitrogen. In these trials and in the seed multiplication plots, the superiority of line P 798-B4-4-1T was evident and it will be named as a variety in 1978.

A regional variety trial was observed in which some promising varieties such as CICA 9 and CICA 7 were being compared. Plots of CICA 9 showed a severe incidence of straight head.

Generally, the experimental fields at the IRGA Experimental Station were receiving good management and the objectives were well-oriented for producing varieties of high productivity.

Baragem do Duro Irrigation District in Camaquã

Approximately 25,000 hectares of rice are grown in the municipality of Camaquã. The irrigation district has the capacity for irrigating 10,000 hectares.

The system has four principal canals and many secondary canals for distributing water to the rice crops. The monitoring team was received by Agronomist Celenio Oliveira, who was trained in rice production at CIAT.

Crops belonging to a community of colonists, who own 20-hectare farms, and large crops of private companies or private farmers with areas of 200 to 300 hectares were observed in this area.

In the 1977-78 season, the variety grown most was Bluebelle, which is well-adapted to the conditions predominating in the region and yields more than 4.5 ton/ha.

### Faculty of Agronomy, University of Pelotas

A research agreement exists between EMBRAPA and the University of Pelotas which has the objective of resolving rice production problems in the municipality of Pelotas, one of the major producing areas in Rio Grande do Sul. The cooperative project includes the experiments listed in Appendix 4.

## PARAGUAY

### Status of the crop

#### General aspects

Paraguay has conditions similar to those of the states of Rio Grande do Sul in Brazil and Corrientes in Argentina. However, as a rice research program has not yet been established, production is limited to that of large producers who import technology from the neighboring countries. Although the total upland rice area in Paraguay is low, the area cultivated in 1976-77 tripled from that of 1971-72 (from 5000 to 15,000 hectares). Technology for upland culture has been introduced from Brazil.

In Paraguay, rice is grown under both upland and irrigated systems. Irrigated production is concentrated in the departments of Itapúa, Misiones, Cordillera and Paraguarí. Upland production is in the departments of Alto Paraná, Canendiyu, Amambay and part of Itapúa.

Table 1 shows the area, production and average yield of the two growing systems. Production in 1976-77 (80,000 tons) met the national demand (45,000 tons) and generated a surplus of 23,000 tons of paddy rice, which was inadequate for external markets mostly because of low grain quality. Some 7000 tons were destined for seed use.

Rice consumption in Paraguay is low (11.2 kg of milled rice per capita annually), not because of production deficits, but due to the high price and deficiencies in distributing rice to consuming areas.

Total area planted in the 1976-77 season (37,500 hectares) was characterized by three levels of exploitation: 56 percent in areas of less than 5 hectares; 40 percent on areas of 5 to 50 hectares and 4 percent on areas of more than 50 hectares.

The production system on the small areas corresponds, for the most part, to tenant producers who lack technical and credit assistance which does not allow them to use improved production methods. The irrigated system of cultivation is used on most of these exploitations.

On the areas of 5 to 50 hectares the irrigated production system is also most frequently used and the technology level is of an intermediate level. However, the use of selected seed and agrochemical inputs (fertilizers and herbicides) is still limited.

The largest farms of more than 50 hectares employ the highest level of technology including completely mechanized cropping systems. These companies or agricultural corporations are directly in charge of the production, benefits and distribution of milled rice for both internal and external consumption.

Varieties grown

Varieties cultivated most in the 1976-77 season were Bluebonnet 50 (30 percent of the area), CICA 4 and CICA 6 (20 percent of the area), Fortuna and Blue Rose (35 percent of the area) and other varieties of diverse origin (15 percent of the area). The varieties CICA 7, CICA 9 and line 4440, named Adelaida 1, are in the stage of being distributed.

## Limiting factors

The primary problems in rice research and production in Paraguay include:

a) Lack of varieties.

b) Lack of certified seed.

c) Blast incidence in some irrigated varieties (Blue Rose).

d) Lack of personnel trained in improving and producing rice.

e) Lack of a well-structured Rice Program at the national level with its own experimental areas.

## Visits and observations

### Promoción Agropecuaria S.A.

The team visited the Promoción Agropecuaria S.A. company, located in Arroyos y Esteros, 50 km northeast of Asunción. At this company the Rice Program of the Ministry of Agriculture and Livestock (MAG) carries out regional variety trials; the company is dedicated to the commercial production of rice and to livestock raising.

The Rice Program has its headquarters in the National Agronomic Institute, in Caacupé, 48 km north of Asunción. Research work with rice was interrupted for several years and reinitiated again in 1970. Research is concentrated on the introduction and selection of improved varieties with high yield and good milling qualities, both for irrigated and upland conditions. Experiments are also under way with fertilization and weed control.

The program has only one professional at the M.S. level but receives the help of personnel in the Soil Department and from extension agents who grow the regional trials. By means of the regional trials, the program has evaluated material introduced from CIAT and since 1972 has recommended CICA 4 and IR 22 to the farmers. Presently, the varieties CICA 6, CICA 7, CICA 8 and CICA 9 are in the diffusion stage.

A regional trial was observed at Arroyos y Esteros in which were being evaluated 14 lines introduced from CIAT in 1975, 17 lines and/or varieties introduced from Brazil and 7 introduced from Argentina (Fig. 22). The material introduced from CIAT was generally performing well in this region. Growth of CICA 6, CICA 7 and CICA 9 was normal; CICA 7 was superior to CICA 9. Moderate symptoms of brown leaf spot, narrow brown leaf spot and sheath blight were observed on all the material.

The Promoción Agropecuaria S.A. company is owned by Mr. José Pappalardo, and covers an area of 14,000 hectares of which 7000 are suitable for rice production. About 500 hectares of rice are grown annually. In the 1977-78 season, 412 hectares were planted with CICA 6, 28 with CICA 7, 32 with CICA 9 and 40 with line 4440. Several lots of CICA 6 and one lot of CICA 7 were observed. The CICA 9 and line 4440 lots had already been harvested, with average yields of 5.5 ton/ha. It is important to mention that when the tall varieties Bluebonnet and Fortuna were planted, yields varied from 2.8 to 3.5 ton/ha; these yields have been doubled with the semidwarf varieties.

The lots of CICA 6 (seen at maturity) had received good management. The variety was well-developed and was producing well. However, some small areas of the fields were affected by sheath blight. Also observed was some red rice and areas infested with barnyard grass (E. colonum). The lot of CICA 7, which was being harvested (Fig. 23), showed good development and yielded well; brown leaf

Figure 22. The Monitoring Group observes a regional trial of the National Rice Program planted at Arroyos y Esteros, Paraguay.

Figure 23. The Monitoring Group observes a commercial field of CICA 7 being harvested at the Promoción Agropecuaria at Arroyos y Esteros, Paraguay.

spot affected the foliage of this variety and some plants had symptoms of sheath blight. The period for harvesting the lot of CICA 7 had passed, as it should have been harvested 20 days earlier. The high temperatures (36°C) and the untimely harvest affect the quality at the mill; the yield of head rice is very low. This problem has occurred with crops of CICA 6 because not enough combines are available to do the harvesting. It has been recommended to make staggered plantings of 50 hectares every 10 days, so that harvesting is done on time with the combines available, and in this manner, low yields of head rice at the mill are avoided.

Rice production at this company is according to a high technological level. The fields are well-leveled and divided into lots of 4 hectares with dikes. Planting is done by broadcasting 140 kg of seed/ha. A 9-36-12 fertilizer is applied at 150 kg/ha. After planting, 100 kg/ha of urea (45 percent) is applied in split doses at 30 and 60 days. Propanil is applied for weed control. Insects (stink bugs) are controlled, but not diseases. The land rotation system utilized consists of rice for two or three years and grazing of native grasses by cattle during the next three years.

The company mills the rice produced and distributes it (packed with the commercial seal "Adelaida") to principal markets of Asunción and also exports to neighboring countries. Presently, the company is providing commercial seed of line 4440, from CIAT, under the name Adelaida 1.

Afterward, the group drove to the National Agronomic Institute of MAG in Caacupé. This institute is located 48 km from Asunción, at an altitude of 228 meters, at latitude 25° 24' and longitude 57° 06' West. Average annual precipitation is 1540 mm and the average annual temperature is 22.6°C.

## PERU

### Status of the crop

#### General aspects

Rice production in Peru is of third importance, after maize and potatoes. Socially, rice is also of great importance since it generates 1.7 million jobs each season, which represents 28 percent of the value of the gross national rice production.

As a consequence of its better economic benefits, compared with other crops, it is not considered likely to be replaced very soon in the coastal valleys; rice will continue to be cultivated for several years in this region.

This situation has come about thanks to the introduction of high-yielding varieties which have been grown under good management techniques. These have substantially increased yields and in some cases, have doubled them; for example in the Camaná Valley, the local yield from using variety Lambayeque 2 (5.2 ton/ha) was doubled (10 ton/ha) by cultivating IR 8. Increases in yield and area planted has permitted the country to be self-sufficient since 1970.

During the 1976-77 season, 133,700 hectares were grown of which 80 percent were irrigated and the rest were under upland culture. In the irrigated production system, 96 percent of the area was seeded by transplanting and 4 percent was direct-seeded. This season total production was 639,600 tons of paddy rice, with average yields of 5.5 ton/ha under irrigated conditions and 1.7 ton/ha on upland conditions (Table 1).

Production systems

Irrigated rice. The irrigated rice zone is concentrated in the North Coast (valleys of Jequetepeque, Chancay, Alto Piura, Chira and Tumbes), in the high jungle (Jaem and Bagua) and, to a lesser extent (7000 hectares) on the South Coast (Camaná Valley).

In the valleys of the North and South Coast, with the exception of Chira where availability of irrigation water is assured by the reservoir at Poechos, the irrigation pattern is irregular and the rice crops depend on the flow of waters of the rivers descending from the western Andes range. The climate in the valleys is subtropical, without severe problems of low temperatures; relative humidity is low and solar radiation is high. In the high jungle, the climate is similar to the tropical rice zones; there are no temperature problems and rice can be planted at any time of the year. However, production is limited by the availability of water.

The soils of the coastal rice zones are alkaline, of a clay-loam texture, poor in organic matter, and with a medium level of phosphorus and a high content of potassium. The soils are classified as alluvial, without serious drainage problems, except in the low sections near the Pacific Ocean where there are problems of drainage and salinity (on hydromophic soils). The topography is slightly undulating and permits leveling in sections up to 3 hectares. The production system utilizing transplanting is highly technified. All the work of cultivation, excepting the transplanting, is mechanized. Seedling beds are established in October and materials are transplanted when the seedlings are 30 to 40 days old. Planting distances are 25 x 25 cm or 20 x 25 cm, placing three to six seedlings in each site.

Weed control is done manually, when the infestations are minimal, and with herbicides (Propanil, Butachlor and Benthiocarb), when infestations are moderate or severe.

Only nitrogenous fertilizers are applied as there are no responses to phosphorus or potassium. Between 240 and 320 kg/ha of nitrogen is applied to semi-dwarf varieties at two stages (50 percent at 20 days after transplanting and the other 50 percent when the reproducing phase begins). For traditional varieties, the optimum levels are 160 kg of nitrogen/ha for the coastal zones and 60 to 80 kg/ha for the high jungle. The nitrogen source used most is urea.

Harvesting is manual-mechanized or totally mechanized; in the first case, the rice is cut and bound in sheaves by hand and the threshing is done by stationary combines or threshers. In the latter case, all harvesting is done mechanically.

Upland rice. Areas cultivated under upland conditions are located in the Amazonian jungle, all along the Huallaga, Ucayali and Amazon rivers.

Planting in the low and high jungle zones is done manually and directly on the land, placing seed from 20 to 50 cm between each site and using 50 kg of seed/ha.

In the zones near the Amazon River, the soils are clayey. Planting is done by hand, broadcasting pregerminated seed at a rate of 25 kg/ha.

The low jungle is characterized by a humid tropical forest climate, with precipitation of more than 2000 mm annually; soils are Ultisols, acid, little weathered, low in saturated bases and with a high content of aluminum.

The high jungle zone is a dry tropical forest climate; limitations are mainly those of availability of rains.

Gathering of upland rice (cutting and threshing) is done manually.

In the upland zone, problems limiting production include the acid soils and their high aluminum content, irregular distribution of rains and the presence of the diseases blast, brown leaf spot and leaf scald.

Varieties grown

Some 62 percent of the irrigated area was seeded with semidwarf varieties (Naylamp, Inti, Chancay and IR 8) and the other 38 percent, with traditional varieties (Minabir 2 and Radin China). In the upland area the traditional varieties (Fortuna, Carolina and others) covered 92 percent of the area and the other 8 percent was planted with semidwarf materials. The contribution of the semidwarf varieties to national rice production was 64 percent, with the traditional varieties providing the remainder.

Limiting factors

The principal problems affecting rice production in Peru are:

a) Disease incidence, mainly blast, brown leaf spot, leaf scald "hoja blanca" and sheath blight.

b) Low temperatures during the flowering period.

c) Salinity in the low zones of the coastal valleys.

d) Presence of acid soils and those high in aluminum in upland areas.

e) Irregular water flows in the rivers irrigating many of the rice-growing valleys.

f) Untimely application of inputs (fertilizers and herbicides) because of lack of technology transfer generated by the project.

## Visits and observations

### Vista Florida Experiment Station

The National Project for Rice Research of Peru has its principal site at the Vista Florida Experiment Station of CRIA II, 8 km from the city of Chiclayo. The station is at an altitude of 37 meters, at latitude 64°44' South and longitude 79°48' West. Average temperature is 23°C and average annual precipitation is 22 mm.

The National Rice Project was created in 1968, with the principal objective of directing and coordinating crop research. Activities are in close cooperation with the Experiment Stations at Chira (CRIA II); Tulumayo, Yurimaguas and Iquitos (CRIA III) and Arequipa (CRIA IV); the National University Pedro Ruiz Gallo in Lambayeque; the Agrarian University in Tingo María; and the National Technical University of Piura.

Research work is in charge of 19 professionals of the CRIA and 7 of the collaborating entities. Their main objective is to increase production and productivity of rice, in order to meet the needs of the country's population.

The project is well-structured and has the following strategies:

a) To obtain varieties with good plant type and high yield, early maturity, with good grain quality and resistance to insects and diseases.

b) To produce genetic, foundation and registered seed of commercial varieties and promising lines.

c) To develop techniques permitting the better utilization of nitrogen and its sources.

d) To create and formulate methodologies for improving production systems.

Appendix 4 provides details of the different experiments visited by the monitoring team at the Vista Florida Experiment Station and at the University Pedro Ruiz Gallo. All of the experiments were established by transplanting, except for those dealing with methods of seeding. All materials at Vista Florida were between the flowering and maturity stages.

Experimental trials

In the preliminary and advanced yield trials, the material from the program was superior to the introductions from IRRI and CIAT (Fig. 24). Because of their good vigor, plant type and production, the lines from crosses between IR 480 x IR 305 and IR 480 x IR 930 were outstanding. The variety Inti was superior to the other semidwarf commercial varieties selected by the program. Among the introduced materials, the selections Bg 90-2 and Juma 58 were outstanding. Line PNA 46-25, developed in the program, figured as one promising material.

The field with $F_2$-$F_4$ segregating material was very heterogeneous, indicating that mass selection up to the $F_4$ generation allows identification of a diversity of genotypes which will be evaluated later using the pedigree method.

Experiments of the Departments of Entomology and Plant Pathology were well-oriented technically and practically. The station pathologist showed the moni-

Figure 24. The Monitoring Group listens to Agronomist José Hernández' explanat on on promising materials at the Vista Florida Experiment Station, at Chiclayo, Peru.

toring team plants affected by bacterial blight, from which the causal agent X. oryzae had been isolated.

In the herbicide evaluation trials, times of application and dosage were being compared. Among the materials tested were Propanil, Benthiocarb, Butachlor, Oxadiazine and several newer products, especially granular formulations.

Also visited were trials for evaluating the response of 10 varieties to different levels, times of application and sources of nitrogen (urea, ammonium sulfate and coated urea) (Fig. 25).

In fertilization trials done in previous years it was determined that the semidwarf varieties require 240-320 kg/ha of nitrogen and the taller varieties, 160-180 kg/ha. Semidwarf varieties yielded 4 ton/ha less when nitrogen was not applied.

University Pedro Ruiz Gallo

IRTP nurseries. In the field at the University Pedro Ruiz Gallo, the team visited the VIOSAL sent from CIAT. The nursery was planted in a low, poorly drained and highly saline area. Next to this nursery, materials (55 lines) from the National Rice Program were being evaluated. In the VIOSAL, the susceptible check (M1-

Figure 25. Fertilization experiments at the Vista Florida Experiment Station, at Chiclayo, Peru.

48) was seriously affected (grade 7) and several lines had died. Lines IR 2145, IR 2153-26, DA 29, Patnai 23, SR26B, B57-c-Md-10-1, IR 2055-481-2-1-2, Kencana and Pokkali showed tolerance. The experimental conditions were excellent for evaluating resistance to salinity.

Along the way between Vista Florida and the University, commercial crops were seriously affected by a drought that dominated the country during January and

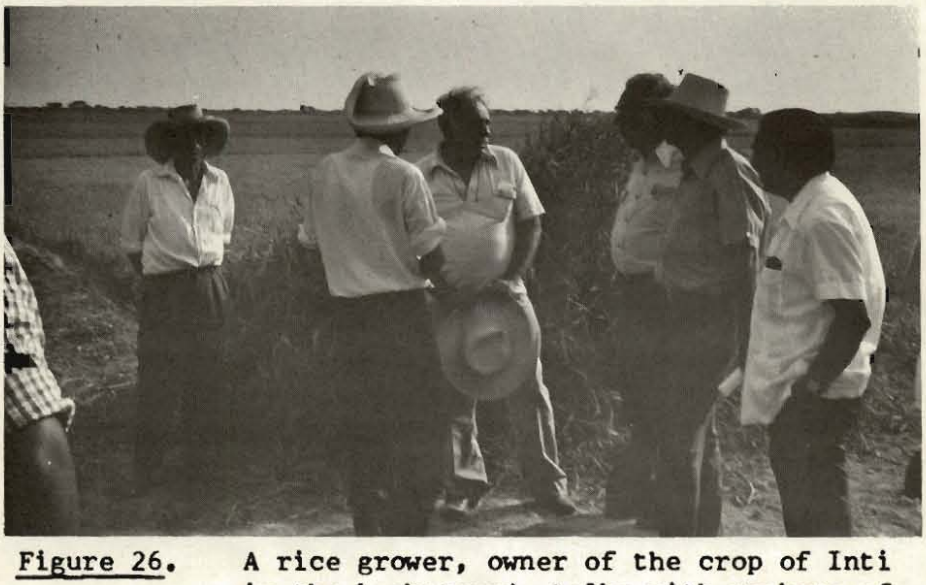

Figure 26. A rice grower, owner of the crop of Inti in the background, talks with members of the Monitoring Group at Lambayeque, Peru.

February. Water in the reservoir at Tinajones was too low to permit supplying irrigation water. The drought seriously affected at least 50 percent of the rice area planted in the Chancay Valley.

In spite of the drought, at Lambayeque two fields of Inti (90 hectares) were observed which were ready for harvesting and in excellent condition. The yield was estimated to be 7-8 ton/ha. These fields were not affected by the drought (Fig. 26).

Unfortunately, the monitoring team was not able to spend very much time in Peru, but it did learn much about the advances and problems of the National Project for Rice Research.

## RECOMMENDATIONS

The monitoring team discussed several aspects of their observations in the different countries visited and from these, makes the following recommendations:

1. Personnel Training

   a) To continue training personnel of the national programs, not only in genetic improvement and rice production, but also in other basic disciplines of rice cultivation, such as pathology, entomology, physiology and soils.

   b) That IRRI and CIAT will technically advise national programs by sending professionals to observe and discuss problems *in situ* and also plan research, if this is needed.

   c) To establish, in IRRI or CIAT, special training courses on rice quality for national program personnel.

   d) To establish regional courses in the different countries to train personnel from one country in another where production systems are similar. For example, training technicians from Bolivia in Brazil or training (for irrigated rice) technicians from Brazil in Peru, etc.

2. Germplasm

   a) To increase shipments of $F_2$ segregating materials from CIAT and IRRI. These materials would be progenies from selective crosses for irrigated and upland conditions. Also, to continue the IRTP nurseries for Latin America.

b) To include in the irrigated nurseries sent to Brazil short-grained materials with resistance to blast and with good milling quality, such as varieties from Egypt, India and Nepal.

c) To send the IRTP nurseries from CIAT and IRRI to Peru.

d) To establish specific nurseries of promising materials for favored upland conditions and soils with salinity problems.

e) Through the IRTP, to establish a better interchange of promising materials for irrigated conditions between Brazil, Argentina, Uruguay and Paraguay. It was suggested to participating technicians that they nominate materials to be included in future nurseries.

3. Monitoring Tours

- To continue the monitoring tours, at least every two years, in order to determine progress in the national programs and to identify new production problems.

4. Upland Rice

- The monitoring team defined the differences between favored and non-favored upland rice. Favored upland rice are those crops in zones with a good distribution of rainfall, seeded on level soils with good water retention capacity and a water table of 50 cm. Non-favored upland rice are those crops grown in zones with an irregular distribution of rainfall, seeded on level or slightly undulating sandy soils. Technicians in Brazil considered non-favored upland rice to be transitory in some states and the change can occur in 10 or 15 years; in other states it will continue to be planted for many years since this type of cultivation pays the costs of acquiring and establishing grasses. Many farmers again plant rice after several years in order to improve the grasses in their pastures.

Based on this fact, in Brazil it is considered urgent to furnish farmers with varieties more tolerant to drought and blast.

5. Personnel and Working Facilities

a) To increase the technical personnel of national programs in accord with their needs. Personnel should be previously trained in the various disciplines of genetic improvement and rice production.

b) To increase the physical facilities for research, such as laboratories and equipment in the programs so that the present personnel and those to come in the future will be able to solve problems more rapidly and efficiently.

Appendix 1. Participants on the monitoring tour.

José Francisco Valente Moraes
Director of the Centro Nacional de Investigación de Arroz y Fríjol
CNPAF/EMBRAPA
Caixa Potal 179
Goiânia, Goiás, Brazil

Derly Machado de Souza
Director of the National Rice Program of the Instituto Agronómico
Caixa Postal 28
13.100 Campinas, São Paulo, Brazil

Paulo Sergio Carmona
Coordinator of the Rice Research Program of the Instituto Rio Grandense do Arroz - IRGA
Caixa Postal 1149
Rio Grande do Sul, Brazil

Wolfgang Jetter
Director of the National Rice Program of the Estación Experimental Agropecuaria of Instituto Nacional de Tecnología Agrícola - INTA
Casilla de Correo 57
Corrientes, Argentina

José Hernández Leyton
Coordinador and Breeder of the National Rice Program
Regional Center of Agricultural Research II, CRIA II,
Experimental Station "Vista Florida"
Apartado 116
Chiclayo, Peru

Harold E. Kauffman
IRTP Joint Coordinator
IRRI
P.O. Box 933
Manila, Philippines

John C. O'Toole
Agronomist
IRRI
P.O. Box 933
Manila, Philippines

Héctor Weeraratne*
Breeder of Rice Program
CIAT
Apartado Aéreo 6713
Cali, Colombia

Manuel J. Rosero
IRRI Liaison Scientist for Latin America
Apartado Aéreo 6713
Cali, Colombia

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* Dr. Héctor Weeraratne participated in the Brazilian portion of the Monitoring Tour, in Brasilia, Goiânia, Campinas and Experimental Station of IRGA, Porto Alegre.

Appendix 2. Institutions, commercial companies and sites visited by the monitoring team in five countries of the southern region of South America.

BRAZIL

- Headquarters of EMBRAPA, Brasilia.
- Centro Nacional de Investigación de Arroz y Frijol CNPAF/EMBRAPA: experimental fields and laboratories, Goiânia.
- Experimental fields of rice of Hacienda "Capivara" and "Agrovet", Goiânia, EMBRAPA.
- Production fields of lowland rice - Secretary of Agriculture, Goiás.
- Instituto Agronómico de Campinas (IAC)
  Experimental Station of Campinas - Experimental fields of upland and lowland rice - Commercial rice favored upland crops of small farmers.
- Experimental Station of Rice - IRGA - Porto Alegre
  Experimental fields and laboratories.
- Irrigation District of Baragem do Duro in Camaquã, Rio Grande do Sul.
- Federal University of Pelotas, UFPEL
  Rice experimental fields UEPAE/Pelotas - Cooperative Project - EMBRAPA/UFPEL.

ARGENTINA

- Interview with the Governor of the Province of Corrientes.
- Agricultural Experimental Station of Corrientes of the Instituto Nacional de Tecnología Agropecuaria - INTA
  Experimental fields of rice, laboratories of entomology, plant pathology and natural resources.

- Commercial rice crops and installations of the farm "Santa Ana Ñu" of Mr. Ernesto Meabe in Corrientes.
- Commercial rice fields and installations of the farm "Las Tres Marías" of Mr. Alexander Cook in Corrientes.
- Rural Society of Formosa, interview with the Minister of Agriculture of the Province of Formosa.

PARAGUAY

- Promoción Agropecuaria S.A. in Arroyos y Esteros of Mr. José Pappalardo
  Commercial rice crops of this corporation and experimental crops of the Rice Program of the Ministry of Agriculture.
- Instituto Agronómico Nacional of the Ministry of Agriculture in Caacupé.

BOLIVIA

- Sub-Experimental Station of Portachuelo, Santa Cruz
  Experimental fields and commercial rice crops.
- Rice areas of the northern part in San Pedro, Santa Cruz
  Regional trials and commercial crops of small farmers.
- Estación Experimental Agrícola de Saavedra (EEAS) - Experimental plots of rice.

PERU

- Vista Florida Experiment Station of the Centro Regional de Investigación Agropecuaria II - Chiclayo
  Experiments of the National Rice Program.
- National University "Pedro Ruiz Gallo" - Lambayeque
  Rice experiments of salinity tests.
- Commercial rice crops in Lambayeque.

Appendix 3. Rice scientists and technical and administrative personnel met by the monitoring group.

BRAZIL

Empresa Brasileira de Pesquisa Agropecuária
EMBRAPA, Brasilia

| | |
|---|---|
| Edmundo Fontoura Gastal | Executive Director |
| Heitor Amaral Oliveira | Chief Department |

Centro Nacional de Pesquisa - Arroz, Feijão
CNPAF/EMBRAPA
Caixa Postal 179
Goiânia, Goiás

| | |
|---|---|
| José Francisco Valente Moraes | Chief CNPAF |
| Ricardo José Guazzelli | Joint Technical Chief |
| Adelson de Barros Freire | Joint Administrative Chief |
| Alvaro Manuel Nunes A.A. Texeira | Rice Breeding |
| Altevir de Matos Lopes | Rice Breeding |
| Anne Sitarama Prabhu | Rice Plant Pathology |
| Australino Silveira Filho | Rice Agronomy |
| Beatriz Pinheiro da Silveira | Rice Physiology |
| Carlos Augusto Matos Santana | Rice-Bean Economy |
| Fernando Maida Dall'Acqua | Rice-Bean Economy |
| Francisco José P. Zimmermann | Rice-Bean Statistic |
| Goes Matsutaro Ajimura | Rice Mechanization |
| Jaime Roberto Fonseca | Rice Seed Technology |
| José Francisco da Silva Martins | Rice Entomology |
| Luis Fernando Stone | Rice Irrigation and Drainage |
| Nand Kumar Fageira | Rice Physiology |
| Noris Regina de Almeida Vieira | Rice Seed Technology |
| Silvio Steinmetz | Rice Climatology |

Secretary of Agriculture - Goiás
Irrigation Project

Francisco Adonais de Morais Sobreira
Benedito D. Cardoso
Jairton de Almeida Diniz
Carlos Nereu Campos

Agrovet

Rice Technical Personnel of CNPAF

Instituto Agronómico Campinas (IAC)
Caixa Postal 28
13.100 Campinas, São Paulo

| | |
|---|---|
| Lourival Carmo Mónaco | Director General |
| Armando Conagin | Director, Feeding Crops Division |
| Derly Machado de Souza | Rice Research Program Coordinator |

Instituto Rio Grandense do Arroz (IRGA)
Caixa Postal 1927
Porto Alegre, Rio Grande do Sul

| | |
|---|---|
| Araré Vargas Fortes | Administrative Director |
| Delcy Gadea de Freitas | Technical Director |

IRGA - Experimental Station of Rice
94.900 Cachoeirinha - RS
Caixa Postal 1149
Porto Alegre, Rio Grande do Sul

| | |
|---|---|
| Clovis Henrique Scherer | Administrator |
| Paulo Sergio Carmona | Coordinator, Irrigated Rice Research |
| Brasil Aquino Pedroso | Rice Agronomy |
| Pedro Roberto de Souza | Ecology |
| Richard Elías Bacha | Soils and Water (Soils Chemistry) |
| Alceu Salaberry Ribeiro | Plant Pathology |
| Jorge Kalil Abud | Weeds Control |
| María da Piedade Vianna Reginatto | Technology (Quality) |
| Sidnei Bicca da Rocha | Seed Production |
| Jaime Vargas de Oliveira | Entomology |
| Alcaldor Fisher Conill | Agricultural machinery |

IRGA - Extension Service
Caixa Postal 67
Camaquã, Rio Grande do Sul

| | |
|---|---|
| Selenio Oliveira | Rice Extension and Production |

Unidad de Ejecución e Investigación Estatal de Pelotas (UEPAE)
EMBRAPA/UFPEL Project
Caixa Postal 553
96.100 Pelotas, Rio Grande do Sul

| | |
|---|---|
| José Francisco Pereira Gonçalo | Rice Breeding |
| Ademir Gonçalves | Rice Breeding |
| José Alceu Infeld | Rice Ecology |

Universidad Federal de Pelotas (UFPEL)
Caixa Postal 553
96.100 Pelotas, Rio Grande do Sul

José Galli

ARGENTINA

| | |
|---|---|
| Luis Carlos Gómez Centurión | General of Division and Governor of the Province of Corrientes |

Instituto Nacional de Tecnología Agropecuaria (INTA)
Estación Experimental Agropecuaria de Corrientes (EEA)
Casilla Correo 57
Corrientes

| | |
|---|---|
| Diego S. Rodríguez | Director EEA |
| Hugo Pescetti | Chief, Extension Agency |
| Pedro Godoy | Supervisor of Extension |
| Wolfgang Jetter | Rice Program Coordinator |
| Rodolfo Capurro | Specialist in Soils and Natural Resources |
| Rafael M. Trujillo | Entomologist |
| Jorge Tanzi | Economist |

Secretary of Agriculture and Livestock of the Province of Corrientes

| | |
|---|---|
| Carlos María Roteta | Secretary |
| Orlando Manunta | Sub-Secretary |
| Miguel Aróstegui | Specialist Rice Extension |

Dealers in Cattle and Rice Productors - Corrientes

| | |
|---|---|
| Ernesto Meabe | Owner of the Farm "Santa Ana Ñu", Loreto District Department of San Miguel |
| Alexander Cook | Owner of the farm "Las Tres Marías" |

Secretary of Agriculture and Livestock of the Province of Formosa

| | |
|---|---|
| Raúl Néstor Maglietti | Minister of Agricultural Business and Natural Resources |
| Hugo W. Roig | Extensionist |

PARAGUAY

Ministry of Agriculture and Livestock - Asunción

| | |
|---|---|
| Luis Alberto Alvarez | Director, Research and Agriculture and Cattle Extension |
| Juan Ciro Spezzini | Vice-Director, Agricultural Extension |
| Nelson de Barros Barreto | Secretary, Technical Coordination |
| Jorge Esteban Rodas | Rice Program Coordinator |
| Martín Guillen | Rice Extensionist |

Promoción Agropecuaria S.A.
Arroyos y Esteros

| | |
|---|---|
| José Pappalardo | Director General |
| José Pappalardo | Manager |
| Conrado Pappalardo | National Senator |
| Oscar E. López | Rice Soils Specialist |
| Antonio Galeano (until Feb./78) | Rice Production |
| Ricardo Samudio | Animal Production |

Instituto Agronómico Nacional - MAG
Caacupé

| | |
|---|---|
| Roberto Casaccia | Director |
| Augusto Fatecha | Soils Specialist |

ABC Color Newspaper
Asunción

| | |
|---|---|
| Aldo Zuccolillo | Director Owner |

BOLIVIA

Centro de Investigación Agrícola Tropical (CIAT)
Agricultural Experimental Station of Saavedra (EEAS)
Casilla 247
Santa Cruz

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|---|---|
| Charles Ward | Entomologist-Cereals, Technical Consultant Consortium for International Development - CID |
| Gustavo Pereyra C. | Director EEAS |
| Francisco Paz Antelo | Rice Program Coordinator |
| Erwin Ortiz A. | Irrigation and fertilization |
| Cleto Siles I. | Agricultural Extension-Rice |
| Hugo Serrate R. | Entomologist - EEAS |
| Hervert Zurita O. | Oleaginous - EEAS |

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| Francisco Kempff M. | President and Head Faculty of Agricultural Sciences |
| Francisco Hubsch N. | Secretary |
| J. Daniel Candia | Partner and Dean Faculty of Agricultural Sciences |
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| Guillermo Kenning V. | Partner and Director of CIMCA |

PERU

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| José Hernández Leyton | Coordinator - Plant Breeder National Project of Rice Research |
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| Federico Minguillo C. | Rice Agronomy |
| Jorge Vélez G. | Rice Agronomy |
| Neptalí Peña O. | Rice Entomologist |
| Rafael Olaya V. | Plant Pathologist |
| Ricardo Vergara U. | Rice Agronomy, Chepen |
| Martín Delgado | Plant Pathologist |
| Luis Navarrete G. | Technology Transference |
| Elva Llontop Castro | Plant Pathologist Bean-Wheat |
| Ubaldo Arcaya M. | Plant Breeder on Rice in Bagua |
| Juán Chiroque | Rice Entomologist in Bagua |
| Andrés Serquen | Rice Agronomy in Bagua |

"Pedro Ruiz Gallo" National University - Lambayeque

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| Luis Castillo G. | Plant Breeder |
| César Morante R. | Rice Agronomy |
| Mercedes de la Torre Ugarte | Plant Breeder |
| Alberto Jiménez | Plant Pathologist |

Appendix 4. Experiments on Rice Research observed by the monitoring group.

## BRAZIL

### CNPAF/EMBRAPA, Goiânia, Goiás

1. Comparison of upland varieties (8 early and 5 late varieties).
2. Segregating lines -Selection by resistance to lodging under upland conditions.
3. Chemical seed protection vs. density of sowing under upland conditions.
4. Leaf Scald National Nursery (infection beds).
5. International Rice Blast Nursery, 1977 - IRBN (infection beds).
6. International Upland Rice Observational Nursery 1977 (IURON).

CNPAF/EMBRAPA, "Capivara" field

1. International Rice Yield Nursery for Latin America - Upland varieties, 1977 (VIRAL-S).

2. International Upland Yield Nursery, 1977 (IURYN).

3. Basic seed production of IAC 47 variety under upland conditions.

4. Studies for classification and rice insects control under upland conditions.

AGROVET (irrigated conditions)

1. International Rice Yield Nursery for Latin America, 1977 Early varieties (VIRAL-P)

2. International Rice Yield Nursery for Latin America, 1977 Medium varieties (VIRAL-T)

3. International Rice Observational Nursery 1977, (IRON)

4. Seed multiplication of 5 commercial varieties.

Experimental Center of Campinas, IAC, São Paulo

Greenhouse

1. Evaluation of blast resistance of 252 observation lines of the Rice Program - Infection beds.

2. Evaluation of drought resistance of lines introduced from IRRI.

3. Identification of blast races - Weekly plantings with 40 varieties.

4. Evaluation of material for resistance to brown leaf spot.

5. Evaluation of material for resistance to sheath blight.

Field

1. Upland yield trials with 8 varieties in two sowing distances (30 and 60 cm between rows).

2. Selection of 954 segregating lines ($F_2$-$F_7$) under upland conditions.

3. Comparative trial of promising varieties and/or lines introduced under lowland conditions - 16 varieties and lines - 4 replications.

4. Comparative trial of varieties under lowland conditions - 8 varieties - 8 replications.

5. First International Rice Yield Nursery for Latin America 1977, Early varieties - VIRAL-P.

6. First International Rice Yield Nursery for Latin America 1977, Medium varieties - VIRAL-T.

7. Genetic and basic seed production of 8 commercial varieties.

<u>IRGA, Experimental Station of Rice, Cachoeirinha, Rio Grande do Sul (lowland conditions</u>)

1. Blast infestion beds - $F_3$-$F_7$ segregating varieties and/or lines.

2. $F_2$ segregating populations of 112 progenies.

3. Germplasm garden - 500 varieties introduced and selected by the program.

4. Preliminary yield trials - 25 lines, 2 replications.

5. Advanced yield trials - 16 lines - 4 replications in 2 levels of N (40 and 60 kg/ha).

6. Bioclimatic and dates of planting trials - 26 varieties.

7. International Rice Yield Nursery for Latin America 1977 - Early varieties - VIRAL-P.

8. International Rice Yield Nursery for Latin America 1977, Medium varieties - VIRAL-T

9. Regional trial of varieties - 10 varieties.

10. Seed production and purification of promising lines: P 790, P 793 and P 798.

UEPAE/Pelotas, EMBRAPA/UFPEL Agreement, Rio Grande do Sul
(lowland conditions)

1. Bioclimatic trial of adaptation of varieties in three dates of planting.

2. Regional trial of varieties - 10 varieties in 4 levels of N (0-30-60-90 kg/ha).

3. Advanced yield trial - 16 varieties, 3 replications.

4. $F_2$-$F_3$ segregating populations.

5. Study of interaction of varieties - herbicides and levels of nitrogen.

6. Response of lowland rice to different levels of Ca and Zn.

7. Dosis and dates of application of nitrogen in different varieties.

8. Influence of methods and densities of planting on rice production.

## ARGENTINA

INTA, Agricultural Experimental Station (EEA) of Corrientes

(Lowland rice)

1. Seed production of Fortuna INTA and Bluebonnet 50 INTA varieties in 7 and 9 ha respectively.

2. Basic seed multiplication of the line IR 841-63-5-18 - 4 ha.

3. First International Sheath Blight Nursery for Latin America, 1977 - VIAVAL-1977.

4. First International Rice Yield Nursery for Latin America, 1977 - Early varieties - VIRAL-P.

5. First International Rice Yield Nursery for Latin America, 1977 - Medium varieties - VIRAL-T.

6. Comparative Yield Trial of 9 promising lines and 2 commercial varieties.

7. Seed purification of Fortuna INTA and Bluebonnet 50 INTA varieties and the line IR 841-63-5-18.

8. Seed multiplication of 4 promising lines.

9. Fertilization trial of N and $P_2O_5$ with the line IR 841-63-5-18.

10. Insecticides trial to control water weevil.

11. Official Network of Territorial Trials (ROET) 15 varieties of official and particular breedings with definitive or provisional inscription.

## PARAGUAY

Ministry of Agriculture and Livestock, Rice Program, Asunción

Promoción Agropecuaria S.A., Arroyos y Esteros

(Lowland rice)

1. Regional trial of introduced varieties - 14 from CIAT, 17 from Brazil and 7 from Argentina.

2. Regional yield trial with 12 varieties.

3. Commercial rice production of the varieties CICA 6, CICA 4, CICA 7 and CICA 9. Total 500 ha.

## BOLIVIA

Centro de Investigación Agrícola Tropical (CIAT), Santa Cruz

Experimental Sub-Station - Portachuelo

(Upland rice)

1. Comparative trial of introduced varieties and/or lines; 10 from IRRI, 4 from CIAT, 3 from USA and 1 local.

2. Basic seed multiplication of Bluebonnet 50 and CICA 6.

3. Influence of sowing densities on rice production; 5 densities and 4 varieties.

4. Systems of insecticides application to control plagues in Bluebonnet-Sel.

Extension Agency, San Pedro - Farm located in Murillo county

(Upland rice)

1. Regional trial of varieties; 10 from IRRI, 4 from CIAT, 3 from USA and 1 local.

2. Trial on technology transference comparing 4 technologies in 3 varieties.

Agricultural Experimental Station of Saavedra

(Upland rice)

1. Seed multiplication of 6 promising lines (4 from IRRI and 2 from CIAT).

2. Comparison and adaptation of varieties - 18 varieties: 10 from IRRI, 4 from CIAT, 3 from USA and 1 local.

3. International Rice Stem Borer Nursery (IRSBN) from IRRI.

4. Evaluation of drought tolerance of 10 lines from IRRI and 3 local checks.

5. International Rice Blast Nursery from IRRI (IRBN).

6. International Rice Yield Nursery for Latin America, 1977 - Upland varieties (VIRAL-S).

7. Chemical insects control - Stem borers, stink bugs.

8. Association studies of corn-rice in 5 methods of planting.

9. Technology transference; 4 technologies in 3 varieties.

10. Densities of planting - 5 densities in 4 varieties.

11. Weeds control systems.

PERU

Centro Regional de Investigación Agropecuaria II (CRIA II), Chiclayo

Agricultural Experimental Station "Vista Florida"

(Lowland rice; transplanting)

1. Uniform yield trial (24 lines and 6 checks).

2. Preliminary yield trial (33 lines and 7 checks).

3. Observation lines (415 lines obtained of 11 crosses).

4. Collection and evaluation of germplasm - 104 early varieties in study.

5. $F_1$ generation (63 simple, triple and multiple crosses and back-crosses in evaluation).

6. $F_2$-$F_5$ segregating material
   - 48 $F_2$ populations, 16 in $F_3$ and 11 in $F_4$
   - 6136 $F_5$ lines Indica type, and
   - 391 $F_5$ lines Indica/Japonica type.

7. International Rice Observational Nursery, 1977 (IRON) from IRRI.

8. Observation of national and introduced varieties.

9. Identification studies, biology, populations and control of leaf miner (Hidrellia) and leaf hopper (Sogatodes and Orthezia).

10. Evaluation of introductions for resistance to blast.

11. Chemical control of blast.

12. Comparison of varieties at transplanting age, and planting dates.

13. Weeds control
    - Evaluation of herbicides
    - Comparison of dosis and dates of application

14. Fertilization
    - Varietal response to nitrogen
    - Sources and application dates of nitrogen

15. Production of basic, registered and certified seed of commercial varieties.

"Pedro Ruiz Gallo" National University

1. International Rice Salinity and Alkalinity Observational Nursery for Latin America, 1977 (VIOSAL).

2. Varietal reaction to salinity of 55 lines of the National Program.

Appendix 5. Most promising selections of the IRTP nurseries and the programs trials.

IRTP Nurseries

BRAZIL

a. Goiânia

| CNPAF | Line or selection number |
|---|---|
| IURON/77 | - 2, 3, 4, 5, 10, 16, 30, 42, 57, 79, 91, 97, 104, 105, 106, 107, 114, 127, 128, 129, 130. |
| **CAPIVARA** | |
| IURYN/77 | - 2, 4, 7, 19, 21, IAC 25 |
| VIRAL-S/77 | - 1, 2, 6, 9, IAC 25 |
| **AGROVET** | |
| VIRAL-P/77 | - 2, 5, 10 |
| VIRAL-T/77 | - 1, 2, 3, 5, 12, 15 |
| IRON/77 | - 17, 24, 26, 46, 47, 48, 54, 64, 68, 69, 70, 74, 85, 86, 89, 96, 97, 194, 291, 308, 309, 315, 336 |

b. Campinas

| | |
|---|---|
| VIRAL-P/77 | - 3, 8, 9, 10 |
| VIRAL-T/77 | - 1, 2, 3, 6, 11, 12, 13, 15 |

c. Porto Alegre

| | |
|---|---|
| VIRAL-P/77 | - 4, 9 |
| VIRAL-T/77 | - 5, 6, 11, 15 |

ARGENTINA

Corrientes

| | |
|---|---|
| VIRAL-P/77 | - 1, 2, 4, CICA 7 |
| VIRAL-T/77 | - 6, 9, 11, 12, 14, Bluebonnet 50 |
| VIAVAL/77 | - 11, 12, 13, 19 |

BOLIVIA

Saavedra

| | |
|---|---|
| IRBN | - Moderate infection |
| IRSBN | - Low infection |
| VIRAL-S/77 | - 6, 11, 14 |

PERU

a. Vista Florida

| | |
|---|---|
| IRON/77 | - 21, 22, 24, 39, 64, 71, 74, 84, 89, 101, 138, 157, 172, 216, 217, 246, 304, 364. |
| IRBN/77 | - Under seed multiplication for future trials in 3 places |

b. University

| | |
|---|---|
| VIOSAL/77 | - 1, 10, 11, 12, 18, 23, 25, 32, 34, 36. |

PROGRAM TRIALS

BRAZIL

Campinas

| | |
|---|---|
| Lowland | - P 899-55-6-4-6-1B, Bg 90-2, CICA 9, IR 2307-84-2-1-2, P 899-55-5-2-3-1B, P 899-55-6-4-5-1B |

Upland (with severe
drought at the stage
of maximum tillering)

1. Tall varieties (they will recover and will produce seed) Selections N° 14, 15, 50, 53, 54, 85, 104, 130, 138, 149, 153, and IAC 47 (check)

2. Dwarf (very short but tolerant)
Selections N° 30, 31, 32, 69, 70 and 92

Porto Alegre (IRGA) - P 798-B4-4-1T, P 790-B4-4-1T, P 793-B4-38-1T

ARGENTINA

Corrientes - IR 841-63-5-18, P 791-16, CICA 9, Fortuna INTA, Bluebonnet 50 INTA, Yerua P.A., Taipero P.A.