# PROGRESS IN UPLAND RICE RESEARCH

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# ADAPTIVE RESEARCH, PREPRODUCTION TESTING, AND PRODUCTION PROGRAMS IN BRAZIL

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How can research institutions assure that agricultural research results more rapidly benefit rural producers for whom the research is intended? This question has recently started to receive special attention in Brazil.

The Brazilian agricultural research system was developed under the influence of the diffusion model imported from the more developed countries (5). The model implies a freedom of choice in research projects so that scarce resources can be allocated to a broad range of research topics depending on the investigator's decision. The tendency to develop research activities oriented toward solving real problems was supposed to result from pressure by farmers on government research agencies.

Extension services were seen as the means of bridging the gap between research agencies and farmer fields. The challenge of making research results from the literature available to farmers in usable form was placed almost exclusively on the shoulders of the extension services.

This institutional system was, in fact, found to *increase gradually* the gap between the amount of research results and that part which crystallized into new technologies adapted to farm conditions. Farmers were not organized well enough to orient research activities toward solving their real problems. Scientists went their own way, doing the work they were interested in, rather than directing it toward the solution of problems noted in the field. Researchers and extension personnel did not work together to adapt research results to farmer's conditions. Extension services were limited to gathering what they could from wherever they could find the information.

This agricultural research system was not homogeneously inefficient (3, 4). A dependence on imports, which characterized the Brazilian pattern of capital accumulation, made governments more responsive to export crops (coffee, sugarcane, cotton, and soybeans) than domestic crops (rice, beans, cassava, and maize). In this sense, research on rice had never been given high priority, despite its importance in both the diet of the Brazilian population and agricultural income and employment. Rice is the principal source of

CNPAF/EMBRAPA, Brazil.

calories and the third and fourth most important crop in terms of cultivated area and value of production in Brazil. A limiting situation was experienced in upland rice, which in the 1960s represented about 80% of total Brazilian rice area and 70% of production.

Research institutions were unable to attract financial resources for upland rice research. Almost all information on this crop was produced by only one agency: the Agronomic Institute of Campinas. The location-specific nature of results made it difficult for extension services to adapt the results generated for the state of São Paulo to farmers' conditions elsewhere in Brazil. Average rice yields dropped from 1.6 t/ha in 1938-42 to 1.4 t/ha in 1968-70.

The 1960s were characterized by food shortage and political instability. A sharply rising cost of living led to growing social discontent. Increased political activity of urban and rural workers created a situation of profound instability and transformed the food crisis into a political crisis. The government became aware that food-price inflation was an important factor contributing to social disturbances.

## APPLIED RESEARCH UNDER EMBRAPA

Increasing political pressure to raise agricultural yields and production created a favorable climate for a profound restructuring of the existing research apparatus. In late 1972, the federal government launched a massive reform in the research system. The Brazilian Agricultural Research Enterprise (EMBRAPA) was created to do research at the federal level and to coordinate and supervise state-level agencies. Applied research directed toward solving immediate production problems was explicitly defined as the major philosophy of EMBRAPA agencies, including the National Rice Research Center. Research was to focus on problems noted in the field to generate technologies for prompt incorporation into existing production systems. Once technology was chosen, it would be tested in farmers' production systems. The test was a cooperative effort of applied researchers and extension personnel. Problems were fed back to research scientists to redesign their experiments for new answers. In brief, agricultural research was to be a process that starts with the farmer's problem and ends only when the newly developed technology has been adopted.

I will quickly review development of this applied research program at CNPAF, then conclude with a description of adaptive research, preproduction testing, and production programs on upland rice under way in Brazil.

## THE TECHNOLOGICAL PACKAGE PROGRAM

In 1975, CNPAF/EMBRAPA, in cooperation with the Rural Extension Service (EMBRATER), organized the Technological Package Program. Emphasis was on disseminating existing technological information. The premise was that sufficient technological knowledge to overcome important

production constraints was available but was not being used by farmers for whom it was intended. If farmers accepted these technologies, a significant impact would result in improved agricultural yield and production.

The Technological Package Program was organized at meetings of researchers, extension personnel, and local farmers in the main production regions. This group defined the best practices for three levels (subsistence, intermediate, and high technology) of each aspect of crop management, such as mechanization, fertilization, weed control, and insect control, under existing conditions. Some questions were:

- What are the best crop varieties for the region?
- What is the recommended NPK application?
- Which insect pests are important constraints to production?
- Which insecticides perform best against the limiting insect pests?
- When and how many insecticide applications are required for control?
- What is the best weed control practice for the region?
- Which herbicides best control weeds in upland areas?

The resulting pieces of information were brought together in a *technological package,* which was distributed to local farmers for adoption.

Although the program produced more than 1,200 packages for diverse crops, its usefulness was not formally evaluated (1). Field tests originally planned were rarely conducted. The feeling is that the proposed program had little effect of changing the inadequate technological level under which most of the upland rice crop was grown in Brazil, before the 1970s. One support for this argument is that upland rice yield decreased 10% in the 1974-84 period.

Reasons for this unfavorable performance include the following:

1. Lack of sufficient technological knowledge which could be readily transferred to upland rice farmers;
2. Inability of the institutional system to ensure complete profit incentives to intended users;
3. Profit potential was insufficient to overcome climate risk and managerial deficiencies associated with the transitional purpose of upland production; and
4. Farmers were more willing to substitute one isolated practice rather than the full system.

Most upland rice production in Brazil comes from the transitional purpose system in which farmers do not look for an adequate rate of return in the upland rice crop, but for a cost reduction in the process of clearing areas for other purposes. Rice is chosen as transitional crop because of its 1) good performance in poor soil, 2) low level of investment and low production cost, and 3) easy adaptation to newly opened areas (2).

## RICE RESEARCH UNDER CNPAF

Parallel to the technological package effort, the National Rice Research Center (CNPAF), established in 1975, immediately began work on rice

research. According to the philosophy underlying EMBRAPA, the National Rice Research Program is a cooperative effort between CNPAF and state research agencies. Since then, research specifically in this program has been directed toward assessing and studying major constraints to farmers' productivity. This information is used at research meetings to define regional and national priorities. State agencies are responsible for testing any pertinent technology under diverse conditions in farmer fields or other predefined areas. Thus, applied-research results generated at CNPAF are transferred to state agencies for local-adaption testing. Results from adaptive trials go into the existing organization for a National Production Program for rice farmers.

Under this system, breeding work at CNPAF has produced the best results. Unfortunately, in other disciplines, efficient coordination of basic and applied research effort has not been achieved. Appropriate methodological techniques are also factors limiting further development of adaptive research program.

**Breeding program and preproduction testing**

The varietal improvement program of the National Rice Research Center has identified high yield or stability of yield, and disease and insect resistance across all rice environments as breeding objectives. The breeding program provides varieties for more than 6 million ha of Brazil's extremely diverse rice-growing environments. Because it is impossible to breed a single variety suitable for the diverse Brazilian environment, research goals were set by regions. Brazil was divided into three regions for evaluation trials of elite germplasm.

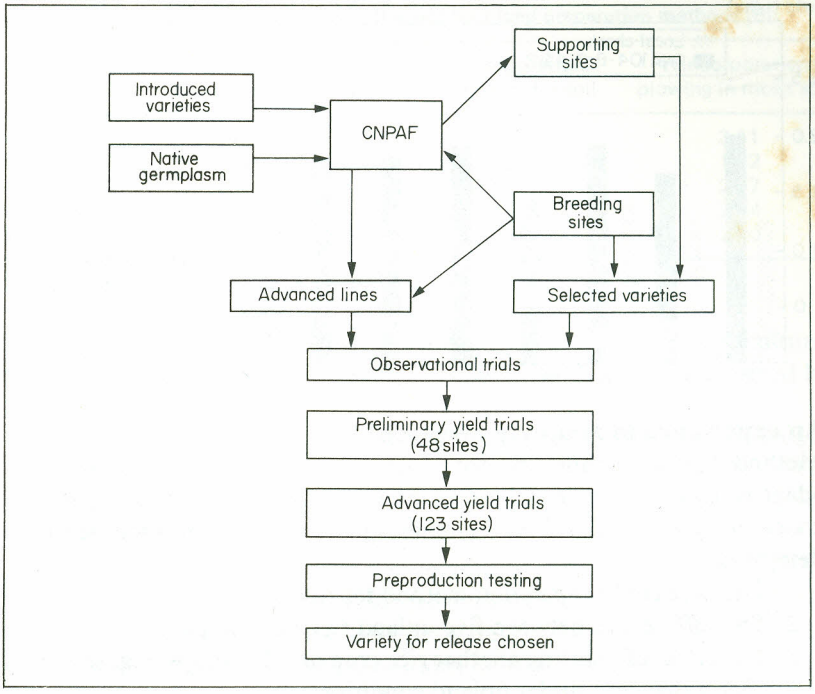
Region I — Rio Grande do Sul and Santa Catarina
Region II — South-East and Center-West States
Region III — North and Northeast States

The program is coordinated by a team of breeders at CNPAF closely linked to state research agencies in each region. Extension services, in general, participate only in preproduction testing. An organization chart (Fig. 1) shows the steps in developing new rice varieties.

The observational plots, composed of material from foreign countries and other national institutions, are in selected localities of each region. Promising lines from these trials are then included in preliminary yield trials to identify good performers in each environment. Experimental trials, statistically designed with two or three replications, are conducted as a cooperative effort between CNPAF and state research agencies.

The most promising lines in each state or region based on preliminary observations are included in advanced yield trials and tested for 2-3 yr before release for preproduction testing. The most promising advanced lines for preproduction testing are jointly decided by CNPAF and state representatives at the Annual Rice Researcher Meeting.

Preproduction testings are organized as a cooperative effort between CNPAF, state researchers, and local extension services. The most promising

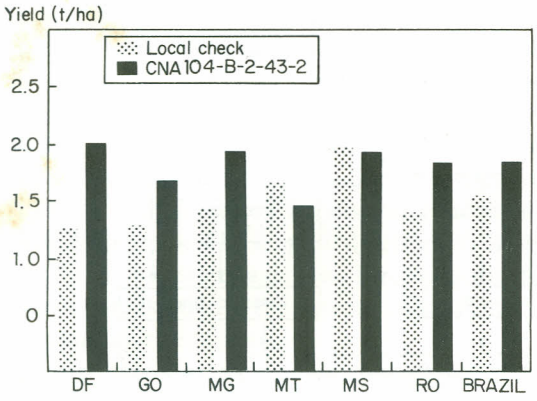



1. Steps in developing new rice varieties.

lines are tested under diverse conditions in farmer fields against a popular local variety as a check. Crop management (including input level decisions) is fully by the farmer.

Performance of the promising lines is evaluated based on data from 2-3 yr advanced yield trials and collaborating farmers' opinions. Parallel to preproduction testing, the breeders increase seed at CNPAF. A minimum of 50 kg seed is made available to the Basic Seed Production Service which provides it to registered farmers for multiplication.

Actual CNPAF experiences in using this methodology will illustrate the procedure. In 1982 after identifying three promising lines (CNA 104-B-4-1-1, CNA 95-BM30-BM9-11, and CNA 104-B-2-43-2) in experimental yield trials, CNPAF suggested that state researchers and extension services evaluate the lines in farmer fields. Trials were planned by local agencies in six states in the central part of the country. Results were obtained from 52 of 70 farmers selected for the research. CNA 104-B-2-43-2 had an average production advantage of about 0.3 t/ha over the traditional varieties IAC 25, IAC 47, and IAC 46 (Fig. 2). The average productivity of upland rice in Brazil is only 1.2 t/ha. Additionally, 85% of the producers who used CNA 104-B-2-43-2 had equal or better grain quality and disease resistance than those who used traditional varieties. The farmers' opinions and results of advanced yield trials led to release of CNA 104-B-2-43-2 in 1984.




2. Grain yield of advanced promising lines in comparison with local check in farmer fields in six Brazilian states. DF = Distrito Federal, GO = Goias, MG = Minas Gerais, MT = Mato Grosso, MS = Mato Grosso do Sul, RO = Rondonia.

## An experience in adaptive research

Methodological techniques have limited more rapid development of adaptive trials at the state level. A new program proposed in 1984 was a cooperative effort of CNPAF, state agencies, and extension service to determine:

1. The best land preparation method for rice under upland conditions;
2. The differences between five upland rice varieties; and
3. The effect of planting another rice crop or other crops (e.g. soybeans), after a rice crop under upland conditions.

Special attention for both methodological aspects and precision in gathering data was attained by limiting initial trials to three sites over a representative area of upland rice production. The 4-yr program is now in its second year.

The first and second objectives were partially achieved in the first year.

One method of land preparation differed greatly from the others (Table 1). Preincorporation followed by plowing in moist soil produced almost 2 t/ha more than heavy harrowing (Rome plowing), the traditional method in the region, or direct plowing and preincorporation in dry soil. This result is impressive considering that the regional upland average yield is only 1.1 t/ha. All five varieties were tested only with preincorporation followed by plowing in moist soil. IAC 47 produced 0.3-1.2 t/ha more than IAC 165, CNA 791059, CNA 104-B-34-2, and CNA 790954. However CNA 104-B-34-2, which produced 2.6 t/ha, has more blast tolerance which may prove to be an advantage.

This work had its greatest impact in central Brazil where the three research areas of the project are located. After broadcasting the results on television, CNPAF received more than 20,000 letters from farmers asking for more information. Farmers have been quick to adopt preincorporation followed by plowing in moist soil because the method is not more expensive.

## Production pilot unit and production programs

Often, problems noted in farmer fields are not of production, but of credit, marketing, management, and others. The close association of both kinds of

**Table 1. Grain yields (t/ha) for five varieties and four land preparation methods (6).**

| Variety | Heavy harrowing[a] | Direct plowing | Preincorporation/ plowing in dry soil | Preincorporation/ plowing in moist soil |
|---|---|---|---|---|
| IAC 47[b] | 1.10 | 1.21 | 1.23 | 3.11 |
| IAC 165[b] | – | – | – | 1.92 |
| CNA 791059 | – | – | – | 2.47 |
| CNA 104-B-34-2 | – | – | – | 2.84 |
| CNA 79054 | – | – | – | 2.20 |

[a]Local traditional method. [b]Popular varieties.

problems at the farm level implies that any recommended agricultural technology evaluated only in terms of production may not be adopted by producers.

A goal of the production pilot unit is to identify institutional constraints in facilitating the dissemination of new technologies generated by CNPAF. Essentially we evaluate the institutional capacity in providing full profit opportunities from the use of the recommended new technology.

The production pilot unit is a 400-ha testing area in which the CNPAF experimental station simulates farmer management. Testing new technologies in this environment enables researchers to evaluate, for example, the effect of credit and market conditions on profitability and opportunity for utilization of the technology. Changes in agricultural policy can then be recommended on the basis of the limiting effect of these institutional variables. Modification of the credit system to meet the timing of capital needs and repayment capability associated with the use of rock phosphate fertilizer in upland rice illustrates the kind of information derived from the analysis of the production pilot unit.

Unfortunately, results from this research have not been fed to the government for a national production program for rice farmers. In fact, the official programs for the agricultural sector have not contributed to the increase in rice production in Brazil in the last few years.

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