Rice in Brazil

P.A. Arraes Pereira, B. da Silveira Pinheiro, S.M. Texeira, S.S. Prabhu and R.P. Ferreira
Researchers, EMBRAPA/CNPAF, Goiânia, Goiás, Brazil

Although rice in Brazil accounts for only 4.2 percent of the world's area under rice and 2.4 percent of world production, it occupies a relatively important position within the Latin America region, accounting for 74 percent of the area cultivated and 37.3 percent of production.

Today, Brazilian production exceeds 11 million tonnes of rice, covering about 6 million ha with annual average growth of 1.5 percent in the last four decades (Table 1). Rice ranks third in extent of area cultivated and fourth in value, accounting for 13.5 percent of the total agricultural income.

Rice is the staple food for more than 120 million people in Brazil, providing 18 percent of the calories and 12.5 percent of the protein in their diet. Together with beans, it accounts for 20 percent of the average Brazilian's protein intake. For the poor consumers in the northern areas rice is the main source of caloric intake for the rural population, and the second source after cassava for the urban population. In southem Brazil it is the main source of calories and proteins for both rural and urban poor.

Rice is cultivated throughout the country in a wide array of ecosystems. As the greater part of production takes place under upland conditions, the average yield is low, however, under irrigated conditions it attains the same level as that of developed countries.

RICE CULTIVATION SYSTEMS

The situation of the rice crop in Brazil can be better understood if the peculiarities of the diverse cultivation systems are considered.

Four major cultivation systems have been identified, based on water availability:

- lowland rice with controlled irrigation (irrigated rice);
- lowland rice without water control;
- rain-fed lowland rice (*várzea úmida*);
- upland rice.

More recently, Brazilian upland rice was conveniently subdivided into favoured and unfavoured upland rice (EMBRAPA, 1981).

Lowland rice with controlled irrigation

Irrigated rice represents 38 percent of the total production. Its average yield of 4.6 tonnes per hectare is comparable to the yields in developed countries (Table 2).

The rice crop is planted in lowland areas, in bunded fields with controlled irrigation and water drainage. Soils in this system possess low water-infiltration capacity to avoid excessive water use and nutrient percolation beyond the root zone.

This system is mainly concentrated in the states of Rio Grande do Sul and Santa Catarina, under sub-temperate climate.

The expansion of the area cultivated with irrigated rice is somewhat limited in the traditional southern areas. However, it has shown a discreet increase in recent years in tropical areas, as in the states of Sergipe, Alagoas and Tocantins. It would be feasible to further explore the potential of the river deltas of Araguaia and Tocantins in the Midwest, São Francisco and Paranaíba in the northeast, as well as of the Amazon River in the North of Brazil. Although most of these areas are very far from the main consumer centres, they have the advantage of allowing the growth of two crops a year.

In Rio Grande do Sul, most of the production volume comes from farms generally exceeding 100 ha. The production process is highly mechanized from soil preparation to the harvesting stage. Use of improved cultivars as well as adequate crop management allow for yields of over 6 000 kg per hectare; the actual average state yield is 5 100 kg per hectare.

In the state of Santa Catarina, the average property size is less than 25 ha. Mechanization is less intensive than in Rio Grande do Sul and the average yield is 4 700 kg per hectare.

The major problems of irrigated rice in traditional areas are blast disease, iron toxicity, cold temperatures and weeds, especially red rice. The dramatic increase in field and seed infestation by red rice (*Oryza sativa* L.) is causing concern to producers and constitutes one of the state's main research problems.

Before 1970, the cultivars in this system belonged to

TABLE 1 **General market information for Brazilian rice production**

	1980/81	1982/83	1984/85	1986/87	1988/89
Area (*100 ha*)	6 100	5 425	5 356	5 997	5 278
Production (*'000 tonnes*)	8 228	9 224	8 760	10 578	11 082
Stocks (*'000 tonnes*)	2 040	1 644	1 051	2 287	4 532
Supply (*'000 tonnes*)	10 477	10 333	10 311	13 100	15 804
Consumption (*'000 tonnes*)	9 000	9 150	9 660	10 000	11 000
Exports* (*'000 tonnes*)	73	12	5	5	10
Imports* (*'000 tonnes*)	200	465	500	235	190
Per caput consumption	72.5	70.5	71.2	70.7	77.6
Yields	1 349	1 516	1 635	1 764	2 099

* Net importers in the last decade.
Note: Supply has risen fast since 1986; stocks filled up as result of miscalculations.

TABLE 2 **Main rice cultivation systems in Brazil**

Rice cultivation systems	Area (*ha*)	Production (*t*)	Productivity (*t/ha*)
Irrigated	923.7	4 202.8	4.55
Rain-fed lowland	295.6	831.6	2.81
Upland	4 059.1	6 048.1	1.49
Total	5 278.4	11 082.5	2.1

Note: Approximations based on yields for states where system is predominant.

the traditional type, being of high stature and susceptible to lodging. In the early 1970s, the tendency was to grow North American cultivars because of their fine grain quality and good market price. Intensive breeding work by local institutions was started at that time, using traditional, American and semi-dwarf cultivars, as well as advanced lines from the International Centre for Tropical Agriculture (CIAT) programme. A range of high-yielding adapted cultivars was released, starting in 1978 (Carmona, 1989).

Research results and plant materials from international centres may be adapted to solve research problems of irrigated rice in Brazilian tropical areas. A specific national breeding programme has been recently initiated and the first cultivars have just been released.

Lowland rice without controlled irrigation

This system is typical of the Amazon region, where the crop is seeded on the river beds and periodically flooded by tides. Even though this system represents only a small share of national production, it has strong social implications for subsistence farming and should be further explored. Although it is a considerable distance from consumer centres, it nevertheless represents a potential resource to be explored in the future.

Lowland rain-fed rice (*várzea úmida*)

This system is common in the states of Minas Gerais, Rio de Janeiro and Espírito Santo and in some areas in the northern region.

Under this method, rice is grown in hydromorphic soils, which are generally plain, rich in organic matter and located in river basins or valleys. These soils usually have excessive moisture and are maintained at near saturation by the replenishment of the water-table by rains and/or impeded drainage. Drainage is normally required to allow for satisfactory *várzea* utilization and crop growth.

Yield, although usually higher than under upland conditions, is somewhat variable depending on the level of water control, drainage and technological input. The size of the property is usually smaller than 20 ha and a high percentage of local manual labour is requires. This method accounts for approximately 7.5 percent of total Brazilian production (Table 2) and has a great potential for expansion both in area and grain yield.

The incorporation of *várzeas* into the production process had its beginning with a governmental incentive in the state of Minas Gerais and later extended to other parts of Brazil. The programme PROVARZEAS Nacional was initiated with the aim of incorporating 150 000 ha a year and, by 1988, 715 000 ha of *várzeas* were covered. Of this total, 33 percent is drained areas and the remainder could come under controlled irrigation.

The main research problems for this system are weeds, blast and brown spot disease and iron toxicity. Because regional cultivars of the traditional plant type are still in use, lodging is a serious concern. The optimal plant type should possess moderate plant height and tillering ability (da Silveira Pinheiro and Rangel, 1987). Efforts to create such cultivars are under way and the present recommendation is to use irrigated cultivars as a substitute for regional ones.

Upland rice

Rice culture under upland conditions accounts for 76.9 percent of the area under cultivation and more than 50 percent of national production (Table 2). It is the predominant cultivation system in the states of Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul and Minas Gerais.

Besides water stress, blast, weeds and low soil fertility are responsible for the low average yield, which ranges around 1 400 kg per hectare and constitutes the principal priority for the national research programme.

Based on the concept of risk resulting from water stress, upland rice was classified into two groups: upland favoured and upland unfavoured (EMBRAPA, 1981). Research priorities, especially those for plant breeding, have been formulated taking into account the peculiarities of the two situations. According to da Silveira Pinheiro *et al.* (1985), favoured regions would benefit from the change in plant type of the upland traditional cultivars, which are tall, long-leaved and susceptible to lodging.

More recently, Steinmetz, Reyniers and Forest (1989) studied a range of Brazilian regions based on a water balance simulation model and expanded this classification from highly favoured to highly unfavoured. They also showed the important role played by the soil water reserve and rooting depth in elaborating such classification.

Based on a minimum soil water availability of 30 mm, the state of Amazonas and the northwest area of the state of Pará are considered favoured regions; the states of Maranhão, Goiás and Mato Grosso and other regions of Pará state fall under the category of intermediate risk; and eastern Goiás, limits of Mato Grosso and Mato Grosso do Sul, southeastern Minas Gerais, northern São Paulo, Paraná and Santa Catarina are unfavourable or high-risk areas. As far as the soil water availability (50 mm) is concerned, a great part of the northern region is classified as highly favourable and Goiás, Mato Grosso, Maranhão and southeast Minas Gerais are classified as favoured.

It is important to note that, while hectarage under irrigated rice systems has been increasing with time, there has been a tendency to increase upland production under favoured conditions. Production areas have been relocated from southern areas like São Paulo, Paraná and Minas Gerais to northern areas. Upland rice has been shifted from traditional areas to the new ones.

In the central-west region and in the southeast, where production is frequently limited by the occurrence of dry periods (*veranicos*), rice crops have been typically transitory. Newly opened *cerrados* (savannahs), composed mainly of dark red or yellow red latosols possessing low cation exchange and water retention capacity, are planted to allow the future establishment of either pastures or a more profitable export crop such as soybean. Rice is planted mainly to minimize the costs of other activities. The crop is produced for one to three years and is sometimes intercropped with pastures with low level of technology. Inputs are kept to a minimum and are usually not enough to meet the nutritional requirements of the plant.

In recent years, the tendency of the rice crop under upland conditions to assume a definite role in a well-defined farming system, together with other crops, can be observed. This is common in large farms in the states of Goiás and Mato Grosso, where water stress is not a serious concern. As this type of agricultural system aims at sustainable productivity, technological inputs are high, sometimes including supplementary irrigation. Under this situation yields may be as high as 3 000 kg per hectare.

RESEARCH ORGANIZATION AND MAIN ACHIEVEMENTS

Rice research in Brazil is mainly conducted by the national cooperative system. The association of state research enterprises and research units of the EMBRAPA system (UEPAE) are coordinated by the National Research Centre for Rice and Beans (CNPAF), which also has its own research facilities and objectives. A good example of this cooperative programme is the breeding network that covers three cultivation systems: irrigated, *várzea úmida* and upland (Fig. 1). It involves a total of 25 institutions, which are grouped according to geographic region and monitored by three distinct

TABLE 3 **Institutions composing the regional technical rice commissions**

Region I		Region II		Region III	
1	2	1	2	1	2
CNPAF IRGA CPATB	EMPASC UFPel	CNPAF EMPA IAC IAPAR	U/Porto Velho EMGOPA EPAMIG EMPAER U/Dourados EMCAPA PESAGRO	CNPAF U/Boa Vista	CPATU EMAPA U/Manaus U/Rio Branco U/Teresina U/Macapá U/Porto Velho

1 – breeding site.
2 – supporting site.

technical commissions (Table 3 and Fig. 2). This joint programme holds about 250 trials every year. The results of these trials and the composition of the subsequent year's trials, as well as cultivars released, are discussed at the annual meetings of these commissions. Table 4 presents the rice cultivars released since 1982 through the cooperative effort of the national research institutions.

The important gain in average yield of irrigated rice in traditional areas is basically attributed to the change of traditional cultivars, which are tall and susceptible to lodging in the case of improved cultivars or shorter and possessing higher tilling capacity, disease resistance and grain quality (Carmona, 1989). It should also be pointed out that the significant yield increase is also caused by the increased use of fertilizers and better water and plant management techniques.

On the other hand, for upland rice, the instability of yields caused by water stress in unfavoured areas does not provide a clear picture of the impact of research. However, a slow increase of 0.5 percent a year from 1986 to 1989 is noticeable, coincident with the adoption of new cultivars possessing a higher yield potential and higher blast tolerance. Better agronomic practices, like timely sowing, deep soil preparation, balanced fertilization and adequate pest control, constitute important factors for minimizing climatic risk and increasing average yield of upland rice (Blumenschein *et al*., 1985).

New research lines are under way to meet the emerging demand for a more technical and intensive agriculture under *cerrado* conditions. Soil and fertilizer management as well as crop rotation studies (Seguy *et al*., 1984, 1989; Moraes, 1987) indicate that the viability of the rice crop is an important component of an intensive and sustainable farming system. Recent studies have shown that degraded pasture can be effectively renewed with rice, lowering establishment costs, reducing deforestation and guaranteeing adequate management of natural resources.

The application of high input technology by rice farmers is discouraged by agricultural policy and low price. According to the *Boletim de Preços Agrícolas/ FEALQ*, the price of 60 kg of rice is at its lowest in ten years (Table 5).

Besides the higher profit resulting from its increased productivity and return of technological inputs, irrigated rice has another clear advantage over upland rice: the higher market price for its grains. The consumer preference in Brazil is for the clear, long and slender grains, which are characteristic of irrigated rice. This calls for a serious breeding effort to improve grain quality in upland rice or government initiative in the promotion of agro-industries to offer a wider range of alternatives to consumers.

PROSPECTS FOR THE RICE CROP IN BRAZIL

There has been a substantial increase in the availability of rice over the last decade as a result of an increase in both production and importation (Table 1). The increase in consumption during the Cruzado Plan as well as the erroneous estimates of drought losses led to an increase in the volume of rice imported in 1986, causing a piling up of government stocks since that date.

It is estimated that 70 percent of the production in 1987 covered human consumption. The north, northeast and southeast regions are net importers of the product. Rio de Janeiro and São Paulo import more than 75 percent of their needs. Although Maranhão state has excess stocks, they are not enough to cover the total

TABLE 4 **Rice cultivars produced and released by the cooperative research network in Brazil for three cultivation systems from 1982 to 1989**

Cultivation system	Cultivar name
Lowland with controlled irrigation	BR IRGA 411, 412, 413 and 414 (RS)
	EMPASC 104 and 105 (SC)
	MG 1 and MG 2 (MG)
	EPEAL 101 and 102 (AL and SE)
	METICA 1 (GO, DF, MT, RJ, MA and PI)
	PESAGRO 101, 102, 103, 104 and 105 (RJ)
	FRANCISCANO (ES)
	BR MS 1 and 2 (MS)
Rain-fed lowland	BR 1 (AM)
	BR 3 CAETE (PA)
	AJURICABA (AM, AP)
	PERICUMA (MA)
Unfavoured	BR 4 (AP, RR and PI)
	EMCAPA 01 (ES)
	CUIABANA (MT)
	RIO PARANAÍBA (CO, MG and MS)
	CENTRO AMÉRICA (MT)
	ARAGUAIA (GO)
Upland	GUARANI (GO, MT, MG and MS)
	CABAÇU (GO and MS)
	DOURADÃO (MG)
	TANGARÁ (MT)
Favoured	GUAPORE (RO)
	MEARIM (MA)
	XINGÚ (PA)

TABLE 5 **Prices obtained by farmers for 60 kg of rice in October 1989** (real values)

Year	Price (NCz$)
1980	128.5
1981	65.0
1982	83.1
1983	73.5
1984	73.8
1985	96.8
1986	97.0
1987	33.6
1988	60.3
1989	31.1

Source: Boletim Preços Agrícolas/FEALQ. Globo Rural, Economia, Dezembro, 1989.

demand for the northeast. On the other hand, the mid-western and southern regions export more than two-thirds of their production.

According to the demand estimates for the year 2000, it will be necessary to gradually increase rice production from the current 11 million tonnes to about 17 million tonnes. The existing potential for further expansion of *várzea* systems (30 million ha), the growing tendency toward upland rice cultivation in favoured regions and investment in research to increase average yields together make this desired production target attainable. The specific strategies, which combine government policies as well as research goals, include:

- Incorporation of 150 000 ha of *várzeas* per year. Considering that 60 percent of the *várzeas* may be cultivated with rice, an average yield of 4.5 tonnes per hectare would give an additional 3.2 million tonnes by the year 2000.
- Increase of average irrigated rice yields from 4.6 to 6 tonnes per hectare. There are limited chances of expanding the total of 1.09 million ha cultivated under this system mainly in the southern areas. However, if the productivity is increased to 6 tonnes per hectare, 1.5 million tonnes would be added by the year 2000. This increase may be attained through adequate control of red rice alone.
- Increase of average upland rice productivity from 1.4 to 2 tonnes per hectare. Considering the high risk involved in the upland system, as well as the low average yield increase in the last decade, this seems to be a very ambitious goal. However, the adoption of already existing risk-reducing technologies, including supplementary irrigation, as well as the increase in cultivated area in favoured regions, makes it feasible. An increase of 0.8 tonnes per hectare in the already existing 4 million ha would provide the required 3.2 million tonnes to fulfil the target of 6 million tonnes.

Although dependent on government incentives and appropriate agricultural policies, research plays the pivotal role in attaining these goals. In order to achieve the target yields in both irrigated and upland systems a series of challenges should be met, involving traditional research in such areas as breeding, plant nutrition, plant pathology, entomology and agronomy, as well as research lines that require basic knowledge of crop behaviour and its social implications under new environments or under new agricultural systems.

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FIGURE 1
Brazilian cooperative breeding programme for evaluation and utilization of rice germplasm

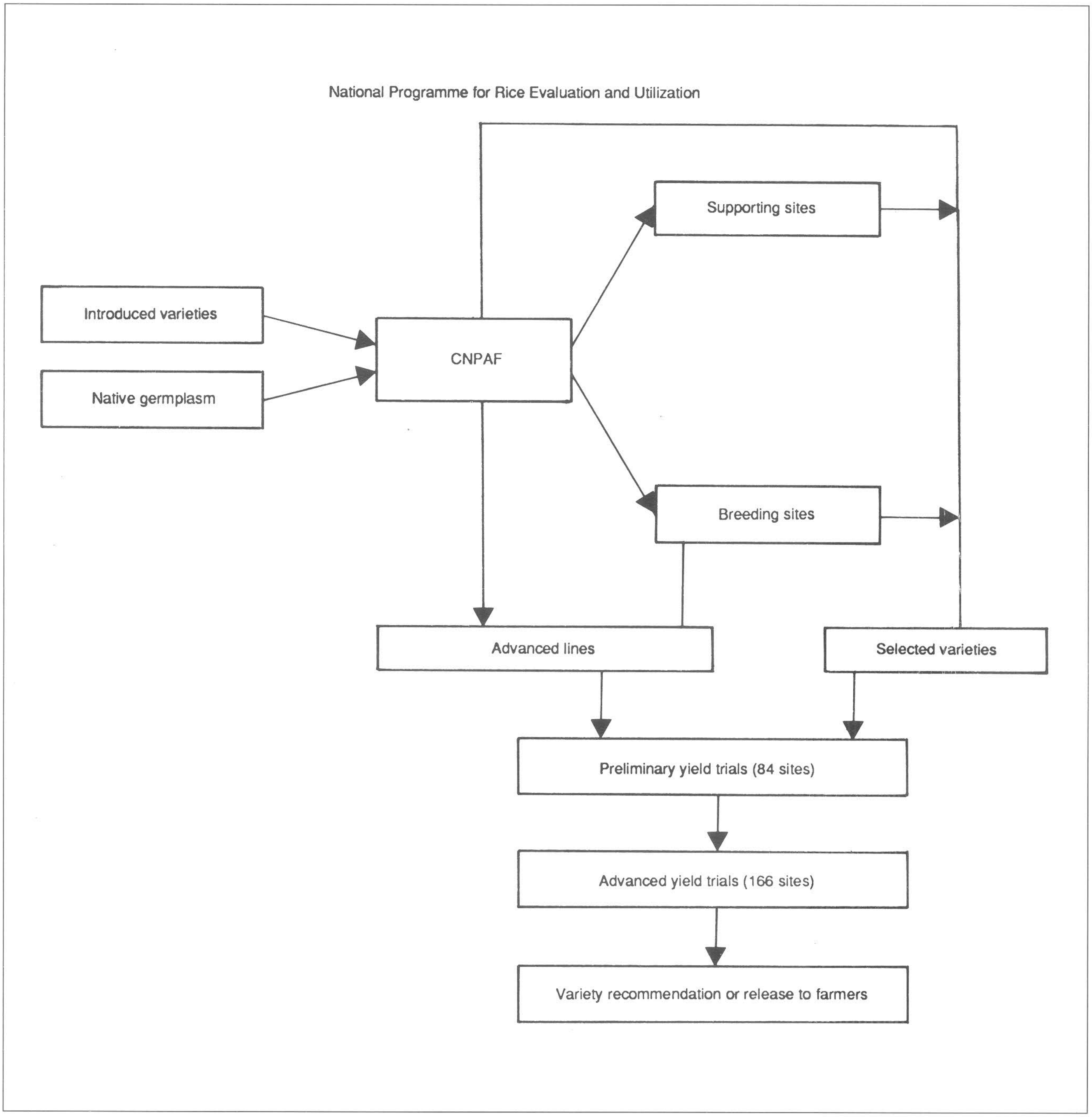

FIGURE 2
The three technical rice commissions comprising the Brazilian rice breeding network