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PROCEEDINGS OF THE UPLAND RICE CONSORTIUM WORKSHOP

4-13 January 1996; Padang, Indonesia

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UPLAND RICE IN BRAZIL: PROBLEMS AND PROSPECTS

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Upland rice is the main rice cropping system in Brazil and represents 70% of the total rice cultivated area. Rice is present in all states, and considered the most important crop in the southern, west-central, and northern regions. While several rice cropping systems are practiced in Brazil, the most commonly used are the irrigated lowland rice, lowland rice, upland rainfed rice, and favored upland rainfed rice systems. Favored upland rainfed rice is cultivated under sprinkler irrigation or in regions with good rainfall distribution with no risk of water stress and represents about 20% of the total upland rice area. Upland rainfed rice is usually cultivated in areas with higher risks of drought spells and where artificial irrigation is not a common practice.

The total cultivated rice area in 1995 was 4.4 million ha with a production of 11.2 million t and an average yield of 2.5 t ha^{-1} (Table 1). Upland rice occupied an area of 3.1 million ha, and produced 4.6 million t at a yield of 1.5 t ha^{-1}. This is lower compared with the yield of irrigated lowland rice which is 5.0 t ha^{-1}. The most common factors causing such low yields in upland rice are drought, diseases (especially blast caused by *Pyricularia grisea*), insects (mainly termites and *Elasmopalpus*), low fertility soils, weeds, and low input utilization by the farmers. The importance of each problem varies according to region and crop season.

In southern and central-west area of the country, where agriculture is more developed, upland rice yield is higher, around 2.0 and 1.7 t ha^{-1}, respectively, in 1995 (Table 2). In the north and northeastern regions, rice yield is lower and crop technological input is also low. In general, most of the upland rainfed rice is produced in farms below 10 ha, with a satisfactory level of mechanization, from soil preparation to sowing and harvesting.

Upland rice is a very important food crop in Brazil for several reasons:

- It is possible to reduce or increase the area and production of rice quickly by shifting upland areas from rice to other crops. In most cases, lowland areas do not allow this flexibility due to specificity of land systemization and to the high cost involved in making these areas suitable for other crops.

- Upland rice is an alternative crop to farmers; agriculture with options is less risky physically and economically.

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- Upland rice has low requirements and is suitable for soils recovering from depletions; low income farmers have lower production costs with upland rice than with other cropping systems. Additionally, under favorable conditions, it is possible to attain good yields using varieties especially developed for the uplands.

- Upland rice can from part of a number of crop rotation system, e.g., soybean, corn, cotton, or pasture. The Rice and Bean National Research Center (CNPAF) developed a very important technology to recuperate degraded pastures. The technology, known as the "Barreirao System", consists of sowing the pasture together with rice in a single operation, using a conventional planter. Sown at different depths, the rice is harvested somewhat before the grass reaches the desired height for cattle grazing. The rice grain harvest indirectly finances pasture formation, often providing profit to the farmer. This technology is widely accepted in Brazil and is being practiced by cattle growers.

GENERAL PROBLEMS

Rice in Brazil has endured many difficulties, especially due to the low prices paid to farmers. Costs are high, being aggravated by taxes, transportation fees, and delays in the definition of government policies. The combination of such factors has contributed to a 30% reduction in cultivated area of upland rice in the past five years. Some important aspects related to upland rice production are described below.

Drought

The occurrence of water stress periods, especially during the reproductive stage, has contributed to great losses in some years. In regions of high risk of occurrence of drought spells, total crops losses are not uncommon. The highest levels of rainfall are observed in the north and west-central regions and the smallest in the northeast, southeast, and southern regions (Steinmetz et al 1988). The probability of drought spells of 6-10 d duration increases in the north-south and northwest-northeast direction. Probability of drought occurrence is a risk factor that influences the farmer's decision to use high levels of technology. Research on this area has attained some promising results which are being considered for rice cultivation in regions with higher risk of water stress. These results are as follows:

- With reliable data from rain distribution and frequency, it is possible to select planting times to avoid the coincidence of the crop flowering stage with periods of high probability to drought.

- Deep soil preparation allows a deep root penetration for better exploitation of soil water during stress periods.

- Development of drought-tolerant varieties and selection of early maturing genotypes to avoid risks of drought damage are essential.

- The use of sprinkle irrigation is recommended. Cost of irrigation equipment, however, may impose some economical constraints. During the rainy season, one or two irrigations are usually enough to get good yields.

Grain quality

Approximately 20 yr ago, consumers preferred typical upland varieties with bold grains, and placed major concern on cooking properties rather than on length or shape of the grain. With changes introduced from lowland germplasm, especially from American varieties, upland rice grain became more translucid, uniform, with higher milling recovery, and better cooking and eating qualities. Thus, consumer preferences have changed dramatically. At present, rice varieties must be of the long-thin grain type, with good milling yield, and must be loose and soft after cooking to be acceptable to consumers.

Since traditional upland varieties have bold grains, breeding programs usually focus on introducing genes for improved grain characteristics, especially the long-thin grain type with intermediate to high amylose content and high milling recovery.

Diseases

Disease incidence in upland rice is a very serious factor affecting yield, in addition to an array of stress conditions presented by this particular crop system that makes plants more fragile and sensitive. According to Prabu (1989), the most important disease in upland rice is blast (*Pyricularia grisea*) followed by brown spot (*Drechslera oryzae*), and leaf scald (*Rhynchosporium oryzae*). The first two have been frequently responsible for severe yield losses.

Varieties now used by farmers have reduced blast tolerance and fungicides have been helpful to resist blast. It has been observed that, over time, rice varieties lose their original resistance to blast, and it is necessary to replace them periodically.

Research efforts in Brazil for disease control have been directed toward the combined objectives of varietal resistance, better cultural practices, and chemical control. Breeding programs for disease resistance have concentrated mainly on blast and brown spot.

Insect pests

Pest infestation in rice is more important in upland than in lowland conditions, especially due to the diversity of insect species causing damage as well as the intensity of crop damage. In a field survey, Ferreira and Martins (1986) observed losses ranging from 23 to 34% caused by various insect species. The most important pests in upland rice are termites, *Elasmopalpus*, and spittle bug (Reis 1989), which result in the widespread use of seed treatment with systemic insecticides.

Diatraea saccharalis and grain bugs have been considered very serious pests and stronger research efforts and field control measures are needed for control. It has been observed that late planting dates to reduce insect infestation have caused increased disease damage and drought risks. Pest research in Brazil has focused on cultural practices, chemical control, plant breeding, and biological control.

Weeds

Weed infestation reduced yield and, even in the absence of precise data, it is estimated to cause yield losses of up to 20%. Lorenzi (1994) estimated that losses due to weeds in Brazilian crops, including rice, are around 20-30%. The upland rice plant is not as competitive as corn or soybeans, and consequently, the rice crop requires man's intervention to control weeds in extensive areas. Also, available herbicides are not as effective for rice as they are for other crops and the application of carbofuran seed treatment for insects has imposed restriction on some herbicides due to incompatibility problems. Recently released new varieties have short stature and may be less competitive against weeds. Some farmers are using herbicides, but the majority still use mechanical control or animal-drawn equipment. Increased research is needed to develop integrated weed management through a combination of chemical control and cultural practices, and by taking advantage of some aspects of the natural competition between the rice plants and the weeds.

Tillage operations

Soils with a compacted layer prevent adequate root penetration and affect yield and cause grain production instabilities. The most common procedure in soil preparation consists of plowing the field once or twice using a plow harrow followed by a disk harrow. This procedure cultivates the surface layers of the soil, but can cause soil compaction at a depth of about 15 cm. In this situation, the plant's ability to sustain stress is impaired once a drought spell occurs, because most of its root system is shallow. On the other hand, because water infiltration to depth in the soil is limited by compaction, excessive precipitation causes saturation of the surface layer and running water on the soil surface may promote soil erosion.

Research results indicate that deep soil penetration allows deeper root penetration and consequent higher drought tolerance (Kluthcouski et al 1995). The utilization of a moldboard plow promotes not only deep soil penetration but also contributes to more effective and economic weed control by placing weed seeds deep into the soil where emergence is reduced. In many cases, no further weed control is necessary. Research on soil preparation has provided important information over the years, but some interesting aspects such as minimum tillage in upland rice cultivation systems need more work.

Rice monoculture

The continuous use of land for rice production has been responsible for significant reduction in yield in upland condition. Usually, farmers cultivate rice for up to three years in the same area. In the second year, some grain yield reduction is commonly observed and losses tend to increase in subsequent years. Although the subject is already under investigation, there is no reliable information available until now to farmers. Some preliminary research results suggest that the problem is not so severe in clay soils and it is almost insignificant in soils rich in organic matter.

Nutrient management

Fertilizers are commonly applied to upland rice, but usually not in the required amounts. Upland rice is considered a high-risk crop and production costs are minimized. Additionally, the risk situation strongly influences farmer's decision making for low input application. Nitrogen surface application is also questionable, due to negative effects in conditions of drought stress or disease incidence. For some cases of nutrient deficiency, there are efficient and practical solutions, but for some others, additional research is necessary. Some risks can be reduced by following modern procedure and recommendations to attain high yield and good financial return.

UPLAND RICE PERSPECTIVES

Rice as an alternative crop

Brazil has a large area suitable for mechanical upland cultivation with deep and well-structured soils. Main limitations are low soil fertility and rain distribution, classifying the regions in range from favorable to unfavorable for rice production. Climatically favorable areas are concentrated in the northern region, intermediate favorable areas are mainly located in the west-central and in the southeastern regions, while the unfavorable ones are concentrated in the northeast. It has been observed, however, that with the utilization of good cultural practices and research recommendations, it is possible to cultivate intermediate areas and attain yields similar to those obtained in favorable areas. In these regions, rice is produced as an alternative crop and farmer's decisions depend on the current opportunities, taking into consideration factors such as price of product, local advantages, and farmer's ability and traditional practices in rice cultivation.

Production in small areas for on-farm use

More than 70% of upland rice is cultivated for subsistence purposes in areas below 10 ha. In this situation, rice is little reactive to prices or government policies. In the medium term, rice will continue to be grown as a subsistence crop over an extensive area of the total upland region. However, the current balance between costs and prices is not very favorable for rice and the cultivated area is being reduced, especially among more developed farmers who use improved levels of technology.

Rice pasture association

The Brazilian savannah (cerrado) occupies an area of more than 200 million ha, which represents one fourth of the country's territory. Native and improved pastures cover more than 117 million ha, almost 60% of the savannah area, and support about 50 million livestock at a stocking rate of 0.5 animal ha^{-1} or 2 ha $animal^{-1}$. Low stocking rates are due to the fact that the native pasture is growing in naturally degraded soils of low fertility and the improved pasture, which cover the majority of the area, is also degraded.

CNPAF has developed and recommended an undersowing system to recover degraded pasture. This technology consists of sowing the pasture (either by using only grass or a combination of grass and legume species) together with rice or another suitable grain crop. The return from the grain harvest is used to offset the costs of pasture formation.

Soybean - rice and other rotation systems

Upland rice can no longer be considered as an isolated crop but as one crop component in broader farming systems. The interaction of activities between system components can maximize farm efficiency. Fertilization and liming of a soybean crop, for instance, can be very beneficial to a subsequent rice crop. Some farmers have planted rice after soybeans, using low levels of fertilization in the rice crop, and they obtained a very good yield response. Rice cultivation after soybean, however, in areas heavily limed for soybean production, may impose Zn and Fe availability problems and cause negative effects on yield. Some disease problems in soybeans have induced farmers to look for alternative crops for rotation. Rice, in this situation, has been cultivated under high technology and with total mechanization. Rice varieties, which possess the ability to respond to inputs without lodging, need to be developed. Research work has to focus on crop improvement and management from a farming systems point of view. The cultivated area of soybean in Brazil is around 10 million ha and rice can be used as an important rotation crop for an efficient rotation system.

Summer rice under sprinkler irrigation

Brazil has more than 300,000 ha of upland areas under sprinkler irrigation. Upland rice can be an important crop choice for this system, especially during the rainy season (summer). Traditional varieties are not well adapted to these favorable conditions, in terms of water and nutrient, and excessive plant growth causes crop lodging and reduced yield. Lowland varieties are also not well adapted, especially due to problems of water supply, and are very susceptible to diseases. CNPAF has released three upland varieties recommended for this system. These varieties have intermediate plant height, erect leaves, good lodging resistance, and are highly productive.

During the rainy season, one or two supplementary irrigations are enough to supply adequate water to the rice crop. Such irrigation systems are also used to provide water for dry season crops.

Rice as an option for regions with adequate rain distribution and frequency

Upland areas are classified into favorable and unfavorable for rice production based on the amount and distribution of rain (Steinmetz 1988). Unfortunately, some highly favored areas are located in less developed regions where production infrastructure is restricted. But even in these areas, there is a great promise for considerable expansion for rice production.

With the use of appropriate varieties, appropriate technology on planting dates, soil management, and cultural practices, it has been possible for extensive areas to obtain yields as high as 4-5 t ha^{-1}. The low production cost and high yield suggest that this system is very competitive. In the future, rice may be a major crop component in such regions, represented by an area of several million hectares.

CITED REFERENCES

Ferreira E, Martins J. 1986. Avaliacão de infestacão e dano de insetos. In: EMBRAPA. Centro Nacional de Pesquisa de Arroz e Feijão (Goiânia, GO). Sintese dos resultados de pesquisa do CNPAF. Goiânia. p 29 (EMBRAPA-CNPAF. Documentos, 14).

Kluthcousk IJ, Pinheiro B da S, Yokoyama LP. 1995. O arroz nos sistemas de cultivo do Cerrado. In: Conferência internacional de arroz para a américa latina e o caribe, 9, 1994. Goiânia. Arroz na América Latina: perspectivas para o incremento da producão e do potencial produtivo. Goiânia: EMBRAPA-CNPAF-APA, (EMBRAPA-CNPAF. Documentos, 60). p 95-115.

Lorenzi HJ. 1994. Manual de identificacão e controle de plantas daninhas: platino direto e convencional. Nova Odessa, ed. Plantarum. 336 p.

Prabhu AS. 1989. Controle das principais doencas do arroz de sequeiro. Inf. Agropecuário Belo Horizonte 14 (191):58-63.

Reis PR. 1989. Principais pragas do arroz de sequeiro. Inf. Agropecuário Belo Horizonte 14 (161):44-58.

Steinmetz S, Reyniers FN, Forest F. 1988. Caracterizacão do regime pluviométrico e do balanco hídrico do arroz de sequeiro em distintas regioes produtoras do Brasil. Goiânia: EMBRAPA-CNPAF, v. 1 (EMBRAPA-CNPAF. Documentos, 23).

Table 1. Production and yield of upland and lowland rice in Brazil (1986-95).[a]

Year	Upland rice			Lowland rice			Total		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
1986	4.5	5.4	1.2	1.1	4.4	4.0	5.6	9.8	1.7
1987	4.9	5.5	1.1	1.2	5.1	4.3	6.0	10.6	1.8
1988	4.7	5.9	1.3	1.3	5.8	4.5	6.0	11.8	2.0
1989	4.1	5.2	1.2	1.2	5.9	4.8	5.3	11.1	2.1
1990	3.1	2.9	0.9	1.1	5.0	4.6	4.2	8.0	2.0
1991	3.1	4.2	1.4	1.2	5.6	4.8	4.2	9.8	2.3
1992	3.4	3.7	1.1	1.2	6.0	4.9	4.7	9.7	2.1
1993	3.2	4.2	1.3	1.3	6.3	4.9	4.5	10.5	2.3
1994	3.1	4.8	1.5	1.3	5.7	4.4	4.4	10.5	2.4
1995	3.1	4.6	1.5	1.3	6.6	5.0	4.4	11.2	2.5

[a]Area in million ha; production in million t; yield in t ha^{-1}.
Source: CONAB/IRGA/IBGE

Table 2. Upland rice in Brazil, by region (1986-95).[a]

Year	North		Northeast		Southeast		South		Central-West		Total	
	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production	Area	Production
1986	0.3	0.4	1.2	1.5	0.8	1.1	0.3	0.3	1.9	2.1	4.5	5.4
1987	0.2	0.3	1.3	0.8	0.8	1.2	0.3	0.4	2.2	2.7	4.9	5.5
1988	0.3	0.4	1.3	1.7	0.8	1.1	0.2	0.3	2.1	2.5	4.7	5.9
1989	0.7	1.0	1.3	1.4	0.7	1.0	0.2	0.3	1.2	1.5	4.1	5.2
1990	0.4	0.5	1.0	0.6	0.6	0.7	0.2	0.3	0.8	0.8	3.1	2.9
1991	0.4	0.5	1.2	1.6	0.6	0.9	0.2	0.1	0.7	1.0	3.1	4.2
1992	0.5	0.6	1.2	0.7	0.4	0.7	0.2	0.3	1.2	1.5	3.4	3.7
1993	0.5	0.9	1.1	1.1	0.6	1.0	0.2	0.3	0.9	1.0	3.2	4.2
1994	0.5	0.7	1.2	1.6	0.5	0.9	0.1	0.2	0.8	1.3	3.1	4.8
1995	0.5	0.8	1.2	1.6	0.5	0.8	0.1	0.2	0.7	1.2	3.1	4.6

[a]Area in million ha; production in million t; yield in t ha^{-1}.
Source: CONAB/IRGA/IBGE