Upland rice in the Peruvian jungle

K. Kawano, P. A. Sánchez, M. A. Nureña, J. R. Vélez

Upland rice in the Peruvian jungle is grown under shifting cultivation. Several IRRI selections are superior to all traditional varieties under a wide range of planting seasons. They consistently yield from 4 to 6 t/ha while local varieties yield from 1 to 3 t/ha. The concept of the IRRI plant type developed for lowland conditions seems applicable to the development of a variety for primitive upland conditions. Blast and Helminthosporium leaf spot are the most serious diseases of rice in the Peruvian jungle; Helminthosporium leaf spot can be as destructive as blast. A variety that is both high yielding and tolerant of these diseases has not yet been found. Eighteen date-of-planting experiments showed that yields are closely related to rainfall pattern. An average monthly precipitation of about 200 mm was needed for producing over 4 t/ha. Three consecutive rice crops produced up to 12 t/ha in 14 months. Yield responses to closer spacings were higher than to planting methods, planting densities, or fertilization.

INTRODUCTION

In Latin America, about 65 percent of all the rice produced is grown under upland conditions (Bray, 1969). In Peru, upland rice is grown under shifting cultivation in various parts of the Amazon jungle basin.

The climate of the Peruvian jungle is humid-tropical, characterized by mean annual temperatures higher than 24 C and by rainfall that varies from about 600 to 3,500 mm/year. Upland rice is grown only where the monthly rainfall is more than 150 mm for 4 consecutive months. In these areas, the soils are mostly acid Ultisols with low or high base status and young alluvial soils with high base status along the major rivers (Sánchez and Delgado V., 1969; P. A. Sánchez and S. W. Buol, *unpublished*).

Two kinds of cropping systems, known locally as *tacarpo* and *barriales*, are practiced but some mechanized direct seeding is done in the Tingo María area. In the *tacarpo* system, farmers cut and burn the jungle during the drier months and, without further land preparation, drop eight to 25 seeds into holes, 8 to 15 cm deep, spaced 50 cm apart, that have been punched into the soil in an irregular pattern with a stick called a *tacarpo*. Usually the crop gets little care between sowing and harvest. The major varieties planted are

K. Kawano, P. A. Sánchez, National Rice Program (NRP) and North Carolina State University Agricultural Mission to Peru, Lambayeque. *M. A. Nureña, J. R. Vélez*, NRP and Ministry of Agriculture, Lambayeque.

Table 1. Yields at various planting seasons in Yurimaguas and Tingo Maria.

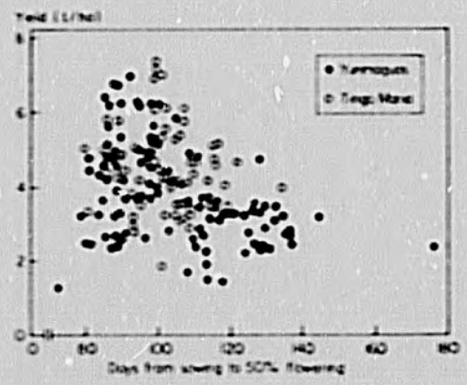
	Grain yield (t/ha)										
	Yurimaguas								Tingo Maria		
Line or variety	Nov 1968	Jan 1969	May 1969	June 1969	Sept 1969	Nov 1969	Feb 1970	Sept 1970	Nov 1969	Dec 1970	Mean
IR8	5.07	3.29	0.73	0.83	4.82	3.84	2.55	5.17	5.20	4.19	3.57
IR4-2	6.30	3.04	0.90	1.03	5.59	4.12	2.30	5.32	5.38	4.72	3.87
IR4-93-2	3.51	3.37	2.34	1.82	4.71	—	2.49	3.68	5.20	4.19	3.48
IR578-8	—	—	—	—	6.25	3.92	4.99	6.93	7.22	5.75	5.85
Catelino (local)	2.93	1.71	0.42	0.44	2.25	2.01	1.05	2.76	4.53	1.81	1.99

relatively low-tillering, early-maturing, tall indicas. Varietal mixtures or heavy segregation always occurs. Maturation is therefore irregular and harvest is done by hand, panicle by panicle. Yields are low, between 1 to 2 t/ha. The fields are normally abandoned after one crop because of the fast jungle regrowth. In *barriales*, the seeds are broadcast on the deposition shores of major rivers when the water level goes down. The crop is harvested before the water rises again (R. E. Zumaeta and S. Berba, *unpublished*).

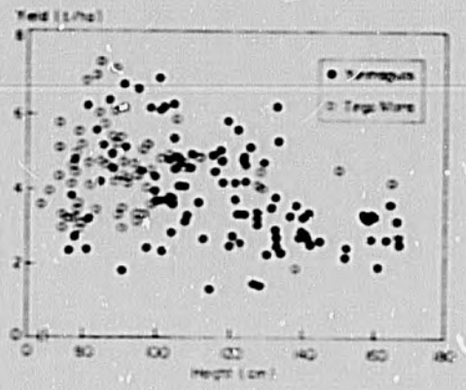
Experiments have been conducted in two representative areas, Yurimaguas and Tingo Maria, to determine the possibility of introducing newly developed genotypes and of improving cultural practices.

VARIETAL IMPROVEMENT

Yield comparisons during several seasons at Yurimaguas and Tingo Maria, in *tacarpo* and drilled plantings, demonstrated the superiority of several IRRI lines over the local variety (Table 1). In the September-to-December plantings, some IRRI lines yielded more than 6 t/ha. In the May and June plantings, when rainfall during the growing season was insufficient, yields were low but some IRRI lines consistently outyielded the local check varieties.



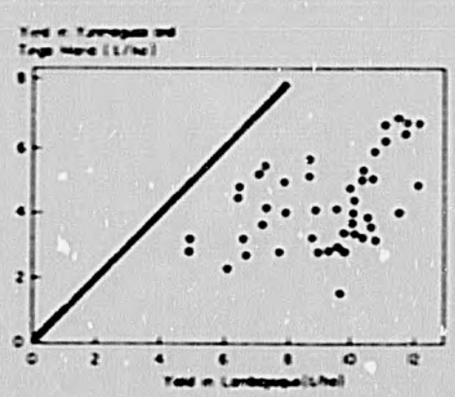
1. Relationship between growth duration and grain yield.



2. Relationship between plant height and grain yield.

In three advanced yield trials at Yurimaguas (Nov. 68, Sept. 69, and Sept. 70) and in two in Tingo Maria (Nov. 69 and Dec. 70) (M. Nureña, J. Vélez, and K. Kawano, *unpublished*), the effects of growth duration (number of days from sowing to flowering) and plant height on yields were analyzed (fig. 1 and 2). All the high-yielding lines flowered between 80 and 110 days after sowing, although many lines that flowered during the same period failed to produce high yields. Most high-yielding lines had short plants (80 to 100 cm). Thus, it is reasonable for breeders to select for relatively early maturity and shortness for these conditions.

Rice cropping in the Northern Coast of Peru is considered highly productive. It is characterized by favorable climatic conditions, fertile soils, and more or less constant water supply (K. Kawano and S. Velásquez, *unpublished*). Varietal yield data obtained in Yurimaguas and Tingo Maria and in this highly productive environment (K. Kawano, P. Arriola, and S. Velásquez, *unpublished*) were compared (fig. 3). The genotypes that yield low under the highly productive environment also yield poorly under primitive upland conditions. The high yielding genotypes under primitive upland conditions also yielded well under the highly productive environment, but the high yielders in the highly productive environment did not always perform as well in primitive upland conditions. Thus, breeders have a better chance of obtain-



3. Varietal yield comparison between highly productive conditions (Lambayeque, Northern Coast) and upland jungle.

ing good selections for primitive upland culture from the materials that are high yielding in productive, transplanted, and well-irrigated environment. Rice breeders probably could extend the same concept of plant type developed for lowland rice varieties to the more primitive upland condition.

PLANT DISEASES

Rice blast and Helminthosporium leaf spot are the main diseases in this area. Blast attacks are sometimes so severe that farmers lose a major part of their harvests. Recent studies have shown that varieties can be grouped into three categories based on their reactions to blast. The first category consists of varieties that were attacked heavily by blast in almost any place and season; the second consists of varieties that were susceptible to changes in some places and seasons, but not in others; and the third consists of varieties that showed a constant resistance in any trial during 3 years (H. Huerta, M. Nureña, H. Olaya, L. Chang, and G. Encurra, *unpublished*; H. Huerta, *unpublished*).

Helminthosporium leaf spot can become a serious problem when it also attacks the panicles. Since soil improvement is unlikely in this area, new varieties must have resistance. Many genotypes are clearly susceptible. Some genotypes seem to have more tolerance than others, however no lines are completely free from this disease. So far, a combination of high yield and resistance to blast and Helminthosporium leaf spot has not been achieved.

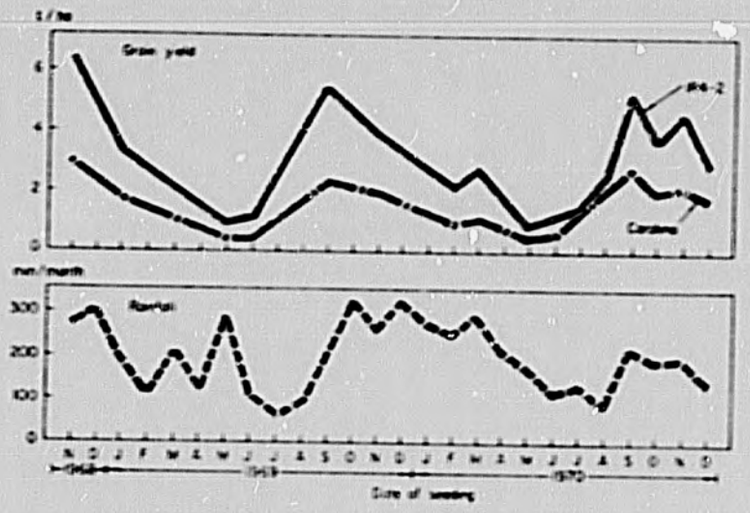
Insect problems are often serious, but no significant research on them has been conducted.

AGRONOMY

Studies were conducted in Yurimaguas to determine the yield response of the varieties with improved plant type to date of seeding and rainfall, to spacing, to fertilization, and to continuous cultivation under upland conditions.

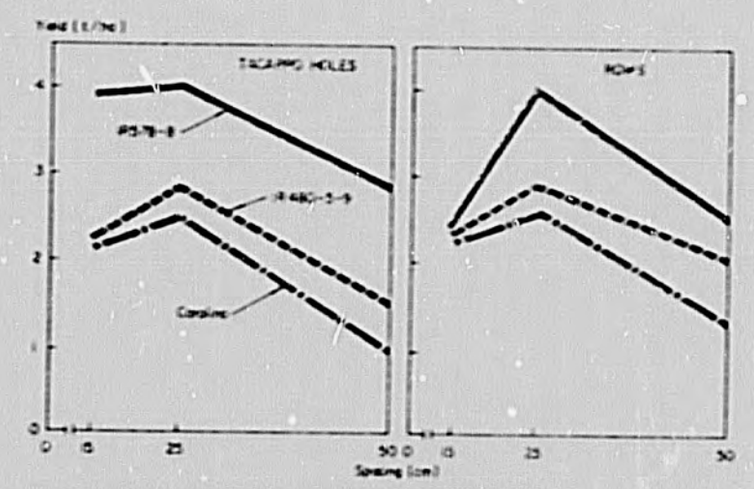
The most important weather variable affecting upland rice yields in the Peruvian Selva is total rainfall and rainfall distribution during the 120-day period of plant growth. Figure 4 shows that the grain yields obtained with an improved variety and a conventional variety in 18 plantings at Yurimaguas are closely related to the rainfall pattern in that region. The improved plant-type selection, IR4-2, outyielded the local variety, Carolino, even when droughts reduced yields. In the five plantings in which IR4-2 produced over 4 t/ha, the rainfall during the growing season averaged about 200 mm/month but high rainfall did not always result in high yields.

The conventional 50-cm spacing of *tacarpo* holes is the most limiting cultural practice. The responses to closer spacing, whether in tacarpo or in row seeding, of three varieties differing in plant type are illustrated in figure 5 (M. Nureña, *unpublished*). The spacing of 25 cm between holes or rows is optimum for all plant types tested. Combining a superior plant type, such as that of IR578-8, and close spacing can produce a yield three to four times that of a conventional

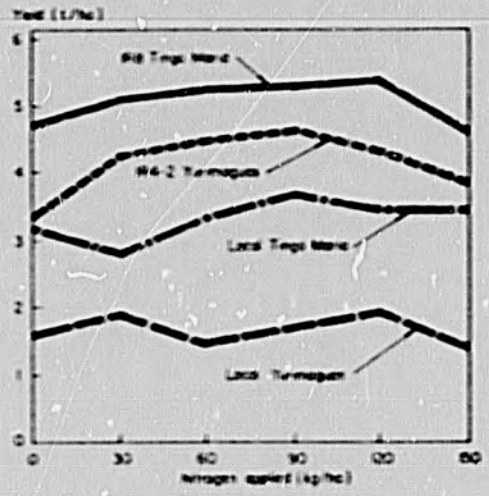


4. Performance of IR4-2 and Carolino, the local variety, as a function of date of planting under land conditions and rainfall. Yurimaguas, 1968-71.

variety planted at the conventional 50-cm spacing. Studies have shown no great difference between seeding rates ranging from 25 to 100 kg/ha at the same spacing (Salhuana and Sánchez, 1969; P. A. Sánchez and M. Nureña, *unpublished*; J. R. Vélez, *unpublished*; M. Nureña, *unpublished*). Germination is superior in row seeding (M. Nureña, *unpublished*), but in general yields do not differ between the *tacarpo* and drilled systems at the proper spacing. The choice between the two seeding systems depends on how clean the fields are of tree trunks and other debris.



Effects of spacing and plant type on the performance of upland rice under the primitive planting system and row seeding. Yurimaguas, 1970.



6. Nitrogen response of contrasting plant types at two upland rice locations in the Peruvian Selva.

Closer spacing did not affect the intensity of blast attacks (P. A. Sánchez and M. A. Nureña, *unpublished*), but it reduced weed competition and t permitted harvesting with a sickle, instead of by hand, with improved varieties.

Results from Yurimaguas (P. A. Sánchez and M. A. Nureña, *unpublished*) and Tingo María (Candela, 1968; J. R. Vélez, *unpublished*) show no response to NPK fertilization during the first planting after the forest was cut, and responses to N only afterwards. The varietal response of the short-plant typ to N at two locations (fig. 6) was positive up to 60 to 90 kg/ha, while little or no response was obtained with the tall lodging local varieties. The graph resembles wet season data from the Philippines, the solar radiation levels being similar. The soils of both stations, however, are representative only of the most fertile areas where upland rice is grown and not of the more extensive low base status Ultisols of the Low Selva.

An attempt was made in Yurimaguas to keep the cleared land continuously cropped with rice beginning in September 1968 (P. A. Sánchez and M. A. Nureña, *unpublished*). Three consecutive crops were grown in approximately 14 months. Nitrogen rates were 20 kg/ha in the first crop, 0 kg/ha in the second crop, and 150 kg/ha in the third crop, except for a plot that received no nitrogen. Total yields ranged from 9 to 12 t/ha per year, compared with the conventional level of 1 to 2 t/ha. Weed control seems to be the most limiting factor but fertility depletion must also be considered. Further research must demonstrate the feasibility of abandoning the shifting cultivation system and developing a realistic continuous cropping scheme with modest amounts of inputs for small farmers.

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Discussion: Upland rice in the Peruvian jungle

N. E. Borlaug: Where does the inoculum of the blast fungus and Helminthosporium come from in the *tacarpo* type of rice culture in the Peruvian jungle?

K. Kawano: We did not find any difference in blast and Helminthosporium attacks between *tacarpo* system and other systems. Disease outbreaks are all by natural infections.

A. O. Abramson: It has been shown that incidence of Helminthosporium leaf spots is associated with low fertility level and *Piricularia* to high fertility level. It is uncommon to have an attack of both diseases. What are the conditions that brought the simultaneous incidence of these two diseases on your plot?

K. Kawano: Our NPK experiment in an upland jungle area did not give us any indication that Helminthosporium can be corrected by fertilization, although there certainly is a soil problem in this area, too. Varieties susceptible to blast are always attacked by blast in Yurimaguas regardless of nitrogen level.