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OVERALL PROGRESS

Genetic evaluation and utilization

CICA 7, a new rice variety

Manuel J. Rosero, director until June 1976, ICA Rice Program; Jorge Vallejo and Alvaro Celis, agronomists, ICA Rice Program; and Elias Garcia, agronomist, FNA: CIAT, Cali, Colombia

A new semidwarf rice variety, CICA 7, has been selected by the integrated rice program of the Instituto Colombiano Agropecuario (ICA) and the Centro Internacional de Agricultura Tropical (CIAT), with cooperation of the Federacion Nacional de Arroceros (FNA). It was released to farmers in May 1976.

CICA 7 was selected from the cross IR22//IR930/Colombia 1 made in 1970 at the Palmira Experimental Station. It is high yielding and has extra-long grains and excellent milling and cooking qualities. It is tolerant of blast disease *Pyricularia oryzae* Cav. and resistant to the direct damage of the leafhopper *Sogatodes oryzicola* (Muir).

It matures in 125 to 135 days and is well adapted to irrigated areas between sea level and 1,200 m above sea level.

CICA 9, a high yielding rice variety

Manuel J. Rosero, director until June 1976, and Jorge Vallejo, Edmundo Garcia, Ernesto Andrade, and Carlos Franco, agronomists, ICA Rice Program

A semidwarf rice variety, CICA 9, was released to farmers in May 1976 after it was selected by the integrated rice program of the Instituto Colombiano Agropecuario (ICA) and the Centro Internacional de Agricultura Tropical (CIAT), with cooperation of the Federacion Nacional de Arroceros.

CICA 9 was selected from the cross IR665//IR841 /C46-15, made in 1971 at the Palmira Experimental Station. It is long grained, with a high yield-capacity and good milling and cooking qualities. It is tolerant of blast disease (*Pyricularia oryzae* Cav.) and resistant to the direct damage of *Sogatodes oryzicola* (Muir).

It matures in from 126 to 138 days after planting and is well adapted to the lowland rice areas of tropical Latin America.

Collecting rice germ plasm in the Uttar Pradesh hills of India

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The hill district of Uttar Pradesh, India, including Nainital, Almora, Pithoragarh (Kumaon), Chamoli, Uttarkashi, Pauri, Tehri, and Dehrdun (Garhwal), presents a range of stresses to rice, from moisture, cold, blast, and brown spot. A program of collection, screening, utilization, and conservation of germ plasm from the area was initiated in 1973. Of 292 collections made in 1973 from the Almora district, 11 lines resistant to blast have been identified by Rana and others. In 1976, 98 collections were made from Pauri, Tehri, Uttarkashi, Chamoli, and Almora – mainly from direct-seeded, rainfed terraces. The purification, screening, and cataloguing of the collections have begun. Additional tours are planned.

High yielding varieties like IR24, Ratna, Saket 4, and VL 8, which are suitable for the irrigated valleys, are gradually spreading. There is yet no suitable variety for the upland terraces. Local upland and transplanted varieties like Matmari, Inakat, Rikhua, Laldhan, Gyarsu, Chaurhdan, Munjala, and Chima 4 are popular.

GENETIC EVALUATION AND UTILIZATION

Agronomic characteristics

Evaluation of rice cultivars for their response to limiting nutrients

K. Alluri and I. W. Buddenhagen, International Institute of Tropical Agriculture, Ibadan, Nigeria

At the International Institute of Tropical Agriculture, certain paddies had been used to investigate yield reductions when certain nutrients were limited. Paddies with low levels of different nutrients were planted in 1976 to 25 cultivars (see table) that had been selected earlier for general performance in West Africa. The question was: would the plants respond differently when a certain nutrient or nutrients (nitrogen, phosphorus, potassium, sulfur, or zinc, or all of them) were withheld than when normal, complete nutrients were provided. The cultivars were grown as the paddies' eighth crop from which the particular nutrients had been withheld. Cultivars markedly differed in growth and yellowing symptoms in the different minus-one-nutrient paddies. Yield differences also revealed interactions between nutrient deficiency and variety. The two highest yielding varieties (more than 39 g/plant) across all nutrient-deficient paddies were Pelita I-1 and IR578-95-1-3. Five others yielded moderately well (more than 24 g/plant) when nitrogen, phosphorus, potassium, or all three nutrients were low. They were BG 90-2, BPI 76^{9}/Dawn, FARO 15, IR2153-338-3, and TOX 161-5-5. The yield depression with nutrients missing was not consistently correlated with yield when soil fertility was high. The preliminary data indicate that varieties for lowland African soil conditions should be screened for performance at low nutrient levels.

The experiment is being repeated to better quantify yield performance.

Cultivars tested in paddies with histories of low status of different nutrients.

4421 from Colombia	IR578-95-1-3[b]
4440 from Colombia	IR529-430-4
BG 90-2[a]	IR2035-242-1
Biplab	IR2071-179-304
BPI 76^{9}/Dawn[a]	IR2153-338-3[a]
FARO 15[a] (BG 679/IR8)	IR2153-550-2-6-3
IAC 1391	IR2863-31-3
IET 1444	OS6
IET 2845	Pelita 1-1[b]
IR269-26-3-3 (TOS 78)	Pokkali
IR480-5-9-3-3	TOS 4106
IR503-1-91-3-2-1	TOS 4138
	TOX 161-5-5[a] (TKM 6/ IR269-26-3-3)

[a]Highest yielding under low N, P, K, and NPK.
[b]Highest yielding across all low-nutrient plots.

GENETIC EVALUATION & UTILIZATION

Disease resistance

Varietal resistance to kernel smut disease of rice under natural conditions

K. K. Baloch and I. M. Bhatti, Rice Research Institute, Dokri, Sind, Pakistan

Seventeen promising rice cultivars were tested in the field against kernel smut disease caused by *Tilletia barclayana* (Bref.) Sacc. & Syd.

Disease incidence varied from variety to variety and from year to year. Maturity period had no marked effect on the incidence. No variety was highly resistant. All the early-, medium-, and late-maturing varieties tested were moderately resistant, with disease incidence averaging 1 to 5% (see table). Only IR8/C-621 and IR1561 were moderately susceptible; their disease incidence averaged 11.4 and 8.4%, respectively.

"IR-6," which is widely grown throughout both Sind and Punjab, showed an average infection of 1.72%.

Reactions of certain rice cultivars to kernel smut. Rice Research Institute, Dokri-Sind, Pakistan, 1974–77 kharif seasons.

Reaction	Growth duration	Cultivar
Moderately resistant (1–5% incidence)	Early maturing	Kangni-27; IR661; IR8 (Mut.); IR841
	Medium	IR8; "IR6;"Jajai-77; IR506-61
	Late maturing	Bas. 197; Bas. 198; IR424; IR579-48-2; Bas. 370; J-77/D. Bas; IR579
Moderately susceptible (6–25%)	Early maturing	IR1561
	Late maturing	IR8/C-621

Reaction of six rice varieties to *Xanthomonas oryzae* in the field and in the greenhouse in West Java

Suparyono, J. Soepriaman, L. T. Palmer, and Sunendar K., Department of Plant Pathology, Central Research Institute for Agriculture, Sukamandi, W. Java, Indonesia

Nine isolates of Xanthomonas oryzae were tested for pathogenicity to six rice varieties in the field and in the greenhouse. The plants were inoculated by clipping 55 days after transplanting; data were collected 14 days later.

Five isolates induced a susceptible (S) reaction in the greenhouse on at least one variety that showed a resistant (R) reaction in the field (see table), and greenhouse scores tended generally to be higher than field scores. It may be that the greenhouse offered conditions more favorable than those in the field for development of the fungus isolates. Temperatures in the greenhouse, for instance, ranged from 27 to 35°C (average 29°C) while those in the field ranged from 23 to 28°C (average 25°C).

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Reactions of nine isolates of *X. oryzae* on six varieties tested in the greenhouse and in the field, Sukamandi, West Java, 1977.

Variety	Reaction score[a] of isolate[b] 1		2		3		4		5		6		7		8		9	
	G[c]	F	G	F	G	F	G	F	G	F	G	F	G	F	G	F	G	F
TN1	x	x	9	9	9	7	7	9	9	5	9	9	9	9	9	9	9	9
C4-63	5	x	9	9	9	9	7	5	9	5	7	9	9	9	9	9	9	9
Pelita I/1	3	x	5	5	7	3	x	x	3	x	3	3	9	3	9	3	3	3
IR26	x	x	3	3	1	3	x	1	x	1	5	3	7	3	3	3	3	3
IR29	x	x	3	3	5	3	1	1	1	1	3	3	3	3	3	3	3	3
IR30	x	x	9	3	5	3	1	x	1	x	5	3	5	3	5	3	3	3

[a]Score: 1 = R (resistant); 9 = S (susceptible); x = no infection. [b]Isolates: 1 = Parakan; 2 = Purwokerto; 3 = Jalaksana; 4 = Mandiraja; 5 = Indramayu; 6 = Pringsurat; 7 = Tambak; 8 = Sukamandi; 9 = Pacet. [c]G = in the greenhouse; F = in the field.

Donors of resistance to rice tungro

A. Anjaneyulu, virologist, Central Rice Research Institute, Cuttack-753006, India

In greenhouse studies in India, the cultivars Kataribhog, Latisail, Pankhari 203, Kamod 253, Ambemohar 159, and Ambemohar 102 were identified as donors of resistance to rice tungro and have been extensively used in the breeding program. When subjected to infestation pressures in the field at Cuttack, the cultivars except Kataribhog were found to be less resistant than 16 other highly resistant cultivars, *viz.,* ARC 7125, ARC 7140, ARC 10342, ARC 13560, ARC 13804, ARC 13820, ARC 13901, ARC 13959, Ac 58, Ac 982, Ac 3541, Ac 4108, Ac 4163, Ptb 18, T 371, and T 397. The 16 cultivars were identified at Cuttack after rigorous screening of about 4,000 cultivars under high disease pressure artificially induced under field conditions. The new resistance donors can be useful in a breeding program and can also be used as differential varieties for identification of rice tungro virus strains.

Insect resistance

Some gall midge-resistant rice hybrids in northeast Thailand

Weerawooth Katanyukul, Wanit Yaklai, and Suchin Chantarasa-ard, Rice Entomology Branch, Entomology and Zoology Division, Department of Agriculture, Bangkok, Thailand

Gall midges annually cause severe damage to rice in northeast Thailand, especially along the Mekong River. That damage, coupled with poor sandy soils, lowers rice yields. Insecticidal applications are economically impractical. Farmers object to currently available varieties that are resistant to the gall midge (e.g., RD 4 and RD 9) because of their susceptibility to certain diseases and their unacceptable cooking qualities. Further investigation is needed to obtain desirable hybrids.

In 1975, 15 lines of rice hybrids were screened out of 60 lines. During the 1976 rainy season those 15 lines, with susceptible and resistant checks, were tested in a farmer's field at Piboonmangsaharn, Ubonratchatani province, where annual gall-midge infestations are heavy.

Damage caused by the gall midge in 19 entries ranged from 0.8% for BR 1030-28-2 to 31.4% for RD 1, the susceptible variety (see table). Only two lines of the new hybrids were susceptible. However, many lines that showed little damage, produced very few panicles and consequently gave low yields. BR 1031-3-4-3 and BR 1031-7-5-4, from the cross BKN 6517-63-4-3/RD 9, showed a high level of gall midge resistance, a good plant type, a good number of panicles, and high yields. They also exhibited high resistance to brown spot. At heading stage, little to no brown spot infection was found on them although RD 9 and MN 62 M were heavily infected. These two lines are long grained, nonglutinous, and about 80 to 100 cm tall. They are taller than RD 4 and RD 9, which are grown in northeastern Thailand. Since local farmers like the tall plant type, BR 1031-3-4-3 and BR 1031-7-5-4 offer good promise as a substitute for RD 4 and RD 9 for gall midge resistance in northeast Thailand.

Infestation by the gall midge of rice end yield performance of gall midge-resistant hybrids at Piboonmangsaharn, Ubonratchatani, Thailand.

Cultivar[a]	Damaged tillers (%)	Panicles (av. no./hill)	Yield (t/ha)
BR 1030-12-1	1.2	3.3	0.93
BR 1030-16-2	1.8	4.6	1.05
BR 1030-18-1	1.9	3.6	0.93
BR 1030-26-2	3.5	6.4	0.90
BR 1030-26-3	1.3	5.1	1.41
BR 1030-26-4	3.0	5.8	1.52
BR 1030-28-2	0.8	3.5	1.07
BR 1030-51-2	2.1	4.4	1.08
BR 1030-100-2	7.3	6.5	1.38
BR 1031-3-3-3	21.3	7.4	1.45
BR 1031-3-4-3	3.6	7.4	1.65
BR 1031-6-3-2	26.3	6.5	1.46
BR 1031-7-5-4	1.5	8.0	1.40
BR 1031-16-1-6	1.4	9.7	1.58
BR 1031-16-1-8	6.3	9.4	1.47
MN 62 M (R check)	3.6	4.9	2.05
RD 1 (S check)	31.4	8.5	1.09
RD 4 (R check)	6.8	8.5	1.53
RD 9 (R check)	3.7	9.3	1.37

[a] BR 1030 = BKN 6625-109-1/RD 9; BR 1031 = BKN 6517-63-4-3/RD 9.

Some promising gall midge-resistant rice varieties at an Indian hot spot

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The gall midge *Pachydiplosis oryzae* severely damages the main rice crop (May to November) in Sambalpur district of Orissa, India. Breeders since 1968 have incorporated into high yielding varieties a degree of resistance to the insect. Three varieties that attracted attention are RPW.6-17, RPW.6-13, and Sakti. Researchers in various centers have

Yield and silver shoot count of selected rice cultivars in a trial for gall-midge resistance. Orissa, India, 1973–75 wet seasons.

Designation	Parentage	Silver shoots (no./sq m)			Yield (t/ha)		
		1973	1974	1975	1973	1974	1975
ORS.461	Leung 152/IR8/2	7	22	21	4.47	1.97	3.04
RP.9-10-3-2-1-1	IR8/W.1251	9	7	1	3.76	1.33	2.56
RP.352-28-1-14	Eswarakora/IR8	9	3	3	1.42	2.20	2.40
ORS.261	Leung 152/IR8/2	10	11	7	2.34	3.01	2.16
RP.350-57-1-1	820862/820916	5	5		3.02	3.04	1.71
RP.352-25-2-1-1	IR8/Ptb 18//Eswarakora/IR8	2	9	7	1.09	0.81	1.50
13231	IR8/W.1263	96	20	40	2.59	0.32	1.38
RP.352-63-6-1-2	IR8/Ptb.l8//Eswarakora/IR8	21	38	2	2.29	0.55	1.31
RP.351-9-1-1	820862/820851	12	14	4	0.93	0.78	1.12
2	Ptb 10/IR8	40	40	40	2.32	1.42	1.02
12754	IR8/W.1257	89	75	74	2.34	0.98	0.97
ORS.112	Leung 152/IR8/2	0	3	185	3.40	2.75	0.64
Jaya (susceptible check)		251	364	450	0.41	1.13	0.69

developed cultivars from resistant donors like W.1257, W.1263, Ptb 18, Ptb 21, and Leuang 152 but have not achieved consistent resistance and yield.

In 3 years of wet-season trials, more than 70 varieties from various parts of India have been tested and a number have been found promising (see table).

The rice brown planthopper and its predator, *Cyrtorhinus lividipennis,* on some rice cultivars in India

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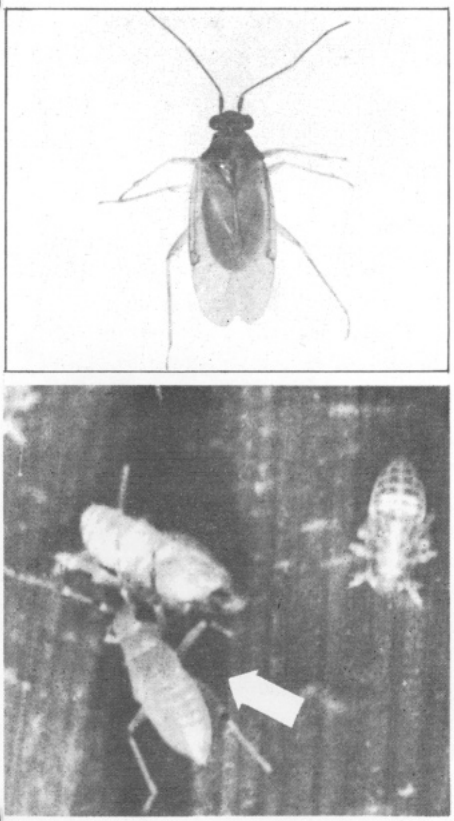
In a varietal trial of 27 rice cultivars during kharif 1976, hopperburn was noted in November in mature grains. Examination revealed the presence of the brown planthopper *Nilaparvata lugens* Stal. and its predator, *Cyrtorhinus lividipennis* Reuter.

Both insects were found on all the cultivars and the predator was found invariably associated with the pest. The number of planthoppers varied from 5 to 133/sq m with a mean of 45 ± 6; that of the predator, from 37 to 423/sq m with a mean of 187 ± 25. The hopperburn was noted in only one of three replications with the variety IET 3229 indicating, as did observations in several farmers' fields, that the pest infestation was highly localized and that in the absence of natural enemies the insects would have caused much more crop damage.

The *Cyrtorhinus* population was about four times the planthopper's, and the population varied together (r = + 0.88).

The present data support the statement of Manjurath et al., who reported that until the crop flowered, the brown planthopper population generally exceeded that of the predator, but as the crop neared harvest, the situation reversed.

Cyrtorhinus seems a promising predator. We have developed methods for mass-rearing it in the laboratory, and for making inundative, timely releases in brown planthopper-infested fields to evaluate its value as a biological control agent.



Brown planthopper predator, Cyrtorhinus lividipennis.

Populations of *Nilaparvata lugens* and *Cyrtorhinus lividipennis* on and yields of selected rice cultivan. Mandya, Karnataka, India, kharif 1976.

Cultivar	Yield (kg/plot)[a]	*N. lugens* (no./sq m)	*C. lividipennis* (no./sq m)
IET 1444	4.61	68	268
IET 2222	4.13	11	54
IET 2662	4.26	11	41
IET 2707	4.03	68	261
IET 2742	3.56	29	53
IET 2914	3.21	57	295
IET 2924	3.76	48	343
IET 2967	3.81	13	43
IET 3116	4.39	15	45
IET 3279	3.86	12	37
IET 3325	3.92	55	273
IET 3331	3.43	33	85
IET 3626	4.48	63	268
IET 3629	4.57	57	315
IET 3630	4.34	95	350
IET 4111	3.95	53	228
IET 4112	4.00	59	223
IET 4554	2.85	70	333
IET 4556	4.09	133	288
IET 5704	4.49	24	113
IET 5857	4.41	26	105
IET 5858	4.63	5	79
IET 5859	3.75	8	67
Ratna	4.26	101	372
Cauvery	4.30	90	423
IET 5860	4.20	15	43
MR 272	5.41	7	53
Mean	4.10	45	187
SE_m		6.5	24.9
F test	*	NS	NS
CD (0.05)	1.10		
CV (%)	16. 2		

[a]Plot size = 6.75 sq m. *Significant at 5% level.

List of scientists in brown planthopper research

E. A. Heinrichs, Entomology Department, International Rice Research Institute

At the brown planthopper symposium held at IRRI 18–22 April 1977, a preliminary list of scientists involved in research on the brown planthopper was developed. The list includes 103 names and addresses of scientists from 13 countries. Research areas listed are taxonomy; migration; surveillance and forecasting; biogeography; flight behavior; bionomics; varietal, breeding resistance; physiology; ecology; chemical, biological, cultural, and integrated control.

To obtain a copy of the list, write the Entomology Department, IRRI, P. O. Box 933, Manila, Philippines.

Pest management and control
DISEASES

Pathogenic Strains of X.oryzae

Pathogenic variability of *Xanthomonas oryzae* populations in India

A. P. K. Reddy, plant pathologist, and G. Shyam Sundar, research scholar, All India Coordinated Rice Improvement Program, Rajendranagar, Hyderabad 500030, India

Various researchers in tropical Asia have studied the pathogenic variability of *Xanthomonas oryzae.* Depending on the "differential varieties" used, *X. oryzae* populations were classified into "strains," "pathotypes," "pathogenicity groups," or "virulence patterns." Some workers reported distinct strains of *X. oryzae;* others reported the absence of clearcut strains. The discrepancies may be attributed to differences in the differentials used; in ages and nitrogen status of test plants at time of inoculation; in methods of inoculation; in concentrations of inoculum; or in types and origins of bacterial cultures.

The effect of experimental methodology and of the genetic diversity of bacterial populations on the pathogenicity of *X. oryzae* was studied at the All India Coordinated Rice Improvement Program (AICRIP).

Samples affected by bacterial leaf blight were collected from six endemic regions — Aduthurai, AICRIP, Maruteru, Cuttack, Chinsurah, and Faizabad — in the 1975 wet season, and 150 bacterial isolates were made from the samples. Four dwarf varieties [derivatives of Sigadis (RP 31-17-2), LZN (CR 129-I0'), TKM 6 (IR20), and BJ1 (RP 633-431)] possessing different resistance genes were used as differentials.

Studies of 72 representative isolates from 6 locations showed that they vary in virulence. High- and low-virulence isolates were present at all locations. Neither location-specific pathotypes nor true "races" were observed. The isolates were divided into seven pathotypes based on the reaction of five rice varieties. Most (50 of 72) were highly virulent and were made up of two pathotypes. Isolates from the Central Rice Research Institute, Cuttack, were the most virulent. They were followed in virulence by isolates from Chinsurah, Aduthurai, Faizabad, AICRIP, and Maruteru.

Differential varieties used in the current studies might have been arbitrary and inadequate for detecting the "strains" or "races" which some earlier workers have reported. Conversely, the apparent absence of races in India might be due to extensive cultivation of cultivars that are susceptible to bacterial leaf blight and cannot foster races.

Leaf symptoms (lesions on leaf edges) of bacterial blight caused by Xanthomonas oryzae.

Pathogenic variability of *Xanthomonas oryzae* and related varietal reaction in Bangladesh

S. A. Miah, plant pathologist, Bangladesh Rice Research Institute, Joydebpur, Dacca, Bangladesh

Even though bacterial blight affects rice crops of Bangladesh the year around, except in the winter months, mild differences in the size and spread of lesions, even on the same varieties, have been observed in different areas. To learn whether the differences are due to pathogenic variability, infected samples were collected from four areas representing different rainfall zones - Comilla, Habiganj, Joydebpur, and Rajshahi. The bacterium was isolated and purified by streaking and selecting single colonies. Eight rice varieties including varieties from the resistant, intermediate, and susceptible groups were inoculated at panicle initiation stage by pinprick with 0.7 O.D suspensions prepared from 2-day-old cultures of each isolate on Wakimoto's medium. The reaction (old scale) of each variety was noted 21 days after inoculation. Differences in spread and size of lesions produced by the four isolates were too small to cause the isolates to be designated as races or strains. In further studies, consideration should be given to the influence of factors like soil nutrition, photosensitive period, temperature, and relative humidity of preinoculation and postinoculation periods; age of test plants; and concentration of inoculum, on the spread and size of the lesions. Differential varieties should be selected from materials that show differential reactions in different parts of the world.

X. oryzae and its pathotypes in Indonesia

D. M. Tantera and Hartini R. Hifni, Central Research Institute for Agriculture, Bogor, Indonesia

Leaf blight may damage rice in Indonesia when susceptible varieties are planted and weather conditions are suitable. Studies by various researchers in the past 5 years conclude that several pathotypes occur.

Based on the Kozaka Grouping System, four pathotypes have been identified and labeled pathotypes III, IV, V, and VI. Pathotype III appears to be the most common and most widespread in Indonesia. Pathotypes I and II do not currently occur there. Pathotype IV has a broad spectrum of virulence and can infect varieties of all groups.

To differentiate pathotypes in Indonesia, the four groups of varieties in the Kozaka System are expanded into five: Kinmaze, Kogyoku, Rantai Emas, Wase Aikoku, and Jawa. The Indonesian differentials are Kencana and Padi Jambu, representing the Kinmaze group; IR5, representing Kogyoku; Rantai Emas and Tetep, representing Rantai Emas; Kuntulan, representing Wase Aikoku; and Remaja and Jelita, representing Jawa.

Tests using the bacterial exudation technique indicate that several varieties have moderate to high levels of quantitative resistance to *X. oryzae* in Indonesia. They are Dara, Remaja, Jelita, IR20, IR22, IR26, IR28, IR29, IR30, Syntha, Dewi Ratih, Pelita I/1, Pelita I/2, and Nihonbare.

Xanthomonas oryzae strains in Thailand

Sunetra Eamchit, plant pathologist, Rice Protection Research Center, Plant Pathology Division, Department of Agriculture, Bangkhen, Bangkok, Thailand

Samples of bacterial leaf blight of rice were collected from four parts of Thailand from 1972 to 1977: 31 isolates from the central region; 28 isolates, northern; 13, northeastern; and 26, southern. Their pathogenic behavior was tested on three rice varieties that show different degrees of resistance or susceptibility in Thailand. The varieties were PN 16/Sigadis and IR8/Tadukan (resistant), and RD 1 (highly susceptible). Plants with four fully developed leaves were inoculated beside the main vein at the middle part of each leaf blade by single-needle pinprick. Observations were made 15 days after inoculation, using the International Rice Research Institute (IRRI) scale. Comparisons of the pathogenicity of the isolates were also made from bacteriophage tests using the streak plate method. The pathogenic strains of bacterial leaf blight of rice in Thailand seem to fall into three groups. Pathogenic strain A produced big lesions in both resistant and susceptible varieties. Strain B produced big lesions only in the susceptible variety and small lesions in the resistant varieties. Strain C produced small lesions in both susceptible and resistant varieties. The predominant pathogenic strain was strain B. According to their sensitivity to the five types of bacteriophages, the isolates of *X. oryzae* in Thailand fell into 12 groups (A, B, C, ... L). Bacterium strain A predominated; it was distributed throughout the country. Strain B was mainly in central and southern areas, and Strain C was found everywhere in Thailand except in the northeast. Strain E was predominant in southern Thailand. Strains A, B, C, D, and E encompassed more isolates than the others, which presented only one or two isolates each. The fact that strain B was sensitive to all of the Thai *X. oryzae* bacteriophages was useful for the forecasting of bacterial leaf blight of rice in Thailand. No correlation was observed between pathogenic strains and phage-sensitive strains.

Grouping of *Xanthomonas oryzae* isolates in terms of virulence in Japan

S. Wakimoto, Faculty of Agriculture, Kyushu University, Japan

Grouping of *Xanthomonas oryzae* isolates in terms of pathogenicity or virulence has been attempted in Japan since 1957. Isolates from various Japanese sites were assigned to group A or B, each containing three subgroups, or to group I, II, or III, by needle prick inoculation of young leaves or flag leaves of the differential rice varieties. Some workers used more than 10 rice varieties for differentiation; others used wild rices and weeds as well. Classification methods and criteria varied markedly. Multineedle prick inoculation of the flag leaves of four groups of differential varieties (Kinmaze, Kogyoku, Rantai Emas, and Wase Aikoku) has recently been recommended to standardize reporting of pathogenicity in Japan. Isolates can be grouped as follows:

Group I	virulent to only Kinmaze varieties
Group II	virulent to Kinmaze and Kogyoku varieties
Group III	virulent to Kinmaze, Kogyoku, and Rantai Emas varieties
Group IV	virulent to all varieties

The criterion was established by inoculating the leaves of young seedlings with Japanese isolates only. Some attempts were made to apply the criterion to tropical isolates. Because using tropical isolates in the field in Japan is impracticable, young seedlings were inoculated in the greenhouse. Pathogens with higher virulence than the Japanese isolates seem to be frequent and widely distributed in the tropical areas, particularly in India, Cambodia, and Thailand. With some exceptions, virulent isolates showed high virulence to all varieties, isolates with low virulence expressed it with all varieties. Clearcut specialization in pathogenicity was not observed. By the above criterion, most of the highly virulent isolates were considered to belong to Group III or IV.

An isolate showing a distinct pathotype was reported recently to exist in Bali, Indonesia. A group V (virulent to Kinmaze and Wase-Aikoku group varieties) was proposed. Pathotype differentiation was also noticed at the International Rice Research Institute. When young seedlings are inoculated, the virulence of *X. oryzae* isolates seems generally to vary quantitatively, depending on the combinations of isolates and hosts, without clearcut specialization. The groups suggested above will, therefore, be separated into the smaller clusters according to judgments of virulence, or by additions to the differential varieties. Of course, data suggesting pathogenic specialization were often obtained, but were too much complicated to be analyzed. More intensive studies are needed in each country, using adult plants and sophisticated techniques.

Pathogenic strains of *Xanthomonas oryzae* and related resistant and susceptible rice varieties in Korea

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Two phage-type strains of *Xanthomonas oryzae* were identified in Korea by the use of four different bacteriophages, in 1968, and seven had been identified by 1971. The seven strains were categorized according to virulence into three groups, but the groups were not called pathotypes or races.

By 1976, five groups of pathotypes were recognized in Korea. To classify the isolates, they were inoculated to four groups of differential varieties. Of 67 isolates collected from limited areas of the country, 22 belonged to pathotype I, 8 to pathotype II,2 to III,5 to IV, and 30 to V.

Pathotype I attacks only Kinmaze-group varieties including IRI 323, 326, 327,330, Milyang 21, 23, 28,34, Suweon 264, 265, 267, 268, 271, Jinheung, and Glutinous Tong-il. Pathotype II attacks, in addition to those varieties, Kokyoku-group varieties such as Iri 319,328, Milyang 25, and Suweon 263. Pathotype III attacks all varietal groups except the Wase-Aikoku group varieties (Milyang 30), and pathotype IV attacks all the varieties tested. Pathotype V attacks varieties of the Kinmaze and Wase-Aikoku groups.

During the 1976 growing season, severe epidemics of kresek disease occurred in areas where the new variety Milyang 23 had been introduced. It was the first time that kresek was officially reported in Korea. Of all cultivars used in studies of kresek, Milyang 23 showed the most susceptible reactions to all five pathotypes. The relationship between pathotypes and kresek symptoms was not clearly proved, although it seemed to be affected by inoculum concentrations, inoculation sites, and varietal differences.

Pathogenic strains of *Xanthomonas oryzae* in the Philippines

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The virulence patterns of *X. oryzae* isolates collected in the Philippines from 1963 to 1976 were evaluated on four host varieties: IR8, which has shown no genes for resistance to bacterial blight; IR20, which has the dominant gene *Xa 4;* IRl545-339, which carries the recessive gene *xa 5;* and DV85, which has one recessive gene similar to *xa 5* and a dominant gene that is different from *Xa 4.*

Pathogenic strains or races clearly exist in the population of *X. oryzae* in the Philippines. Most of the 83 isolates belong to one group that we call the common strain, exemplified by isolate PXO 61. Host genotypes carrying either of the two major genes (*Xa 4* or *xa 5*) are resistant to that strain. The Isabela strain is exemplified by the isolate PXO 79 collected in Davao; the host genotype carrying the recessive gene *xa 5* is resistant. The third group of isolates, which makes up a small portion of the present collection and is typified by PXO 71 from the Palawan area, overcomes the resistance of host genotypes that carry both the dominant and recessive genes. It appears that PXO 71 is more compatible with genotypes with *xa 5* than with those with *Xa 4.* It always produces more lesions on IR1545-339 than on IR20. DV85. is resistant to all isolates. A variety like IR8, with no apparent genes for resistance to bacterial blight, is susceptible to the three groups of isolates. All isolates under study produced lesions on IR8, but isolates such as PXO 10 that have weak virulence produced considerably fewer lesions.

The results also confirmed that isolates compatible with a certain host genotype are present in an area before the particular host genotype is widely planted. PXO 71 is one of the isolates found in Palawan in 1974; some isolates of the Isabela strain were collected in Davao in 1963.

Pest management and control

INSECTS

Eriophyid mite appears on rice in Thailand

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The 4-legged eriophyid mites are quite uncommon on rice. In Keifer’s 1967 index, only one rice-infesting species is given — *Eriophyes bakkeri* Keifer, which was described from Africa. Another species — *Cheiracus sulcatus* Keifer — has been found in Thailand. I encountered it on the undersides of mature blades in paddy at Ban Pa Ha, Chiang Rai Province, North Thailand.

The infestation was heavy, but it occurred on old leaves blemished by other agents. It would therefore be premature, on the basis of visual inspection only, to attribute damage to the mite. The mite has to be evaluated under controlled conditions.

Grasshoppers on rice in Pakistan

Mohammad Irshad, assistant entomologist, Pest Management Project, Agricultural Research Council, Islamabad, Pakistan

Rice suffers considerable loss due to grasshopper attack in Pakistan. The important species are *Heroglyphus banian* (F.) and *Oxya multidentata* Will. *H. banian,* earlier reported as a Serious pest in the plains, currently occurs mostly in hilly areas. Intensive cultivation in the Plains may be responsible for the destruction of egg pods there. Abundance of *H. banian* in the hills may be due to favorable climate or undisturbed oviposition sites. *O. multidentata* is found all over Pakistan but is more abundant in hilly areas. *Oxya velox* (F.), a serious pest in almost all rice-growing countries, is of minor significance here. It is found only in the hills and foothills. *Acrida exaltata* Wlk., *Acrida* sp., *Acrotylus humbertianus* Sauss, *Atractomorpha acutipennis* (Guer.), *Calliptamus* sp., *Catantops pinguis* Stal., *Chroedicus illustris* Wlk., *Eyprepocnemis plorans* Charp, *Shirakiacris shirakii* I. Bol., *Oedaleus abruptus* Thunb., and *Truxalis grandis* Dirsh are also found on rice but in low numbers.

Grasshoppers are more serious in the rice nurseries where young nymphs accumulate in large numbers and damage the seedlings. In some cases almost the whole of a nursery plot is destroyed. Plowing of fields and digging of embankments during winter seem good control measures because they destroy most of the egg pods.

Insecticidal control of the brown planthopper in the field

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Field studies on the efficacy of insecticides against the rice brown planthopper *Nilaparvata lugens* showed that the maximum reduction of insect numbers occurred in plots treated with carbofuran 3% G (2.25 kg a.i./ha), followed by that in plots treated with methamidophos (0.1% spray), Phorate (2.25 kg a.i./ha), and phoxim (0.05% spray). In general, mephosfolan 10% G was found to be ineffective.

Effect of paddy-water and foliar applications of insecticides on brown planthopper populations 9–12 weeks after transplanting, Annamalainagar, India, kuruvai, 1973.

Treatment[a]	Application rate (kg a.i./ha)	Planthoppers[b] (no./hill)					Change from control level (%)
		9 wk	10 wk	11 wk	12 wk	Mean	
Carbofuran granules	0.75	0	61	27	28	29	- 67
	1.50	0	0	0	44	11	- 88
	2.25	0	0	0	0	0	- 100
Phorate granules	0.75	5	39	121	143	77	- 13
	1.50	6	33	153	156	87	- 2
	2.25	3	13	62	71	37	- 58
Mephosfolan granules	0.75	2	58	160	128	87	- 2
	1.50	3	132	123	125	96	+ 8
	2.25	4	20	122	122	92	+ 4
Methamidophos spray	0.025%	3	17	62	61	41	- 54
	0.05%	4	2	111	88	51	- 42
	0.1 %	7	18	46	76	37	- 58
Phoxim spray	0.025%	4	37	128	131	73	- 17
	0.05%	2	45	78	76	50	- 43
	0.1 %	4	77	99	92	68	- 23
Control	-	13	48	132	143	89	....

[a]Chemicals applied on 15th and 45th days after transplanting; treatments significant at 1% level (C.D. = 1.741).
[b]Av. of 20 hills.

Research on pests of rice in Malawi (Central Africa)

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From 1971 until 1975 a research project was conducted to determine the relative importance of various insect pests of rice in Malawi.

The most numerous insect pest of rice is the stem borer *Diopsis thoracica* Westwood *(Diptera; Diopsidae).* Other diopsids are unimportant. Lepidopterous stem borers, such as *Maliarpha separatella* Rag., *Chilo partellus* (Swinh.), *Chilo diffusilineus* (de Joannis), *Sesamia calamistas* (Hamps.), *Schoenobius* sp., and *Thopeutis* spp., are of little importance, since they are controlled by many parasitoids. At the end of prolonged rainy seasons, fields planted late were attacked by the rice gall midge *Orseola oryzae* (Wood-Mason). Three larval parasitoids kept that pest under control. Several outbreaks of the rice beetle *Trichispa sericea* (Guer.), occurred in rice fields with high water levels. In the 1972–73 season several hectares of nurseries were destroyed by this species. However, parasitoids usually kept the beetle under control. Other pests of minor importance were lepidopterous defoliators such as *Nymphula depunctalis* (Guen.), *Spodoptera cilium Guen., Diacrisia scortillum* (Wllgr.), *Borbo borbonica* (Boisd.), *Grammodes geometrica* F., *Mythimna* sp. and *Brachmia* sp., the green rice bug *Nezara viridula* (L.), and the mole cricket *Gryllotalpa africana* (P. de Beauv.).

Most of the Lepidoptera were identified by Dr. P. E. S. Whalley and Dr. I. W. B. Nye of the British Museum (Natural History).

The project formed part of the Lake Chilwa Coordinated Research Project and was financed by the Netherlands Foundation for the Advancement of Tropical Research (WOTRO), and the Research Council of the University of Malawi.

Pest management and control

WEEDS

Weed competition in transplanted rice

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To study the effect of various weeds in season-long competition with IR34, the desired weed species were sown with the rice at transplanting. Then at regular intervals all weeds, except the species under study, were removed.

All weeds except *Salvinia natans* caused yield losses (see table). The losses ranged from 19% (with competition from *Marsilea minuta*) to 43% (with competition from *Fimbristylis* sp. and *Echinochloa colona*). Losses were greater when competition was from more than one weed. The greatest loss (55%) occurred in the unweeded check plot, where all the tested weed species and the natural weed population competed simultaneously against rice.

Surprisingly, in the plots with competition from *S. natans,* which is regarded as a major problem in rice fields in Java, yields were slightly higher and the number of productive tillers was 19% higher than in the weed-free check. It is not known why, but the weight of *S. natans* competing with rice was lower than that of other weeds, and it is possible that the weed, which rapidly covers the surface of the water, reduced volatilization losses of applied nitrogen.

Effect of competition from various weed species on number of productive tillers and grain yield of transplanted rice IR34.

Competing weed species	Weed weight 70 DT[a] (t/ha)	Productive rice tillers (no./hill)	Rice yield (t/ha)
Salvinia natans	16.0	1.0	4.4
None	13.4	0	4.2
Marsilea minuta	13.7	2.5	3.4
Monochoria vaginalis	11.2	1.4	3.1
Cyperus sp.	9.6	4.5	2.9
Fimbristylis sp.	9.3	4.6	2.4
Echinochloa colona	7.1	7.6	2.4
M. vaginalis + *Cyperus* sp.	7.5	9.8	2.3
Cyperus sp. + *Fimbristylis* sp.	8.0	8.9	2.3
M. vaginalis + *Fimbristylis* sp.	7.6	6.3	2.0
All + natural weed flora	8.8	6.5	1.9

[a]DT = days after transplanting.

Soil and crop management

Azolla utilization in rice culture

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Azolla can grow on nitrogen-free media with the aid of the nitrogen-fixing blue-green algae *Anabaena azollae.* Under suitable conditions, it doubles its weight in 3 to 5 days by fixing 0.45 to 0.57 mg N/g fresh weight each day. Phosphorus, calcium, and iron are critical macronutrients in the water culture of *Azolla.* Temperatures above 31 °C inhibit its growth. *Azolla* that grew in field plots for 20 to 23 days accumulated about 24 kg N/ha. From October to January (106 days), five crops of *Azolla* were harvested, accumulating 120 kg N/ha.

Azolla nitrogen was released slowly; its availability to a single rice crop was about 70% of that of nitrogen from ammonium sulfate. A field was inoculated with *Azolla* at the time of transplanting of dry-season rice. Adding superphosphate improved *Azolla* growth; 40 days later the *Azolla* covered the surface and was incorporated into the soil with a hand weeder. The result was a 13% increase in grain yield over a plot that was puddled in midseason without *Azolla.*

Effect of *Azolla* on yield of rice

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The effect of *Azolla* on rice yield was compared with the effect of urea fertilizer. Four treatments were used on rice variety BG 77-11 transplanted when 3 weeks old into 15-sq m plots: (1) control — no *Azolla,* no fertilizer; (2) *Azolla,* no fertilizer; (3) *Azolla* + a fertilizer mixture of phosphorus (67.3 kg/ha), potassium (43 kg/ha), and molybdenum (5.04 kg/ha); and (4) phosphorus, potassium, and molybdenum with urea (89.7 kg nitrogen/ha). When *Azolla* was used, it was inoculated 3 weeks before transplanting at 150 g/plot and again 1 week after transplanting. The urea was applied in three doses, 1, 5, and 9 weeks after transplanting.

Treatments showed no significant differences in number of panicles per hill. The urea treatment showed the greatest number of grains per panicle, closely followed by *Azolla*-plus-fertilizer. The two *Azolla* treatments outdid the urea treatment in percentage of filled grains. *Azolla*-plus-fertilizer registered 132% as many filled grains per panicle as the control; the urea treatment registered 95%. Perhaps the *Azolla* treatment reduced sterility; further study of that question would be needed before drawing such a conclusion, however. The results clearly indicate that *Azolla* has a beneficial effect on yield of this rice variety.

Sulfur responses of lowland rice in South Sulawesi, Indonesia

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In many areas of South Sulawesi, Indonesia, farmers report little or no response of rice to urea in nitrogen-deficient areas. Because sulfur deficiency is the likely cause, studies of the response to ammonium sulfate were begun in 1976 (see table).

A decrease in the number of tillers was the major cause of yield reduction in sulfur-deficient plants. The plants showed yellowing of new growth. Symptoms generally were not uniform throughout a paddy; they were milder in areas with less waterlogging. To alleviate the problem farmers often drain paddies — a risky practice where there may not be sufficient water supply until harvest.

Response of lowland rice to additions of sulfur.

Site	Grain yield (t/ha)		
	Control	Urea[a]	Ammonium sulfate
1	1.13	2.55	3.57
2	0.73	3.52	4.49
3	3.04	3.59	5.22
4	4.83	5.05	4.78
5	2.75	4.05	5.35
6	2.63	3.99	4.46
7	2.28	3.00	2.45
8	2.66	5.64	3.50

[a]Equal rates of nitrogen.

The yellow color of the plants may disappear as the roots proliferate in the oxidized surface layer of the soil at the end of tillering. Nonetheless yields are reduced because there are fewer tillers.

Experiments on the response of rice to sulfur applied in the paddy as ammonium sulfate, gypsum, and elemental sulfur are in progress.

Effects of late sowing on dry-season rice in West Bengal

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Dry-season rice in West Bengal experiences low temperatures in the nursery and during early growth after transplanting. Nine local and introduced cultivars were sown on four dates representing the range used by local farmers (Table 1). Perhaps because the temperature remained at about 10°C throughout their nursery period, seedlings sown on 6 and 26 December were shorter at all growth stages than the seedlings sown on 25 October and 15 November. Seedlings from all sowings produced only about one leaf for each 10 days of nursery growth. Seedling height vaned more than leaf number.

In another experiment, dry-season and wet-season seedling heights were compared (Table 2). Sowings on 6 December and 26 December resulted in seedlings noticeably shorter than those from wet-season sowing. Final plant height, however, depended more on field temperatures after transplanting.

Table 2. Effect of sowing date on rice seedling height and final plant height.[a] West Bengal, India, 1976 dry season.

Nursery sowing date	Seedling ht[b] (% of wet-season ht)	Final plant ht (cm)
25 October	65.09	76.19
15 November	61.41	86.77
6 December	76.51	82.62
26 December	73.06	91.51

[a] C.D. at 5%. 5.94; C.D. at 1%. 8.03.

[b] 20 days after sowing. Wetseason seedling ht, 21.94 cm.

Table 1. Relation of mean rice seedling height and number of leaves to sowing date of nine rice cultivars. West Bengal, India. dry season.

Plant age (DS)[a]	25 October Plant ht (cm)	25 October Leaves (no.)	25 October Av temp. (°c)	15 November Plant ht (cm)	15 November Leaves (no.)	15 November Av temp. (°C)	6 December Plant ht (cm)	6 December Leaves (no.)	6 December Av temp. (°c)	26 December Plant ht (cm)	26 December Leaves (no.)	26 December Av temp. (°c)
20	7.76	2.44	18.1	8.46	2.69	14.2	5.13	2.30	9.2	5.57	2.36	10.1
30	11.61	3.14	14.9	11.37	3.87	11.7	6.79	2.97	10.1	9.30	3.39	10.6
40	12.29	4.51	14.2	11.43	4.09	11.1	7.91	3.36	10.6	11.52	3.84	10.7

[a] Days after sowing.

Udbatta disease and the application of nitrogen in paddy

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It has been said that heavy applications of nitrogen induce diseases. An experiment at Mandya confirmed that the incidence of Udbatta disease *(Ephelis oryzae* Syd) was generally much higher when nitrogen was applied at 100 kg/ha than when no nitrogen was applied (see table).

E. oryzae **disease in rice (Cauvery) at various times and rates of nitrogen fertilizer application, Mandya, India, 1971.**

Nitrogen (kg/ha)	Disease incidence (%) when N was applied at: Planting	Tillering	Panicle initiation	Booting	Panicles (no./hill)	Disease incidence (%)
000	0	0	0	0	8.9	2.5
100	100	0	0	0	10.5	4.1
100[a]	100[a]	0	0	0	12.4	4.6
100	75	25	0	0	13.5	5.4
100	75	0	25	0	13.1	5.5
100	75	0	25[b]	0	11.8	5.2
100	75	0	0	25	12.1	5.6
100	50	25	25	0	13.4	6.1
100	50	0	25	25	12.6	5.2
100	25	25	25	25	12.3	6.4

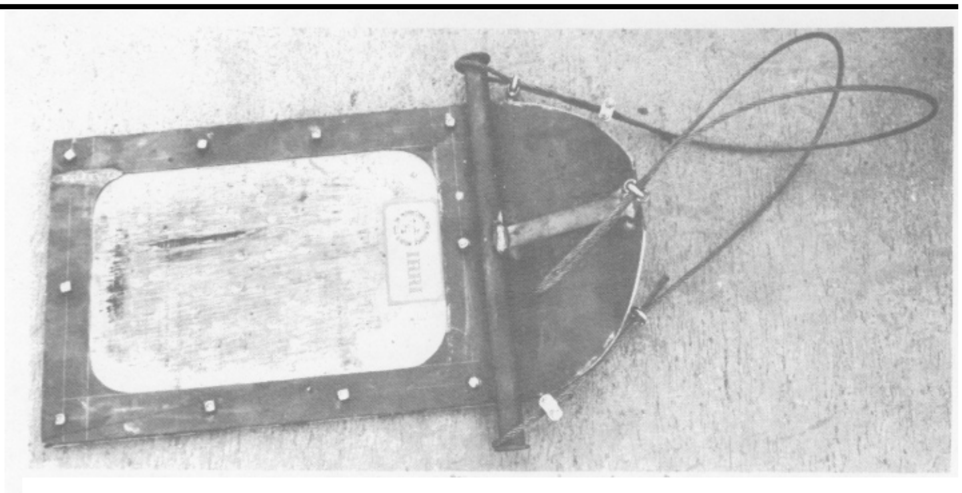
[a] Sulfur-coated. C.D. at 5% highly significant. [b] Foliar spray.

The disease incidence also was higher when the nitrogen was given in split doses than when it was applied basally; that result is unexplained.

Machinery development & testing

IRRI offers plans for time-saving, labor-saving paddy sled

Agricultural Engineering Department, International Rice Research Institute



Paddy sled attaches to power tiller and allows operator to ride above surface of the mud.

Engineers of the International Rice Research Institute (IRRI) have developed a simple sled that permits rice farmers with power tillers to speed up harrowing and ease the drudgery of tillage in flooded paddies. The sled attaches directly to the tiller and allows the operator to ride above the surface of the mud.

The sled increases labor productivity by about 40% above that of machine-harrowing without it. Labor productivity is approximately five times that of a farmer working behind a water buffalo. One machine operator can perform the work usually handled by two. Energy monitoring tests at IRRI indicate that 70% of the human energy expended during land preparation is used in walking through the mud.

The sled fits any power tiller equipped with conventional draft implements. It costs approximately US$10. Requests for plans should be addressed directly to the Agricultural Engineering Department at IRRI.

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