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Style for IRRN Contributors

Units of measure and styles vary from country to country. To improve communication and to speed the editorial process, the editors of the *International Rice Research Newsletter (IRRN)* request that contributors use the following style guidelines:

- Use the metric system in all papers. Avoid national units of measure (such as cavans, rai, etc.).
- Express all yields in tons per hectare (t/ha) or, with small-scale studies, in grams per pot (g/pot) or grams per row (g/row).
- Define in footnotes or legends any abbreviations or symbols used in a figure or table.
- Place the name or denotation of compounds or chemicals near the unit of measure. For example: 60 kg N/ha; not 60 kg/ha N.
- The US dollar is the standard monetary unit for the *IRRN.* Data in other currencies should be converted to US$.
- Abbreviate names of standard units of measure when they follow a number. For example: 20 kg/ha.
- Express time, money, and measurement in numbers, even when the amount is less than 10. For example: 8 years; 3 kg/ha at 2-week intervals; 7%; 4 hours.
- When possible, round off numbers to one or two decimal points. For example; 5.2 t/ha, *not* 5.232.
- Write out numbers below 10 except in a series containing some numbers 10 or higher and some numbers lower than 10. For example: six parts; seven tractors; four varieties. *But* There were 4 plots in India, 8 plots in Thailand, and 12 plots in Indonesia.
- Write out all numbers that start sentences. For example: Sixty insects were added to each cage; Seventy-five percent of the yield increase is attributed to fertilizer use.
- Type all contributions double-spaced.

Genetic evaluation and utilization

OVERALL PROGRESS

BG-90-2, a promising rice variety

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Thirty-four varieties and lines from the International Rice Yield Nursery (IRYN) were tested against the checks Jaya and IR26 in the 1974 kharif. The entry BG-90-2 (Peta*3/TNl//Remadja) from Sri Lanka was identified as promising and entered in uniform variety trials for further evaluation.

BG90-2 has given consistent yields during the past 4 years (see table). Its yields ranged from 3.4 to 6.6 t/ha compared with those of Jaya (2.2 to 4.9 t/ha) and IR26 (2.2 to 5.8 t/ha). It is a semidwarf that matures in 130 days; in the field it is resistant to blast and moderately resistant to bacterial blight.

Performance of BG 90-2 at different locations in Bihar, India, in kharif, 1974–77.

Location	Year	Yield (t/ha)		
		BG 90-2	Jaya	IR26
Patna	1974	5.6	4.9	4.5
	1975	3.4	2.2	3.1
	1976	3.5	2.9	3.2
	1977	6.6	4.5	5.8
Sabour	1975	5.4	4.5	4.5
	1977	5.7	4.5	5.1
Pusa	1975	3.9	3.5	2.2
	1976	4.4	4.0	4.0
	1977	3.7	3.2	2.4

Thailand releases new rice varieties

Rice Division, Department of Agriculture, Ministry of Agriculture and Cooperatives, Bangkok, Thailand

Thailand released three new varieties in 1978 – RD8, RD13, and RDl5. All are photoperiod sensitive, medium tall, and especially adapted to the extensive rainfed areas of the country and the monsoon season. A committee composed of officials of the Thai Government, including Deputy Minister of Agriculture and Cooperatives Thamnong Singalavanich; farmers; and members of support groups formally approved the releases.

RD8, which has a glutinous endosperm, is adapted to the North and Northeast regions. Compared with the popular variety Niaw San Patong, it yields 9–12% more under irrigation and 35–39% more under drought stress; it is 10 cm shorter. Its photoperiod sensitivity is similar to Niaw San Patong's but it matures 3 days earlier in the Northeast. Its grain is shorter and bolder, but its cooking quality is similar to that of Niaw San Patong.

RD8 originated from cross 6721 made at Bangkhen Rice Experiment Station in 1967. An F_2 plant from IR262/Niaw San Patong used as female was crossed again with Niaw San Patong. Early generation materials of this cross were grown at Bangkhen Rice Experiment Station until F_5. Intermediate and tall glutinous lines were sent to the Khon Kaen Rice Experiment Station for evaluation in yield trials under rainfed conditions of the Northeast. After several seasons of testing, line 6721-5-7-4 was selected. It is superior to Niaw San Patong under the drought-stressed rainfed conditions of the Northeast.

RD13 is adapted to the southeast coastal areas. Compared with the popular southern variety Nahng Payah 132 it matures 7 days later, has 17% higher yield, and superior blast resistance. Its grains are shorter than those of Nahng Payah 132 but longer than Pak Sian 39. Its cooking quality is similar to that of both varieties. A cross of Nahng Payah 132 and Pak Sian 39 made in 1964 at Bangkhen Rice Experiment Station was grown as a bulk hybrid in early generations. Hybrid seeds were sent to Kuan Gut Rice Experiment Station where BKN6402-352 became the final selection.

RD15 is likely to be accepted most in parts of the Northeast. Compared with the popular Khao Dawk Mali 105 variety, it is 10 cm shorter, matures 10 days earlier, and has better drought tolerance under drought-stressed rainfed conditions of the Northeast. Its grain. cooking quality, and disease and insect resistance are similar to those of Khao Dawk Mali 105. It is nonglutinous and long-grained. It resulted from the irradiation of Khao Dawk Mali 105 and was selected as KDML65G_1U-45 in the Northeast.

Two other varieties, RD6 and RD11, were released in 1977.

RD6 is likely to be most widely accepted in rainfed areas of the Northeast. It is similar to Khao Dawk Mali 105 and RD6 in its long, glutinous scented grain, good cooking quality, maturity, and plant type. However, it has better blast and brown spot resistance, yields more, and is 10 cm shorter. It is photoperiod sensitive and is suited to the monsoon period only. Glutinous, it was a mutant of Khao Dawk Mali 105 produced through gamma rays.

RD11 performs best where farmers have good control of irrigation water and desire a variety that matures slightly later than RDl. It is a nonphotoperiod sensitive semidwarf variety that matures 130–140days after seeding. It has long, slender, nonchalky high amylose grain. It is slightly taller, has longer grain, and yields slightly more than RD1.

Prasad: a new rice variety

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Prasad, a new 120-day rice variety was approved by the Uttar Pradesh variety release committee in May 1978. It has long slender grain; resistance to bacterial blight, blast, and brown spot diseases; and high yield potential.

Prasad is from the IRRI cross IR1561(IR579-48/IR747B_2-6-3) and was selected at Pantnagar under pedigree UPRI71-12. Prasad has shown its superiority when transplanted, including in hilly valleys up to an elevation of 1,200 m. Since 1971 it has consistently outyielded Ratna, IR24, and Saket 4, varieties of similar growth duration. Prasad responds well to nitrogen fertilizer, even at moderate levels, and to management.

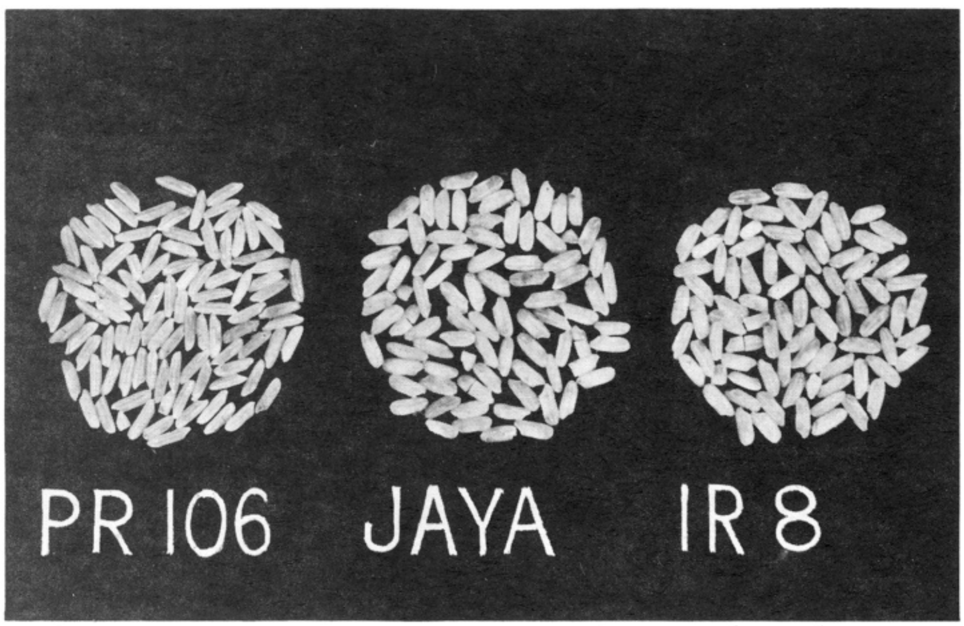
In late-sown trials, its performance was better than that of the varieties of the same maturity group. It has good plant type, good seedling vigor, synchronous flowering, and easy threshability. In 114 demonstrations conducted on farmers' fields from 1974 to 1977, its yields averaged 5.7 t/ha, a 10% increase over those of Ratna or Saket 4. Besides its high yield and good cooking quality, Prasad has resistance to bacterial blight.

PR106 – a new rice variety for the Punjab

S. S. Saini, Regional Rice Research Station, Kapurthala, Punjab, India

IR8 and Jaya have yield potentials of up to 10 t/ha in northern India, but PR106 has been identified as superior to Jaya in productivity and grain quality.

PR106 is the progeny of a single plant selected from lR665-79-2, a breeding line received from IRRI in 1969. lR665-79-2 is from the cross IR8//Peta*5/Belle Patna. PR106 was compared with Jaya in 10 variety trials at 3 research stations of the Punjab Agricultural University from 1971 to 1974 and in 18 adaptive trials on farmers' fields in 1975. In 10 research station trials, PR106 produced an



Milled rice showing chalkiness in Jaya and IR8, and its absence in PR 106. Punjab, India.

average yield of 7.1 t/ha, 3.9% more than Jaya. In the farmers' fields its yields averaged 0.4 t/ha more than those of Jaya. The highest yield obtained with PR106 in adaptive trials was 12.8 t/ha; with Jaya it was 10.7 t/ha. PR106 has practically the same growth duration as Jaya but it is 7 cm taller. Its panicles are longer than those of Jaya; its grains are long, slender, and clear while those of Jaya are long, but bold and chalky (see photo).

PR106 has a cooking quality almost as good as that of Basmati 370 (a famous quality rice variety of the Punjab); however, its grains are somewhat bolder and nonaromatic. In 1977, PR106 brought a considerably higher market price than IR8 or Jaya.

In the 1978 kharif, PR106 is expected to replace IR8 and Jaya in more than half of the Punjab's rice area. More than 1,500 t of foundation and certified seed of this variety have been sold to farmers.

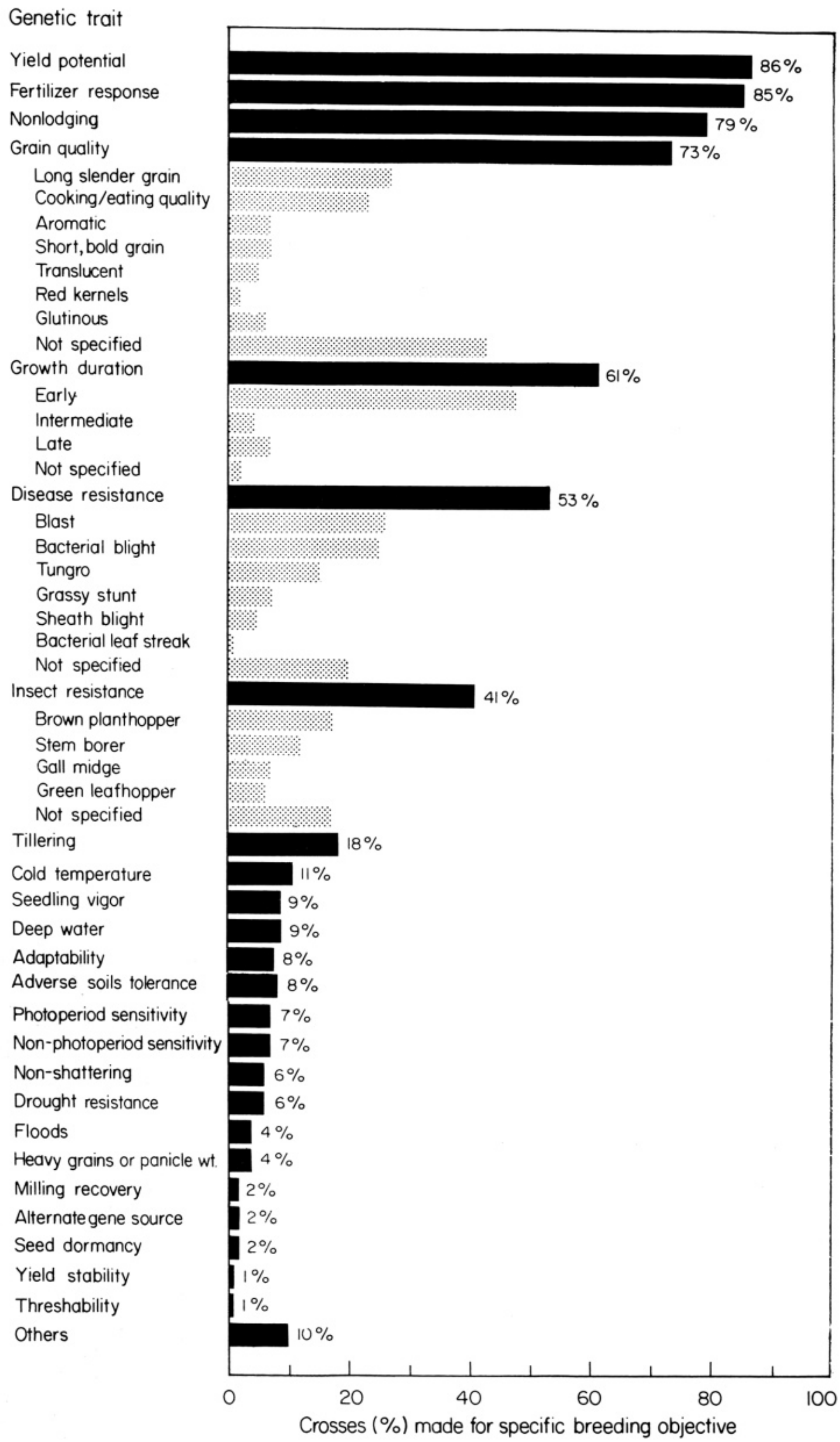
Objectives of rice breeders in Asia

T. R. Hargrove, associate editor, International Rice Research Institute

In a study of rice breeding programs in Asia, crosses were randomly selected from the 1974–75 hybridization records at 27 experiment stations and universities in Bangladesh, India, Indonesia, Iran, Korea, Nepal, Pakistan, Philippines, Sri Lanka, and Thailand.

The breeders who made the crosses were surveyed to determine why they used each of 343 parents in 161 crosses. The traits that the breeders hoped to transfer into progeny varieties were compiled as the overall breeding objectives of the programs.

Increased yield potential was the objective most frequently cited (86% of the crosses), followed by high fertilizer response (85%) and resistance to lodging (79%) (see figure). Improved grain quality was cited for 73% of the crosses, but specific grain-quality objectives varied considerably, indicating a variety of consumer preferences.



The objectives for which rice breeders made 161 randomly selected crosses in 1974–75. Twenty-seven agricultural experiment stations and universities in 10 Asian nations, 1975.

Most crosses were aimed at achieving early growth duration but a few were for long duration. The latter crosses were for single-cropped regions with a long monsoon season, where farmers want varieties that mature after the rains have ended.

Insect or disease resistance was an objective of about 40 to 50% of the crosses. The most common pests for which resistance was sought were blast, bacterial blight, tungro, brown planthopper, and stem borer. Few crosses were made for tolerance or resistance to cold temperature, deep water, adverse soils, or drought.

The project was partially funded by a research grant from The Rockefeller Foundation.

Types of parents used to convey specific genetic traits in Asian rice breeding programs

T. R. Hargrove, associate editor, International Rice Research Institute

The types of parents that Asian rice breeders use to convey specific genetic traits into progeny varieties were determined as part of a study of rice breeding programs in Asia (see preceding article). Each rice used for various breeding objectives in the 1974–75 sample of 343 parents used in 161 crosses was classified by plant type and source.

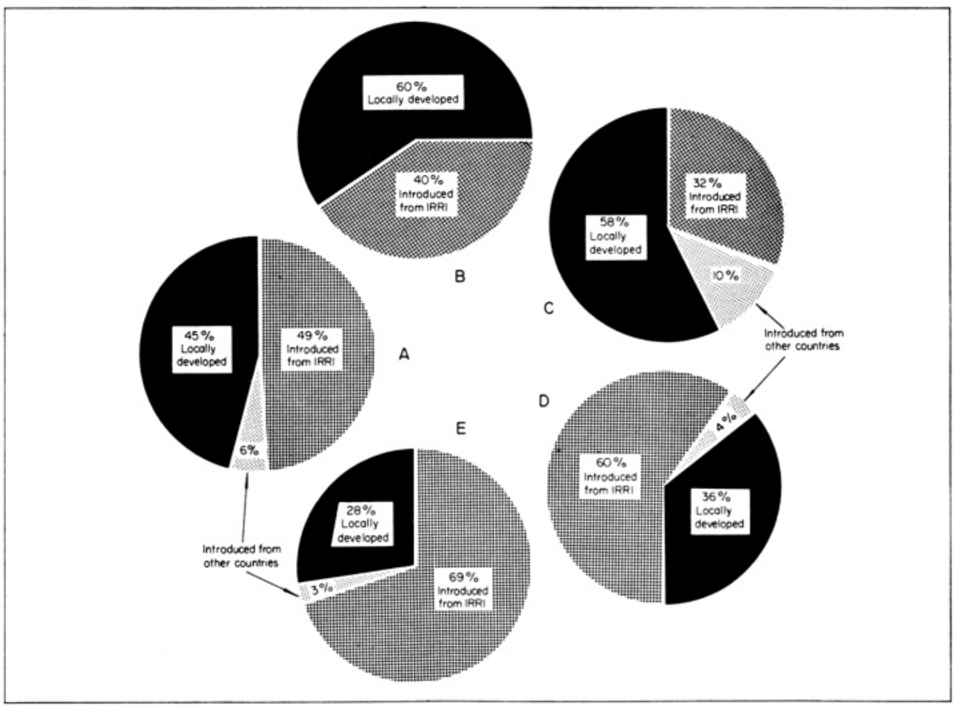
Semidwarf rices were almost invariably used as parents for the yield-fertilizer response-nonloding complex (see table). Sixty-five percent of the times that a breeder used a tall variety in a cross, he hoped to transfer a preferred type of grain from the tall donor into a progeny. Grain quality was a breeding objective 40% of the time that a semidwarf parent was used.

The tall and semidwarf varieties were used about equally as genetic donors of preferred growth duration. Because farmers in deepwater areas need varieties that mature after the water recedes at the end of the monsoon season, long growth duration was an objective 80% of the times a deepwater or floating parent was used, and photoperiod sensitivity, 90%.

The frequency with which rice breeders sought desired genetic traits from 201 semidwarf, 47 intermediate, 85 tall, and 10 floating parents in 161 randomly selected crosses made in 1974–75 at 27 agricultural experiment stations, 10 Asian nations.

Breeding objective	Use (%[a]) as parents			
	Semidwarf	Intermediate	Tall	Floating or deepwater
Lodging	85	40	4	10
Fertilizer response	84	40	5	10
Yield potential	80	51	5	10
Disease resistance	36	64	25	20
Insect resistance	30	15	19	–
Grain quality	40	60	65	20
Growth duration	34	36	31	80
Tillering	10	17	4	–
Seedling vigor	4	17	4	–
Photoperiod sensitivity, insensitivity	4	2	5	90
Adverse soils tolerance	3	19	9	–
Adaptability	2	13	2	–
Heavy grains or panicle weight	2	4	–	–
Drought resistance	2	4	5	–
Cold tolerance	1	17	11	–
Nonshattering	–	–	5	–
Threshability	–	–	–	–
Alternate gene source	–	2	1	–
Protein content	–	–	–	–
Milling recovery	–	2	1	–
Yield stability	–	–	–	–
Deepwater tolerance	–	4	5	100
Seed dormancy	–	–	1	–
Others	3	11	8	–

[a] Percentage of total times each type of rice was used as a genetic source for each desired trait.



Sources of semidwarf parents used for different breeding objectives. A) Origin of 201 semidwarf parents. B) Origin of 80 semidwarf parents used for grain quality. C) Origin of 69 semidwarf parents used for growth duration. D) Origin of 73 semidwarf parents used for disease resistance. E) Origin of 61 semidwarf parents used for insect resistance.

To determine if Asian breeders differed in their reasons for using *semidwarf parents* that were local, from IRRI, or from other countries, the use of semidwarfs for some major traits was analyzed. About half of the 201 semidwarfs used as parents in the total 1974–75parental pool were from IRRI and 45% were locally developed (see figure, A); about 60% of all semidwarfs used for preferred grain quality and for a specific growth duration (usually early) were developed locally (figure, B, C).

On the other hand, 60% of the semidwarfs used as sources of disease resistance and almost 70% of the insect-resistance donors were introduced from IRRI (figure, D, E).

Thus, IRRI material often does not meet local farmers' and consumers' needs for grain quality and growth duration, but pest resistance is a strong reason for its use. That may be a clue to the reason why breeders tend to use locally developed — rather than IRRl — semidwarfs as parents.

The research project was partially funded by a grant from The Rockefeller Foundation.

GENETIC EVALUATION & UTILIZATION

Grain quality

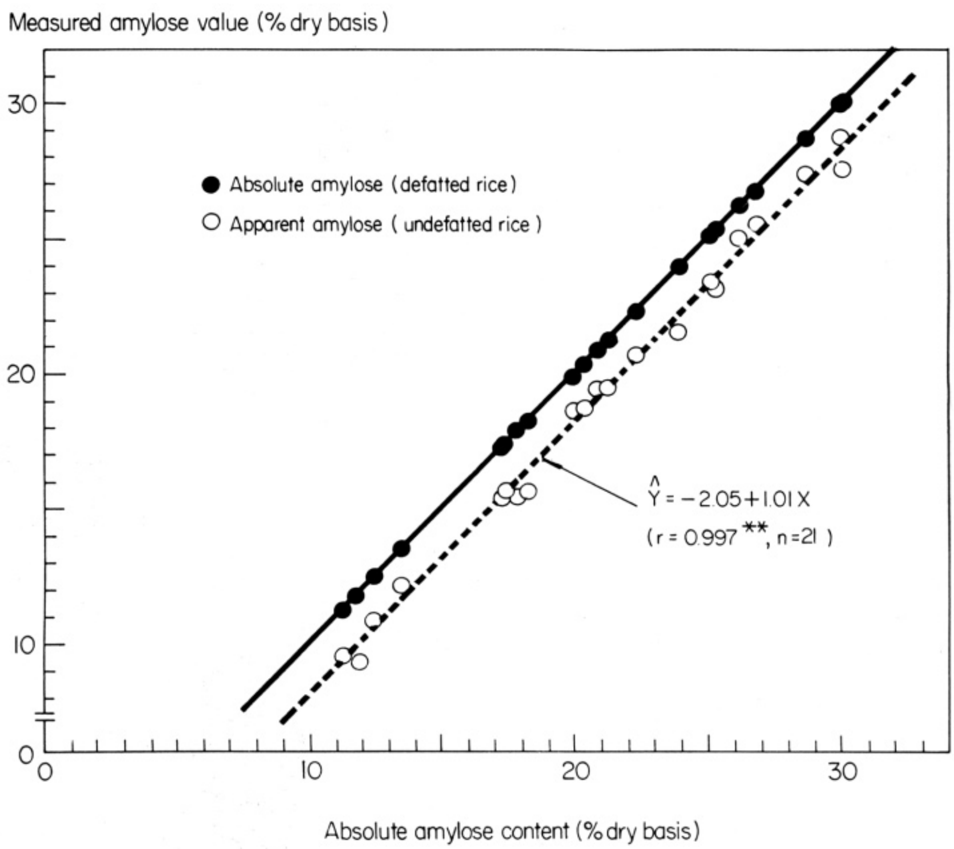
Modification of the simplified amylose test

C. M. Perez and B. O. Juliano, Chemistry Department, International Rice Research Institute

The major disadvantages of our simplified amylose test developed at IRRI are the interference of amylopectin-iodine color with amylose-iodine color at 608 nm at pH 4.5–4.8 and the interference of residual fat with amylose-iodine complexing. During the last few years, we have tried to modify the test to reduce the interferences. Use of pH 10.2 sodium carbonate-bicarbonate buffer instead of pH 4.5 acetate buffer effectively reduced amylopectin-iodine color but magnified residual fat interference 2 to 3 times that at pH 4.5.

To reduce the two interferences, we proposed the use of check undefatted milled-rice samples of known amylose content in place of potato amylose in preparing the standard curve as a modification to the simplified assay. Amylose content of these check samples needs to be determined by the method of Williams. The flour is defatted with cold 95% ethanol, dispersed in KOH at 100°, and iodine color is read at pH 10.2 against the amylose standard. The experimental samples remain as undefatted milled rice flour.

Apparent amylose values thus obtained were about 2 percentage points lower than the absolute amylose content obtained from milled rice defatted with refluxing 95% ethanol (see graph). Thus, cold 95% ethanol defatting does not completely extract the residual fat of milled-rice flour. The results also suggest that apparent amylose content by our modified simplified procedure was lower from absolute amylose value by a constant difference rather than by a constant multiplication factor, as the ratio of apparent amylose to absolute amylose was not constant but decreased with increasing content. Thus the simplified amylose test at pH 4.5 with milled-rice check samples remains the method of choice in a rice breeding program.



Effect of defatting of milled rices with refluxing 95% ethanol on their measured amylose content at pH 4.5, using check undefatted milled rice for the standard curve. Amylose values of these check samples have been determined using cold 95% ethanol defatted flour at pH 10.2. lRRI, Philippines.

Disease resistance

Role of epicuticular waxes in blast resistance

S. Suryanarayanan and S. H. Ou, International Rice Research Institute

Although horizontal resistance to rice blast has not been demonstrated in the true sense of the term, varieties such as Tetep and Carreon show stable resistance. Only a few lesions of any type develop on them. In the context of breeding for blast resistance, it seems useful to understand why.

The number of lesions that develop on a rice leaf is a function of the number of conidia deposited on the leaf surface and their success in developing the necessary infection structures to penetrate the leaf tissue. Conidia of the blast fungus are essentially released between 2300 and 0400 hours. They germinate in dew or water drops on the leaf surface and form appressoria on the epicuticular wax layer.

For the establishment of lesions, it is essential that germination, appressorium formation, and penetration of the leaf tissue be completed before the dewdrops disappear (8-10 h). A study of the role of epicuticular waxes and dew in this context showed that both are important for rapid appressorial formation by the blast fungus (see table). Appressoria1 formation was virtually complete in 6 h on epicuticular wax in the presence of dew, but longer in other treatments.

Effect of dew and epicuticular wax on appressorial formation by *P. oryzae* (race P38) in vitro.

Treatment	Appressorial formation (%) at intervals[a] of		
	6 h	8 h	11 h
Water	12	31	27
Khao-teh-haeng dew	23	23	40
Khao-teh-haeng wax	26	29	50
Wax + dew	63	65	68

[a]Based on over 200 germinated conidia in not less than 20 microscope fields (12.5 × 10.0).

Fewer appressoria are formed on epicuticular waxes extracted from the resistant Tetep than from the susceptible Khao-teh-haeng. Appressoria1 formation by *P. oryzae* (isolate 2017) in vitro after 18 hours was 69.4% in water, 64% in Khao-teh-haeng wax, 37% in Tetep wax. The results suggest that the fewer lesions on varieties like Tetep may be associated with the physicochemical properties of the leaf surface wax. Further studies might lead to the development of alternate techniques to screen for that portion of resistance affecting lesion numbers. In the meantime, assessment of lesion numbers in the International Rice Blast Nursery entries appears worthwhile in evaluating stable resistance to blast.

Reaction of rice cultivars to rice sheath and leaf blight

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The reaction of 121 rices to rice sheath and leaf blight *Corticium sasakii,* which is gaining importance in Assam, was tested in a field trial at the experimental farm, Assam Agricultural University, Jorhat. Most of the test plants were local varieties but a few were from the Central Rice Research Institute, Cuttack (CR series). Twenty-day-old seedlings were transplanted in small pots (5 rows each), replicated twice. Twenty days later, the plants were inoculated with the fungus grown on sterilized pieces of rice straw.

On the basis of both lesion length on the sheaths and percentage of infected leaves, the reactions of the cultivars were categorized into three groups (see list).

Two were moderately resistant, 65 moderately susceptible, and 54 susceptible. Of the two moderately resistant cultivars, Sonferi showed a moderately susceptible reaction in an earlier pot test. S4-380-10-828 (W), which was moderately resistant in that test, was moderately susceptible in this test.

The following are the rice cultivars that are moderately resistant, moderately susceptible, and susceptible to rice sheath and leaf blight:

Moderately resistant. Sonferi, Lalsatkara.

Moderately susceptible. Chufon Sali, Chingfoe, Kartik Colma, Sukdas Sali, Jati Sali, Latoi (cult. 2), Kalijira (cult. 1 & 2), Langli Sali, Chandra Sali (cult. 1 & 2), Gouri Sali (cult. 1 & 2), Makon I, Tarabali (cult. 3), Kukri Sali, Kejorghos, Thakurbhog, Bengali Joha, Kataribadal (cult. 2), Saildhara, Kingsown, Si. R. Osaki, CR167-35, CR170-3, S4-380-10-828(W), CR163-3, CR162-30, CR132-168-73, CR30(K)-14, Sikirimonko Sikirimonkoti, Kartik Sali, Goa Sali, Tepra Sali. Chotra Sali, Khusi Sali, Prosadbhog, MTUl7 mut. 12, Culture 89-II, Changormuri, Phul Sali, Kachu Sali, Lalbalam, Guasari, Matanga (cult. l), Kola Joha, Borshal Sali, Kharaijali, B 15-1, IR8, Jaya. Aliraj, Guarchar (cult. 1 & 2), Laudumra, Keriary, Chaku Sali, Chotra Sali, Longutra, CR380-10-828(R), CR38-6-3, CR142-3-2, CR166-19, Supkhera and Maloti (cult. 2).

Susceptible. Maina Sali, Dholamukh Sali, Komolbhog, Bhasamanik, Pusa 2-21, CR142-3-8, CR171-13-7, CR164-7, CRl72-28, CRl69-22, CR168-17, CRl71-103-11, CR30(K)-7, CR30(K)-13, CR30(K)-40, CR30(K)-46, CR167-26, CR171-13-7, CRl67-26, Guti Sai, Pani Sali (cult. l), Hemcha, Khaijuria, Gobindabhog, Tarabali (cult. 2), Dholabasiraj, Dhoukou, Culture 301-I, Barasaiamara, Magri, Khai Sali, Baki Sali, Kalamdani, Latoi (cult. l), Badshabhog, Culture 4201, Sailbarak, Dholabalam, Basiraj, Kataribadal (cult. 1 & 3), Jalkumari, Latamaguri, Malbhog, Geerge Sali, Baki Sali, Sualpani, Balam, Kolamula, Chopo Sali, Salkora, Meghraj, Dholachuplaish, and Ghukoch.

Resistance of some rice cultivars to various diseases in Karnataka, India

S. Sanne Gowda, pathologist, All India Cooperative Rice Improvement Project; Shantha D'Urs, research assistant, Regional Research Station (RRS), V. C. Farm, Mandya; and T. H. Khan, research assistant, Agricultural Research Station, Ponnampet, University of Agricultural Sciences, Hebbal, Bangalore, Karnataka, India

Diseases that are gaining importance in some localities of Karnataka include leaf and neck blast, Helminthosporium, Rhynchosporium, and grain discoloration. These diseases were previously observed in screening trials at the RRS. Entries from the International Rice Blast Nursery (IRBN) and from the National Screening Nursery (NSN) were tested during kharif 1977.

From 476 IRBN entries, the following were found resistant to leaf and neck blast, Helminthosporium, Rhynchosporium, and grain discoloration: BRJ51-26-12 and BRJ51-46-15 (Bangladesh); 71/1454 (Iran); Chulweon 1 and Chulweon 3 (Korea); C4-63/Tetep (Malaysia); IR3271-PP134-68-3-IF12, IR3271-746-1480 F12, IR4547-6-1-4, IR4547-6-1-3, IR4547-6-2-4 F6, IR4547-14-3-1 F6, IR.5533-13-1-1, IR5533-PP 856-1, IR9559-PP-871-1, IR9559-PP 870-1, IR9559-00889-5-3-F6, IR9660-50-3-1-1 F7, IR9669-PP 836-1, IR9669-PP 830-1, IR9669-PP 827-1, IR9669-PP 823-1, IR9669-22-26 F9, 1R9669-23-12-7 F9, IR9669-27-4-8 F9, IR2053-522-5-4, IR2055-462-3-2-3, IR2058-78-1-3-2-3, IR3464-126-1-3, IR3478-97-2-3, IR4427-23-2-3, lR879-24-1-1-4, 1R879-183-2 (IRRI); and EL Gopher, J-519 (USA).

From 540 IET entries from the NSN the following were found resistant to leaf and neck blast, Helminthosporium, and Rhynchosporium: JET numbers 5922 (PAU128-1191), 5924 (PAU41-306-2-1), 5959 (MXWIO), 6074 (RP825-28-7-l), 6137 (CR204-27-33-398-293), 6377 (RAU38-3-3-1), 6453 (MTU4407), 3626 (TNAU13613), 3629 (TNAU7892), 5857 (RP979-58-3-2-1-1), 2246 (RP79-2), 2490 (CS054), 2570 (IRM16), 2730 (6475), 2830 (RP6-590-22-5-4-1), 2864 (Pusa 5-2-3-8-1-2), 2866 (Pusa 5-2-3-30-3-6-2), 4086 (CR140-62), 5631 (lR2071-176-1-2-1), 5656 (RP975-109-2), 5853 (CR210-1010), 5854 (RP1017-76-1-4-3), 5897 (CR210-1009), 6204 (CN536), 6205 (CN540), 6208 (OR1102), 6209 (OR117-4), 6210 (MTU6280), and 6211 (MTU4407).

GENETIC EVALUATION & UTILIZATION

Insect resistance

Electrophoretic variations in esterase among biotypes of the brown planthopper

K. Sogawa, visiting scientist from Tropical Agriculture Research Center, Entomology Department, International Rice Research Institute

Esterase polymorphism in male adults of the brown planthopper (BPH) *Nilaparvata lugens* was studied. Laboratory colonies of three biotypes and of the field population at IRRI were sampled and assayed by agar gel electrophoresis on individual insect homogenate. About 100 insects of each group were examined.

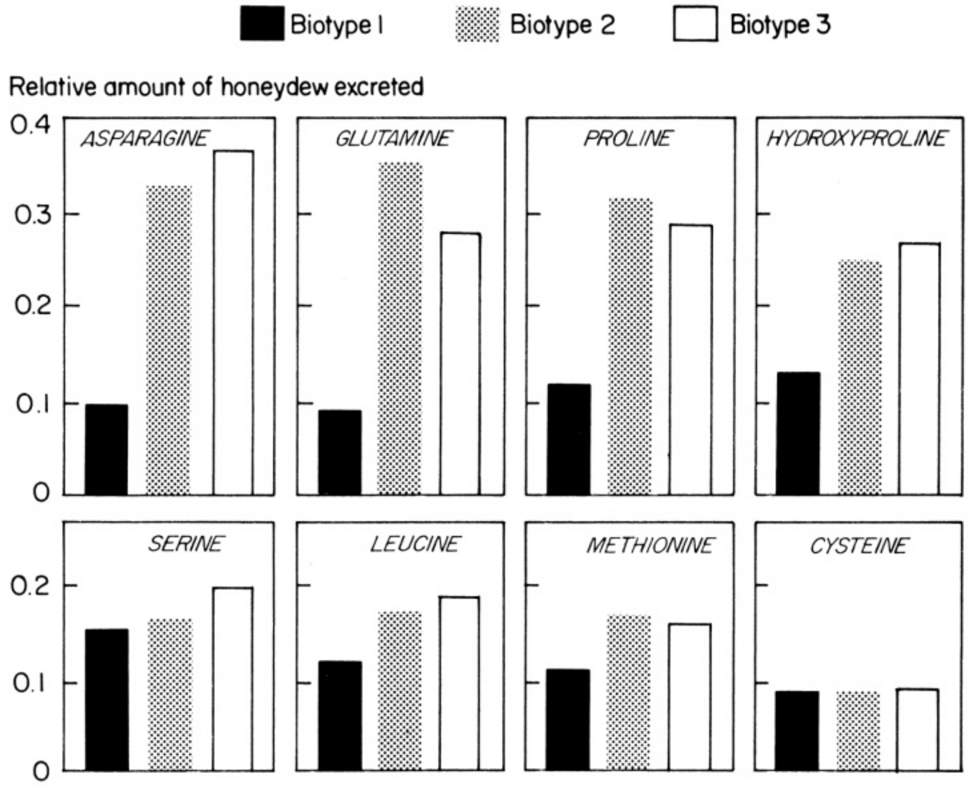
Six electrophoretic phenotypes were detected and designated as types A to F (see table). The zymogram of each type was composed of three to six esterase bands with different mobility toward the anode side. All types have three fast mobile bands – E4 to E6. The enzyme activity of the bands, particularly of E4. was much stronger than that of the slow-but-mobile E1 to E3 bands. Type C was always predominant in all biotypes and in the natural population. Type E was also invariably detected in all biotypes, although much less frequent than type C. The frequencies of those two electrophoretic phenotypes in biotypes 1 and 3 were about equal – 60 to 70% for type C and 15 to 30%, for type E. Two new biotypes developed on

Electrophoretic phenotypes (Origin E1 E2 E3 E4 E5 E6 (+))	Biotype[a] 1 B	1 M	2 B	2 M	3 B	3 M	Wild M
A	9.4	10.2	12.3	1.9	8.5	13.0	1.9
B	1.9	0.9	0	0	0	0	0
C	54.8	68.5	63.2	79.3	70.8	63.0	89.8
D	0	0.9	11.3	9.4	0.9	0.9	0
E	29.2	16.7	11.3	7.5	18.9	23.1	8.3
F	0	0	1.9	1.9	0.9	0	0
No activity	4.7	2.8	0	0	0	0	0

Percentages of different electrophoretic variants in the three biotypes and a wild population of brown planthopper[a]. IRRI, 1978.

[a]*B = brachypterous; M = macropterous*

Babawee and Rathu Heenati reacted similarly in preliminary experiments. But, the percentages of type E in biotype 2 and in the natural population were apparently lower — about 10% — than those in biotypes 1 and 3. An interesting phenomenon is that type D with esterase E3 band appeared almost exclusively in both brachypterous and macropterous forms of biotype 2 at a frequency of about 10%. The occasional occurrence of type F carrying E3 band in biotype 2 may be linked with the substantial occurrence of type D. Because the enzyme activity of type A was usually weak, it is doubtful that it is a particular electrophoretic phenotype. Type B was detected only in biotype 1. The experiments demonstrated that biotype 2 could be differentiated from the other biotypes by the involvement of electrophoretic variant type D in its population. But more detailed studies on the genetic system that controls the esterase polymorphism in BPH are clearly essential before further conclusions are drawn.



Acceptability of different kinds of amino acid — sucrose solutions to the time biotypes of brown planthopper.

Variations in gustatory response to amino acid-sucrose solutions among biotypes of the brown planthopper

K. Sogawa, visiting scientist from the Tropical Agriculture Research Center (TARC), Entomology Department, International Rice Research Institute

The gustatory blockage of sucking has been established as the principal cause of varietal resistance of rice to the brown planthopper *Nilaparvata lugens.* Biotypes 2 and 3, which can infest resistant rice varieties, have also been shown to have better ability than biotype 1 to feed on resistant varieties. This leads to the assumption that the differential abilities of biotypes to feed on resistant varieties may be due to differences in their gustatory response to dietary substances in different rice varieties.

To verify this, the acceptability of various types of amino acid-sucrose solutions to the three biotypes was compared. Thirteen types of amino acid were individually subjected to the sucking of female adults of each biotype. Each amino acid was dissolved in a basic solution (20% sucrose and 0.2% aspartic acid, pH 6.5) at 0.2% concentration. The insects were allowed to feed on the solutions through a parafilm membrane. The amount of sucking was estimated by colorimetric measurements of excreted honeydew.

The solutions containing asparagine, glutamine, proline, and hydroxyproline were significantly more acceptable to biotypes 2 and 3 than to biotype 1 (see figure). Those amino compounds are not always major constituents in rice plants. Likewise, the sucking of biotypes 2 and 3 was enhanced by alanine, gamma-aminobutyric acid, glutamic acid, glycine, and valine. But all biotypes took up cysteine, leucine, methionine, and serine almost equally. It is noteworthy that no amino acid-sucrose solution was more acceptable to biotype 1 than to biotypes 2 and 3. That indicates that biotypes 2 and 3, which break host resistance, have wider adaptability to unusual dietary substances. That may partly explain their ability to feed on resistant varieties.

Brown planthopper-resistant cultures show promise

S. Sukumaran Nair, N. Rema Bai, and K. P. Vasudevan Nair, Rice Research Station, Moncompu, Kerala state, India

Work to develop rice varieties that are resistant to brown planthopper (BPH) and have good agronomic characters has been initiated at the Rice Research Station, Moncompu, with assistance from the Ford Foundation.

BPH-resistant donors were crossed with susceptible varieties widely cultivated in the Kuttanad tract. Success Varied. The cultures were screened in the screenhouse and in the field and scored using the Standard Evaluation System adopted by IRRI in 1975.

Many of the cultures identified as promising are from crosses involving Kochuvithu, a local variety.

Below are 5 promising entries that were screened in the National Screening

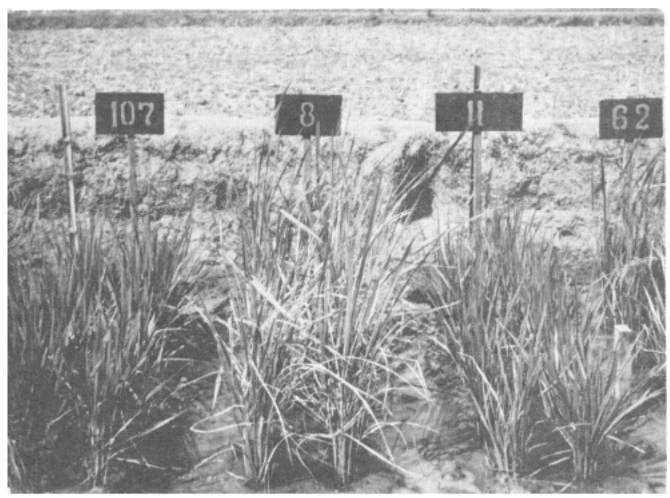
Nursery trials at the All India Coordinated Rice Improvement Project, Hyderabad, and scored for damage on a 0–5 scale as follows:

IET no.	Culture	Parentage
Entry with a damage score of 1.1 to 2:		
6481	M24-63-1	Kochuvithu/ IR8//MOI/IR8
Entries with damage scores of 2.1 to 3:		
6476	M11-47-3-2	IR8/PTB20
6477	M11-57-5-1	IR8/PTB20
6480	M14-2-3	Kochuvithu/IR8
6482	M24-76-4	Kochuvithu/ IR8//MOI/IR8

Screening for stem borer resistance in Thailand

Sompong Pongprasert and Sutohn Suwanabutr, rice entomologists, Rice Division, Department of Agriculture, Ministry of Agriculture and Cooperatives, Bangkhen, Bangkok 9, Thailand

1. General view of method of screening for resistance for stem borer in the field. Thailand. 1977.



2. Stem borer infestation on test varieties or lines. No. 107 and 11 show high resistance to stem borer (very low percentage and deadheart); No. 8 shows susceptibility (high percentage of deadheart).

One hundred and fifteen lines and varieties were tested for reactions to rice stern borers under natural infestation in the field from November 1977 to February 1978 at the Koksomrong Rice Experiment Station in the central plain region. The test materials were transplanted in 2-row plots at 1 plant/hill and 10 hills/row in a randomized complete block design with 2 replications. Hills were spaced 15 cm apart and rows 25 cm apart. Thirty days after transplanting, fluorescent lights (40-watt lamps) at the rate of 1 lamp/10 testing lines, were installed 3 m above the ground (Fig. 1). The lights were on from 1900 to 2030 hours for several days. Deadhearts were counted 60 days after transplanting. Infestation was severe (Fig. 2); the percentage of deadhearts varied from 1 to 68. The damage in this test was caused by the yellow stem borer *Tryporyza incertulas.* The resistant check variety had only 2% infestation but the susceptible check, Sapan Kwai 3, had 68%. IR30 and IR36 showed the highest resistance among the tested lines. The lines and varieties with high levels of resistance to the yellow stem borer were:

1% deadhearts: SPK7284-14 (RD3/IR648), RP516-34-1 (IR8/TDK// TKM6/TN1), IR36 (IR2042/CR94-13), IR1561-228-3-3 (IR8/TDK//TKM6/TN1).

2% deadhearts: IR30 (IR1541//IR20/ *O. nivara*), BKN6914-63 (IR661-1-140-3/ IR442-2-59).

3% deadhearts: BKN7128-3-11-9 (Short Sigadis/GR88).

5% deadhearts: BKN7033-3-3-3-2-2-3 (Iratom 20/SPT6624-113-2-3), RP633-9-5-8-1 (IR8/BJ1-43//IR22), BKN6820-6-3-2 (PKR/PN16//C4-63).

6% deadhearts: BKN6986-45-1 (IR262/PG56), BKN6987-128-2-17 (IR262/KNN11).

8% deadhearts: SPR7344-19-1-1-1 (RD3/IR1541),WP252 (IR66l/RD1). BKN6987-107-3-7 (IR262/KNN 11), SPR7344-45-1-1-2 (RD3/IR1541), SPR105-3-3-1 (KH/IR22), BKN7022-52-4 (BKN6624-46-2/ T442-36).

9% deadhearts: SPR7236-58 (BKN17-3/IR648), BKN6916-22-2-2-2-1-1-1 (IR661-1-140-3/IR844-86), BKN6997-37-2-3 (IR332-10-1-2-2-2/ IR841-131-1).

Varietal reaction of rice to spider mite

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A field study was conducted during Sornavari (Apr.–July) 1978 under upland conditions to investigate drought resistance in 36 rice cultivars.

The occurrence of the spider mite *Oligonychus* was also observed and recorded. Because of a dry spell, spider

Reaction of certain rice cultivars to spider mite. Tamil Nadu, India.

Designation	Parents	Mite infestation (%)
TM2861	Annapoorna/Cult. 4314	5.9
TM2902	TKM8/IR127	6.2
IET1444	TN1/CO29	6.4
TM2831	Annapoorna/Cult. 4314	6.5
TM2944	CO34/Pusa 2-21	6.8
TM3161	ASDl4/TKM7	11.0
KN361-1-8-6	Jerak/IR8	47.0

mites were widespread and severe in several rices. The natural spider mite infestation in the rice cultivars was scored during the maximum tillering phase of the crop.

Six rices were relatively resistant to spider mite. KN361-1-8-6 had the maximum infestation (47%) (see table).

Genetics of resistance to the brown planthopper

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Studies on the genetics of resistance to the brown planthopper (BPH) at Hyderabad, India, showed it to be governed by one or two genes, either dominant or recessive in the varieties studied. Resistance is controlled by

- a single dominant gene in ARC10550, ARC10599, ARC14636, ARC14988, ARCl5570A, ARC15570D, ARC15680, and ARC15831;
- a single recessive gene in ARC14394, ARC15570C, ARC1 5608, ARCl 5694, Leb Mue Nahng, Malalwariyan, MR1523, MR1.550, PTB21, RPW6-13, and Umsum; and
- duplicate dominant genes in ARC6650, ARC7080, ARCl1354, ARC14529A, ARCl4636A, ARC14766, ARC14771, ARCl5694A, ARC15872, PTB33, and Lua Ngu.

Results of allelic studies indicated that single recessive genes in MR1523, PTB2 1, and Umsum are allelic to each other and appear closely linked with one of the duplicate genes in PTB33, ARC6650, and Lua Ngu. The corresponding genes at the two loci in the latter three varieties were also found to be allelic.

An association between the pericarp color and BPH resistance was evident among the crosses studied. On the other hand, no association was observed between resistance and several agronomic attributes that were studied.

GENETIC EVALUATION & UTILIZATION

Deep water

Yields of deepwater rice in Bangladesh

E. J. Clay, Agricultural Development Council, Inc. (ADC), New York; H. D. Catling, Deep-Water Rice Pest Management Project; and P. R. Hobbs, associate agronomist, IRRI-Bangladesh Project, Bangladesh

Deepwater rice is grown in about 20% of the total rice area of Bangladesh in water depths of 1 to 3 m. Known locally as broadcast aman, deepwater rices are usually planted in March and April and harvested from mid-October to early December. A large proportion is also sown mixed with broadcast aus rice (early monsoon crop), which is harvested from late May to July.

In 1977 the first systematic assessment of deepwater rice yields by crop cuts in farmers' fields was undertaken. It involved 63 crop cuts and 90 interviews at sites representing many typical deepwater rice areas of Bangladesh. (The methods developed and detailed results appear in the 1978 unpublished report "Yield assessments of broadcast aman (deepwater rice) in selected areas of Bangladesh in 1977," by E. J. Clay and coworkers, Bangladesh Rice Research lnstitute and ADC, Dacca.)

The overall mean grain yield was 2.5 t rough rice/ha (0.97–4.25 t/ha), close to the yields obtained in experiment stations in Bangladesh. Official crop statistics reported that the national mean rice yield from 1960–70 to 1977–78 was 1.3 t/ha.

The highest yielding of the farmer-named varieties from which four or more crop cuts were taken are listed in Table 1. No significant relationship was found between yield and chemical fertilizer application; fertilizers were applied on 19% of sampled plots but application rates were low. Application of chemical fertilizer was more common in one region surveyed. Farmers generally considered the 1977 crop the best in the last 5 years.

The survey also yielded preliminary findings on the relationships between other selected factors and yields:

1. Yields were highest at a maximum flood depth of 1.8 m.
2. Early- or late-maturing varieties yielded less than those that matured in the middle of the harvesting season.
3. Farmer-named varieties were specific to particular hydrogeologic zones and water depths; varietal choice apparently confounds the influence of other factors that affect yields.
4. Ninety-two percent of the fields where samples were taken were double- or triple-cropped. A third of the plots were mixed-sown with broadcast aus. Pure stands yielded significantly higher than mixed stands.

The findings have interesting implications for future research: there are already some "traditional" varieties or land races of deepwater rice with yield potential as high as 4 t/ha when grown under favorable water conditions without modern inputs. But data collected on management practices at the

Table 1. Mean yields and maximum water depth of deepwater rice varieties, Bangladesh, 1977.

Variety[a]	Crop cuts[b] (no.)	Mean maximum water depth (m)	Yield (t/ha) Mean	Range
Khama	6	1.7	3.0	2.5–3.9
Sarsari	12	1.8	2.9	1.8–4.2
Lakshmi Digha	5	1.5	2.6	1.8–3.1
Chota Bawalia	4	1.9	2.5	2.0–3.8
Digha	4	1.9	2.5	1.9–2.8
Ejuli Khama	5	1.9	2.4	1.0–3.1
Sail Kotha	4	1.2	2.3	2.0–2.5
Puiatipari	4	2.1	2.0	1.2–2.6
Total (all crop cuts)	63	1.7	2.5	1.0–4.2

[a]Only varieties for which 4 or more crop cuts were taken are listed separately. There were 21 farmer-named varieties among 63 crop cuts.
[b]The yield for each sample plot was based on four crop cuts of 4 m^2 each, i.e., 16 m^2 in total.

Table 2. Mean human labor and draft power input and yields on surveyed broadcast aman plots, 1977.

Stand	Labor: Human[a] (man-days/ha)	Labor: Bullock pair[b] (days/ha)	Yield (t/ha): B. aman[c]	B. aus[d]	Combined
Pure	198	54	2.63	–	2.63
Mixed	302	67	2.25	1.17	3.42

[a] Includes land preparation, sowing, intercultivation, hand weeding, harvesting, and threshing of aus and aman.
[b] Includes only land preparation and intercultivation. There is additional use of draft animals in threshing. A bullock pair day is assumed to be only 5 hours.
[c] The yields of pure stands and mixed stands were significantly different: $P(F = 5.18; 1, 61) = 0.03$.
[d] Farmer recall estimate.

sites indicate that labor and draft inputs are high (Table 2).

The annual yield potential of existing deepwater rice cropping patterns is also high. The combined yield of deepwater rice mixed with broadcast aus and followed by a winter crop of khesari *Lathyrus sativa,* mustard, or wheat commonly exceeds 4 t/ha in a good year. The existing yield potential of those systems with traditional technology provides further insight into the special set of circumstances that has permitted high agricultural population densities on the Gangetic, Brhmaputra, and Meghna floodplains of Bangladesh. The deepwater rice crop and cropping systems present a special challenge to the rice scientist: the yield potential of those systems is already high, yet actual performance depends on the fickle combination of weather and floodwater conditions.

Varietal differences in ethylene gas release by an etiolated seedling and their possible relationship to the submergence tolerance of Nam Sagui 19

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Ethylene gas is known to be a regulator of plant growth. Therefore, varietal differences in ethylene gas release by etiolated rice seedlings were examined to determine any significant difference between floating and nonfloating types of rice.

The 15 varieties used represented different degrees of deepwater tolerance. One seed of each variety was allowed to grow in darkness at 30°C in a glass tube covered by a rubber cap.

After 8 days of seed incubation, ethylene gas concentrations were

Varietal differences in release of ethylene gas and length of the second leaf sheath. Tropical Agriculture Research Center, Japan.

Variety[a]	Seed source	Type of rice[b]	Ethylene gas concn[c] (ppm)	Length of 2nd leaf sheath[d] (mm)
Wild rice (Maharaj)	Thailand	F1.	0.236 g	35.8
Wild rice (Atg-Spb)	Thailand	F1.	0.239 g	30.5
Bhadua	Bangladesh	F1.	0.951 def	52.8
Kekoa	India	F1.	0.614 fg	49.1
DW 6255	India	F1.	1.166 bcdef	56.1
Habiganj Aman III	Bangladesh	F1.	1.003 cdef	53.1
Pin Gaew 56	Thailand	F1.	1.416 bcd	43.1
Leb Mue Nahng 111	Thailand	F1.	1.023 bcdef	46.0
Kwian Hak	Thailand	F1.	1.585 b	43.8
Bayar Putih	Indonesia	DW	1.5 30 bc	44.8
Nam Sagui 19	Thailand	Non-F1.	2.911 a	67.5
Niaw Sanpatong	Thailand	Non-F1.	1.240 bcde	47.5
Khao Dawk Mali 105	Thailand	Non-F1.	0.799 efg	44.3
Rice Division I	Thailand	Non-F1.	1.128 bcdef	40.8
Nipponbare	Japan	Non-F1.	0.848 def	37.4

[a] The two wild rice strains were collected at Maharaj and between Angthong and Suphanburi, Central Thailand.
[b] F1. = floating rice, DW = deepwater or tidal swamp rice, Non-Fl. = nonfloating rice.
[c] In 24.2 ml of air in a glass tube after 8 days incubation. Any 2 values followed by the Same letter do not differ from each other at the 1% level of significance.
[d] Under normal exposure to daylight and darkness. Av. of 10 plants.

determined by a gas chromatograph equipped with a flame ionization detector.

Although no marked differences were noted between floating and nonfloating forms, the remarkable ethylene gas release of one nonfloating variety, Nam Sagui 19, drew attention (see table).

Two wild-rice strains produced the least ethylene, probably partly because of their slow growth.

Nam Sagui 19, known to be submergence tolerant, has been used as a resistant check variety in Thailand and at IRRI. Vergara and associates reported that submergence-tolerant varieties did not elongate during submergence. Since ethylene acts as a growth inhibitor, the absence of elongation in submergence-tolerant varieties is likely to be related to the effect of ethylene.

To verify that hypothesis, it would be desirable to correlate submergence tolerance and ethylene-releasing ability. Such a correlation study should include seedling morphology.

Chenab 64-117, a promising deepwater rice variety for Bihar, India

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Chenab 64-117 is a pureline selection from the Chenab rice group of northern Bihar. Highly tolerant of waterlogging, it can withstand total submergence for 8 to 10 days after the post tillering stage and is suitable for situations where water depths range from 50 to 200 cm. It is highly sensitive to photoperiod, and flowers during the third week of October. Chenab 64-117 has coarse grains with red kernels and brownish-black husk. In yield trials and in minikit demonstration trials in farmers' plots from 1970 to 1976, it showed yield consistency and wide adaptability. It has been well accepted by farmers in some deepwater regions of northern Bihar.

Chenab 64–117 has field resistance to bacterial blight, *Helminthosporium* leaf spot, and green leafhopper; and moderate resistance to stem borer. It has an average yield of about 2.0 t/ha (maximum of 3.5 t/ha), better than that of the deepwater varieties BR14 and BR46.

Pest management and control
DISEASES

A technique to harvest additional sclerotia of *Sclerotium rolfsii*

M. Montazer Rahman and M. Aminul Haque, Plant Pathology Department, Bangladesh Rice Research Institute, Joydebpur, Dacca, Bangladesh

Large numbers of sclerotia are at times needed to artificially inoculate soil with *Sclerotium rolfsii,* the causal organism of rice seedling blight. An easy method to obtain extra sclerotia has been found.

Sclerotia rolfsii was grown in potato-dextrose agar slants by planting 2–4 mature sclerotia per tube. Sclerotia from 7-day-old cultures were harvested with a hooked needle, leaving as many mycelia as possible on the test tube slants. During collection of the sclerotia, the tube mouths were below horizontal level to prevent entrance of airborne spores of common contaminants.

After harvest the slants were again placed in the incubator at 28° + 1°C. Within a week the fungus developed more sclerotia that matured within 10 days. No new mycelia grew. The sclerotia yield from the second harvest was about one-third that of the first (see table). It was directly related to the amount of mycelia left in the tube at the first harvest. After the second harvest, the slant cultures were again incubated for 10 days, but no sclerotium nor new mycelia was produced.

A set of slant cultures was incubated undisturbed for 4 weeks from the date of the first culture. The average sclerotia yield per tube was less than average combined yield of the first and second harvests. Disturbing the mycelia in the process of scraping during the first harvest stimulated the production of more sclerotia.

The technique produces more sclerotia at less labor and cost. Sclerotia may be mixed with coarse sand and evenly spread over the seedbed to artificially inoculate seedlings with seedling blight disease. Sclerotia may also be stored as stock culture of the fungus for a long period.

Average number of sclerotia produced in potato dextrose agar slant culture in the first and second harvests compared with that in a single harvest, Joydebpur, Dacca, Bangladesh.

Harvest	Total sclerotia in slant tube					Sclerotia
	1	2	3	4	5	(no./slant tube)
First	206	182	229	182	199	199.6
Second	10	64	12	63	34	60.6
Single	218	196	231	198	234	215.4

Effect of temperature on the movement of *Nephotettix virescens*

S. A. Miah and K. C. Ling, International Rice Research Institute

The effect of temperature on the transmission of rice tungro virus by the green leafhopper (GLH) *Nephotettix virescens* was reported by Ling and Tiongco in 1975. Their results indicated that tungro spreads less at low day/night temperatures (24°/16°C) than at high temperatures (30°/22°C) – perhaps because temperature variation affects the insect's frequency of movement. Therefore, the effect of temperature on the movement of GLH adults on rice seedlings of Taichung Native 1 was studied by the method described earlier by Ling and Carbonell, except that 32 tests, involving 480 insects, were conducted in three Koitotron KB-10D growth cabinets set at 15, 25, and 35°C.

Insect movement varied with temperature. At high temperatures, the percentage of insects that moved, the average number of moves per insect, and the average number of seedling-to-seedling moves per insect were higher than at low temperatures, although differences between 25 and 35°C were not significant (see table). At high temperatures, the insects moved more frequently, and thus visited more seedlings but at a shorter visiting duration per seedling. Temperature, therefore, affects insect movement and, subsequently, the spread of tungro.

In most of tropical Asia, the temperature does not fluctuate drastically during the rice-growing season. Hence, temperature may not significantly contribute to tungro outbreaks under natural conditions in the tropics.

Effect of temperature[a] on movement of green leafhopper *Nephotettix virescens.* IRRI, 1978.

Temperature (°C)	Insects that moved (%)	Moves (no./insect)	Seedling-to-seedling moves (no./insect)	Seedlings visited (no./insect)	Insect's visiting duration (h/seedling)
15	38 a	0.8 a	0.7 a	1.6 a	5.7 a
25	48 b	1.3 b	1.0 b	1.9 b	4.4 b
35	50 b	1.6 b	1.4 b	2.2 b	4.2 b

[a]In a column, means followed by a common letter do not differ significantly at the 5% level.

Research on leaf scald in Colombia

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Since 1975, leaf scald disease of rice *(Rhynchosporium oryzae* H.Y.) has been observed infecting lowland and upland rice in the eastern plains (llanos orientales) of Colombia. Symptoms were first observed on older leaves, 30-35 days after rice emergence. In association with *Pyricularia oryzae* and *Helminthosporium oryzae,* leaf scald also attacks rice panicles.

A scale of 0 to 9 has been proposed to evaluate the symptoms: grades 1 to 4 refer to type of lesions; grades 5 to 9, to the percentage of dead foliage. Cica 8, Cica 6, Cica 4, and Costa Rica are moderately resistant and Cica 9, Cica 7, IR22, and Bluebonnet 50 are susceptible. Fentin OH 20% (Duter) at 0.45 kg a.i./ha and benomyl 50% (Benlate) at 0.15 kg a.i./ha controlled leaf scald adequately.

Infected leaves were evaluated at 40, 60, and 90 days after seeding. Plots that received three or four applications of the fungicides were compared with the untreated control plot. The experimental design was a randomized complete block with three replications. Results (see table) indicate that leaf scald infection in lowland rice may reduce grain yield by at least 33%.

Chemical control of leaf scald *(Rhynchosporium oryzae)* measured as leaf infection (%), and yield (t/ha). La Libertad, Villavicencio, Colombia, South America, 1977.

Treatment	Rate (kg a.i./ha)	Leaf infection[a] (%) at 40 DE	60 DE	90 DE	Yield t/ha[b]	Yield %over control
Three applications[c]						
Benomyl	0.15	2.0	2.9	3.4	3.7 a	123
Fentin OH	0.45	2.0	2.6	4.0	3.8 a	127
Four applications[d]						
Benomyl	0.15	1.0	1.5	2.1	3.7 a	123
Fentin OH	0.45	1.0	1.5	2.4	4.0 a	133
Untreated control	–	2.0	11.8	21.6	3.0 b	100

[a]DE = days after rice emergence.
[b]Any 2 means followed by the same letter are not significantly different from each other at the 5% level.
[c]Applications every 20 days starting at 40 days after seeding (DS).
[d]Applications every 1.5 days starting at 40 DS.

Pest management and control

INSECTS

Greenhouse evaluation of insecticides broadcast on paddy water for control of the striped stem borer Chilo suppressalis

E. A. Heinrichs, entomologist, and S. L. Valencia, research aide, International Rice Research Institute

Modern high yielding rice varieties so far released have only moderate levels of resistance to the striped stem borer. Because insecticides are still the major method of controlling the striped stem borer, we continue to evaluate them for effectiveness against the pest.

In a greenhouse study 8 insecticides in a granular formulation applied at 0.5 a.i./ha were evaluated (see table). Rice stems were removed and first-instar larvae were placed on them at 1, 5, 10, and 20 days after treatment. Miral, the most effective, provided 100% control through 10 days. Carbofuran, which is effective against the yellow stem borer *Tryporyza incertulas* in IRRI field trials,

Application to paddy water of granular insecticides at the rate of 0.5 kg a.i./ha for striped stem borer control. IRRI greenhouse, 1977.

Insecticide	Mortality[a] (%)			
	1 DAT	5 DAT	10 DAT	20 DAT
Miral 3G	100 a	100 a	100 a	26 a
Carbofuran 3G	53 b	30 b	8d	10 bc
Cytrolane 3G	45 b	40 b	17 cd	30 a
Metalkamate 3G	31 bc	35 b	18 bcd	18 ab
FMC 27289 2.5G	29 bc	18 b	35 b	24 a
Acephate 3G	9 cd	24 b	17 cd	25 a
FMC 35001 2.5G	6 cd	35 b	19 bcd	23 a
Oftanol 5G	1 d	41 b	25 bc	36 a

[a]Av. of 4 replications, each consisting of 20 freshly hatched larvae placed on treated cut stems of rice. Mortality was determined 48 hours after larval infestation. In a column, means followed by a common letter are not significantly different at 5% level. DAT = days after treatment.

provided only 53% control. Because residual activity is generally much shorter in the field than in the greenhouse, even Miral would not be expected to provide effective control for much more than a week at 0.5 kg a.i./ha.

Brevennia rehi (Lindinger) is the valid name for rice mealybug

Alberto T. Barrion, research assistant, and J. A. Litsinger, associate entomologist, International Rice Research Institute

A name change has been made on the rice mealybug belonging to the genus *Heterococcus* Ferris. The species *rehi,* formerly treated under this genus, was transferred to *Brevennia* Goux (Miller, 1973, Entom. Soc. Wash. Proc. 74 [3] :372). The valid name becomes *Breuennia rehi* (Lindinger), superseding both *Heterococcus rehi* (Lindinger) and *Ripersia oryzae* Green.

Rice mealybug is considered a rice pest of well-drained soils in Bangladesh, India, Java, Nepal, and Pakistan.

Predacious spiders in a BPH endemic area of West Bengal, India

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Predacious spider populations in rice fields exert a profound influence on pest populations. Six species of spiders belonging to the families Oxyopidae, Lycosidae. Thomisidae, Argiopidae, Salticidae, and Lynyphiidae, occur on the boro crop (summer rice) at Khanakul, a flood-prone area of West Bengal that is chronically infested with brown planthoppers (BPH).

The spiders immigrate in the rice field just after transplanting in late January to early February and check the initial BPH populations in the early half of March. The spiders and BPH occupy the basal portion of the rice clump, where they can escape direct contact with insecticidal sprays.

In the latter half of March, the temperature is conducive to rapid BPH multiplication, and the spiders can no longer check their populations. During the peak BPH infestation, most of the spiders observed in the rice fields were linyphids. Spider populations vary considerably in different areas of the same locality, possibly because of previous flooding or indiscriminate use of insecticides.

Cyst nematode infestation of rice in Kerala State, India

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A cyst nematode that infests rice has been collected in routine surveys of rice and rice soils from the paddy fields of Trivandrum (southern region of Kerala). It has been identified as *Heterodera oryzicola* n. sp. by Rao and Jeyaprakash by CRRI at Cuttack, Orissa, India.

Leaf chlorosis in rice due to infestation by this nematode in northern Kerala has been reported by Rao and Jeyaprakash in the IRRN. The present observation suggests the wide distribution of the nematode and the need for surveys in Kerala and adjacent states — Tamil Nadu, Karnataka, and Maharashtra — to find the extent of distribution, identify the problem areas, and check the nematode's spread and damage to rice.

Filipino farmer use of plant parts to control rice insect pests

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A sample of 108 farmers from three Philippine provinces representing dryland (Batangas) and rainfed wetland (Iloilo and Pangasinan) rice environments were asked to enumerate methods they used to control insect pests. A surprisingly high percentage (43%) placed branches or other plant parts in their fields to attract or repel insects.

We recorded 13 plant species in the survey. In Pangasinan 72% of the farmers said they placed branches of "madre de cacao" *Gliricidia sepium* (Leguminosae) in rice fields to repel caseworm and whorl maggot. Twenty-eight percent of Batangas farmers used branches of "anonang" *Cordia dichotoma* (Borganinaceae) to draw termites away from dryland rice early in the season. Farmers enumerated 11 other species that repel unspecified insect pests: *Bambusa vulgaris* (Gramineae), "tagwanak" — stems placed in the corners of fields; *Annona reticulata* (Annonaceae), "anonas" — branches and leaves; *Alocasia macrorrhiza* (Araceae), "biga" — whole plant chopped and broadcast on tields: *Aegle gultinosa* (Rutaceae), "tabon" — branches and leaves; *Enterolobium saman* (Legutninosae), "acacia" — branches and leaves; *Pinus insularis* (Pinnaceae), "agoho" – branches and leaves; *Corypha elata* (Palmae), "buri" – leaves; *Kleinhofia hospita* (Sterculiaceae), "tanag" – branches and leaves; *Cordyline roxburghiana* (Liliaceae), "tigue" – leaves; *Virex negundo* (Verbenaceae), "dangla" – branches and leaves; and *Amorphophallus campanulatus* (Araceae), "pongapong" – whole plant.

Occurrence of the brown planthopper on rice in Pondicherry region, India

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In recent years the brown planthopper (BPH) *Niluparvata lugens* has been reported in epidemic form in several areas of Pondicherry region. In June 1977 it caused hopperburn in several fields around Ouzhugaret, Bahour, Mannadipet, and Villanour communes. During July to October 1977, the pest was reported from Nettapakkam and Ariankuppam communes of Pondicherry region, where all the varieties grown are susceptible. Varieties that have been severely at tacked are IR20, Ponni, and Jaya. BPH infestation seems likely to become severe in all rice-growing tracts of Pondicherry region.

The outbreak of BPH was followed by the virus disease, grassy stunt. The early-planted samba crop of 1977 (August to December) had reduced yields. Asynchronous planting being popular in the outbreak areas, hopperburn and virus disease were noted at all growth stages. The highest numbers of planthopper nymphs and adults counted directly in farmers' fields on IR20 and Ponni were 85–115/hill. Approximately 95% of the hills were infected with grassy stunt disease at some places despite low population densities of the vector. Yields were not expected in cases of BPH infestation in the early growth stages – in the seedbed or just after transplanting.

Effect of soil application of systemic fungicides on control of rice sheath blight

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Four systemic fungicides were applied to soil at the late tillering stage of rice to study their effectiveness in sheath blight control. Bavistin was most effective in disease control and increased yield; vitavax was next (see table).

Mean disease score and yield of rice under four fungicide treatments. Kerala, India.

Treatment	Dose (kg a.i./ha)	Disease control		Yield (t/ha)
		Score[a]	Efficiency over control (%)	
Benlate (Benomyl)	3	1.8	156	4.1
Kitazin granules	5	1.8	156	4.6
Bavistin	3	1.2	283	5.0
Vitavax	20	1.8	156	4.8
Untreated control	–	4.6	–	4.8

[a]1 = most effective; 9 = least effective.

Root-zone application of carbofuran in rice-fish culture

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The Philippine government is studying the feasibility of rice-fish culture to increase farmer income and provide an additional protein source for human nutrition. A major difficulty in rice-fish culture is the incompatibility of insect control with insecticides and fish culture.

Previous IRRI research had indicated that insecticide concentration in the paddy water was much less when insecticides were applied in the root zone

Yields of IR34 rice and fish *Tilapia mosambica* as affected by carbofuran root-zone and broadcast applications, Central Luzon State University, 1976 dry season.

Application rate (rate a.i./ha)[a]	cost of insecticide application (US$)	Rice yield[b] (t/ha)	Fish[c]		Income[d] (US$)	Income change[e] (US$)
			Yield (kg/ha)	Value (US$/kg)		
No insecticide	0	4.1	155	127	703	–
Broadcast						
1 kg at 3 DT	30	4.3 bc	141	115	690	–13
1 kg at 3, 23, 43, and 63 DT	120	4.9 abc	0	0	571	–132
Root-zone						
1 kg at 3 DT	46	5.1 ab	166	136	806	103
2 kg at 3 DT	92	5.6 a	150	123	817	114

[a]a.i. = active ingredient; DT = days after transplanting.
[b]In a column, any 2 means followed by a common letter are not significantly different from each other at the 5% level.
[c]Fish seeded 7 days after first insecticide application at the rate of 3,000/ha.
[d]Income = value of rice + fish minus insecticide and application costs. Based on price of rice at US$0.14 and fish at US$0.82/kg.
[e]Income change = Income from insecticide treatments – income from control (no insecticide).

than when they were broadcast over paddy water. The results of an experiment conducted at Central Luzon State University in 1976 indicated that seeding fish 7 days after broadcast application over paddy water or a root-zone application with a liquid band injector did not adversely affect fish yields (see table).

In the treatment where repeated broadcast applications were made, however, no fish survived. Because the residual activity of carbofuran in paddy water is short, several broadcast applications are required for season-long control. One root-zone application, however, is equivalent to several paddy water broadcast applications because carbofuran applied in the soil has longer residual activity. Thus, the root-zone application technique can provide long-term insect control without causing fish mortality. Fish analysis with gas chromatography indicated no detectable residues of carbofuran in either the broadcast application 3 days after transplanting or the root-zone treatments. Another experiment indicated that soil incorporation of carbofuran granules at the last harrowing provided effective insect control and left no carbofuran residues in fish.

Income in the two root-zone treatments was US$l00–200 more than that in the broadcast treatments.

Carbofuran residues in rice grain as affected by application technique

E. A. Heinrichs, entomologist, International Rice Research Institute, O. H. Fullmer, analytical chemist, FMC Corporation, Richmond, California, USA; J. N. Seiber, visiting scientist, and G. B. Aquino, senior research assistant, IRRI

Carbofuran is extensively used as an insecticide for insect control in lowland rice. It is primarily a paddy water broadcast treatment but is used to a lesser extent as a foliar spray. Results of research conducted in the Philippines and in several other Asian countries indicate that the effective duration of carbofuran is much longer when the chemical is applied to flooded soil than when it is broadcast over paddy water. Because of the extent of the present use of carbofuran as a broadcast treatment and as foliar spray, and its possible future use as a soil application, an experiment was conducted to determine whether its residues could be detected in the grain at harvest.

Five treatments — two soil application methods, two broadcast treatments, and a foliar spray treatment — were compared (see table). Residues of all treatments, except the extremely high rate of 6 broadcast applications at 14-day intervals, were below allowable levels. Brown rice with the hull removed would probably have had even lower residue levels than the rough rice analyzed. The combined uncorrected residues of carbofuran and 3-hydroxycarbofuran (on which the U.S. Environmental Protection Agency tolerance of 0.20 ppm is based) were 0.46 ppm for this treatment. However, there appears to be little danger from residues of carbofuran applied at the rates and with the methods most farmers currently use for rice pest control.

Residues of carbofuran and 3-hydroxycarbofuran in whole grain (brown rice) of IR22 rice plants treated by different application techniques, IRRI, 1976–77.

Treatment[a]	Residues[b] (ppm)	
	Carbofuran	3-hydroxycarbofuran
Soil incorporation	0.08	0.06
Root zone with liquid band applicator	0.08	0.02
Broadcast at 14-day intervals (6 times)	0.34	0.12
Broadcast at 20-day intervals (4 times)	0.11	0.05
Foliar spray at 20-day intervals (4 times)	0.04	< 0.02
Control	0.06	< 0.02

[a]In the soil incorporation treatment, insecticide was applied before transplanting whereas in the root-zone treatment it was applied at 3 days after transplanting. The broadcast and foliar spray applications were begun 5 days after transplanting. Flowering occurred at 70–80 days after transplanting; thus 1 application of the broadcast treatments at 14-day intervals and 1 application of the broadcast and foliar spray treatments at 20-day intervals were applied during the flowering period. All applications were made at the rate of 1 kg a.i./ha except for the foliar spray which was applied at 0.5 kg.

[b]Values were not corrected for percentages of recoveries (91% for carbofuran and 97% for 3-hydroxycarbofuran).

Rice pest control and income as affected by method of carbofuran application

E. A. Heinrichs, entomologist, and G. B. Aquino, senior research assistant, International Rice Research Institute

Because of the high cost of insecticides, methods of application that increase their effectiveness, increase farmer income, and minimize risks must be developed. Previous studies have shown that a systemic insecticide such as carbofuran has longer residual activity when placed into the soil than when broadcast on paddy water.

In 1977, four methods of carbofuran application were compared for control effectiveness and income return: 1) soil incorporation, i.e. broadcasting granules and incorporating them into the soil with a power tiller 1 day before transplanting; 2) applying into the root zone with a liquid band applicator 3 days after transplanting; 3) broadcasting granules over paddy water at 20-day intervals after transplanting; and 4) foliar spraying (see table).

Soil incorporation best con trolled the whorl maggot *Hydrellia philippina;* the foliar spray was the least effective. All treatments provided equal control of virus vector and stern borer (primarily *Tryporyza incertulas*). The brown planthopper (BPH) *Nilaparvata lugens*

Frequency, rate, and method of insecticide application for the control of rice pests on IR22, IRRI, 1977 dry season.

Treatment[a]	Times (no.)	Rate (kg a.i./ha)	Whorl maggot damage[b] 29 DT	Deadhearts (%) 60 DT	Virus (%) 60 DT	BPH/10-linear m row 78 DT	Hopperburn (%) 92 DT	Grain yield (t/ha)	Net income[c] (US$)	Income change[d]
Carbofuran (SI)	1	1.0	1.0 ab	1.54 bc	0.16 a	1,584 a	14 ab	3.7 a	476	238
Carbofuran (RZ)	1	1.0	3.0 c	2.01 c	0.16 a	3,461 a	0 a	3.2 a	404	166
Carbofuran (B_{14})	6	1.0	4.0 cd	0.97 ab	0.93 ab	5,098 ab	13 ab	3.5 a	294	56
Carbofuran (B_{20})	4	1.0	5.0 d	0.81 ab	1.09 ab	1,744 a	4 a	3.3 a	329	91
Carbofuran (B_{20})	4	2.0	4.0 cd	0.46 a	0.78 ab	3.500 a	25 ab	3.5 a	236	–2
Carbofuran (F_{20})	4	0.50	7.0 e	1.16 abc	1.40 ab	29,965 c	97 c	1.9 bc	166	–72
Untreated		0.0	9.0 f	4.93 d	12.49 c	4,812 ab	8 ab	1.6 c	238	–

[a]SI = soil incorporation; RZ = root zone with liquid band applicator; B_{14} = broadcast every 14 days, B_{20} = every 20 days; F_{20} = foliar application every 20 days.
[b]Based on a scale of 0–9: 0 = no damage; 9 = > 50% of leaves damaged. DT = days after transplanting.
[c]Net income = value of rice at US$0.I4/kg – cost of insecticide + labor. Cost of insecticide: carbofuran 3% granule = US$29.84/kg a.i.
[d]Income change = net income in treatments – income in control.

was not controlled because it is resistant to carbofuran at IRRI. Because carbofuran when regularly applied causes a resurgence of the BPH, the planthopper population in plots that received the foliar spray applications was six times greater than that in the untreated plots. As a result, the sprayed plots were (97% hopperburned. The soil incorporation treatment gave the highest income change because of its insect control effectiveness and low labor cost for application.

Seed treatment with granular insecticides to paddy

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As the cost of insecticides increases, the treating of production seed gains in importance. Seed treatment gives immediate protection to seed, sprouts, and tillers. It is economical because less insecticide is required. The costs, hazards, and soil residues that contribute to environmental pollution are also reduced. Wettable powders are generally used in dilute solutions, but treatments with emulsifiable concentrates and systemic granules are gaining importance. Seed treatment gives good control of seed- and soil-borne diseases.

A large number of insects infest the paddy crop from the nursery through storage and its final products in rice mills. Obviously, the rice crop may need protection at all stages. An experiment was conducted in May 1978 at the Main Research Station, Namagam to study the feasibility of seed treatment and its possible toxic effects on germination and seedlings.

Fifteen granular insecticides (Table 1) were used in solutions at 0.02% concentration.

Treatments were repeated five times in a completely randomized design in the laboratory. One hundred seed of variety GR11 were put in glass test tubes marked 1 to 80. Weighed quantities of granules were placed in glass beakers and insecticidal solutions were prepared by thoroughly dissolving the granules. The paddy seed were soaked in the solutions for 24 hours and then placed in petri dish bottoms 9 cm in diameter, each lined with blotting paper. The petri dishes of all sets were watered three times a day and covered with wet thick cotton cloth to minimize evaporation. Germination counts were taken on the 4th, 5th, 6th, and 7th day after treatment.

Table 1. Insecticides, their trade names, and quantity used as seed-soaking treatment for the rice variety 117-1(GR 11), Gujarat, India.

Insecticide	Trade name	Formulation	Quantity (g/liter of water)
Phorate	Thimet	10 G	2
Aldicarb	Temik	10 G	2
Mephosfolan	Cytrolane	5G	4
Disulfoton	Solvirex	5G	4
Fenitrothion	Folithion	5G	4
Chlorfenvinphos	Birlane	10 G	2
Dimethoate	Rogor	5G	4
Gamma-BHC	Lindane	6G	3.33
Ecndosulfan	Thiodan	4G	5
Quinalphos	Ekalux	5G	4
Diazinon	Diazinon	5G	4
Carbaryl	Sevin	4G	5
Fenthion	Lebaycid	5G	4
Monocrotophos	Azodrin	5G	4
Carbofuran	Furadan	3G	6.67
Control (water only)			

Table 2. Effect of seed treatment with granular insecticides on germination and seedling count, Gujarat, India.

Treatment	Germination of first set[a] at 4 DAT	5 DAT	6 DAT	7 DAT	Av. seedling count (%) of second set[b]
Phorate	94.5	95.8	96.0	96.2	88
Aldicarb	91.0	93.8	94.4	94.6	79
Mephosfolan	86.8	91.4	92.2	92.2	73
Disulfoton	83.0	97.4	97.8	98.0	93
Fenitrothion	90.8	96.2	96.2	96.8	77
Dimethoate	93.2	95.2	95.2	95.4	83
Chlorfenvinphos	91.8	93.2	94.4	94.4	74
Gamma-BHC	94.0	95.2	95.8	95.8	86
Endosulfan	92.0	93.0	93.4	93.4	90
Quinalphos	93.6	96.6	96.8	97.0	78
Diazinon	93.2	94.6	94.8	94.8	72
Carbaryl	94.2	94.8	95.2	95.2	77
Fenthion	96.4	97.2	97.2	97.4	71
Monocrotophos	94.6	96.0	96.6	98.6	82
Carbofuran	93.4	94.2	94.2	94.2	81
Control	90.2	93.6	93.8	94.2	82
S.Em.	2.23	1.13	2.24	2.24	5.92
C.D. at 5%	6.41	3.20	n.s.	6.32	n.s.
C.V. %	5.19	2.66	2.74	2.68	14.78

[a]Av. of 5 replications. DAT = days after treatment.
[b]10 DAT; av. of 4 replications.

The experiment was repeated to confirm the first results. Fifty seed—instead of 100—were used to allow sufficient space for seedling development. The set was replicated four times. After 24 hours of soaking, the seed were put in the containers and watered. Seedlings were counted 10 days after treatment (Table 2).

None of the treatments adversely affected germination. The seedling count revealed that none were toxic to seedling. The treated seedlings were generally stouter, healthier, and darker in color than those in the control.

Brown planthopper resistance to MIPC and MTMC in Taiwan

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The susceptibility of field collected brown planthoppers (BPH) to MIPC and MTMC increased slightly after the BPH were reared for 13 generations in the laboratory without insecticidal selection pressure. The strain was designated as susceptible (S). Under increasing selection pressure of MIPC, the S strain developed 6.1 times more resistance after 6 generations. Under similar conditions, it developed 8 times more resistance to MTMC after 7 generations. Further Fcreases in resistance are expected for these two strains.

Among 12 areas surveyed, BPH from Erhleun had 7 times more resistance to MIPC, and those from Mei-nung and Hsin-hua were found to have more than 5 times as much resistance. BPH from other areas seemed to retain their susceptibility to MIPC, BPH from Mei-nung had 6.9 times as much resistance to MTMC, and those from Ta-chia, Ming-shiung, and Hsin-hua developed 5 times as much or more resistance. No apparent resistance to MTMC was found in BPH from the other areas. The survey confirmed the development of resistance to MIPC and MTMC in some field populations of BPH. There seemed to be a moderate correlation between MIPC resistance and MTMC resistance in the field populations of BPH in Taiwan.

Routes of carbofuran losses from rice plants following root-soak, systemic, and foliar-spray applications

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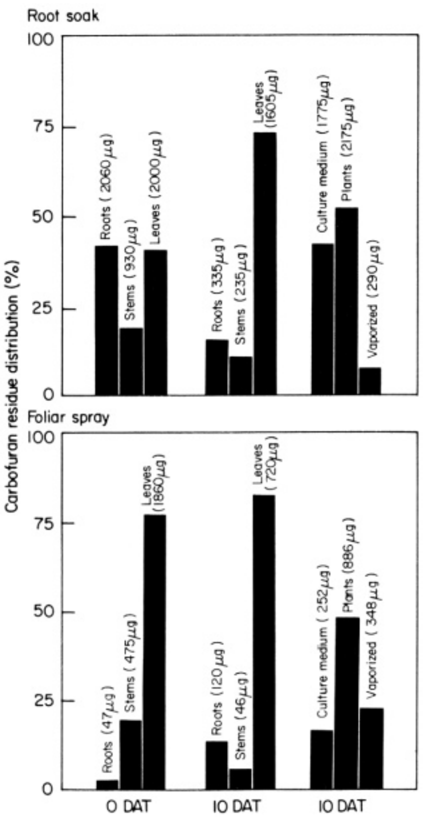
Systemic insecticides have generally been assumed to have longer residual persistence than corresponding foliar sprays because their normal loss routes, such as through evaporation and washing off are minimized. To test this, carbofuran was applied to 100 15-day-old Calrose 76 seedlings by both 24-hour root soak (600 ppm) and foliar spray (700 ppm) treatments to determine runoff in duplicated experiments. The plants were then kept for 10 days in fresh Hoagland's culture medium inside a gas-tight 3.8-1 glass chamber under illumination for 12 hours/day with an air flow of 11/minute during the illumination period. Plant parts, culture medium, outflow vapor trap (XAD4 resin), and chamber walls were analyzed for carbofuran by gas chromatography. Vaporized carbofuran was calculated as the sum of residue accumulated in the vapor trap and on the chamber walls.

Although seedlings at 10 days after transplanting (DAT) contained more than twice the carbofuran residue after root soaking (4,990 μg) than after foliar spray (2,382 μg), the leaves in the two treatments had similar quantities of residue (2,000 and 1,860 μg, respectively respectively) (see figure). Carbofuran decreased by 52.3% at 10 DAT in systemically treated plants; most of the loss was by root exudation to the culture medium, but a comparable leaf residue (1,605 μg) to that at 0 DAT was retained. Sprayed plants lost 59.3% of the initial residue by 10 DAT; their leaf residue (720 ppm) was less than half of that at 0 DAT. Most significant, both treatments resulted in the vaporization of similar quantities of carbofuran (290 μg systemic, 348 μg foliar spray) during the period from 0 to 10 DAT.

The leaves of several root-soaked seedlings were rinsed by two 2-second dips in carbon tetrachloride at 0 and 12 DAT. It was found that 8.4% and



Carbofuran residue distribution in plant parts and chamber components. Percents are normalized to 100 for each set of data. DAT = days after transplanting.

2.3% of the total leaf residue, respectively was recovered in the rinse solutions, an indication of the proportion of residue on the leaf surface at the time of sampling.

The results indicate that rice plants may lose systematically applied carbofuran intact by root exudation and by vaporization, and that vaporization is at least partly because of the translocation of sizeable quantities of residue to the leaf surface. Field conditions that enhance the loss of surface residue, especially high winds, high temperatures, and heavy rainfall, may thus shorten the residual lifetime of systematically-applied carbofuran. Because those loss routes are available for systemic insecticides, the long-term efficiency of root-zone and soil-incorporation treatments may be caused more by the continual replenishment of plant residue from soil deposits of insecticides than by the stabilization of initially absorbed residue within the plant.

Natural enemies of rice leafhoppers and planthoppers in the Philippines

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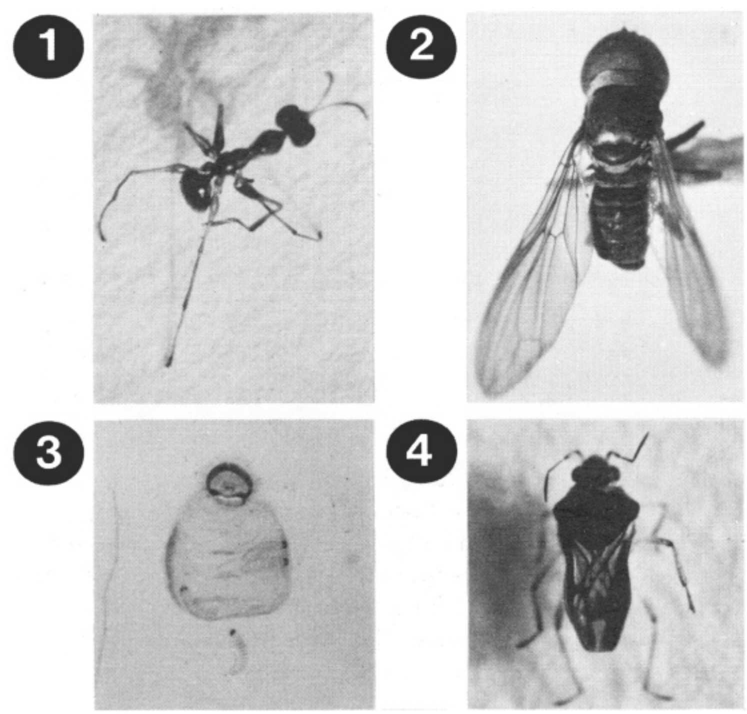
The few records of natural enemies of rice leafhoppers and planthoppers in the Philippines mention some species of predatory insects, spiders, and entomophthoraceous fungi. During biological control studies at IRRI, several species of parasites and predators were discovered. The following list may be useful to those initiating further studies and planning to introduce or augment natural enemies of rice hoppers in different countries.



Nymphal-adult parasites of rice hoppers: 1) Pseudogonatopus *nr.* nudus, *2)* Pipunculus (Eudorylas) mutillans, *and 3)* Elenchus yasumatsui *female with four triungulins (larval, parasitizing stage); Predator: 4)* Microvelia *nr.* atrolineata.

PREDATORS OF RICE HOPPERS

Coccinellidae (Col.)	*Coccinella arcuata, Menochilus sexmaculatus*
Empididae (Dipt.)	*Drapetis* spp.
Mesovelidae (Hem.)	*Mesovelia* sp.
Miridae (Hem.)	*Cyrtorhinus lividipennis*
Nabidae (Hem.)	*Nabis* sp.
Veliidae (Hem.)	*Microvelia* nr. *atrolineata*
Odonata	Several species of the genera *Agriocnemis, Diplacodes, Epiophlebia, Ischnura, Macrodiplax, Neurothemis, Orthethrum, Pantala,* and *Pseudagrion.*
Spiders	Several species of the genera *Aranea, Argiope, Lycosa, Oedothorax, Tetragnatha,* and *Thiridion.*

Species of Carabidae. Dolichopodidae, Formicidae, Reduviidae, Staphylinidae, and frogs were also found preying on hoppers in low numbers. No predator, however, was specific to any hopper species.

PARASITES OF RICE HOPPERS

Parasite species	Host record
Egg parasites	
• Mymaridae (Hym.)	
Anagrus flaveolus	*Nilaparvata lugens, Nephotettix* spp. and *Sogatella furcifera*
Gonatocerus sp.	*Nephotettix nigropictus* and *N. virescens*
• Trichogrammatidae (Hym.)	
Oligosita sp.	*Nephotettix* spp. and *N. lugens*
Nymphal-adult parasites	
• Dryinidae (Hym.)	
Echthrodelphax fairchildii	*N. lugens, Nephotettix* spp. and *S. furcifera*
Haplogonatopus sp. 1	*N. lugens, Nephotettix* spp., *S. furcifera,* and *Stenocranus* sp.
Haplogonatopus sp. 2	*N. lugens, Nephotettix* spp. and *S. furcifera*
Pseudogonatopus nr. *nudus*	*N. lugens, Nephotettix* spp., *R. dorsalis, S. furcifera* and *Stenocranus* sp.
Pseudogonatopus flavifemus	*N. lugens* and *S. furcifera*
• Pipunculidae (Dipt.)	
Pipunculus (Eudorylas) mutillatus	*N. nigropictus* and *N. virescens*
Tomosvaryella subvirescens	*N. nigropictus* and *N. virescens*
Tomosvaryella oryzaetora	*N. nigropictus* and *N. virescens*
• Strepsiptera	
Elenchus yasumatsui	*N. lugens, R. dorsalis, S. furcifera* and *Stenocranus* sp.
Halictophagus sp. 1	*Nephotettix* spp.
Halictophagus sp. 2	*Cicadella spectra*
• Nematode	
Mermithid (unidentified)	*Nephotettix* spp., *N. lugens,* and *S. furcifera*
• Pathogens	
Entomophthora coronata	*N. lugens*
Hirsutella sp.	*N. lugens*

The spiders and egg parasites contribute to the greatest mortality of hoppers in the field. Egg parasitism often rises to 58%. The new predator *Microvelia* nr. *atrolineata* (see photo), which usually hunts on the water surface but occasionally attacks young nymphs on plants, appears to be quite effective against the first- and second-instar nymphs. The *Crytorhinus lividipennis* population fluctuates much but even at high densities does not appear to cause much damage to the pest population. In the wet season, parasitism by Pipunculids is as high as 50% and that by dryinids, 40%. The strepsipterans usually cause about 10% parasitism, but occasionally up to 63% has been recorded. Nematodes and pathogens are rare in the field. By and large parasitism is considerably lower during the dry season than during the wet.

To detect the percentage of parasitism accurately, it is advisable to rear the field-collected nymphs and adults of each species separately in the rearing cage described in IRRN 3(1):12, before dissecting them under the binocular microscope. Neither the dissection method nor rearing alone gives a true picture of field parasitism.

Note: Dr. Chandra offers to identify the Dryinidae reared from rice hoppers. Interested parties may send pinned dryinid specimens reared from rice hoppers with collection data to the author for identification.

Occurrence of the rice gall midge in the central plain and southern peninsula of Thailand

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The rice gall midge has been reported in northern, northeastern, and eastern Thailand, and in some parts of the central plain. The insect was recently reported in Chachengsao province, near Bangkok (IRRN 2 [5], 1977). Its occurrence in cultivated and wild rice was surveyed in the central plain and southern peninsula.

The gall midge was found not only on wild rice grown in Muang and Uthong districts, but also on rice plants grown at the Suphanburi Rice Experiment Station, Suphanburi province, and at Minburi in Bangkok. At least 4% of the tillers in those areas were damaged.

For the first time, the insect was collected on rice plants in the southern peninsula: in Sawee district, Chumpon province; and Smothong village, Thachana district, Surathani province. In Chumpon and Surathani provinces 2.9 and 2.3% damaged tillers, respectively, were found among rice plants at the heading stage. Farmers grow a local rice variety known as *white rice* there.

The gall midge was not found on the wild rices that sporadically grow in all of the southern peninsula.

It is interesting that the distribution of the rice gall midge has extended from northern to southern Thailand.

Braconid parasites of rice yellow borer *Tryporyza incertulas* in West Bengal, India

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Hymenopterous parasites have always been found during stubble surveys and sweepnet collections in the rice fields at Chinsurah Rice Research Station. The field-collected borers were reared and many parasites that emerged from the larvae and pupae were collected. Work is in progress to determine the relative abundance of the species in different cropping seasons and to identify cultural practices that may favor parasite establishment in rice fields. The more effective species may be used to regulate the rice borer populations. Identification was done through the Commonwealth Institute of Biological Control, Bangalore, and also by following the key in IBP Handbook No. 14. The particulars of seven braconid species appear below:

Parasite	Susceptible stage of host	Period of adult emergence
Stenobracon nicevillei (Bing.)	larva and pupa	May, Aug. and Nov.
Tropobracon schoenobii (Ver.)	larva	May
Rhaconotus schoenobivorus (Roh.)	pupa	Feb., June, and Sept.
Chelonus munakatae (Muna.)	larva	Mar. and Apr.
Chelonus sp.	larva and pupa	Feb., Mar., and Apr.
Apanteles schoenobii (Wilk.)	pupa	Feb.
Apanteles flavipes (Cam.)	larva	May

Gyrocampa spp. *(Braconidae)* as larval parasites of rice whorl maggot in India

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The rice whorl maggot *Hydrellia* sp. (Diptera, Ephyridae) has become a regular pest of paddy in Karnataka, India, in recent years. It has been noted in all the released high yielding rice varieties and prereleased lines and in many other cultures of national and international origin in experiments at the Regional Research Station, Mandya. Two larval parasites collected from affected tillers in the field were reared and observed in the laboratory. The Conmonwealth Institute of Entomology, London, identified them as *Gyrocampa* spp. (Hymenoptera, Braconidae). The general body color of *Hymenoptera* adults is black; that of *Braconidae* is honey. This is the first record of either parasite on whorl maggot in India.

Whorl maggot incidence prevailed as late as 5O days after transplanting in both the summer and kharif of 1977. The parasites were active in March and April in the summer and in September and October in kharif. Observations on whorl maggot incidence on IET 1444 and its parasitism are summarized in the table.

Incidence of rice whorl maggot and its larval parasitism by *Gyrocampa* spp. Rice Research Station, Mandya, Karnataka, India. 1977.

Days after transplanting	Summer			Kharif		
	Hills affected (%)	Leaves damaged in affected hills (%)	Parasitism (%)	Hills affected (%)	Leaves damaged in affected hills (%)	Parasitism (%)
20	60.0	8.2	18.5	50.0	12.6	27.5
30	33.3	5.4	27.5	60.0	17.1	24.3
40	93.3	17.4	33.7	46.7	10.0	60.4
50	26.7	14.7	24.3	36.7	7.8	44.1
Mean	53.3	11.7	26.0	48.4	11.9	39.1

The percentage of leaves damaged in both seasons was more or less equal, but parasitism in kharif was generally much higher than that in summer. The parasites completed their life cycle in about 15 days at 25.3 to 28.7°C and at 90% relative humidity.

Suppression of *Meloidogyne graminicola* with decaffeinated tea waste and water hyacinth compost

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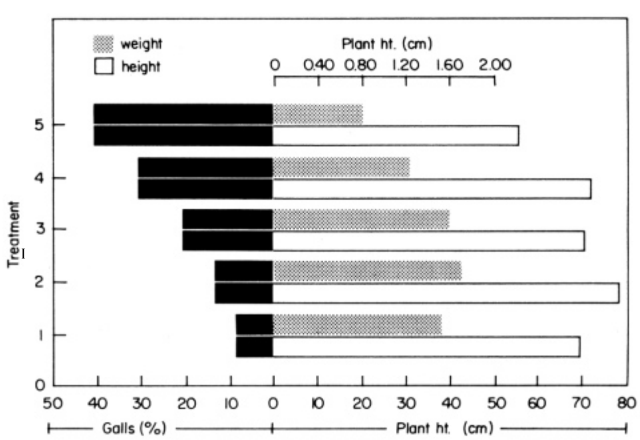
In a pot experiment, soil amendment with decaffeinated tea waste (DCTW) (tea sweepings after extraction of caffeine and water hyacinth compost (WHC) significantly controlled root-knot nematode of rice *Meloidogyne graminicola* and increased plant growth. Each amendment was made in 2 doses – 300 and 600 g/clay pot, 25 cm in diameter, containing 4.5 kg soil.

Although DCTW reduced the percentage of galls more than WHC, both DCTW and WHC had almost the same effect in increasing the plant height and dry root weight (see figure). The increased root weight, however, was not statistically significant. No significant difference in effect was observed between the two doses of either additive, i.e., both doses had almost similar effects in increasing plant growth and in reducing the percentage of galls.



Effect of decaffeinated tea waste (DCTW) and water hyacinth (WHC) on the reduction of the percentage of galls by M. graminicola *and increased plant growth. Variety, Pusa 2-21. Treatments: 1 = DCTW at 600 g, 2 = DCTW at 300 g, 3 = WHC at 600 g, 4 = WHC at 300 g, and 5 = unamended control*

Irrigation and water management

Nitrogen movement in water draining from irrigated rice land

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Agricultural chemicals, especially nitrogen (N) fertilizers, and also insecticides and herbicides, are widely believed to be in water flowing from rice lands to drains, and are often blamed for polluting lakes and other water bodies. A study to quantify the loss of nitrogen from rice fields through surface drainage into drainage outlets and to recommend management practices to minimize such losses was undertaken jointly by the Laguna Lake Developlnent Authority (LLDA), Manila, and IRRI.

Six treatments of fertilizer and water management were applied at three sites in Laguna province, Philippines. At each site, two fertilizer management practices – topdressing (T_1, T_3, and T_5) and incorporation (T_2, T_4 , and T_6) – were combined with each of three water management practices – continuous flow (T_1 and T_2), impounded water (T_3 and T_4), and temporary drainage (T_5 and T_6). A total of 60 kg N/ha was applied as 20 kg basal followed by 40 kg at 45 days after transplanting (DT). The incorporation of second application in T_2, T_4, and T_6 was done by rotary weeder. The continuos–flow treatments were irrigated and drained simultaneously throughout crop growth, including during both fertilizer applications. In the impounded-water treatments, fertilizer was applied on standing water which was then confined to soak into the paddy for 5 days with neither irrigation nor drainage. In the temporary drainage treatments, the fields were drained 1 day before applying N, then irrigation was withheld for the next 2 days. Except during limited periods when fertilizer was applied, the water supply and other inputs and management levels were similar in all six treatments. Water flow into and out of each treatment was measured and sampled several times per day for N analysis. The daily amount of N gained or lost in each treatment was then computed from the data on flow rates and nitrogen concentrations.

In all treatments, N loss in the form of ammonium (NH_4^+) was greater than that in the form of nitrate (NO_3^-). Ammonium-N outflows were always greater than incoming NH_4^+-N (Table 1). Nitrate-N flowing into the treatment plots was usually greater than that going to drainage. The amounts of N as NH_4^+ and NO_3^- entering the treatments were about equal.

Total mean outflows of N were maximum with topdressed N, 3.8 kg/ha (Table 1). Among water-management treatments, the total mean outflow of N was highest (5.4 kg/ha) with continuous water flow; moderate (3.3 kg/ha) with temporary drainage; and lowest (1 kg/ha) with impounded water (Table 1).

Net flows of N through water movement varied considerably by fertilizer treatment. Net losses were much lower in treatments where N was incorporated (0.6 kg/ha) than where topdressed (2.1 kg/ha). The effect of incorporation was more pronounced where water was supplied continuously (Table 2).

The continuous water flow treatments had maximum mean net losses of N, 3.40 kg/ha (Table 2). Treatments with impounded water had lowest N losses regardless of N management; in fact they had a net gain of about 0.75 kg/ha (Table 2). Mean N losses were

Table 1. Mean[a] ammonium, nitrate, and total nitrogen (kg/ha) inflow (I), outflow (O), and net flow for six treatments in Laguna area, Philippines, 1976 wet season and 1977 dry season.

Treat-ment[b]	NH_4^+-N (kg/ha)			NO_3^--N (kg/ha)			Total -N[c] (kg/ha)		
	I	O	Net[d]	I	O	Net[d]	I	O	Net[d]
1	0.9	6.4	–5.5	1.0	0.2	0.8	1.9	6.6	–4.7
2	0.9	3.9	–3.0	1.1	0.2	0.9	2.0	4.1	–2.1
3	0.7	0.9	–0.2	1.0	0.1	0.9	1.7	1.0	0.7
4	0.8	1.0	–0.2	1.1	0.1	1.0	1.9	1.1	0.8
5	0.6	3.6	–3.0	0.9	0.2	0.7	1.5	3.8	–2.3
6	0.9	2.6	–1.7	1.2	0.2	1.1	2.1	2.7	–0.6

[a] Mean of 3 field locations and 2 seasons.
[b] Treatments 1, 3, and 5 = topdressed N; 2, 4, and 6 = incorporated N; 1 and 2 = continuous flow; 3 and 4 = impounded water; and 5 and 6 = temporary drainage.
[c] Total N refers to NH_4^+ + NO_3^+-N.
[d] Net flow = inflow – outflow. Therefore, negative values reflect net losses and positive values reflect net gains.

Table 2. Mean[a] total nitrogen net[b] flows (kg/ha) for the two fertilizer and three water management treatments in Laguna area, Philippines, 1976 wet season and 1977 dry season.

Nitrogen management treatment	Water management treatment: Continuous flow	Impounded water	Temporary drainage	Mean
Topdressed	–4.70	0.70	–2.30	–2.10
Incorporated	–2.10	0.80	–0.60	–0.63
Mean	–3.40	0.75	–1.45	–1.36

[a] Mean of 3 field locations and 2 seasons.
[b] Net flow = inflow – outflow. Negative values reflect net losses and positive values reflect net gains.

intermediate in temporary drainage treatments (1.45 kg/ha).

We concluded that:

1. Although inflow of N from irrigation water compensated for N losses somewhat, the practice of topdressing N and continuous water flow resulted in highest N net losses. If irrigation water contains insufficient N, then N losses should be higher with those practices. Nitrogen incorporation will reduce N losses because it reduces both surface runoff and atmospheric losses. Incorporation would also reduce losses resulting from high rainfall.

2. Continuous water flow also results in large net losses of N. But combining temporary water drainage with N incorporation will reduce N losses. Incorporating N to impounded water will eliminate N losses completely.

3. Because some sources of irrigation water contain high N levels, we recommend a survey of irrigation water sources and a program to use such water for rice production.

Soil and crop management

Effect of plant density under low-nitrogen response conditions

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In coastal regions of Karnataka, India, the nitrogen response of rice in the first crop (kharif) is low because of heavy rainfall and limited solar radiation. The possibility of increasing rice yields under such conditions by manipulating the plant density and number of seedlings per hill was studied in a replicated field trial in 1977 kharif. Except for the spacing treatments, all production practices in the test conformed to current recommendations for the area.

Preliminary results indicate that a close spacing of 15 × 10 cm with 4 seedlings/hill is conducive to maximum yield (see table).

Grain yield of rice (variety Viram) as affected by plant density and seedling number, Karnataka, India.

Treatments	Seedlings (no./hill)	Grain yield (t/ha) at 20 × 10 cm	15 × 10 cm	10 × 10 cm	Mean
1	2	2.7	2.8	3.2	2.9
2	4	3.0	3.6	3.4	3.3
3	6	3.1	3.2	3.3	3.2
Mean		2.9	3.2	3.3	

L.S.D. (5%) = 0.3
CV (%) = 7.0

Nutritional deficiencies of rice in Eastern Timor

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After the completion of a soil survey of Eastern Timor, studies of soil-plant relationships were begun. First, a general reconnaissance survey of the fertility conditions of the soils of the main agricultural regions was carried out to obtain data on the increase of crop yields. Eighty-five sites were selected. Data on symptoms naturally exhibited by the plants and, sometimes, symptoms induced by leaf injections were collected at each site. Leaf and soil samples were also chemically analyzed; in some cases, additional data on fertilization from pot experiments were available.

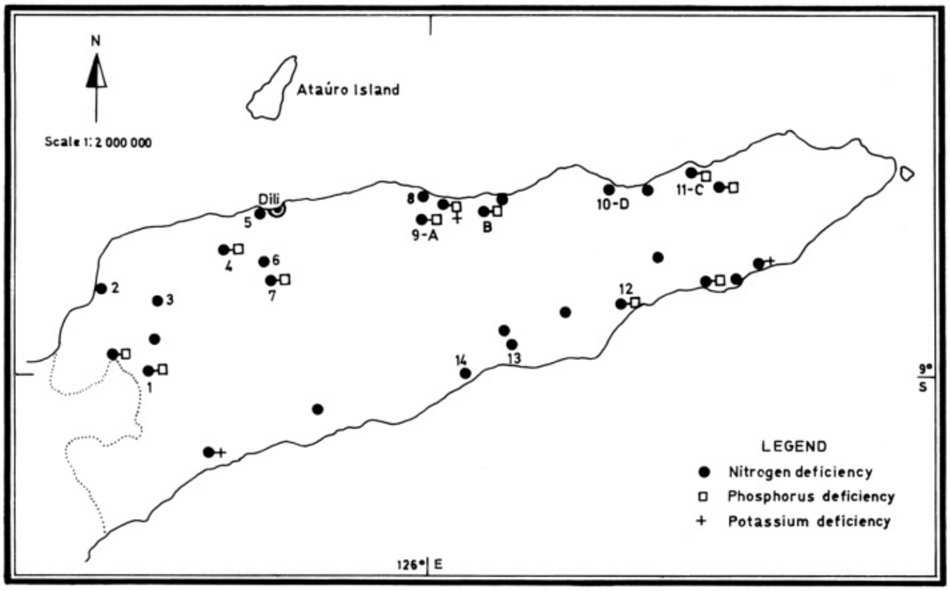
Nitrogen (N) deficiency can be considered widespread; it was identified in 93% of the sites. Phosphorus (P) deficiency was the next most common deficiency (38%), followed by potassium (K) and calcium (Ca) deficiencies (12%), and magnesium (Mg) deficiency (6%). Only in rare cases were iron, zinc, and manganese deficiencies observed.

Twenty-nine of the 85 selected sites were located in paddy areas. According to the observed symptoms, N deficiency is likely to occur in all the sites; P deficiency in 11, and K deficiency in 3 (see figure). Leaf analysis at the 14 numbered sites gave average contents of 2.26% for N, 0.19% for P, 1.62% for K, 0.30 for Ca, and 0.19% for Mg. That confirms part of the N and P deficiencies earlier shown for rice, which is generally raised on alluvial soils (mainly Fluvisols and Gleisols, by the FAO/UNESCO nomenclature).

That information led to the setting up of fertilization trials in four of the main paddy regions (A, B, C, and D on the figure). Twelve varieties were used with several levels of N and P (the highest are indicated in the table). The pH of soils of experimental plots ranged from 8.4 to 8.6, electrical conductivity from 1.2 to 1.5 mmho/cm, exchangeable Ca, Mg, K, and Na from 10.0 to 15.6, 2.4 to 10.1, 0.5 to 0.9, and 0.4 to 3.8 meq/100 g, respectively. Organic carbon ranged from 0.9 to 1.2%, nitrogen from 0.08 to 0.11%, and available phosphorus from traces to 24 ppm (Dyer method).

The table shows average values for IR8, which was the highest yielding variety. The results confirmed that those soils lack N and P. In the 1971–73 trials, plants fertilized with N or P, or both, always showed increased N or P, or both At the same time yield increased considerably in treatments with N + P. A further addition of the 2 elements in 1974 increased paddy yields from 5.6 to 7.8 t/ha at 1 site.

Nitrogen and P deficiencies can



Survey sites of rice culture in Eastern Yimor.

Mineral composition of IR8 at the heading stage in experimental fields. Eastern Timor.

Site and years	Fertilization rate (kg/ha)		Paddy yield[a] (t/ha)	Mineral composition[b] (%)				
	N	P_2O_5		N	P	K	Ca	Mg
A	0	0	2.2	2.20	0.15	1.89	0.41*	0.27
1971–73	90	0	2.9	2.55*	0.19	1.97	0.32	0.30
	0	105	2.4	2.22	0.22*	2.10	0.37*	0.27
	90	105	5.1	2.72*	0.21*	1.94	0.36	0.27
B	0	0	1.9	2.45	0.13	1.87	0.36	0.23
1971–73	90	0	2.9	3.02*	0.11	1.86	0.38	0.24
	0	105	2.8	2.24	0.22*	1.83	0.34	0.24
	90	105	5.5	2.92*	0.23*	1.84	0.33	0.25
B	0	0	1.4	2.49	0.13	2.04*	0.35*	0.21
1971–73	90	0	2.5	2.61	0.13	1.97*	0.35*	0.23
(2nd culture)	0	105	2.5	2.27	0.22*	1.82	0.32	0.20
	90	105	5.0	2.63	0.21*	1.74	0.30	0.21
C	0	0	2.6	1.77	0.12	2.38	0.77	0.33
1971–72	90	0	2.8	2.88*	0.14	2.55	0.92	0.32
	0	105	3.0	2.21	0.22*	2.55	1.01	0.31
	90	105	4.3	2.62*	0.21*	2.42	0.81	0.31
D	0	0	0.5	2.30	0.10	1.72	0.51	0.32
1972–73	90	0	1.4	2.66	0.10	2.04	0.57	0.31
	0	105	2.8	1.73	0.19*	2.07	0.62	0.36
	90	105	5.0	2.65	0.18*	2.25	0.54	0.36
D	90	105	5.6	2.95	0.19	2.40	0.48	0.27
1974	125	105	6.8	3.05	0.26	2.05	0.52	0.23
	160	140	7.8	3.05	0.23	2.30	0.56	0.30

[a] Three seedlings planted per hill at 25 × 25 cm, in 100 m^2.
[b] Second and third blades from top, in 100 tillers.
*Significant at the 5% level of probability.

therefore generally be considered as the main limiting factors to higher yields in soils planted to rice in Eastern Timor. Those deficiencies can be overcome by the proper application of the two elements.

Rice-based cropping systems

Continuous rice cropping

E. Price, L. D. Haws, and R. W. Herdt, International Rice Research Institute

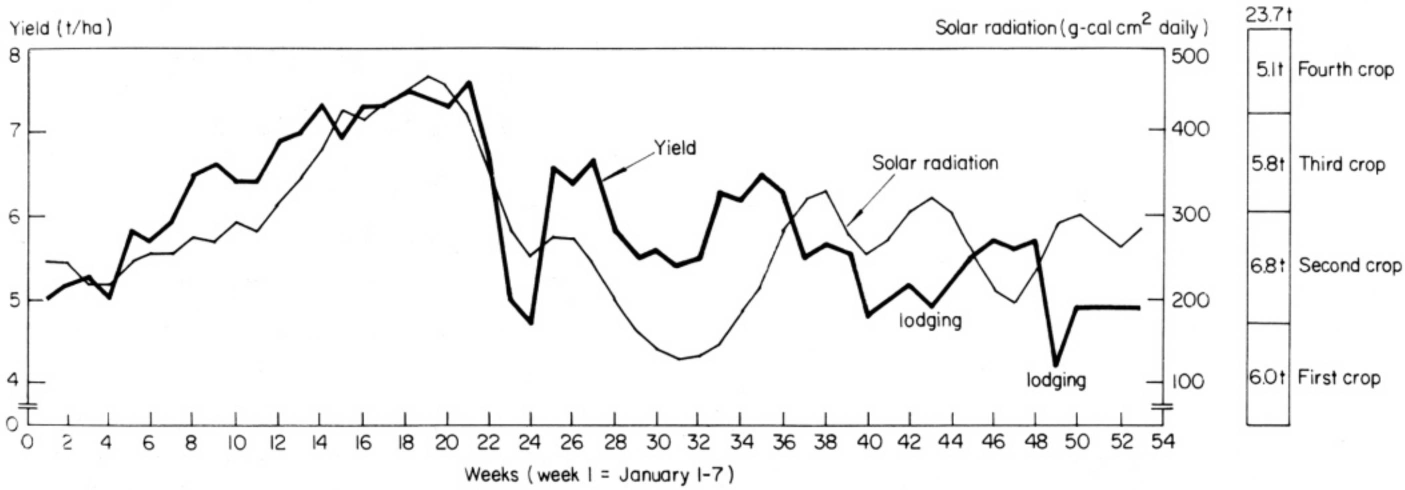
In October, a 1-year experiment was begun to determine the agronomic and economic feasibility of continuous rice cropping. A 1-ha field was divided into 40 plots of 250 m^2. One plot was transplanted every other day and one was harvested on alternate days, 6 days a week.

The 1-day turnaround between each 90-day crop of transplanted IR36 allows 3.96 crops to be grown in a year, and the evenly spread labor can all be performed by a farm family. A minimum labor time was estimated by clocked measurements. The minimum was 1,050 h/crop, or 13.2 h/day, and the maximum was 1,650 h/crop, or 20.7 h/day. The latter was for a meticulously tended field 20 minutes away from the farmhouse. A safe estimate of the labor time required is 1,2 50 h/crop.

Rice yield followed a seasonal pattern, perhaps related to solar radiation (Fig. 1). Since farmgate rice prices vary seasonally, it was not clear whether constant planting was best. We speculated that larger plots and less frequent plantings might be more profitable.

To examine these issues, we constructed a linear programming model that provided for daily plantings of plots of any size. We assumed a labor requirement of 1,250 h/crop. It was constrained by 16 hours family labor daily, unlimited hired labor at US$0.14/hour, and 8 hours of hand-tractor power. The results show that an approximately constant rate of planting is best, at 750 m^2/week — the same as in the field experiment (Fig. 2).

Evidently, the gains from using land and famlly labor through evenly staggered plantings outweigh any gains from



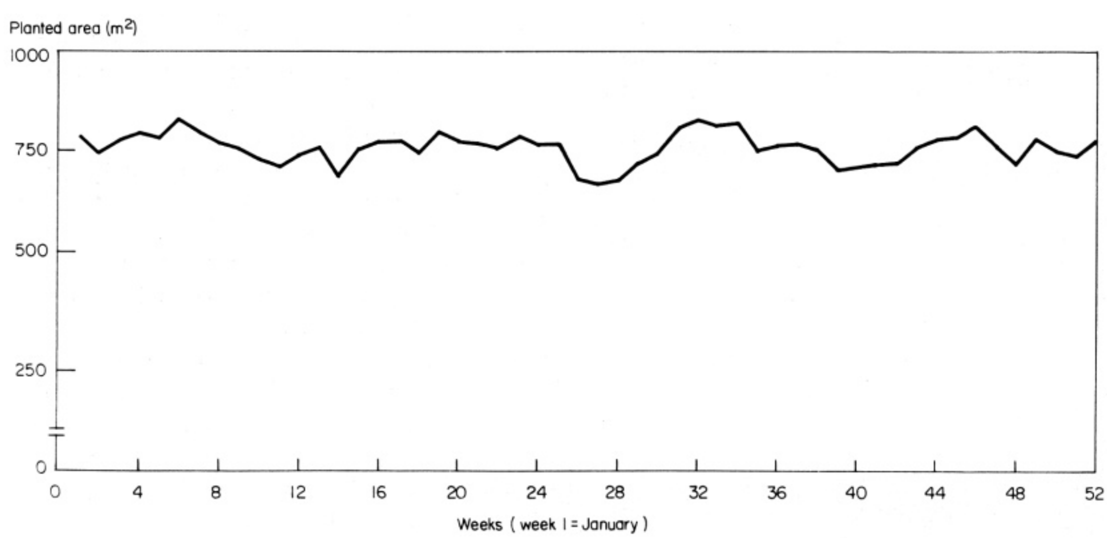
1. Average weekly yield of IR36 and solar radiation at 23 days after heading, Continuous Rice Production Model, IRRI, 1977.

bunching planting when higher yields and prices can be obtained but much hired labor is required. Total production was 24.3 t and net returns above variable costs were US$1,772—almost identical with that of the field experiment.

The 750 m^2 that the model indicated should be planted each week was divided into small daily planting with most plots smaller than 250 m^2. By using integer programming we will be able to determine exactly what standard size of plots should be grown, e.g. 1 plot of 750 m^2, or 6 of 125 m^2.

The above analysis considers only variable costs. The results, therefore, show that continuous rice cropping of 750 m^2 per week most profitably uses a hectare of land and the other farm capital that supports the system. It is a different matter to say whether a farmer should invest in the system, starting from scratch. Even with a continuous water supply, a farmer may need a pump to get the degree of water control he needs. Assuming a maximum needed investment—including a pump, a hand tractor, and a thresher—the system returns 19% on capital if 1,050 h of labor/ha per crop is needed, 14% for 1,250 h/ha per crop, or 4% for 1,650 h/ha per crop. The assumption is that labor, including family labor, is paid US$0.14/hour and depreciation on capital is 12%/year.

The experimental system was adopted from that of Philippine farmer Lorenzo Jose. Our analysis indicates the system will pay good managers who can afford the investment. Research on plot sizes, insect pests, fertilization, and tillage is continuing.



2. Optimum area of rice to he planted each week on 1 ha fully irrigated land by a farm family of 2 full-time workers, assuming seasonally variable rice yields and prices, and casual labor hired at $0.14/hour.

Effect of geomorphic field position, flooding, and cropping pattern on plant parasitic nematodes of crops following rainfed wetland rice in Iloilo, Philippines

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Geomorphic field position along a toposequence — knoll or summit, side slope, plateau, plain, river levee, and bottomland or drainageway — is an important determinant of cropping intensity in rainfed wetland rice environments. Landforms within a similar rainfall pattern differ in the ability to accumulate and retain water. Earlier studies showed that flooding during rice culture suppresses plant parasitic nematode populations that attack the roots of field legumes planted after rice.

The degree to which nematodes are controlled by flooding conditions and cropping pattern in given geomorphic field positions was investigated. Nematode populations in soil and root samples of legumes or other susceptible crops planted after single-, double- or triple-cropped rice (including a ratoon) were determined. The fields sampled had had similar cropping patterns in 3 successive years; however, a second full crop of rice was introduced only in 1977 in Iloilo. Fields within landforms were grouped according to degree of flooding (unflooded, one full crop flooded, and two full crops flooded per year). The ratoon crop is normally not flooded.

The unflooded knolls, as expected, provided conditions suitable for sustaining populations of nematodes (*Rotylenchulus* and *Meloidogyne)* (see table). In addition, light-textured, well-drained river levees harbored high nematode populations even when one crop of flooded rice had previously been grown.

All other landforms involving at least one flooded rice crop were unsuitable to *Rotylenchulus* and *Meloidogyne* populations, regardless of the cropping pattern. Bottomlands, the most water-enriched of all landforms, showed the least nematodes.

Flooding during wetland rice culture is an effective cultural control of plant parasitic nematodes on crops following rice in all 1andforms except river levees.

Effect of geomorphic field position, flooding, and cropping pattern on plant parasitic nematodes in Iloilo, Philippines, 1977.

Fields sampled [a] (no.)	Cropping pattern [b]	Geomorphic position	Nematodes [c] (mean no./300 cc soil + 1 g roots)		
			Meloidogyne	*Rotylenchulus*	Total of 9 genera [d]
		Unflooded fields			
3	Corn-S	River levee	1427 a	1219 a	2711 a
4	S-S	Knoll	41 b	587 b	650 b
		1 crop flooded/year			
4	Rice-S	River levee	108 b	28 bc	200 bc
4		Plateau	1 c	2 c	89 d
4		Slope	9 c	2 c	45 d
4		Plain	0 c	1 c	24 de
4		Bottomland	1 c	1 c	7 e
4	Rice-ratoon-S	Plateau	0 c	9 c	31 d
4		Slope	1 c	4 c	95 d
4		Plain	32 c	12 c	128 d
4		Bottomland	0 c	1 c	22 de
		2 crops flooded/year			
4	Rice-rice-S	Plateau	0 c	1 c	36 d
4		Slope	0 c	1 c	15 de
4		Plain	0 c	1 c	23 de
4		Bottomland	0 c	0 c	5 e
4	Rice-rice-ratoon-S	Bottomland	0 c	0 c	24 e

[a] During the flowering stage of the nematode-susceptible crop.
[b] S = nematode-susceptible crop (Leguminosae, Cucurbitaceae, Malvaceae, Solanaceae).
[c] Soil and roots from 5 locations per field were pooled. Nematodes were extracted from 5 samples of pooled soil by the sieving-Baermann funnel technique and roots were stained in acid fuchsin-lactophenol. In a column any 2 means followed by a common letter are not significantly different from each other at the 5% level.
[d] *Helicotylenchus, Hemicriconemoides, Hemicycliophora, Hoplolaimus, Pratylenchus, Scutellonema,* and *Tylenchorhynchus.*

Alternate crops for rice fallow

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In screening of alternate crops for rice fallow, four grain legumes - field bean, cowpea, green gram *Phaseolus radiatus,* and black gram *Phaseolus mungo* - were sown in rice fallow after one plowing and harrowing. Each crop was replicated twice. Fertilizer nitrogen and phosphate were applied at 25 kg/ha and 50 kg/ha, respectively. The field was irrigated once at sowing and twice thereafter. The crops were hand weeded once.

Table 1. Comparative performance of grain legumes planted in rice fallow, Mandya, Karnataka, summer 1976.

Crop	Variety	Yield [a] (t/ha)	Duration (days)
Field bean	Avare 4	0.2 [b]	110
Cowpea	C-152	1.5	100
Green gram	Jawahar 45	0.7	90
Black gram	Khoragoan 3	1.0	95

[a] Mean of 2 replications.
[b] Severe pest incidence.

Table 2. Data on ancillary characters of grain legumes planted in rice fallow. Mandya, Karnataka, India, summer 1976.

	Plant spread (cm)	Branches (no.plant)	Pod length (cm)	Pods (no./plant)	Plant ht (cm)	Seeds (no./pod)	1,000-grain wt (g)
Field bean	33.4	7.5	20.4	5.7	3.5	50.8	–
Cowpea	49.5	5.5	14.8	14.0	13.7	47.6	105.2
Green gram	35.6	6.4	23.3	7.0	11.1	36.0	37.4
Black gram	38.4	3.3	30.6	5.5	7.3	37.2	59.6

The comparative performance of the four legumes is shown in Tables 1 and 2. Cowpea (C- 152) and black gram (Khoragoan-3) produced good yields. Severe borer infestation drastically reduced the field bean yield despite three sprays of dimethoate and one of Metacid.

In addition to yield advantage (1.5 t/ha), cowpea also had the maximum plant spread (Table 2). The greater canopy cover may enhance moisture conservation and utilization, and suppress weeds as well.

The International Rice Research Newsletter (IRRN) invites all scientists to contribute concise summaries of significant rice research for publication. Contributions should be limited to one or two paragraphs and a table, figure, or photograph. They are subject to editing and abridgement to meet space limitations. Authors will be identified by name, title, and research organization.

Announcement

New Publication: *Rice Abstracts*

The Commonwealth Agricultural Bureaux (CAB) recently began publication of a new abstract journal, *Rice Abstracts.* CAB hopes that *Rice Abstracts* will become an essential source of information for all who wish to stay abreast of research on rice. The new publication is a further addition to the new series of specialized journals covering narrower subject areas than the better-known main abstract journals published by CAB. The new journals (such as *Seed Abstracts, Soyabean Abstracts,* and *Crop Physiology Abstracts)* bring together under one cover abstracts relevant to particular crops or subject areas, that have been published in all the main abstract journals.

Rice Abstracts is issued monthly in collaboration with the International Food Information Service. As with other CAB abstract journals, the emphasis is on coverage of the world research literature, including breeding, agronomy, fertilization, weed control, insects, diseases, physiology, biochemistry, environmental factors, storage, food science and technology, nutrition, economics, and related aspects. *Rice Abstracts* is expected to contain around 2,000 abstracts/year, with author indexes. Subject indexes may be added later.

The new journal is edited by Mr. J. Armstrong of the Commonwealth Bureau of Pastures and Field Crops (address: Hurley, Maidenhead, Berks SL6 5LR, UK). He would be pleased to deal with any technical inquiries and to receive copies of any published research material on rice, especially research reports, monographs, conference papers, reviews, etc. not published in the more usual scientific journals. Suggestions from readers regarding the content and layout of *Rice Abstracts* would be appreciated.

Specimen copies of *Rice Abstracts,* subscription rates (including details of a special introductory offer to new subscribers), and information on other CAB services are available from: The Editorial Director, Commonwealth Agricultural Bureaux, Farnham Royal, Slough, SL2 3BN, UK.

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