International Rice Research Newsletter

VOLUME 3 NUMBER 6 DECEMBER 1978

Published by the International Rice Research Institute, P.O. Box 933, Manila, Philippines

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.
- 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 17 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

Anther culture as a rice breeding technique

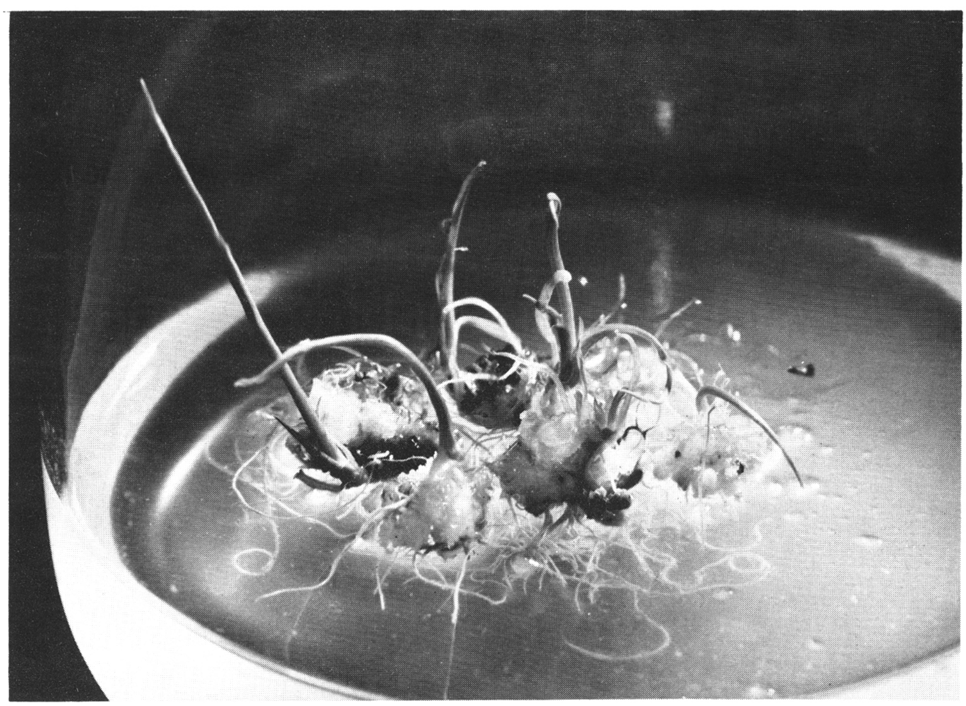
R. S. Chaleff, Department of Plant Breeding, Cornell University, Ithaca, New York 14853, USA

The potential value of anther culture to plant breeding has been widely recognized. In anther culture, callus tissue is induced to form directly from gametes of immature rice anthers plated on an appropriate nutrient medium. Many of the plants that are regenerated from the callus cultures are haploid, but ploidies of regenerated plants vary because of mitotic abnormalities that occur during growth and development. Such nonhaploid plants are completely homozygous, however, because they are produced by multiplication of single haploid (gametic) genomes. Regenerated plants that are haploid can be diploidized by treatment with colchicine. Thus, anther culture may be used to generate homozygous plants directly from the pollen of an F_1 plant rather than through the numerous generations following crossing in conventional methods.

Haploid calluses produced by anther culture may also be used in the direct selection of desirable mutants in culture. By supplementing the culture medium with normally toxic concentrations of salt, heavy metals, and herbicides, it may be possible to screen for mutants that are more tolerant of those compounds. Similarly, analogues or certain growth-inhibitory mixtures of amino acids may be used to select mutants that produce elevated levels of nutritionally essential amino acids.

But anther culture has not yet proved practical as a breeding technique because only a small fraction of cultured anthers produces calluses and those responsive anthers yield few plants.

Another problem encountered is that many of the regenerated plants are



The cultured anthers of the variety Minehikari readily produce green plants.

albino. The responsiveness of anthers to culture, the capability for plant regeneration, and the formation of photosynthetically competent plants seem to be genetically determined characters. Many researchers have found that varieties differ in the fraction of anthers that forms calluses and the proportion of green plants regenerated. In this laboratory, research is being conducted with the variety Minehikari because its cultured anthers readily produce green plants (see photo). Initial experimental results indicate that, while the incorporation of certain compounds into the culture medium is essential to obtain a high frequency of callus formation, the concentrations of the components are not critical. Thus, anthers will not form calluses in the absence of sucrose, but as Table 1 shows, the amount of sucrose in the medium is not important. Similarly, Table 2 demonstrates that NAA (a -naphthalene acetic acid) is required for a high frequency of callus formation, but that the concentration of auxin does not significantly influence frequency. Therefore, it appears that if a variety possesses the genetic competency to respond to anther culture, the concentration of certain important components in the medium is not critical. That conclusion suggests that in the development of anther culture as a breeding technique, emphasis should be on selecting responsive varieties rather than on attempting to define culture media that enhance the response. Once this approach is adopted, germplasm collections can be screened for both responsiveness of anthers to culture and frequency of regeneration of green plants, and those capabilities can be incorporated into cultivated varieties through hybridization.

Table 1. Effect of sucrose concentration on frequency of callus formation, Cornell University, New York.

Sucrose concn (%)	Anthers plated (no.)	Anthers that form calluses	
		No.	%
1	360	128	35.6
2	590	207	35.1
3	838	309	36.9
4	789	344	43.6
5	273	97	35.5
6	838	337	40.2

Table 2. Effect of NAA concentration on frequency of callus formation. Cornell University, New York.

NAA concn (mg/liter)	Anthers plated (no.)	Anthers that form calluses	
		No.	%
0	59	9	15.3
1	61	27	44.3
2	362	166	45.9
5	617	298	44.0
6	57	20	35.1

Ragathi – a mediumearly semidwarf rice for irrigated regions of Karnataka, India

M. Mahadevappa, senior research fellow, Plant Breeding Department, International Rice Research Institute; T. Gopala Reddy, B. T. Shankaregowda, M. P. Shivanandaiah, B. S. Naidu, and M. K. Narasimha Reddy, University of Agricultural Sciences, Bangalore, Karnataka, India

Varieties that are currently popular in Karnataka's irrigated tract include Jaya and Vani with intermediate growth duration; the medium-early varieties IR20, Pushpa, and S-317; and the early varieties Madhu and Mangala. They are cultivated in both summer and kharif, with the farmer's choice depending on the availability of irrigation. All, except the tall S-317, are semidwarfs. Their yields are comparable in terms of grain production per day; the ultimate yield per crop depends on the maturity duration of the variety planted. About half of the total rice area is planted to short-duration rices. Although varieties with very early maturity (110-115 days) are good for conditions of extremely delayed planting and inadequate irrigation water, medium-early varieties (125–135 days) are needed to ensure good yields despite constraints such as delayed planting or water shortages. Indiscriminate use of short-duration varieties will result in low production.

Two semidwarf lines that mature in 130–135 days were selected from segregating generations of the cross Jaya/S-317 (Halubbalu). After homozygosity was reached, the lines were designated as MR292F and MR292C (the suffixes F and C are for fine and coarse grain).

MR292C was evaluated in the coastal tract where consumers prefer coarse rice grain; MR292F was evaluated in both the state-coordinated trials and the All India Coordinated Rice Improvement Project (AICRIP) national screening nurseries (NSN) from 1974 through 1976. MR292F was subsequently tested in farmers' fields in the irrigated tract with the help of the Karnataka State Department of Agriculture and Extension Directorate of the University of Agricultural Sciences in 1976–77. The check varieties in all tests were IR20, Pushpa, and S-317 because their growth duration is comparable and they are popular with local farmers.

On the basis of the tests, the Karnataka state Variety Evaluation Committee in August 1978 released MR292F as *Pragathi* for large-scale cultivation in the irrigated tract.

Yields of Pragathi averaged 7% more than those of IR20, 13% more than those of Pushpa, and 72% more than those of S-317 (Table 1). Furthermore, because Pragathi is photoperiod insensitive, it matures 10 to 12 days earlier than the weakly photoperiod sensitive IR20 in summer. Even that slight earliness might benefit farmers because early monsoon rains often damage the summer crop at harvest. Pragathi's 72% yield increase over S-317 was partly caused by the heavy blast infection S-317 suffered at Hebbal (a common problem with delayed planting). In 64 minikit trials conducted in farmers' fields with IR20, Jaya, and Pushpa as checks, Pragathi's average yields were 11% higher than those of S-317. They ranged from 4.8 to 8.5 t/ha and averaged 6.7 t/ha.

The disease reactions of Pragathi in the NSN in kharif 1976 are in Table 2.

Pragathi has not been recommended for coastal and hilly areas where gall fly and blast are endemic because its reaction to insects is still being studied. It is moderately tolerant of adverse soils and has medium-slender grain with a

Table 1. Performance of Pragathi (MR292F) in 5 seasons at 9 locations.

Season	Trial[a]	Location	Yield of Pragathi (t/ha)	Check variety	Yield of check (t/ha)	Increase or decrease compared with check (%)
1974 late kharif	LPVT	Mandya	2.15	S-317	2.41	+ 14
		Hebbal	1.34	S-3 17	0.58	+ 131
1975 summer	SEVT 1	Mandya	6.16	Pushpa	5.37	+ 15
		Gangavati	3.90	- do -	3.22	+ 21
		Sirguppa	5.01	- do -	5.12	– 1
		Hebbal	9.47	- do -	9.56	– 1
1975 kharif	SEVT 2	Mandya	6.76	IR20	7.74	– 13
		Nagenhalli	4.77	IR20	5.06	– 6
		Mangalore	3.67	IR20	2.78	+ 32
1975 kharif	DISPLAY	Mandya	6.40	Pushpa	5.78	+ 11
1976 summer	SEVT	Mandya	6.08	IR20	5.67	+ 7
				Pushpa	5.37	+ 13
		Hebbal	8.07	IR20	8.69	– 7
				Pushpa	8.34	– 3
		Negenhalli	7.65	IR20	4.70	+ 63
				Pushpa	5.47	+ 40
1976 kharif	SEVT	Mandya	6.17	IR20	6.04	+ 12
		Hebbal	5.45	IR20	6.18	– 12
		Siruguppa	3.48	IR20	4.74	– 27
		Sirsi	3.53	IR20	3.25	+ 9
		Ankola	5.12	IR20	5.55	– 8
		Hiriyur	5.17	IR20	3.93	+ 31

[a]LPVT = Late-Planted Variety Trial; SEVT 1 = State Elite Variety Trial (early varieties); SEVT 2 = State Elite Variety Trial (intermediate growth duration); DISPLAY = plots displayed for visitors; SEVT = State Elite Variety Trial (not classified by duration).

Table 2. Disease reactions of Pragathi in 1976 national screening nurseries, Karnataka, India.

Disease	Location	Score[a] Pragathi	Score[a] Susc. check
Blast	Pattambi	1	9
	Warangal	3	9
	Amberpet	1.5	3.1
	Ponnampet	S	S
Helminthosporium	Coimbatore	1	3
	Cuttack	2	6
	Kalimpong	6	9
	Faizabad	9	9
Bacterial blight	Cuttack	3	4
	Cuttack	5	9
	Maruteru	9	9
	Aduthurai	9	9
	Pantnagar	9	9
Sheath blight	Pattambi	1	7
	Kanpur	3	5
	Kanpur	3	7
Tungro	Chinsurah	0–1	5–7
	Cuttack	2–4	8–9
	Chiplima	4	7

[a]On a scale of 1–9: 1 = resistant; 9 = susceptible.

prominent white back inherited from S-317. Its brown rice recovery rate is 80 to 83%. Its long pointed flag leaf repels birds; its threshability is good.

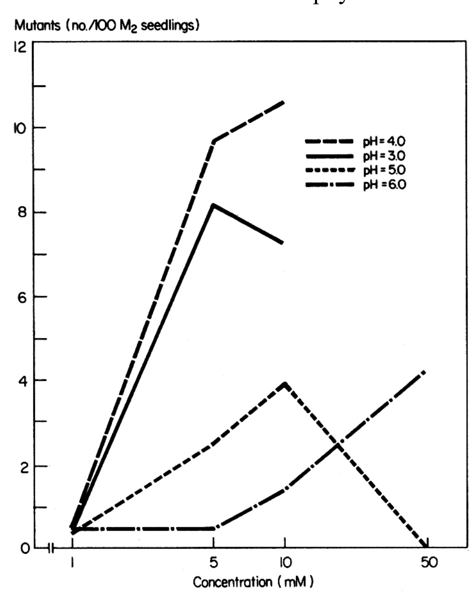
In a seedling-age and spacing experiment at Mandya in 1976, Pragathi responded to close planting. Seedling age at transplanting had negligible effect on yield. The variety will be good for areas where farmers plant nurseries instead of waiting for the rains before transplanting. Its use is spreading rapidly in Karnataka's irrigated tract.

Efficiency of sodium azide as a mutagen for rice

E. P. Guimaraes, plant breeder, EMBRAPA, Centro Nacional de Pesquisa - Arroz, Feijao (CNPAF) CP. 179, Goiania, Goias, Brazil

The influence of pH (3.0, 4.0, 5.0, 6.0) and concentrations of sodium azide (50×10^{-3}, 10×10^{-3}, 5×10^{-3}, 1×10^{-3} M) on the frequency of mutations was studied. Seeds of a popular upland rice, Dourado Precoce, were dried to 12.7% moisture, soaked in sterilized water for 8 hours, and subsequently soaked for 8 hours in the mutagen solution.

The effects of the mutagen were measured in terms of chlorophyll



The effect of concentration and pH of sodium azide solutions on mutation frequency. The control (no mutagen) did not result in mutants. High mutagen concentration and acidity caused mutation, but extreme conditions (50×10^{-3} M; pH = 3.0 and 4.0) were lethal.

mutants. The frequency of mutation was analyzed from observations of 100 seedlings in the M_2.

A significant increase in the frequency of mutations in relation to the control was found. Increased mutagen concentrations and acidity increased the frequency of mutations (see figure). But higher mutagen concentrations and low pH caused drastic effects that had negative influences on the development of M_1 seedlings. The extreme treatments exhibited deleterious lethal effects. The efficiency of sodium azide in inducing mutations was highest at concentrations from 1×10^{-3} to 5×10^{-3} M and at pH between 4.0 and 5.0. The results showed that sodium azide could successfully be used to induce mutations in rice.

Rice breeders' adoption of genetic materials: sources and time lags

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

In a study of the diffusion of genetic materials among Asian rice breeding programs, the sources from which breeders acquired introduced parent materials for use in their crosses, and the time lags until adoption were determined. The breeders were asked how they acquired each of the parents used in 161 randomly selected crosses made in 1974–75 at 27 research centers in Bangladesh, India, Indonesia, Iran, Korea, Nepal, Pakistan, Philippines, Sri Lanka, and Thailand.

Of the parents for which the breeders could recall the source, about half were readily available in local germplasm collections. But 79 of the parents were introduced from outside the experiment stations. The breeders obtained 61% of the introduced material from test nurseries or screening trials (see table). A typical breeder's comment was "I grew it in the blast nursery. I liked the way it looked at our station, so I made some crosses with it."

That finding may indicate that multilocational testing, e.g., India's Initial Evaluation Trials (IET), National Screening Nurseries (NSN), or the International Rice Testing Program (IRTP), offers an opportunity to diversify the genetic base of the world's rice crop.

For 78 of the rices used in the 1974–75 crosses, the breeders could recall both the year in which the variety or line was developed (to the fixed-line or F_5 or F_6 stage) or the year in which they first heard of the particular rice, and the year they first adopted it as a parent.

How rice breeders acquired 79 rice varieties introduced from outside their experiment stations for use as parents in crosses. Twenty-seven agricultural experiment stations and universities in 10 Asian nations, 1974–75.

Source	Parents	
	No.	%
Sent in trials or test nurseries (national or IRRI)	48	61
Requested from IRRI	15	19
Requested from other sources	6	8
Others	10	13
Total	79	100

The average lag from the time a variety or line was developed until its adoption in a breeding program was 3.2 years; that from first awareness of the rice until adoption averaged 1.3 years.

This study was partially funded by a grant from The Rockefeller Foundation.

Information on genetic ancestry of rices available through the International Rice Genetic Survey

Thomas R. Hargrove, associate editor, and Victoria L. Cabanilla, research assistant, International Rice Research Institute

A bank of permanent records on the genetic ancestry of rice varieties and on hybridizations made in national programs is being established through the *International Rice Genetic Survey,* announced in IRRN 3:3 (June 1978).

The genetic background of more than 600 older varieties that are still widely grown by farmers or that are often used as parents in crossbreeding programs has been traced back to their original progenitors. The origin of another 350 older varieties has been recorded. Similar information has been compiled for more than 350 newer rice varieties released by national rice improvement programs during the post-IR8 era.

Progenitor data cards are filled out on the parents of all varieties developed by hybridization, pure line selection, or mutation. If a parent were itself developed by crossbreeding, then cards are entered for each of its progenitors.

The parents that were crossed in 12,500 hybridizations made in national programs have also been recorded.

Among the data entered for each variety (if possible) are its genetic ancestry, country and region of origin, regions where grown, plant height, and important agronomic traits such as photoperiod response, growth duration, and resistance to pests or agroecologic problems.

The records are far from complete. However, the authors invite scientists to request information compiled so far on specific rice varieties, lines, or crosses.

For example, a scientist who screens 100 varieties from half a dozen nations for resistance to a local pest may identify 10 as promising. By tracing the ancestry of the resistant rices, perhaps common ancestors – which could be the sources of the resistance – can be determined.

We urge rice scientists to provide data on rice varieties, elite lines, and crosses in their regions (see IRRN June 1978 for specifics). Such information can help ensure that the ancestry of specific rices will not be lost to future generations.

Genetic ancestry and characteristics of recently released varieties in Asia

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

As part of a study on the diffusion of genetic materials among rice breeding programs in Asia, the genetic ancestry and major agronomic traits of the newest rice varieties was surveyed in late 1975 at 27 agricultural research centers in 10 Asian nations: Bangladesh, India, Indonesia, Iran, Korea, Nepal, Pakistan, Philippines, Sri Lanka, and Thailand.

Table 1. The 36 newest rice varieties released as listed in 1975 by breeders at 27 agricultural experiment stations in 10 Asian nations.

Variety	Stations where named[a]	Genetic composition
	Semidwarf	
• India		
CNM25	West Bengal	IR8 mutant
Jyothi	Kerala	Ptb10/IR8
Bharathi	Kerala	Ptb10/IR8
Sabari	Kerala	IR8/Annapoorna[b]
OR 34-16	Orissa	TN1/TKM6
Vani	CRRI	IR8/CR1014
IET 1039	Bihar	T90/IR8
Kalinga 1	CRRI	Dunghanshali/IR8
Kalinga 2	CRRI	Dunghanshali/IR8
Palman 579[c]	Punjab	IR579 (IR8/Tadukan)
HM95	Punjab	Jhona 349/TN1 (hybrid mutant)
RP4-14	AICRIP	T90/IR8
Pusa 2-21	IARI	IR8/TKM6
CO39	Tamil Nadu	Culture 340/Kannagi[d]
IR24[c]	Uttar Pradesh	IR8///CP231/SLO-17//Sigadis
• Nepal		
IR24[c]		IR8///CP231/SLO-17//Sigadis
• Philippines		
BPI-Ri-2	Maligaya	BE3-37-5/IR20
• Pakistan		
IR841	Sind	IR26243-8-11/Khao Dawk Mali
Mehren 69	Kala Shah Kaku	IR6 (Siam 29/Dee-geo-woo-gen)
• Sri Lanka		
BG90-2	Batalagoda	IR262/Remadja
PD106-1	Peradeniya	Warangal 1263/IR8
• Korea		
Glutinous Tong-il	Seoul National University	Tong-il[e]/IR1317-31
Milyang 21	ORD	IR1317-316-3-2/IR24
Milyang 23	ORD	IR1317-316-5-2/IR24
• Indonesia		
Gati (B 9c)	CRIA	Short Sigadis[f]/Basmati
	Intermediate-statured	
K78-13	Kashmir (India)	Shin-ei/China 971
K84	Kashmir (India)	Mutant of T65
Kajat 14-7	Maharashtra (India)	IR8/Ziniya 149
BG11-11	Batalagoda (Sri Lanka)	H7/H8
LD125	Bombuwela (Sri Lanka)	IR262/H7
BR4	BRRI (Bangladesh)	IR20/IR5
RD7	Bangkhen (Thailand)	C443G/GR88//Sigadis
RD9	Bangkhen (Thailand)	LY34/TN1//W1256///RD2[g]
Pelita I/2	CRIA (Indonesia)	IR5/Syntha
	Tall-statured	
RD5	Bangkhen (Thailand)	Puang Nahk/Sigadis
Mehre	Amol (Iran)	Pure line selection

[a] CRRI = Central Rice Research Institute; AICRIP = All India Coordinated Rice Improvement Project; IARI = Indian Agricultural Research Institute; ORD = Office of Rural Development; CRIA = Central Research Institute for Agriculture; BRRI = Bangladesh Rice Research Institute.
[b] Annapoorna is a semidwarf variety developed in Kerala from the cross Ptb10/TN1.
[c] IRRI variety or line named locally as a variety.
[d] Kannagi, from the cross IR8/TKM6, is the varietal name in Tamil Nadu state for Pusa 2-21.
[e] IR8//Yukara/TN1.
[f] Sigadis/TN1.
[g] TN1/GP15.

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

Rice breeders were asked to identify the newest improved rice varieties released at each experiment station. A standard *genetic data sheet* was completed to trace the ancestry of each variety. If a parent of a hybrid variety were itself a hybrid, its ancestors were identified. Thus, parent materials used in the development of the varieties were traced back several generations.

The stations had released 36 new varieties (Table 1). Ninety-one percent were indicas; 86% were developed locally, and 14% were from IRRI (Table 2). Most of the new varieties were hybrids, but three were mutants: CNM25, developed in West Bengal, India, was a mutant of IR8; K84 from Kashmir was a mutant of T65, HM95, from the Punjab of India, was a hybrid mutant.

Of the 24 new semidwarf varieties, 17 had IR8 in their ancestry and 10 had

---

Thampuran — a tall Kerala rice variety with a stiff straw

U. P. Bhaskaran, director of research, Kerala Agricultural University, Vellanikkara; and N. N. Ramankutty, associate professor, Agronomic Research Station, Chalakudy, Kerala, India

Thampuran is a tall but lodging-resistant indica winter rice that is grown in northern Kerala. Farmers grow tall indicas in about 45% of Kerala's area, mainly because environmental conditions are not ideal for growing semidwarfs, and because their straw, the staple cattle feed, is palatable. The low management costs for indicas make them attractive to low-income farmers.

Considerable straw is lost to lodging and heavy rains at harvest when tall indicas are grown in autumn (May–June to Aug.–Sept.). The loss is less with winter rice. Like all other winter rices, Thampuran, is sown in August; 30- to 35-day-old seedlings are transplanted in puddled soil. The winter crop is less susceptible to insects and diseases. It matures in January (flowering duration of 115–130 days), depending on when it is sown. Table 1 describes Thampuran's

Table 2. Characteristics of 36 newest varieties released by 27 agricultural experiment stations in 10 Asian nations, 1975.

Characteristic	Varieties (%)			
	Tall	Intermediate	Semidwarf	All
Plant type				
Indica	100	18	96	91
Japonica	0	11	0	3
Indica-japonica	0	0	4	3
Ponlai	0	11	0	3
Origin				
Locally developed	100	100	80	86
Introduced from IRRI	0	0	20	14
Method of development[a]				
Hybrid	50	89	96	91
Mutant	0	11	4	8
Pure line selection	50	0	0	3

[a]HM95 was classified as both a hybrid and a mutant; it was selected from irradiated progeny of the cross Jhona 349/TN1.

TN1. IR8 was a direct parent of 13 of the rices and an ancestor of 6. TN1 was a direct parent of two of the newest varieties and an ancestor of eight.

Five of the varieties had locally developed semidwarf parents—all of which were progeny of IR8 or TN1 (Table 1).

Table 1. Morphological characteristics of Thampuran in Kerala, India.

Plant part	Description
Leaf sheath	Green
Leaf blade	Long, narrow, flowing
Internode	Light green
Junctura	Cream to light green
Auricle	Rudimentary
Ligule	White, bifid
Leaf axil	Purple
Pulvinus	Light green
Septum	Colorless
Earhead	Well-exserted
Glume	Colorless
Lemma/palea	Light green with brown furrows ripening into brown
Apiculus	Purple
Stigma	Purple
Awn	Present (up to 3 cm long)
Growth duration (total)	145-160 days
Kernel color	Red

morphological characteristics. At N-P-K fertilizer level of 40-20-20 kg/ha, its grain yields average 2.0 to 2.5 t/ha (Table 2), comparable with yields of the prevailing high yielding tall indicas such as PTB4, PTB12, PTB20, and PTB27.

Thampuran's main advantage over other tall indicas is its stiff straw. The variety did not lodge even at 90 kg N/ha but its yield was no better than that at 40 kg/ha.

Thampuran may be useful as a donor parent for developing tall, high yielding rice varieties that have a stiff straw.

Table 2. Major agronomic characters of Thampuran at different fertility levels. Kerala, India.

	NPK (kg/ha)		
	40-20-20	60-30-30	90-4545
Productive tillers (mean no.)	6	7	8
Mean ht (cm)	129	139	150
Grain yield (t/ha)	2.30	2.45	2.55
Straw yield (t/ha)	4.10	5.21	7.26
Lodging	0	0	0

The *gamete elimination* method of breeding for stress resistance

R. C. Chaudhary and H. Singh, Department of Plant Breeding, G. B. Pant University of Agriculture and Technology, Pantnagar 263145, India

Varietal tolerance for environmental stresses such as cold, drought, high temperature, and problem soils is desirable in rice, which is grown under diverse agroclimatic conditions. Donor parents for tolerance for such stresses are available. So far, the procedure for developing resistant varieties has been to cross certain varieties with the donors, grow the F_1 population under good management, and then screen the segregating generations and fixed lines. In the proposed *gamete elimination* method of breeding for stress resistance, the F_1, generation should be grown so that the reproductive phase coincides with the desired cold period. The lines may also be artificially subjected to cold stress. That would enable cold-sensitive gametes to be eliminated before fertilization. Although spikelet sterility would be high, the resistant recombinants would be concentrated in a small F_2 population. Further screening and purification could be made after pedigree or bulk breeding.

Such a breeding procedure may also be applicable to all stresses where the gametes can be exposed to the stress during formation, maturation, pollination, or fertilization stages. The method would be free from the bondage of the dominant:recessive relationship of resistance genes as only one allele would be exposed to stress. Therefore, even if resistance is imparted by recessive genes, it would express itself. In rice, data on simply inherited resistance, which is easily observed in individual F_2, plants, are needed to prove or disprove the hypothesis behind the proposed method.

Disease resistance

Rice cultures with multiple disease resistance in 1977 screening trials at Aduthurai, India

N. Jaleel Ahmed and P. Chidambaram, All India Coordinated Rice Improvement Project (AICRIP), Aduthurai, Tamil Nadu, India

Under the AICRIPs National Screening Nursery program, 540 cultures were screened during kharif 1977 for resistance to bacterial blight, blast, and brown spot at the Aduthurai Center, considered a "hot spot" for the three diseases. IET no. 6105, 6121, 6126, and 6601 had broad spectrums of resistance to the diseases. Their reactions were almost similar at other hot spots (see table).

Entries with broad-spectrum resistance to bacterial blight, blast, and brown spot at Aduthurai, India, and their reaction in other centers of the All India Coordinated Rice Improvement Project (AICRIP).

		Reaction[a] to																
		Blight at							Blast at					Brown spot at				
IET no.	Designation and cross	Aduthurai	AICRIP	Cuttack	Coimbatore	Marateru	Raipur	Sambalpur	Aduthurai	Ponnampet	Raipur	Ratnagiri	Mandya	Aduthurai	Faizabad	Ponnampet	Cooch Behar	Cuttack
6105	RF974-201-1-10-4 (Sona/RF94)	R	R	MR	R	R	MR	I	R	MR	I	I	R	I	S	–	MR	MR
6121	RP1033-43-2 (RP4-14/Tetep)	I	R	I	MR	MR	MR	I	MR	MR	MR	I	MR	I	S	–	I	I
6126	RP-IR4317-215-3-2 (RPW 6-13/ CR 94-13)	MR	MR	I	MR	MR	MR	I	MR	MR	MR	I	–	I	I	–	I	–
6601	RP633-716 (IR8/BJ1/IR22)	MR	MR	MR	MR	R	I	I	MR	I	R	I	–	R	I	I	MR	R

[a] R = resistant, MR = moderately resistant, I = intermediate, S = susceptible.

Appearance of grassy stunt disease symptoms in rice in Pondicheny, India

B. Rajendran, research assistant (entomology), Krishi Vigyan Kendra, Pondicherry 10, India

Although grassy stunt disease has not been confirmed in Pondicherry, its presence is evident from symptoms in rice fields of the region and at the Farm Science Center (see table). The grassy stunt symptoms followed a severe outbreak of the brown planthopper (BPH) *Nilaparvata lugens.* After infection, the growth of the rice plant is markedly stunted, and numerous tillers develop. Leaves of infected plants are short, narrow, and pale green or yellow, often with numerous small dark brown spots. Diseased plants occasionally produce small panicles that bear brown, unfilled grains. In May 1978 the rice plants in an entire field were diseased and the BPH population remained high (av. count, 8 to 28/hill). The height of infected plants was reduced by 25 to 78%. The crop harvested at the end of the navarai season (Jan.–May) yielded as low as 1.4 t/ha.

Effect of apparent grassy stunt disease on 3 rice varieties, Pondicherry, India, 1978.

Variety	Disease incidence (%)	Reduction in plant ht (%)	Reduction in yield (%)
ADT31	68	33	60
Vaigai	71	47	13
AU1	54	65	58

BPH was the only hopper noticed in the region. Insecticide recommendations were adequate to control the vector. Grassy stunt incidence was rare in fields that were adequately protected. All the rice varieties that are grown in Pondicherry region are susceptible to the disease.

Influence of nitrogen fertilization on the development of bacterial blight in highly susceptible and resistant rice varieties

M. Deiveekasundaram and N. N. Prasad, Microbiology and Plant Pathology Laboratory, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India

The cultivation of semidwarf rice varieties with high nitrogen levels predisposes the leaf tissues to greater infection by *Xanthomonas oryzae,* the bacterium that causes bacterial blight disease. A pot culture trial studied the effect of different levels of nitrogen on bacterial blight during kuruvai (July–Oct.) 1977. Four levels of nitrogen were used: 0, 30, 60, and 90 kg N/ha. Co33, which is highly susceptible to bacterial blight, and BJ1, which is resistant, were grown. Disease development was recorded during the maximum-tiller stage by measuring the length of the lesions down from the cut ends of leaves inoculated by clipping.

Disease scores of bacterial blight in susceptible and resistant rice varieties at different levels of nitrogen. Tamil Nadu, India

Nitrogen levels (kg/ha)	Disease score[a]	
	CO33[b]	BJ1[c]
0	6.25	0.35
30	6.55	0.40
60	7.25	0.55
90	8.55	0.75

[a]Based on the length of the lesions down from the cut ends of leaves inoculated by the clipping method.
[b]Highly susceptible.
[c]Resistant.

Increases in nitrogen levels markedly increased disease incidence in the highly susceptible Co33, but not in the resistant BJ1 (see table). The disease intensity in Co33 was significantly less with zero nitrogen and increased with nitrogen levels. At zero nitrogen, disease incidence in BJ1 was negligible; increases in nitrogen levels did not affect the disease much.

Rice breeding for resistance to virus and bacterial blight in Pondicherry, India

P. Narayanasamy, S. R. Sree Rangasamy, and B. Rajendran, Farm Science Centre, Pondicherry, India

In the 1977–78 samba season, 950 progeny from 105 sets of cross combinations with growth duration ranging from 120 to 170 days were grown for evaluation of their yield potential and resistance to major diseases. Each progeny was transplanted in 3 rows, 5 m long, at a spacing of 20 × 10 cm. The center row of each progeny was harvested separately and its yield was assessed. Disease observations were continued from transplanting until harvest. Virus disease and bacterial blight *Xanthomonas oryzae* occurred in epidemic form. Only 617 of the 950 entries survived; the others dried up because of severe infection. To take advantage of the natural occurrence of these diseases, the surviving progeny were screened and evaluated for yield potential. Degree of infection was scored as follows: free = 0% infection, present (P) = 1-25%, medium (M) = 26–50%, and heavy = above 50%.

Only 53 progeny were free of virus infection. Infection was present in 162 entries; 120 had medium infection and 282 had high. Only four progeny – TNAU 1774, 17590-1-1, 17428-1, and 17399 – were free of bacterial blight infection. They were also free of virus infection.

Yields of the disease-free lines ranged from 1.5 to 5.5 t/ha and averaged 3.0 t/ha.

The virus-free rices that matured in 120–140 days were: Bhavani, TNAU numbers 1774, 1776, 1777, 1778, 1779, 1780, 1785, 1788, 1884, 1885, 1888, 1889, 12320, 12330, 12336, 20-H-12-51, 20-H-47-97, 15776-3, 15777-2, 15850-2, 17572-2, 17575-1, 17576-3, 17590-1-1, P162, P302, P303, P405, P413, P441, P555, P556, P563, P565, P567, P570, P572, P573, P574, P575, P576, P588,

Virus-free rices that matured in 140–160 days were: TNAU 13492-3, 17423-1, 17423-4, 17428-1, 17429-3. Those of more than 160 days maturity were CO40, CO25, TNAU13492, 17399, 17420-3.

Rices that were free of bacterial blight and matured in 120–140 days were: TNAU 1774 (CO30/IR22), 17590-1-1 (Ponni/CO36).

Blight-resistant rices that matured in 140–160 days were: TNAU 17428-1 (IR8/CO25). Those of more than 160 days maturity were TNAU 17399 (IR8/CO30).

Rices that were free of both virus and bacterial blight were: TNAU 1774, 17590-1-1, 17428-1, 17399.

Further study is in progress.

GENETIC EVALUATION & UTILIZATION

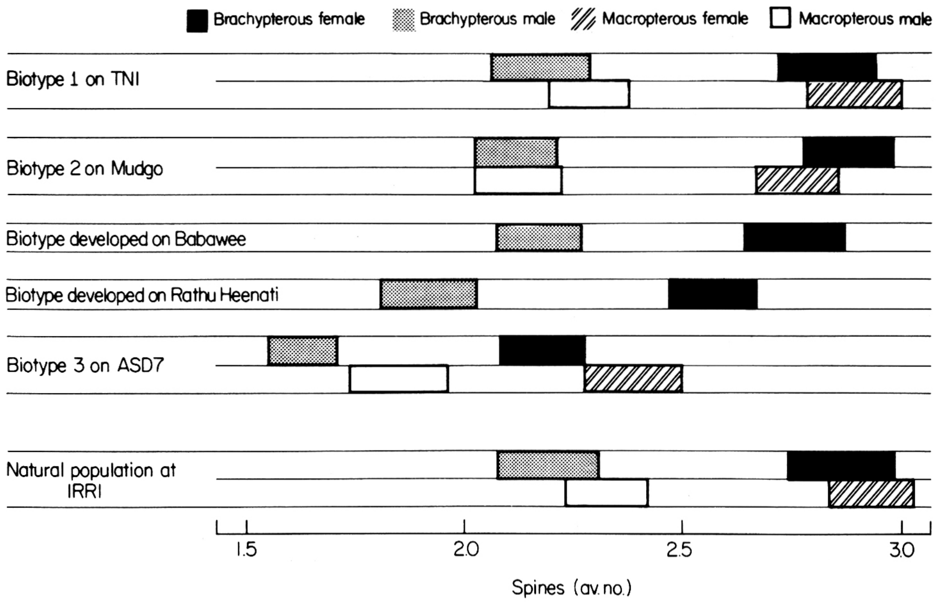
Insect resistance

Quantitative morphological variations among biotypes of the brown planthopper

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

Biotypes of the brown planthopper (BPH) *Nilaparvata lugens* are generally thought to be morphologically identical, and to differ only in their ability to damage particular resistant rice varieties. That assumption was confirmed by evidence that there were no significant differences among biotypes in dimensions of body portions – the head capsule, hind tibia, tegmen, and ovipositor – nor in the morphological characters of the lateral lobe of the female genitalia or the genital style and aedeagus of the male.

But significant variations have been found among biotypes in frequency distribution of number of spines on the hind basitarsus of adult insects. Although spines are nonfunctional, they are an important taxonomic key for the genus *Nilaparvata.* The spine number varies



Confidence range (95%) for the average number of spines on the hind basitarsus of BPH biotypes and natural population at IRRI.

from 0 to 6. The mode in the male is generally two, and in the female, three. The number of spines on the right and left legs are usually equal, although a leg on one side may have one more spine than the other. The average spine number in biotypes 1 and 2, and in the biotype developed on the variety Babawee did not differ significantly from that of natural populations at IRRI; it ranged from 2.76 to 2.93 for the female and 2.12 to 2.33 for the male. Their frequency patterns gave normal distribution curves. But the frequency distribution for the spine number in biotype 3 and for the biotype developed on the variety Rathu Heenati showed skewness toward smaller numbers of spines. Skewness was greater for biotype 3. Consequently, the two biotypes averaged significantly fewer spines (2.18 to 2.58 for the female, and 1.64 to 1.96 for the male) than biotype 1 or the natural population (see figure).

An abnormal venation in the tegmen (the destitution of M2b vein) was also noticed; it appeared more frequently in biotype 3 (13.5% in the female, 17% in the male) than in biotypes 1 and 2 (5–6%for the female, 7–10%for the male).

Although those quantitative variations in morphology obviously do not explain the breakdown of host resistance by the biotypes, they may be responsible for different modes or intensities of selection pressure during the development of each biotype. Another possibility is that gene frequencies change randomly because of the "bottleneck effect" on a small population associated with high mortality during the initial stage of biotype development.

Screening rice varieties for resistance to gall midge

K. Natarajan and K. C. Chandy, Division of Entomology, All India Coordinated Rice Improvement Project (AICRIP) Center, Aduthurai 612101, Tamil Nadu, India

The rice gall midge *Pachydiplosis oryzae,* once considered a minor pest, is now a major pest in the Thanjavur deltaic region of Tamil Nadu, India, especially during the kuruvai season. The larvae feed on the growing meristematic tissue of the plant, turning the terminal leaf into a tubular structure called *siber shoot,* which arrests flower initiation and, ultimately, panicle formation. Among insect-control methods, the role of resistant varieties is significant.

A field study was conducted at the AICRIP Center, Aduthurai, during the 1977 kuruvai season to confirm the resistance of 14 rice varieties already reported as resistant to gall midge. These varieties and 2 checks were grown in 4-row plots, 3 m in length, and screened under natural infestation levels. They were planted at two dates – the first at the normal planting time in this region, the second 3 weeks later – to synchronize the plants' most vulnerable stage with peak gall midge emergence. Silver shoots on all plants were counted at 30 and 50 days after transplanting (DT). Infestation in both plantings was similar. Results of the first planting are reported in the table.

More galls were recorded at 50 DT. The entries W13400, PTB10, RPW9-4-55-1, Leaung 153, and RPW-17 were resistant. In 1975 Panda and coworkers reported that Leaung 152 and other semidwarf selections from the PTB series had had no or low silver shoot incidence. Jaya, a susceptible check, had maximum gall midge damage – a mean of 31.6 galls/100 hills. Some entries that were earlier found resistant now seem susceptible. Those varieties are ORS-JR-214 and CR60-MR1539-IW-1056-1.

Reaction of rices exposed to rice gall midgt during kharif 1977.[a] Aduthurai, India.

Designation	Galls (mean no./100 hills) 30 DT	50 DT
W13400	0	0
RP8-9	0	3.1
W13227	0	3.0
RP356-112-1-1	0.6	0.6
BKN680-5-2	0	1.2
RPW-6-12	0.6	0.6
ORS-JR-214	1.2	14.3
ORS-JR-181	0.7	0.7
PTB10	0	0
RPW9-4-55-1	0	0
CR57-49-5	0	12.2
CR57-MR1523-1W-1035-2	0	3.2
Leaung 152	0	0
CR60-MR1539-1W-1056-1	2.3	9.2
RPW6-17 (check)	0	0
Jaya (susceptible check)	1.0	31.6

[a]DT = days after transplanting.

Genetics of resistance to rice stem borer

K. V. L. N. Dutt, assistant director of research, Andhra Pradesh Agricultural University, Hyderabad, India; D. V. Seshu, plant breeder, International Rice Testing Program, International Rice Research Institute; and S. V. S. Shastry, director of research, International Institute of Tropical Agriculture, Ibadan, Nigeria

Genetic studies were conducted to determine the nature of inheritance of resistance to the rice stem borer *Tryporyza incertulas* in a cross of the resistant variety TKM6 and the susceptible IR8. Results from the F_2 and F_3 progeny of that cross indicate that a single recessive gene governs resistance at the heading stage. The gene for stem borer resistance was observed to be independent of the recessive gene that governs semidwarf plant height.

The assessment of insect resistance under natural infestation is subject to fluctuations in insect population, which cause erroneous classification of resistant and susceptible plants. In this study a special layout was used for the field planting of the F_2 population. The seedlings of each individual F_2 segregant were divided into two parts and were planted at two sites in Andhra Pradesh, India — Tenali and Warangal — where the yellow stem borer is endemic. The resistant check TKM6 and the susceptible check B5580 were planted on both sides of each individual F_2 segregant. The F_2 segregants were then classified for resistance by comparing whitehead incidence in them with that in the adjacent checks. That minimized the chances of rating a plant that "escapes" infestation as "resistant." The overall assessment of segregation was based on the combined observations at both sites (which served as two replications).

Whitebacked planthopper appears on rice in Sind, Pakistan

M. M. Mahar, I. M. Bhatti, and M. R. Hakro, Rice Research Institute, Dokri, Sind, Pakistan

The whitebacked planthopper (WBPH) *Sogatella furcifera* was observed for the first time in Pakistan in 1976 at the Rice Research Station, Dokri, on the widely grown semidwarf variety IR6. WBPH infestation and hopperburn appeared in October at late stages of plant growth. The infestations appeared in patches ranging in size from a few square meters to 25 m^2 and extended to areas of 10 to 15 ha.

Although WBPH attacked the flag leaves and panicles of most of the plants, the hopper population (nymphs as well as adults) was also high on the culms and leaves just above the water level.

At those sites, the plants produced fewer grains and lodged because of hopperburn.

Field observations in mid-October 1977 noted WBPH on the culms, leaves, and panicles of IR6. But that infestation was smaller in scale; only a patch of 60 m^2 was hopperburned. The crop was grown from diseased seed that the Plant Pathology Department sowed and planted in an observational trial to observe the incidence of seed-borne diseases.

This is the first time that the WBPH was reported in Pakistan, probably because — as Dr. Santiago Pablo of IRRI pointed out — the pest could not thrive on local varieties, which are highly resistant to it.

Vigilance on the occurrence of WBPH will be maintained to record and check its spread to larger areas.

Quick method for identifying brown planthopper biotypes in the field

Ida Nyomar Oka, entomologist, Central Research Institute for Agriculture (CRIA), Jl. Merdeka 99, Bogor, Indonesia

The brown planthopper (BPH) *Nilaparvata lugens* is rapidly being selected for biotypes that attack varieties that were formerly resistant to it. Experience in North Sumatra, Banyuwangi, and Bali indicates that the predominant population shifted to a different biotype (similar to that designated as biotype 2 at IRRI) after four successive cropping seasons of IR26 and IR28, under both continuous and staggered plantings.

The change to a new biotype in those sites was confirmed *after the pest had spread rapidly over wide areas* and had reduced yields significantly. IR32 and IR36, which are resistant to biotype 2, are being introduced but the selection for a third biotype could render them susceptible after a few crop seasons.

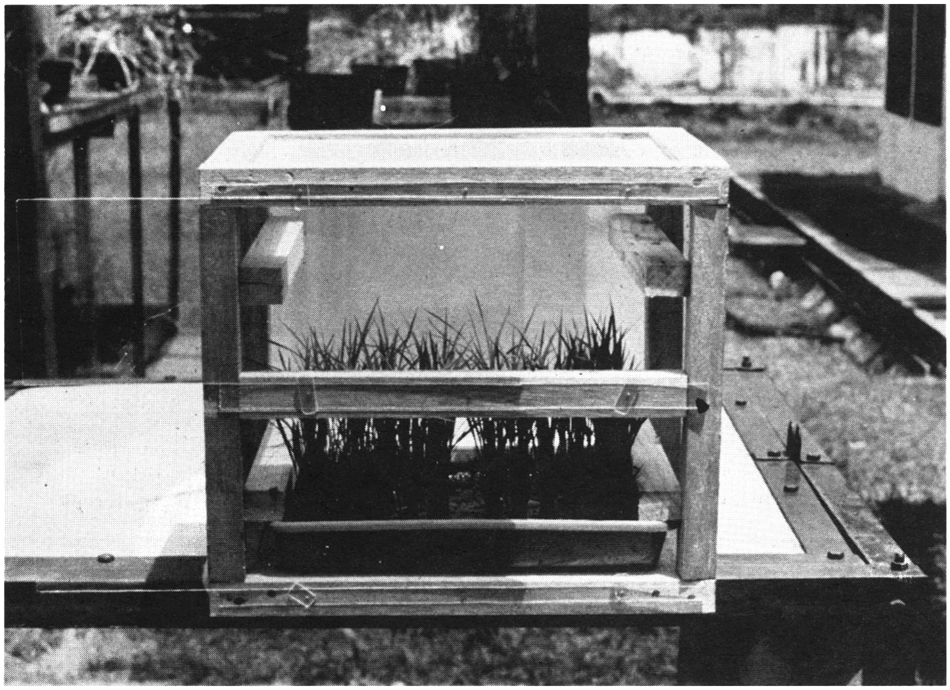
IR26 and other varieties with the Mudgo or TKM6 gene for BPH resistance are still widely planted throughout Indonesia. Because a new biotype may become established in those areas, early detection of its development is necessary. Then, varieties that break down can be replaced with resistant ones.

The biotype identification program is meant to be a continuous activity carried out at least twice a year preceding the wet and dry seasons. Biotype identification has been conducted at about 200 sites throughout Indonesia's main rice centers, beginning in August 1977. By the end of October 1977, complete maps of the distribution of the biotypes had been prepared.

The rice varieties used as differentials are TN1, susceptible to all biotypes; Pelita I-1, susceptible to all biotypes; IR26 and IR28, susceptible to biotype 2 but resistant to biotypes 3 and 1; and IR32 and IR36, susceptible to biotype 3 but resistant to biotypes 2 and 1.

Seed of differential varieties spaced 10 cm between rows in double rows are glued between two sheets of absorbant tissue paper. Four replicates are randomized on each sheet. The varietal names are copied opposite each individual row. This method of seed preparation simplifies the work of field personnel and minimizes errors.

About 1 cm of field soil is placed in plastic trays 30 × 25 × 5 cm in size. Nitrogen fertilizer (urea) is mixed



Cage enclosing sets of differential varieties for identifying brown planthopper biotypes. Indonesia.

with the soil at the rate of 90 kg N/ha before the planting sheet is set on the soil surface. The plastic tray is then placed in an insect-proof cage about 35 × 30 × 25 cm in size. To prevent etiolation of the growing seedlings, the cage is placed under direct sunlight. The trays are watered frequently to prevent the seed from drying. BPH collected from the surrounding area are used to infest the seedlings 3 to 4 days after seeding. Adult insects are used if no nymphs are found in the sampling area. About 100 to 150 adults are released into each box. Assuming that about half are males, they should produce about 2,000 nymphs/box. Each tray contains about 500 seedlings, so each seedling is infested with 4 to 5 nymphs.

When nymphs are present, plants infested with second-, third-, or fourth-instars are collected from the area. To infest seedlings, nymphs are shaken from the sample plants onto the tray. Infestation is maintained at an average rate of 4 to 5 nymphs/seedling.

The BPH predator *Cyrtorhinus lividipennis* is often found on the trays; the bugs are periodically removed with a mouth aspirator.

The scoring of each individual seedling begins as soon as the susceptible check plants TN1 and Pelita I-1 die (1976 Standard Evaluation System for Rice score of 7–9; 7 = wilting and severe stunting, 9 = plants dead). The results of the readings are airmailed to the Directorate of Plant Protection in Jakarta and to CRIA in Bogor for analysis.

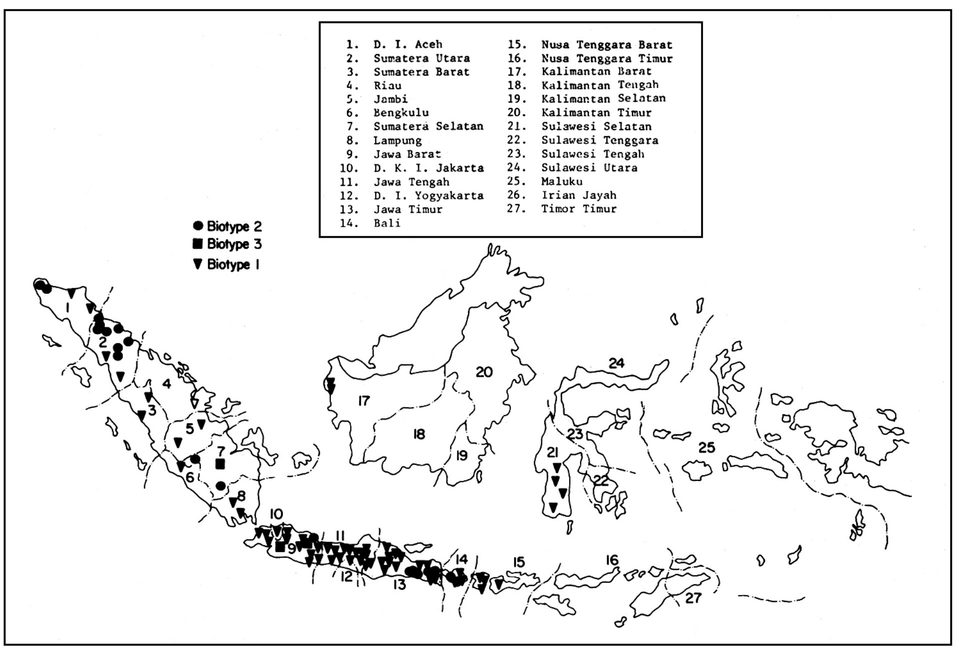
If TN1 and Pelita I-1 show readings of 7 to 9 while IR26, IR28, IR32, and IR36 all show low reading (2–3), then biotype 1 of the BPH still prevails in the area. Susceptible reactions from IR26, IR28, and the susceptible checks, but resistant ratings on IR32 and IR36, may indicate the presence of biotype 2. High ratings (7–9) for the check varieties, intermediate to high ratings (4–7) for IR26 and IR28, and low ratings for IR32 and IR36 suggest that the BPH populations are of mixed biotypes and that the biotype 2 population is increasing.

The results indicate that biotype 2 of BPH is present in the northernmost part of Aceh province, all of North Sumatra, two locations in South Sumatra, three places in West Java, the eastern part of East Java, and the western part of Bali (Fig. 2). So far, there has been no evidence of biotype 2 in Central Java, South Sulawesi, West and South Kalimantan, or West Nusa Tenggara.

This information is pertinent in seed distribution of IR32, IR36, and IR38, which are resistant to BPH biotype 2.

Replacing the varieties that are no longer resistant with resistant ones will minimize yield losses.

Using this method we expect to be able to identify a third BPH biotype if and when it occurs.



Distribution of biotypes of brown planthopper in Indonesia from July to August 1977.

Varietal preferences of the green leafhopper

A. B. Ghosh and S. Mukhopadhyay, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal, India

The relative survival on different varieties and the varietal preferences of the green leafhopper *Nephotettix virescens* have been studied under artificial conditions. This study tried to determine the insect's varietal preferences in the field. The Indian Council of Agricultural Research provided funds for the investigation.

The rice varieties IET2815, IR34, IR32, IR8, IET1991, IET2233, CR44-1, IET2295, Cauvery, IET2895, IR30, IR20, IR579, IR26, IR28, Pusa 2-21, Latisail, and TN1 were grown in the plant virus experimental field during the 1977 kharif. The usual cultivation methods were followed except that no pesticides were applied. Each plot was swept at 1-week intervals from the 1st week of September to the 3d week of October.

The average number of leafhoppers collected for IET1991 and IR579 in the different periods was low — not exceeding five (see table). Leafhopper populations on IET2815, CR44-1, Cauvery, IET2895, and TNl were, however, fairly high during the entire observation period. The results indicate that green leafhoppers have differential preference for different rice varieties in the field.

Varietal preference of rice green leafhoppers. Kalyani, West Bengal, India.

Designation	Leafhoppers[a] (no./sweep at av. of 5 sweeps/plot)					
	1st week, Sept. *(82 days)	2d week, Sept. (90 days)	3d week, Sept. (96 days)	4th week, Sept. (105 days)	1st week, Oct. (113 days)	3d week, Oct. (125 days)
IET2815	3	13	10	5	13	6
IR34	4	11	8	2	12	0
IR 32	4	10	7	4	9	2
IR8	4	13	4	1	10	3
IET1991	0	5	3	1	2	1
IET2233	3	2	1	1	7	2
CR44-1	0	9	13	8	22	10
IET2295	2	0	8	6	8	0
Cauvery	1	4	11	2	12	7
IET2895	3	3	7	6	29	6
IR30	1	3	9	7	9	3
IR20	5	1	9	6	9	4
IR579	0	1	4	1	4	0
IR26	0	16	2	0	9	1
IR28	0	9	5	3	16	2
Pusa 2-21	7	20	6	4	9	5
Latisail	0	9	3	2	16	
TN1	17	14	15	10	12	10

[a]Numbers in parentheses indicate plant age at time of sweeping.

Pest management and control

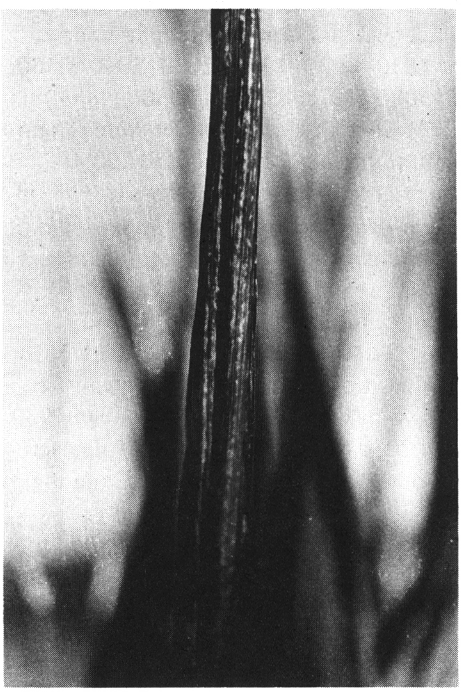
DISEASES

Symptoms resembling those of rice dwarf disease in the Kathmandu Valley, Nepal

V. T. John, consultant; M. H. Heu, joint coordinator; D. N. Manandhar, assistant entomologist, National Rice Improvement Program; and R. B. Pradhan, entomologist, Entomology Division, Khumultar Agricultural Station, Nepal

Rice plants seeded in April and transplanted in May 1978 in farmers' fields in the Kathmandu Valley showed symptoms typical of rice dwarf (or stunt) disease described in Japan. Farmers reported that the disease has been present for 5 or 6 years.

The symptoms included stunting (the degree of which was related to the stage of infection), some reduction in tillering, inhibition of or delayed flowering, and typical whitish-yellow chlorotic spots along the interveinal areas and on the leaves. The spots either were discrete or coalesced to form lines parallel to the



Chlorotic specks forming interrupted streaks, a symptom of rice dwarf disease.

Differences between healthy and diseased plants collected from the crossing block of the Khumultar Agricultural Station, Nepal. August 1978.

Character	Reduction in diseased plants (%)
Plant ht	54.2
Root length	15.5
Root wt	57.5
No. of tillers	47.8
No. of spikelets/panicle	43.0[a]

[a]Only one infected plant flowered.

veins. In extreme cases, the lines coalesced into yellow blotches. Because affected plants were green, it was difficult to distinguish them from healthy plants on the basis of foliar discoloration. The spots on leaves started from the basal portions of newly emerging leaves. The table shows differences between healthy and diseased plants.

Large numbers of *Nephotettix nigropictus,* a green leafhopper reported as a vector of rice dwarf, were found in diseased fields. But there was no record of the presence of two other vectors, *N. cincticeps* and *Recilia dorsalis.*

The disease is suspected to occur in the Tarai regions of Nepal and may also be found in the adjoining Indian border areas. A survey, however, showed very low incidence of the vectors in Tarai fields.

Attempts to determine if the disease can be transmitted by adults or by nymphs, or transovarially are in progress.

Sheath blight control with fungicides

A. K. Roy, ICAR (Indian Council of Agricultural Research) Research Complex, Assam Agricultural University, Diphu 782460, Assam, India

Four fungicides were tested against sheath blight *Corticium sasakii* of rice on the variety Pusa 2-21 in a 1977 field trial at the experimental farm of the Assam Agricultural University at Jorhat. The fungicides—50% edifenphos (0-ethyls, s-diphenyl dithiophosphate) (trade name, Hinosan of Bayer) at 0.1%; 50% carbendazim (methyl 1-2 benzimidazole carbamate) (Bavistin of BASF) at 0.05%; 40% guazatine (guanidated 9-asa-l , 17-diaminohetadecane) (Panolil of KenoCard) at 0.1%; and 80% captafol (3a, 4, 7, 7a-tetrahydro-N-(1, 1, 2, 2-tetrachloroethanesulphenyl) phthalimide (Difolatan or Chevron) at 0.1%—were sprayed with a high-volume sprayer 3 times at 10-day intervals. The first spraying was 35 days after transplanting. One day before spraying, the plants were inoculated with the fungus, which had been grown on sterilized rice grain.

All fungicides reduced the disease incidence significantly. Carbendazim performed best, followed by edifenphos. The disease incidence scores (based on the 1976 Standard Evaluation System for Rice) were 1.25 for carbendazim, 3.50 for edifenphos, 4.50 for captafol, and 4.75 for guazatine. Incidence in the unsprayed control was 7.50. All the fungicides increased crop yields significantly.

Pest management and control

INSECTS

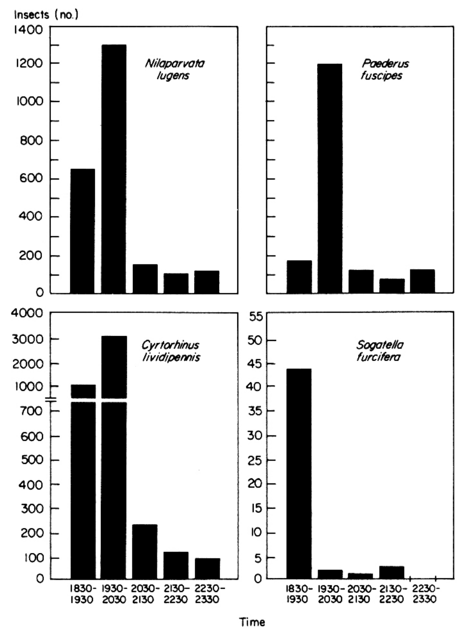
Differential light-trap catches of brown planthoppers in relation to time of operation

G. S. Lim, Malaysian Agricultural Research and Development Institute, Serdang, Selangor, Malaysia

In Malaysia, light traps attracted high populations of brown planthoppers (BPH) during massive outbreaks in 1967 in Trengganu and in 1977 in Tanjong Karang. Depending on the abundance of macropterous hoppers, as many as 92.16 million BPH may be caught by 15 fluorescent lamp traps in 4.5 hours (from 1900 to 2330). Subsequent studies showed that intensive light trapping could rapidly destroy large BPH populations in an outbreak; as many as 141 BPH/hill may be removed by 1 trap/0.4-ha area (1 trap/acre). Increased trapping efficiency could remove more BPH. Therefore, studies were conducted to more precisely determine the most efficient trapping period.

During the investigation, 60-watt tungsten lights were used. Three traps were operated for 4 successive nights (2–5 Sept. 1977) and at different heights (0.9, 1.8, and 2.7 m above the ground). Insect catches were determined hourly at 1830–1930, 1930–2030, 2030–2130, 2130–2230, and 2230–2330.

Most of the insect species were caught within the first 2 hours (1830–2030) (see figure): 84% of the BPH and 92% of the whitebacked planthopper *Sogatella furcifera.* Also caught during the 2-hour period were the common predators *Cyrtorhinus lividipennis* (90%) and *Paedems fuscipes* (80%) (see table). Most of the species, except *S. furcifera,* were caught in the second hour (between 1930 and 2030 h). Catches in each of the last 3 hours never exceeded 7.6%. From the overall catches, it is evident that *C. lividipennis* is also highly attracted to light (see figure). From 1830 to 1930 and 1930 to 2030, the ratio of *Cyrtorhinus:Nilapawata* caught was 1.7 and 2.5, respectively. Evidently a large



Catches of rice planthoppers and their common predators by light traps at various times of operation. MARDI, Malaysia.

number of BPH are removed but more beneficial *Cyrtorhinus* are destroyed in such a situation. The development of a

Catches of rice planthoppers and their common predators by light traps at various periods of operation. MARDI, Malaysia.

Time period	Catches (%)			
	Nilaparvata lugens	*Sogatella furcifera*	*Cyrtorhinus lividipennis*	*Paederus fuscipes*
1830–1930	28.0	88.0	23.3	10.0
1930–2030	56.0	4.0	67.2	10.7
2030–2130	6.4	2.0	4.8	7.5
2130–2230	4.6	6.0	2.5	4.2
2230–2330	5.0	0.0	2.2	7.6

way to separate and conserve the *Cyrtorhinus* merits serious consideration. But with *P. fuscipes,* the predator:BPH ratio is generally less than 1, averaging 0.8 and ranging from 0.3 to 1.1

The findings indicate that the critical period for using light traps against the BPH is early evening. For maximum catches, the traps should operate between 1830 and 2030 hours.

Fate of carbofuran in flooded soil and in rice plants

R. Siddaramappa, postdoctoral research fellow, and I. Watanabe, soil microbiologist, International Rice Research Institute

The decreasing effectiveness of carbofuran in the control of brown planthoppers (BPH) — but not leafhoppers — has been reported in some IRRI trials. Effectiveness was lowered particularly when granular formulations were broadcast into paddy water. Root-zone applications (RZA) have been reported superior to paddy water applications (PWA). Therefore, studies were conducted on the persistence in soil and absorption and movement of ring-labeled ^{14}C-carbofuran in rice plants. Also, the effects of PWA and RZA were compared.

Twenty-five-day-old IR8 seedlings were grown in a greenhouse in Maahas clay soil (pH 5.9) treated with labeled carbofuran solution either applied directly to the paddy water or injected into the root zone with a syringe (near the roots and approximately 3 cm below the surface of flooded soil).

Periodic analysis of radioactivity revealed that the persistence of carbofuran in soil was higher in RZA than in PWA. But plant uptake was more rapid with PWA, apparently because the penetrating insecticide provided easy accessibility to roots near the soil surface. Plant uptake with PWA reached a maximum level in 1 week; that with RZA increased gradually. Most of the carbofuran absorbed by the rice plant was found in leaf blades and roots; only small quantities were found in stems and leaf sheath (see photo). That partly explains the decreased effectiveness of carbofuran for control of BPH, which feeds on leaf sheaths, but not of leafhoppers, which feed on leaves. Carbofuran and its breakdown products are transported acropetally to leaf tips, possibly by the transpiring water. Furthermore, the radioactivity observed in dewdrops collected on leaf blades suggests that carbofuran may be lost by vaporization.

Autoradiograph showing the location of carbofuran inrice plants. Carbofuran was applied to the paddy water. Note the carbofuran concentrating in the leaf tips and the tendency to vaporize into the air. Print from X-ray film.

The radioactivity balance sheet prepared by growing rice plants in culture solution containing ^{14}C-carbofuran showed that almost 87% of the absorbed carbofuran could not be accounted for either in the plant or in the culture solution in a 20-day period. The insecticide was apparently lost to the atmosphere.

More direct evidence of vapor loss of carbofuran was obtained by trapping the circulating air in a controlled growth chamber. Carbofuran was detected in the trap as early as 24 hours after treatment. The loss of radioactivity was directly related to the amount of water lost through transpiration.

Carbofuran losses in rice were more rapid with PWA than with RZA. That was evidently related to the rate of carbofuran uptake and its persistence in the soil in the two application methods.

We conclude that better BPH control by carbofuran as RZA reported by other workers could be because the insecticide is continuously available due to its increased persistence in the soil. The rice plant may lose appreciable quantities of the insecticide through vaporization.

The authors wish to thank the FMC corporation, Middleport, New York, USA, for supplying the samples of ^{14}C-labeled carbofuran used in this study.

Aphids as rice pests in Sierra Leone

D. T. Akibo-Betts and S. A. Raymundo, Rice Research Station, Rokupr, Sierra Leone, West Africa

The plum peach aphid *Hysteroneura setariae* and the root aphid *Tetraneura nigriabdominalis* emerged as rice pests in Sierra Leone in the early 1976 wet season when they were found feeding on various parts of upland rice plants. Since then, the plum peach aphid has been observed feeding on the leaves and unripened grains of some rice varieties in association with an unidentified ant. The root aphid feeds on rice roots.

The adults of the wingless *H. setariae* are about 3 to 4 mm long. When fully

Catches of rice planthoppers and their common predators by light traps at various periods of operation. MARDI, Malaysia.

Time period	Catches (%)			
	Nilaparvata lugens	*Sogatella furcifera*	*Cyrtorhinus lividipennis*	*Paederus fuscipes*
1830–1930	28.0	88.0	23.3	10.0
1930–2030	56.0	4.0	67.2	10.7
2030–2130	6.4	2.0	4.8	7.5
2130–2230	4.6	6.0	2.5	4.2
2230–2330	5.0	0.0	2.2	7.6

way to separate and conserve the *Cyrtorhinus* merits serious consideration. But with *P. fuscipes,* the predator:BPH ratio is generally less than 1, averaging 0.8 and ranging from 0.3 to 1.1

The findings indicate that the critical period for using light traps against the BPH is early evening. For maximum catches, the traps should operate between 1830 and 2030 hours.

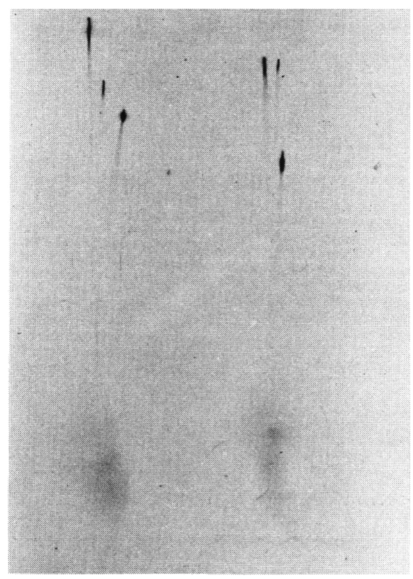
Fate of carbofuran in flooded soil and in rice plants

R. Siddaramappa, postdoctoral research fellow, and I. Watanabe, soil microbiologist, International Rice Research Institute

The decreasing effectiveness of carbofuran in the control of brown planthoppers (BPH) — but not leafhoppers — has been reported in some IRRI trials. Effectiveness was lowered particularly when granular formulations were broadcast into paddy water. Root-zone applications (RZA) have been reported superior to paddy water applications (PWA). Therefore, studies were conducted on the persistence in soil and absorption and movement of ring-labeled ^{14}C-carbofuran in rice plants. Also, the effects of PWA and RZA were compared.

Twenty-five-day-old IR8 seedlings were grown in a greenhouse in Maahas clay soil (pH 5.9) treated with labeled carbofuran solution either applied directly to the paddy water or injected into the root zone with a syringe (near the roots and approximately 3 cm below the surface of flooded soil).

Periodic analysis of radioactivity revealed that the persistence of carbofuran in soil was higher in RZA than in PWA. But plant uptake was more rapid with PWA, apparently because the penetrating insecticide provided easy accessibility to roots near the soil surface. Plant uptake with PWA reached a



Autoradiograph showing the location of carbofuran inrice plants. Carbofuran was applied to the paddy water. Note the carbofuran concentrating in the leaf tips and the tendency to vaporize into the air. Print from X-ray film.

maximum level in 1 week; that with RZA increased gradually. Most of the carbofuran absorbed by the rice plant was found in leaf blades and roots; only small quantities were found in stems and leaf sheath (see photo). That partly explains the decreased effectiveness of carbofuran for control of BPH, which feeds on leaf sheaths, but not of leafhoppers, which feed on leaves. Carbofuran and its breakdown products are transported acropetally to leaf tips, possibly by the transpiring water. Furthermore, the radioactivity observed in dewdrops collected on leaf blades suggests that carbofuran may be lost by vaporization.

The radioactivity balance sheet prepared by growing rice plants in culture solution containing ^{14}C-carbofuran showed that almost 87% of the absorbed carbofuran could not be accounted for either in the plant or in the culture solution in a 20-day period. The insecticide was apparently lost to the atmosphere.

More direct evidence of vapor loss of carbofuran was obtained by trapping the circulating air in a controlled growth chamber. Carbofuran was detected in the trap as early as 24 hours after treatment. The loss of radioactivity was directly related to the amount of water lost through transpiration.

Carbofuran losses in rice were more rapid with PWA than with RZA. That was evidently related to the rate of carbofuran uptake and its persistence in the soil in the two application methods.

We conclude that better BPH control by carbofuran as RZA reported by other workers could be because the insecticide is continuously available due to its increased persistence in the soil. The rice plant may lose appreciable quantities of the insecticide through vaporization.

The authors wish to thank the FMC corporation, Middleport, New York, USA, for supplying the samples of ^{14}C-labeled carbofuran used in this study.

Aphids as rice pests in Sierra Leone

D. T. Akibo-Betts and S. A. Raymundo, Rice Research Station, Rokupr, Sierra Leone, West Africa

The plum peach aphid *Hysteroneura setariae* and the root aphid *Tetraneura nigriabdominalis* emerged as rice pests in Sierra Leone in the early 1976 wet season when they were found feeding on various parts of upland rice plants. Since then, the plum peach aphid has been observed feeding on the leaves and unripened grains of some rice varieties in association with an unidentified ant. The root aphid feeds on rice roots.

The adults of the wingless *H. setariae* are about 3 to 4 mm long. When fully

Yield in a nitrogen-variety trial, Andhra Pradesh, India, 1977 rabi season.

N level (kg/ha)	Grain yield (t/ha) under different methods of split N application					
	BPT1235			RP 4-14 (check)		
	25+50+25%	50+25+25%	0+75+25%	25+50+25%	50+25+25%	0+75+25%
75	6.19	6.26	6.31	5.15	4.97	4.80
100	7.32	6.99	7.31	5.51	5.86	5.33
125	7.21	6.77	7.48	6.06	5.87	6.05

C.D. (P=0.05) for varieties, 0.52 t/ha; for levels of N, 0.30 t/ha.

BPT1235 (identified as ET6202 in India's Initial Evaluation Trials) should be chosen for good yields at lower nitrogen inputs in rabi on the Krishna and Godavari deltas of Andhra Pradesh.

Harvest IR36 in 75 days by transplanting 40-day-old seedlings

W. A. T. Herrera, H. G. Zandstra, and R. Feuer, International Rice Research Institute; and G. V. Bautista, Bureau of Agricultural Extension, Philippines

Preliminary research results at IRRI indicate that a crop of IR36, which matures in 110 days (seed to seed), can be harvested in only 75 days after transplanting if seedlings are grown in a special wetbed and then transplanted at 40 days old (see photo).

The original idea for the research came from the People's Republic of China where rice farmers try to shorten the field time of the summer rice crop so they can plant winter wheat on time.

Sixty trials are under way in the 1978 wet season. If confirmed in farmers' fields, the 75-day system could make possible the growing of 4 rice crops in less than 1 year on fully irrigated farms, 3 crops on partially irrigated farms, or 2 crops on rainfed lowland farms. The use of older seedlings should enable rainfed-lowland farmers to better adjust their transplanting time to the variable onset of the first monsoon rains.

The 75-day system may reduce pest protection costs because the seedlings remain in the seedbed longer. Shortening the field time should also reduce weather risks.

The principle of the 75-day system is to transplant vigorous seedlings of a "fixed duration" variety at least 10 days before panicle initiation. The technology is still highly preliminary, but the authors will he glad to send interested scientists or extension workers a summary sheet of the current procedures.

IR36 at 65 days after transplanting. The crop was harvested at 75 days after transplanting at the rate of 9 seedlings/hill. The yield was 5.4 t/ha. With 3 seedlings per hill yield was 4.9 t/ha in 75 days. IRRI research farm, 15 May 1978.

Environment and its influence

Effect of calcium peroxide on seedling emergence of IR36 from puddled soil at different temperatures

S. Yoshida and C. T. Rivera, Plant Physiology Department, International Rice Research Institute

Poor seedling emergence is a common problem in wetland direct-seeded rice, particularly when water is deep and the soil is muddy. Calcium peroxide has been tested and used to improve seedling emergence in direct-seeded rice, to improve germination of naked barley seed in excessively moist upland soils, and to supply oxygen to rice roots grown in highly reductive paddy soils in Japan and Korea.

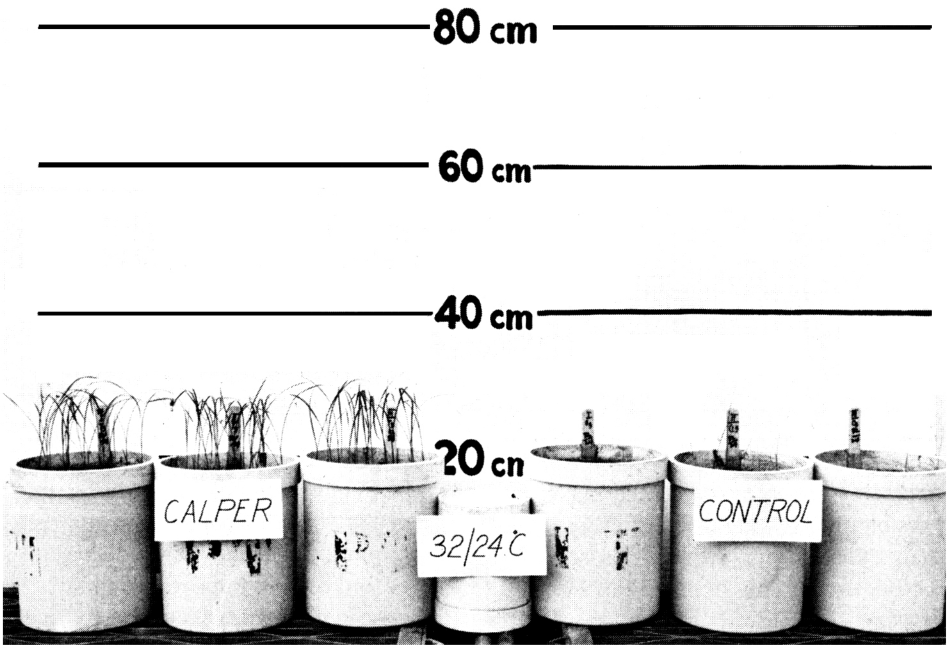
When calcium peroxide is used to coat rice seed, it generates molecular oxygen and supplies it to the germinating seed in water or in puddled soil:

$$2\,CaO_2 + 2\,H_2O \rightarrow O_2 + 2\,Ca(OH)_2.$$

Consequently, the growth of the coleoptile, subsequently developed leaves, and roots is highly improved.

The temperature at sowing time is a major difference between Japan and the tropics. Furthermore, indica rices are reported to be more sensitive than japonicas to low oxygen at the seedling stage.

This experiment reports the effect of calcium peroxide on seedling emergence of an indica rice, IR36, from flooded puddled soil at four temperatures. Maahas clay soil was puddled in 4-liter plastic pots, and then temporarily drained of water. Twenty IR36 seeds, which had been coated with calper (a formulation of calcium peroxide), were placed 1 cm deep in the puddled soil and covered with soil. A 5-cm water depth was maintained. Three treated and untreated pots were placed in the glasshouse at day/night temperatures of 26°118°, 29°/21°, 32°/24°, and 35°/27°C.



Effect of calper (a formulation of calcium peroxide) on seedling emergence of IR36 from a flooded puddled soil. The picture was taken 13 days after seeding. IRRI, 1978.

Effect of seed coatings of calcium peroxide on seedling emergence of IR36 from flooded puddled soil.[a] IRRI, 1978.

Temperature (°C day/night)	Seedling emergence[b] (%)	
	Untreated	Treated
26/18	10	57
29/21	32	78
32/24	30	95
35/27	41	78

[a]Depth of water was maintained at 5 cm; seeds were placed 1 cm deep in the puddled soil.
[b]Counted 13 days after seeding.

The seedlings that emerged above the water surface were counted 13 days after seeding. The seeds with calcium peroxide germinated and grew faster than the untreated ones (see photo). Coating seed with calcium peroxide increased the percentage of seedling emergence from 10 to 57% at 26°/18° (see table). At higher temperatures, the percentage ranged from 30 to 41%) for the untreated pots and from 78 to 95% for the treated. Thus, the use of calcium peroxide appears promising in securing good seedling establishment in wetland direct-seeded rice in the tropics.

Rice-based cropping systems

Effect of crop rotation on nematode populations in dryland rice-based cropping systems of Batangas, Philippines

M. B. Castillo, associate professor, M. S. Alejar, research assistant, Department of Plant Pathology, College of Agriculture, University of the Philippines at Los Baños and J. A. Litsinger, associate entomologist, Cropping Systems Program, International Rice Research Institute

Plant species and cropping patterns influence the composition and populations of plant parasitic nematodes. Plant species determine the kinds of parasitic nematodes that will be favored in a given soil type for the crop duration. The cropping pattern, in turn, determines their populations on a year-round basis. The well-drained soils of dryland environments are most favorable to plant parasitic nematodes.

In Batangas province, Philippines, dryland rice is commonly followed by corn, vegetables (cucurbits, tomato, garlic, chinese cabbage, eggplant), or grain legumes (cowpea, mung bean, lima bean, hyacinth bean).

Vegetables and grain legumes are susceptible to the plant parasitic nematode genera *Rotylenchulus* and *Meloidogyne,* but rice and corn are resistant. Batangas farmers aware of the benefits from crop rotation practice it; they are generally unaware, however, of

Effect of crop rotation on nematode buildup in a dryland rice cropping system. Batangas province, Philippines, 1976.

Cropping pattern[a]	Nematodes[b] (mean no.1250 cc soil and 1 g roots)		
	Rotylenchulus	*Meloidogyne*	Total of genera[c]
1. Continuous susc. host	1,146	346	1,495
2. Cereals preceding 2 susc. hosts	484	412	1,050
3. Cereals alt. with 1 susc. host	274	162	460
4. Cereals for 2 years preceding 1 susc. host	5	0	16
5. Cereals for 3 years preceding 1 susc. host	25	42	75

[a]Three-year period. Nematode-susceptible crop = Leguminosae, Cucurbitaceae, Malvaceae, and Solanaceae. Cereal = rice and corn.
[b]Soil and roots from 10 locations/field were pooled. Nematodes were extracted from 10 subsamples of pooled soil by sieving and the Baermann funnel technique; roots were stained in acid fuchsin-lactophenol to observe implanted nematodes.
[c]*Helicotylenchus, Tylenchorhynchus, Hoplolaimus, Criconemoides, Hemicycliophora,* and *Pratylenchus.*

nematodes.

In a survey to determine if crop rotation is an effective alternative to the use of nematicides (nematode-resistant varieties are not available), farmers were asked to review the crops grown on their land over the previous 3 years. Five generalized cropping patterns based on sequences of nematode-susceptible (S) and nonsusceptible (N) hosts were identified: 1) continuous S, 2) N preceding two S, 3) N alternating with one S, 4) N for 2 years preceding one S, and 5) N for 3 years preceding one S. Nematode counts were taken in the last susceptible crop.

Cropping pattern 1 (continuous cropping of susceptible hosts over the growing season, May-Jan.) resulted in the highest nematode count (see table). Cropping pattern 2 gave little protection. Although pattern 3 reduced nematode incidence, the nematode populations were still high. Patterns 4 and 5 gave the best protection. But such protection lasts for only one cropping of a susceptible host, because the nematode populations recover quickly.

Weeds, always present despite the farmers' weeding practices, also sustained nematode populations. The following common weeds were identified as hosts of *Rotylenchulus* or *Meloidogyne* from field observations and pot confirmation tests in the greenhouse: *Amaranthus spinasus, Ipomoea alba, Portulaca oleraceae, Paspalum conjugatum, Vernonia cinerea, Commelina benghalensis, Digitaria sanguinalis,* and *Eclipta alba.*

We conclude that in dryland environments where vegetables and grain legumes are rotated with rice and corn, crop rotation alone is not adequate to control plant parasitic nematodes.

Cowpea for rice fallow

M. A. Singlachar, rice agronomist; M. S. Narasegowda, research assistant; and Y. S. Veerarajurs, junior agronomist, University of Agricultural Sciences, Regional Research Station, Mandya; and K. Shambulingappa, pulse breeder, Hebbel Campus, Bangalore, Karnataka, India

Five promising cowpea varieties were evaluated for suitability for cropping after kharif rice in a replicated trial in January 1977. A check variety, C152, was included. The field was irrigated once at sowing and twice thereafter. The check variety yielded highest, 1.7 t/ha, followed by SP488. and SP4 (see table). SP17 was superior in mean number of nodules per plant. SP488 was promising, considering its shorter duration, seed yield, and nodulation.

Performance of cowpea in rice fallow. Karnataka, India, 1977.

Variety	Seed yield (t/ha)	Nodules (mean no./ plant)	Branches (no./ plant)	Pods (no./ plant)	Seed wt (g)	Duration (days)
SP2	0.8	2.9	4.63	17.0	9.4	74
SP4	1.3	3.5	3.95	17.3	9.6	76
SP8	1.0	3.3	4.20	17.3	11.1	76
SP17	1.1	6.6	5.18	21.1	9.3	78
SP488	1.2	5.2	3.53	9.9	11.3	72
C152	1.7	5.5	3.50	17.1	16.6	102
CD (5%)	0.41					
CV (%)	23					

A trial on the growing of kharif paddy followed by rabi cotton in western India

K. S. Parmar, rice breeder, VYARA, and Nanubhai Ptel, agri-teacher, Uttar Buniyadi Vidyalay, Vananchal, Panchol village, Tal. Vyara, Surat District, Gujarat, India

The conventional crop technology of most traditional rice-growing areas of South Gujarat, western India, and the coastal parts of Maharashtra and Karnataka is a single crop of kharif (monsoon) paddy, occasionally followed by a dry crop of rabi (cold season) legumes such as Lablab or gram. Monsoon rains usually begin in May or June, and most rice varieties are harvested in 130 to 150 days, Production is low and double-cropping, rare.

Details of an experiment on growing kharif rice followed by rabi cotton, Gujarat, India.

Item	Used in experiment	Suggested for future trials
Paddy variety	IR8	IR28, IR30, Pusa 33-18
Paddy spacing	20 × 20 cm	15 × 15 cm
Fertilizer schedule (kg NPK/plot)	20-10-5	20-10-5
Field duration of paddy (days)	137	110
Kharif paddy yield (t/0.2-ha plot)	1	1
Cotton variety for rabi	Hybrid 4	Hybrid 4
Date of cotton seed planting[a]	20 Sept.	1 Sept.
Date of paddy harvest	15 Oct.	25 Sept.
Date of transplanting of bagged cotton plants	22 Oct.	1 Oct.
Cotton spacing	165 × 105 cm	100 × 100 cm
Cotton plants (no./plot)	1020	2000
Fertilization (kg NPK/plot)	24-8-11	25-10-10
Seed cotton yield (kg/plot)	220	600
Paddy production cost (US$/plot)	62.5	65
Cotton production cost (US$/plot)	68.8	87.5
Value of paddy (US$125/t)	125	125
Value of cotton (US$625/t)	137.5	375
Gross profit/plot per year (US$)	131.2	347.5
Value of own labor/plot per year (US$)	43	45
Gross profit (US$/ha) per year	656.2	1737.5
Value of own labor (US$/ha) per year	215	275

[a]In 25- × 17-cm polythene bags.

An enormous number of landless agricultural laborers and subsistence farmers in the region would benefit from an increased cropping intensity and yearly production of their conventional rice-based cropping systems.

Earlier it was generally thought that the short-duration rice varieties yielded less than medium- and long-duration varieties. That belief has now been dispelled by the introduction of new high yielding, early maturing paddy varieties such as IR28, IR30, Pusa 2-21, Pusa 33-1 8, Pusa 4-1-11, ADT31, Kavery, Karuna, and Bala. Such varieties mature in 95 to 110 days.

Hybrid varieties of crops such as cotton, maize, and sorghum can be used in the rabi season after harvest of kharif paddy. Such hybrids have performed better than traditional cultivars under both optimal and constrained conditions.

A trial of sequential cropping of paddy and cotton (variety Hybrid 4) was conducted in a 0.2-ha plot at Vananchal, Panchol Vyara, Gujarat. The table gives details of the trial and suggestions for modification of future trials.

The experimental results show that Hybrid 4 cotton can be grown successfully after a kharif paddy crop, using residual soil moisture supplemented with light irrigation or even with manual watering. Such a system more than doubles total gross value of production over that of a single paddy crop. The use of early maturing paddy varieties can further increase production. A rabi crop of cotton also provides more days of gainful local employment for the marginal farmer and agricultural laborer.

This trial is being extended to 30 tribal farmers' fields around Panchol, in the 1978 kharif. Planned improvements are listed in the table.

Selection of rice varieties for fodder purposes

I. M. Bhatti, M. A. H. Qureshi, and J. A. Gilal, Rice Research Institute, Dokri, Sind, Pakistan

Many herbicides have been evaluated for effectiveness in weed eradication. But because rice farmers use most weeds as cattle fodder, convincing them to eradicate weeds from their rice fields is difficult. No other fodder is available during the rice-growing period and growing fodder crops is not possible because water stands throughout the rice areas. Scarcity of fodder is reflected in high fodder prices, so that even if good herbicides become available, their use will be limited.

An alternate source of fodder is therefore needed. A promising solution is to select rice varieties that can be grown for fodder on a small piece of land. The farmer can then eradicate weeds in the remaining rice fields.

In the 1977 cropping season, 15 rice varieties and lines were grown to select suitable fodder varieties. Ten rows of each strain were grown on 104 m^2. Two or three cuttings for fodder were made at 25-day intervals, starting at 46 days after transplanting.

The results were encouraging. Not only was substantial fodder obtained, but some rices produced yields as well. The highest fodder yield was 27.8 t/ha; the highest grain yield was 2.9 t/ha. Furthermore, the gross income from growing varieties for fodder and grain was much better than those from growing a regular crop of the widely grown variety IR6 (see table).

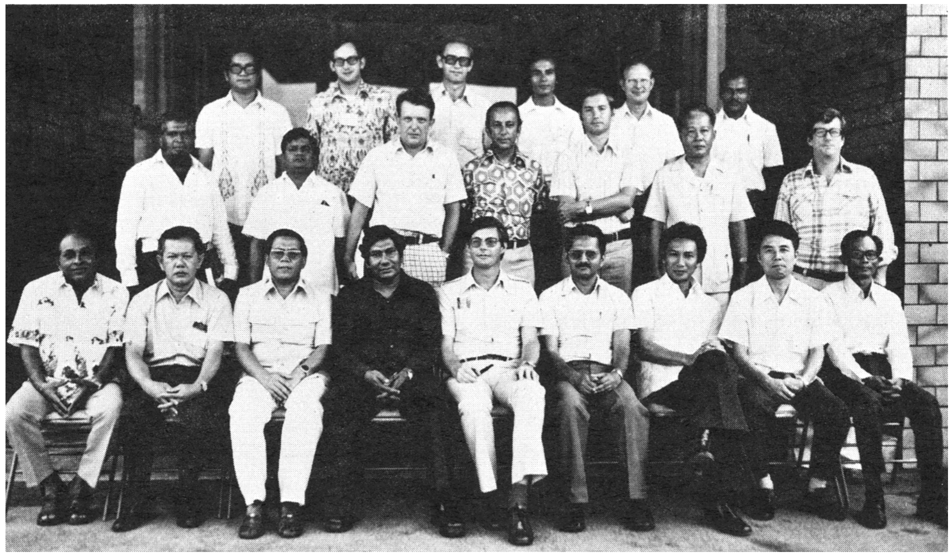
The work is being extended. It may not only help meet farmers' fodder requirements, but also increase rice yields through weed eradication.

Yield of fodder and grain and income from rice varieties and strains grown for fodder during 1977-78.

Designation	Yield of green fodder (t/ha) 1st cutting	2nd cutting	3rd cutting	Total	Income from fodder (US$/t)	Grain yield (t/ha)	Gross income from grain (US$/t)	Straw yield (t/ha)	Gross income from straw (US$/t)	Total gross income (US$/ha)
BKN 6986	6.7	10.5	–	17.2	370	2.7	215	2.7	29	614
IR547-PD10-PD1-PD1-PD3	8.6	11.5	–	20.1	432	2.9	232	2.9	31	695
IR8/Basmati 5875-PM2-PD1-PD4-PD3	8.6	11.5	–	20.1	432	1.0	84	1.0	11	527
IR647-PD12-PD1-PD1-PD2	6.2	10.0	7.6	23.8	512	0.4	34	0.4	4	550
IR6/IR532-PK-37-C4-PK-193-396-2-PD2	9.1	9.6	9.1	27.8	598	0.3	27	0.3	4	629
IR6/IR532-PK-37-C4-PK-193-396-2-PDl	7.6	9.1	8.6	25.3	544	0.4	35	0.4	5	584
IR6/IR532-PK-37-C4-PK-193-593-2-PD3	9.6	8.6	7.6	25.8	555	0.5	37	0.5	5	597
Basmati 6129/IR841-26-2-PK-197-114-2-PD2	6.7	8.6	–	15.3	329	1.3	101	1.3	14	444
IR2070-414-3-9	4.3	8.1	7.2	19.6	421	0.0	2	0.0	0	423
IRl84-67-1-3-2-PD19-PD2-PD11-PD1-PD3	5.7	8.1	–	13.8	297	0.7	56	0.7	8	361
IR932-130-PD1	5.2	8.6	–	13.8	297	1.9	153	1.9	20	470
IR4-90-3-2-K-27-PD1-PD1-PD2	8.1	9.1	–	17.2	370	1.7	138	1.7	18	526
IR8/K-27-1-16-PD2-PD1	6.2	8.6	8.1	22.9	492	0.3	27	0.3	4	523
IR22(Mudgo/IR8)/IR1614-103-2-2	8.6	11.0	–	19.6	421	1.3	104	1.3	14	539
IRI/Basmati 6129-1-10-PD4	9.1	10.5	–	19.6	421	1.5	121	1.5	16	558
IR6(regular crop)	–	–	–	–	–	4.6	371	4.6	50	421

Cropping systems working group evaluates IRRI's program

H. C. Zandstra, agronomist, International Rice Research Institute



Front row (left to right): W. Fernando, Agric. Res. Stn., Sri Lanka; D. Chandrapanya, Dept. of Agric., Thailand; Y. Hashim, MARDI, Malaysia; 2. Hoque, BRRI, Bangladesh; H. G. Zandstra, IRRI, Philippines; S. N. Lohani, Dept. of Agric., Nepal; A. A. Gomez, UPLB, Philippines; Yong Hwa Shin, Office of Rural Dev., Rep. of Korea; Tung Saing, Agric. Res. Inst., Burma (all members). *Middle row (left to right):* S. B. Upasena, Dept. of Agric., Sri Lanka (resource person); K. R. Kulkarni, All India Coordinated Agronomic Experiments, India (member); R. A. Morris, IRRI, Philippines; A. H. Manzano, IADS, Nepal; P. Hobbs, BRRI, Bangladesh; Anvooth Nalampang, Dept. of Agric., Thailand; J. A. Litsinger, IRRI, Philippines (resource persons). *Last row (left to right):* V. R. Carangal, IRRI, Philippines (member); R. L. Tinsley, IRRI, Sri Lanka; G. Banta, IDRC Staff based at Dept. of Agric., Thailand; S. Mathema, IADS, Nepal; J. L. McIntosh, IRRI, Indonesia (resource persons); K. V. N. Weralugolla, Agric. Res. Stn., Sri Lanka (observer).

The 7th Cropping Systems Working Group Meeting was held at IRRI 2–5 October 1978. Participating members from Asia presented progress reports and future research plans for on-farm cropping systems research in their countries. Working committees also reported on methodology, e.g., varietal screening and testing, analysis of cropping patterns monitoring results, field plot techniques for on-farm research, and time required at on-farm research sites. Working committees discussed network plans for future collaborative research on weed control, economics, and entomology for cropping system.

The Working Group inspected cropping-pattern and research-managed trials conducted in farmers' fields at the IRRI-Philippine Bureau of Plant Industry research site in Pangasinan province, Philippines.

A committee on Evaluation of IRRI's Cropping Systems Program made the following observations:

- IRRI's Cropping Systems Program should continue to develop a concept of site-specific research in farmers' fields, taking physical, biological, and socioeconomic factors into account.
- IRRI needs to increase emphasis on the development of production models that integrate soil, plant, and climatic factors. Research methods should be developed to evaluate the effect of several combinations of human, animal, and mechanical power sources on production potential and labor productivity.
- Increased emphasis should be placed on the use of site-related research methodology to provide technology to large-scale crop production programs. The methodology should consider the role of community action in dealing with the institutional support of production, including extension, farm input supply, credit, processing, and marketing.

Announcements

Rainfed lowland rice farmers are subject of 1978 IRRC

The small-scale farmer who grows rainfed lowland rice was the major topic of the 1978 International Rice Research Conference (IRRC), held at IRRI from April 17 to 21, 1978.

Such farmers grow rainfed rice in bunded fields on from 30 to 50% of the world's rice land. They depend entirely on the unpredictable monsoon rains to water their crops, and have little or no control over the timing or amount of water. But in vast regions, the rains often fail, as they did in much of Southeast Asia in 1977, and farmers' fields dry and crack, with disastrous effects on the rice. In other low-lying areas, water accumulates during the monsoon season and stagnates at depths of as much as 1 meter — conditions that the short-statured modern varieties cannot tolerate.

The green revolution has by passed farmers in both situations — too little or too much water. Most of those farmers depend on low- but stable-yielding traditional rice varieties and old technology.

The 1978 IRRC was the first IRRI conference to focus on the special problems of rainfed lowland rice. One hundred twenty-four rice scientists from 28 countries in Asia, Africa, North and South America, Australia, and Oceania participated upon invitation.

A basic theme of the conference was that it is now time for scientists to apply the same general research concepts that brought success on irrigated lands to develop improved rice technology for farmers in rainfed bunded areas. International collaboration is essential for such an undertaking.

For example, yields have risen significantly during the past decade in northern India and neighboring Pakistan, and in southern India and neighboring Sri Lanka, where from 50% to more than 80%) of the rice area is irrigated. But in the largely rainfed rice-growing regions of eastern India and Bangladesh, there has been no such upward trend. Yields in those and similar areas have remained low largely because little research has focused on rainfed lowland rice.

The need for photoperiod sensitivity and long growth duration in rainfed rice varieties was also stressed. Most improved semidwarf varieties are nonsensitive to photoperiod and mature early.

Special reports were given on rainfed lowland rice in Bangladesh, India, Indonesia, Thailand, Burma. and the Philippines. Scientists presented other papers on plant type; tolerance for drought, submergence, and mineral stress; crop management; cropping patterns; and socioeconomic aspects of rainfed lowland rice.

The scientists spent the last 2 days of the conference planning programs of international collaboration in various fields of rice research, including rainfed lowland rice. Special sessions were held on activities of the International Rice Testing Program (IRTP) and the International Network on Fertilizer Efficiency in Rice (INFER).

Committee chairman for the 1978 IRRC was D. V. Seshu, IRRI plant breedee.

IRRI will publish a summary of conference papers and plans for future activities.

Participants in the IRRI 6-month Rice Production Training Program

The 6-month rice production training program is offered yearly to train rice production specialists and extension workers in the principles and practices of modern rice production. Its primary purpose is to train individuals to conduct similar training programs in their home countries.

Participants spend half of the time in the classroom and laboratory, learning the science of rice growing, and the latest rice production technology. They spend the other half in the field, putting that knowledge to practical use and acquiring new skills. Considerable time is devoted to learning the fundamentals of communication as well as the concepts and techniques of applied research.

The photo shows participants in the course offered from March 27 to Sept. 15, 1978.

PARTICIPANTS IN THE IRRI SIX-MONTH RICE PRODUCTION TRAINING PROGRAM, March 27 – September 15, 1978
Front row (l to r): Raihan Uddin Khan (Bangladesh): Md. Abdur Rashid (Bangladesh); William Barsana (RPTR Staff); Alfredo Domingo (RPTR Staff); Conrado Nora (RFTR Staff); Dr. Mano D. Pathak (Director, Research Coordination and Training, IRRI); Dr. Nyle C. Brady (Director-General, IRRI); Dr. Leo Dale Haws (Crop Production Specialist and Department Head, RPTR); Noemi Yapit (Training Coordinator, RPTR); Rex Alocilja (RPTR Staff); Maximo Obusan (RPTR Staff); Ernesto Perez (RPTR Staff); Regalado Aseron (RPTR Staff).
Second row (l to r): Thein Book Chung (Malaysia); Karya Santana (Indonesia); Djaendar Simanungkalit (Indonesia); Abdus Sattar Javed (Pakistan); Sjarif Daradjat Pulungan (Indonesia); Ubuy Yusuf Sobandi (Indonesia); Rab Nawaz Lak (Pakistan); Barat Ali Choudhry (Pakistan); Suparman Mangunsuwiryo (Indonesia); Paresh Cyandra Nandi (India); Md. Mujibul Islam (Bangladesh); Alfredo V. Lamadrid (Philippines).
Third row (l to r): Md. Anwarul Kabir (Bangladesh); Hubert L. Rose (India); Md. Abdul Latif (Bangladesh); Surahman Busri (Indonesia); Liyana Somawardana (Sri Lanka); Bashir Hussain Shahani (Pakistan); Ghulam Abbas Khuhro (Pakistan); Channa Badaruddin (Pakistan); Abdul Jabbar Soomro (Pakistan); Md. Ashraf Chaudhri (Pakistan); Md. Akram Chaudhry (Pakistan); Shahzahan Md. Mohiuddin (Bangladesh).
Fourth row (l to r): Tilak Boralessa (Sri Lanka); Upendra Nath Bhuyan (India); Edward Thomas Cole (Liberia); Josegil L. Parreñas (Philippines); Jesus A. Baranda (Philippines); Remedio D. Zaparilla (Philippines); Joseph Ohn Nyunt (Burma); Rashdi Bin Khalid (Malaysia); Emerito Tipa (RPTR Staff); Asngadi (Indonesia); Adang Wangidiredja (Indonesia); Abdul Kasar (Indonesia): Oscar Garcia (RPTR Staff); Rizalino Dilag, Jr. (RPTR Staff); Ranajit Kumar Bhattacharyya (India).

Ten new publications available from IRRI

Ten new publications have been made available in the past 6 months by IRRI's Office of Information Services and Library and Documentation Services. Prices for the new publications are indicated in the box below:

Title	Price		
	Philippines	Surface mail ($)	Airmail ($)
Cropping Systems Research and Development for the Asian Rice farmer	30.00	5.00	13.00
Proceedings of the Workshop on the Genetic Conservation of Rice	4.00	1.00	3.00
Interpretative Analysis of Selected Papers from Changes in Rice Farming in Selected Areas of Asia	10.00	2.00	6.50
Proceedings of the International Agricultural Machinery Workshop	10.00	2.00	6.50
Research Highlights for 1977	15.00	3.00	6.00
Supplement of the International Bibliography on Rice Research, 1976	50.00	10.00	20.00
Supplement of the International Bibliography on Cropping Systems, 1975	30.00	5.00	10.00
Supplement of the International Bibliography on Cropping Systems, 1976	30.00	5.00	10.00
Handbook on the Methodology for an Integrated Experiment-Survey on Rice Yield Constraints	6.00	1.50	3.00
Irrigation Policy and Management in Southeast Asia	15.00	3.00	9.00

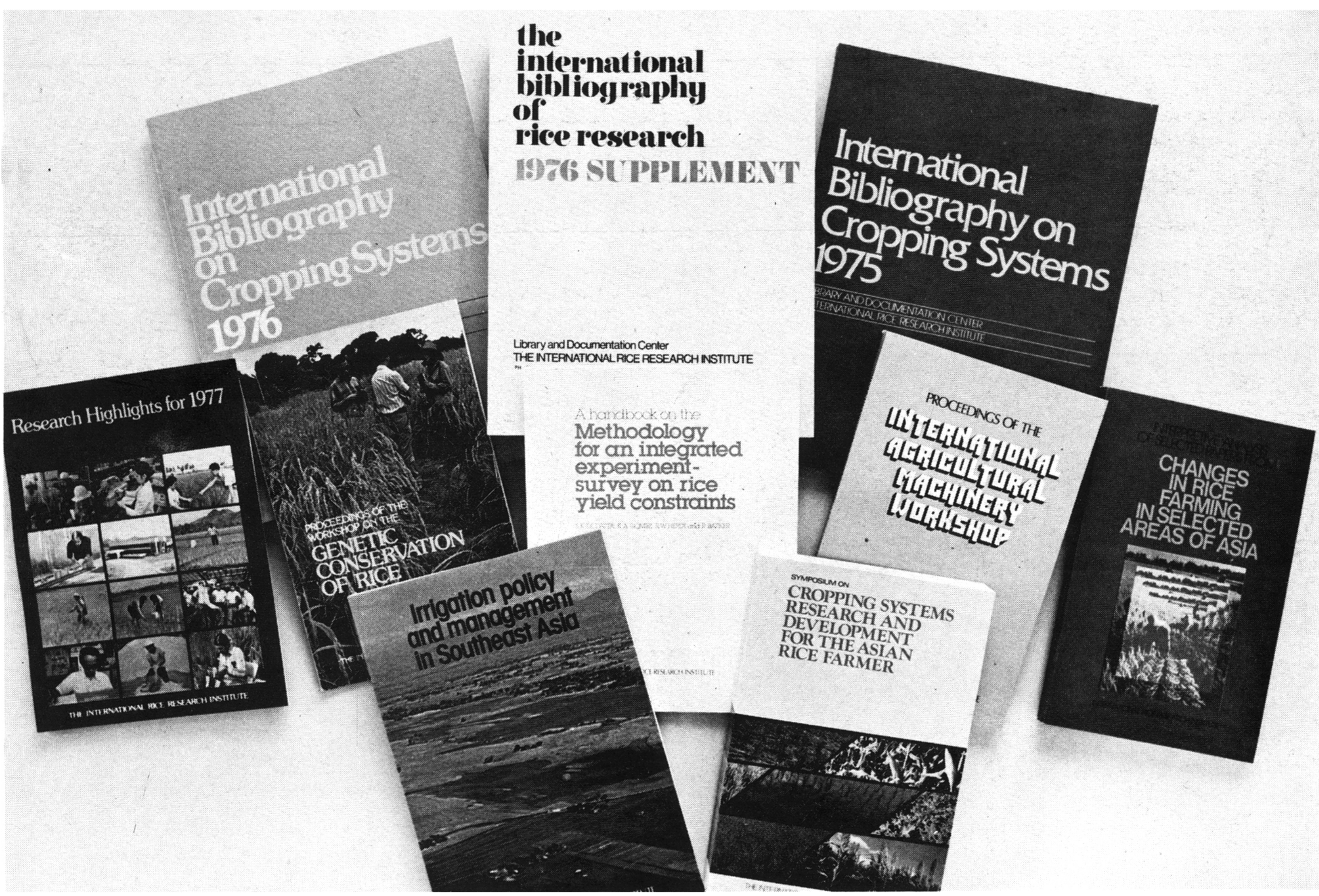
*Prepayment must accompany orders for publications. Payment can be made with US dollar checks, with bank "demand drafts" made payable to the IRRI Office of Information Services, or with UNESCO coupons. Include the name of the country in the address. *Orders and queries should be addressed to the. of ice of Information Services, International Rice Research Institute, Box 933, Manila, Philippines*

IRRN will announce national and international awards

As part of its function as an informatio vehicle for workers in rice improvemen the International Rice Research Newsletter (IRRN) will include in future issues announcements of national and international awards and honors presented to rice scientists, extension workers, and educators.

Write announcements of such award in one-half to one double-spaced page (the IRRN editors will not rewrite announcements from newspaper clippings. programs, etc). A black and white photo may be submitted for consideration.

We regret that only national and international honors will be published. Space does not permit publication of local, state, and provincial awards.



New publications available from IRRI.

About the new cover . . .

Readers will note the new cover of the International Rice Research Newsletter, designed by the IRRI Office of Information Services. We hope to symbolize: 1) the *international* scope of the IRRN, 2) *rice,* the crop that feeds at least a third of the world, 3) *research,* the bond that links rice scientists, educators, and extension specialists across the world; and 4) *communication* of new research results and ideas among those who work with rice.

The Editors
Office of Information Services
International Rice Research Institute

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.

Individuals, organizations, and media are invited to quote or re-print articles or excerpts from articles in the IRRN. Duplicate prints of photos and illustrations are available to media on request from the Office of Information Services, IRRI.
Persons who wish additional details of information presented in IRRN should write directly to the authors.

The International Rice Research Institute
P.O. Box 933, Manila, Philippines

ISSN 0115–0944