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IRRN instructions for contributors

The objective of the *International Rice Research Notes* (IRRN) is to expedite communication among scientists concerned with the development of improved technology for rice and rice-based systems. The IRRN is a mechanism to help scientists keep each other informed of current rice research findings. The concise scientific notes are meant to encourage rice scientists to communicate with one another to obtain details on the research reported.

The IRRN is published quarterly in March, June, September, and December by the International Rice Research Institute; annual subject and variety indexes are also produced.

The IRRN is divided into three sections: notes, news about research collaboration, and announcements.

NOTES

General criteria. Scientific notes submitted to the IRRN for possible publication must

- be original work,
- have international or pan-national relevance,
- be conducted during the Immediate past three years or be work in progress,
- have rice environment relevance,
- advance rice knowledge,
- use appropriate research design and data collection methodology,
- report pertinent, adequate data,
- apply appropriate statistical analysis, and
- reach supportable conclusions.

Routine research. Reports of screening trials of varieties, fertilizer, cropping methods, and other routine observations using standard methodologies to establish local recommendations are not accepted. Examples are single-season, single-trial field experiments. All field trials should be repeated across more than one season, in multiple seasons, or in more than one location as appropriate. All experiments should include replications and an internationally known check or control treatment.

Multiple submissions. Normally, only one report for a single experiment will be accepted. Two or more items about the same work submitted at the same time will be returned for merging. Submitting at different times multiple notes from the same experiment is highly inappropriate. Detection will result in the rejection of all submissions on that research.

IRRN categories. Specify the category in which the note being submitted should appear. Write the category in the upper rlght-hand corner of the first page of the note.

GERMPLASM IMPROVEMENT
genetic resources
genetics
breeding methods
yield potential
grain quality
pest resistance
  diseases
  insects
  other pests
stress tolerance
  drought
  excess water
  adverse temperature
  adverse soils
  other stresses
integrated germplasm improvement
  irrigated
  rainfed lowland
  upland
  deepwater
  tidal wetlands
seed technology

CROP AND RESOURCE MANAGEMENT
soils
soil microbiology
physiology and plant nutrition
fertilizer management
  inorganic sources
  organic sources
crop management
integrated pest management
  diseases
  insects
  weeds
  other pests
water management
farming systems
farm machinery
postharvest technology
economic analysis

ENVIRONMENT
SOCIOECONOMIC IMPACT
EDUCATION AND COMMUNICATION
RESEARCH METHODOLOGY

Manuscript preparation. Arrange the note as a brief statement of research objectives, a short description of project design, and a succinct discussion of results. Relate results to the objectives. Do not include abstracts. Do not cite references or include a bibliography. Restrain acknowledgments.

Manuscripts must be in English. Limit each note to no more than two pages of double-spaced typewritten text. Submit the original manuscript and a duplicate, each with a clear copy of all tables and figures. Authors should retain a copy of the note and of all tables and figures.

Apply these rules, as appropriate, in the note:

- Specify the rice production ecosystems as irrigated, rainfed lowland, upland, deepwater, and tidal wetlands.
- Indicate the type of rice culture (transplanted, wet seeded, dry seeded).
- If local terms for seasons are used, define them by characteristic weather (wet season, dry season, monsoon) and by months.
- Use standard, internationally recognized terms to describe rice plant parts, growth stages, and management practices. Do not use local names.
- Provide genetic background for new varieties or breeding lines.
- For soil nutrient studies, Include a standard soil profile description, classificatlon, and relevant soil properties.
- Provide scientific names for diseases, insects, weeds, and crop plants. Do not use common names or local names alone.
- Quantify survey data, such as infection percentage, degree of severity, and sampling base.
- When evaluating susceptibility, resistance, and tolerance, report the actual quantification of damage due to stress, which was used to assess level or incidence. Specify the measurements used.
- Use generic names, not trade names, for all chemicals.
- Use International measurements. Do not use local units of measure. Express yield data in metric tons per hectare (t/ha) for field studies and in grams per pot (g/pot) for small-scale studies.
- Express all economic data in terms of the US$. Do not use local monetary units. Economic information should be presented at the exchange rate US$:local currency at the time data were collected.
- When using acronyms or abbreviations, write the name in full on first mention, followed by the acronym or abbreviation in parentheses. Use the abbreviation thereafter.
- Define any nonstandard abbreviations or symbols used in tables or figures in a footnote, caption, or legend.

Tables and figures. Each note can have no more than two tables and/or figures (graphs, illustrations, or photos). All tables and figures must be referred to in the text; they should be grouped at the end of the note, each on a separate page. Tables and figures must have clear titles that adequately explain the contents.

Review of notes. The IRRN editor will send an acknowledgment card when a note is received. An IRRI scientist, selected by the editor, reviews each note. Reviewer names are not disclosed. Depending on the reviewer's report, a note will be accepted, rejected, or returned to the author(s) for revision.

NEWS ABOUT RESEARCH COLLABORATION

General. The section facilitates the timely communication to rice scientists of collaborative activities from consortla, networks, collaborating groups, national agricultural research systems, institutions, countries, and other groups.

Items accepted: general news and current update items about consortla, networks, country and regional projects, conference and workshop recommendations, and other information interest to IRRN readers, such as new projects, work plans, memorandums of understanding, and highlights of collaborative projects in progress.

Items not accepted: routine housekeeping information for collaborative groups, research notes, new variety releases, work and trip reports, and personal items.

Length. Limit submissions to one page of double-spaced typewritten text.

Submission. Send contributions to the editor at any time. To be printed in a specific issue, items must be received two and a half months in advance of cover date. Items for the March issue, for example, should be received by 15 Dec.

ANNOUNCEMENTS

General. The section includes announcements of upcoming conferences, symposia, workshops, training courses, meetings, and other activities; new rice-related publications, series, and videos; and a calendar of events.

Format and submission. Same as for news Items. Announcements of workshops, meetings, and conferences need to be received at least 6 months before the date of the event.

OTHERS

Comments. If you have comments or suggestions about the IRRN, please write to the editor. We look forward to your continuing interest in IRRN.

Mailing address. Send all notes, news, announcements, and other correspondence to the Editor, IRRN, IRRI, P.O. Box 933, Manila 1099, Philippines. Fax: 63-2-818-2087.

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Germplasm improvement

Genetic resources

Wild species of *Oryza* with resistance to rice blast (Bl)

P. J. Reimers, B. Consigñado,
and R. J. Nelson, IRRI

The 24 wild species of genus *Oryza* are an important source of useful genes for tolerance for and resistance to adverse abiotic and biotic stresses. We evaluated 73 accessions representing 13 wild species for resistance to B1, using both artificial and natural inoculation methods. Seeds of wild species (see table) were obtained from the International Rice Germplasm Center at IRRI. Pregerminated seeds were sown in 4-inch pots in upland soil in a glasshouse. IR36 and IR50 served as controls in all, and CO 39 in some, experiments. *O. sativa* cultivars were planted later than wild species in some cases to compensate for their varying growth rates.

At about the three-leaf stage, at least four seedlings of each accession were inoculated artificially by spraying with a conidial suspension (10^5 cells/ml) of *Magnaporthe grisea* isolate P06-6. For natural inoculation, pots of seedlings were placed in the midst of infected spreader cultivars of *O. sativa* in the International Rice Research Institute Blast Nursery, Los Baños, Laguna, Philippines. After 5-7 d incubation, leaves were examined for lesions and scored using a scale that differentiates among six reaction levels, where 0 = immune, 1 and 3 = resistant, 5 = intermediate, 7 = susceptible, and 9 = highly susceptible (see table).

Of the 11 wild species tested in both artificial and natural conditions, at least one of six species appeared resistant both to B1 isolate P06-6 and inoculum in the B1 nursery. Accessions of *O. alta, O. barthii, O. latifolia, O. perennis,* and *O. rufipogon* were found susceptible to isolate P06-6 but resistant in the B1 nursery exposure. *O. rufipogon* also contained an accession resistant to isolate PO6-6 but susceptible to B1 nursery isolates. Some accessions of *O. nivara, O. perennis,* and *O. ridleyi* appeared to be heterogeneous for resistance, as suggested by both resistant and susceptible plants being found in the same seed lot.

All 38 accessions of *O. minuta* were highly resistant or immune to both artificial and natural inocula. These results indicate that *O. minuta* and *O. brachyantha* are important sources of resistance to B1. ■

Disease reaction of *Oryza* species to Bl. [a]

Species	Accession	Inoculation method: Spraying method (isolate PO6-6)	Inoculation method: Blast nursery
O. alta	101395	S	R
O. australiensis	100882	S	S
	103318	S	NA
O. barthii	101243	R	NA
	101827	S	S
	101937	R	R
	104304	S	R
O. brachyantha	101232	R	R
O. grandiglumis	101405	R	R
O. latifolia	100914	S	R
	105141	R	NA
	105142	R	NA
O. longistaminata	103886	S	S
O. minuta	101079	R	R
	101080	R	R
	101081	R	R
	101083	R	R
	101086	R	R
	101092	R	R
	101094	R	R
	101099	R	R
	101101	R	R
	101123	R	R
	101124	R	R
	101125	R	R
	101126	R	R
	101128	R	R
	101132	R	R
	101133	R	R
	101134	R	R
	101141	R	R
	101181	R	R
	101187	R	R
	101386	R	R
	103874	R	R
	103876	R	R
	103878	R	R
	103880	R	R
	103882	R	R
	104670	R	R
	104674	R	R
	104676	R	R
	104677	R	R
	105123	R	R
	105124	R	R
	105125	R	R
	105126	R	R
	105131	R	R
	105132	R	R
	105253	R	R
	105307	R	R
O. nivara	100899	S	S
	101193	S	S
	101524	R	R
	101973	R	R and S
	103422	R and S	R and S
	103826	R	R
	103839	R	NA
	104443	R	R
O. officinalis	105220	R	NA
O. perennis	100692	R	R
	103817	R	R and S
	103848	R	R
	104453	S	R
	104764	S	R
	104823	S	S
O. ridleyi	100877	Rand S	NA
O. rufipogon	100211	R	S
	100923	S	S
	103305	S	S
	103817	S	R
	104413	S	S
	104479	R	R

[a] R = resistant reaction (scores of 0, 1, 3), R and S = heterogeneous reaction (all scores), S = susceptible reaction (scores of 7, 9), NA = data not available or not shown due to insufficient number of plants. Sample size: at least four plants per accession.

Genetics

Inheritance studies for aroma in two aromatic varieties of Pakistan

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Basmati 370 and Basmati 198 are highly aromatic, long-grain indica types. Rice pests have caused severe yield losses during the past few years.

Rice breeders would like to develop cultivars with excellent cooking quality, strong aroma, and resistance to major pests. The inheritance pattern of aroma is being studied systematically to achieve this goal.

We crossed parents Basmati 370 and Basmati 198 with Tetep, a nonaromatic short-grain variety with resistance to many rice insect pests and diseases, during 1990 kharif (monsoon). F_1 and parent seeds were sown during 1991 kharif. F_1 plants were selfed and backcrossed to the aromatic parents to produce BC_1 and F_2. The aromatic varieties were again crossed with Tetep to produce F_1 seed.

We grew 2.5 plants each for P_1, P_2, P_3, and F_1 (single 6.3-m row), 100 plants for BC, (4 rows), and 200 plants for F_2 (8 rows) in 1992 kharif. A plant-to-plant and row-to-row distance of 23 cm was used.

We evaluated aroma 45 d after transplanting. Two-gram leaf blades from single plants were cut into small pieces, put into test tubes, and soaked in 10 ml of 1.7% KOH solution for 10 min at 25-30°C. Samples were classified as aromatic or nonaromatic by smelling.

All F_1 plants were nonaromatic, indicating that aroma in the parents was recessive (see table). Segregating ratio of nonaromatic to aromatic plants was 1:1 in BC, and 3:1 in F_2, further confirming the monogenic inheritance of aroma. Fixation of aroma in early-segregating generations is expected. ■

Behavior of parents, F_1, BC_1, and F_2 with regard to aroma 45 d after transplanting.

Designation	Plants (no.)			Ratio of nonaromatic to aromatic		c^2	*P*
	Tested	Non-aromatic	Aromatic	Actual	Expected		
Parents							
Basmati 370	25	0	25	0:1	0:1		
Basmati 198	25	0	25	0:1	0:1		
Tetep	25	0	0	1:0	1:0		
F_1							
Basmati 370/Tetep	25	25	0	1:0	1:0		
Basmati 198/Tetep	25	25	0	1:0	1:0		
BC_1							
Basmati 370//Basrnati 370/ Tetep	100	53	47	1:1:1	1:1	0.36	0.50-0.75
Basmati 198//Basmati 198/ Tetep	100	52	48	1:1:1	1:1	0.16	0.50-0.75
Total	200	105	95	1:1:1	1:1	0.50	0.25-0.50
F_2							
Basmati 370/Tetep	200	148	52	2.9:1	3:1	0.11	0.50-0.75
Basmati 198/Tetep	200	153	47	3.7:1	3:1	0.24	0.50-0.75
Total	400	301	99	3:1	3:1	0.01	> 0.90

Sensitivity to gibberellic acid (GA_3) of seedlings and endosperms of rice lines with different genes for height

He Zuhua, Shi Cunhai, and Shen Zongtan, Zhejiang Agricultural University, Hangzhou 310029, China

Five lines carrying different height genes were studied: Mutant T (tall gene *Sd_1*) and Mutant D (semidwarf gene *sd_1*), both derived from a heterozygotous tall mutant of the cross B_3/Xin-You-Zhan); Tall Zhen-Shan (recessive tall gene eui) derived from the *eui* stock; Chao-Ai (recessive dwarf gene *$sds_{(t)}$*) derived from Xue-He-Ai-Zhao; and dominant dwarf D_{53}. We measured plant elongation 12 d after spraying with 20 ppm GA_3. Meanwhile, endosperms of the lines were plated in media with 0.5% soluble starch and 10 ppm GA_3; they were stained with I_2-KI 72 h after culture.

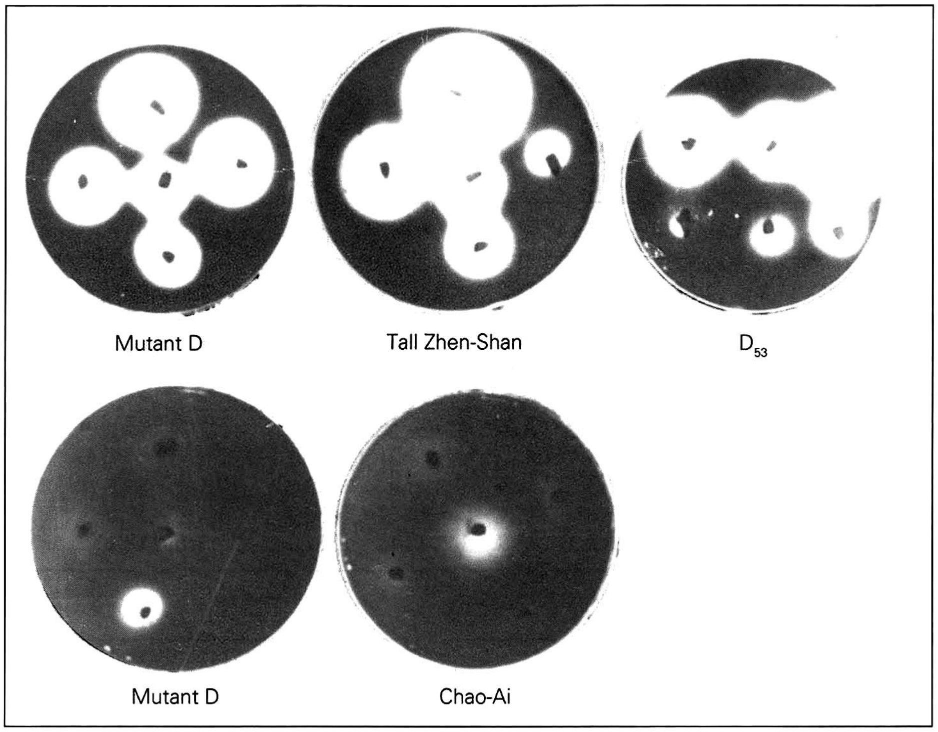
Seedling responses to GA_3 were different among the lines (see table). Based on elongation ratio, Mutant D, Tall Zhen-Shan, and D_{53} were more sensitive to GA_3 than were Mutant T and Chao-Ai. Sensitiveness of the genes for height to GA_3 were $eui>D_{53}>sd_1>Sd_1>sds_{(t)}$.

GA_3 induced the endosperms to produce a -amylase, which degraded the starch in the medium. When stained with I_2-KI, the resulting white spots were larger around the endosperms of Mutant D, Tall Zhen-Shan, and D_{53}, all of which produced more a-amylase than around those of Mutant T and Chao-Ai, which produced less of the enzyme (see figure). Results indicate that genotypes sensitive

Elongation ratios of seedlings treated with GA_3.

Line	Genotype	Seedling height (cm)		Elongation ratio
		0 ppm GA_3	20 ppm GA_3	(%)
Mutant T	Sd_1Sd_1	19.9	24.6	23.6
Mutant D	sd_1sd_1	14.7	26.0	76.9
Tall Zhen-Shan	eui eui	14.5	28.5	96.6
D_{53}	$D_{53}D_{53}$	10.1	18.5	83.2
Chao-Ai	$sds_{(t)}sds_{(t)}$	9.0	10.4	15.6

to GA_3 at the seedling stage also produced endosperm sensitive to GA_3. Endosperm can therefore be used to rapidly identify genotypes that are sensitive to GA_3 with regard to height.



Effect of GA_3 on inducing α-amylase in endosperms.

Breeding methods

Identification of stable cytoplasmic male sterile (CMS) lines for hybrid rice breeding in subhumid tropics

M. Mishra and M. P. Pandey, Plant Breeding Department, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttar Pradesh (UP) 263145, India

Environmental factors influence stability of a CMS line. We need to identify suitable lines for developing hybrids adapted to western UP conditions. We evaluated eight CMS lines with wild abortive cytoplasm during 1990 wet season (WS) in a replicated experiment (Table 1).

Analysis of variance indicated significant differences among the CMS lines for seven characters, The lines generally are early flowering. have shorter plant stature, and have more tillers than their respective maintainer lines. CMS lines IR54752 A. IR54753 A. Pragathi, and Pushpa had fertile pollens and long duration and therefore are unstable. Lines lR46829 A, IR54754 A, IR54758 A, and V20 A had complete pollen sterility and did not set any seed in bagged panicles (Table 2). Spikelet fertility was 0.0, 2.7, 11.4, and 17.7%, respectively, for the lines under unbagged conditions. V20 A and IR54758 A had reasonably good seed set under these conditions, indicating better outcrossing potential, possibly due to their floral traits favoring cross pollination.

Lines possessed early (V20 A) to mid-late (IR46829 A, IRS4758 A, and IR54754 A) duration, nonlodging dwarf (V20 A, IR56829 A) or semidwarf (IR54754 A and IRS4758 A) plant types, high to moderate tillering capacity, and larger sink size.

Overall comparative performance suggests V20 A and IR54758 A are the most suitable CMS lines because they possess complete stability for pollen sterility, better outcrossing potential under natural conditions, and several desirable plant features under WS conditions of' UP. They are being exploited to develop hybrids.

Table 1. Analysis of variance of CMS lines for several characters. [a] **Western Uttar Pradesh, India, 1990 WS.**

Source of variance	Degrees of freedom	Mean square						
		Days to 50% flowering	Plant height	Number of effective tillers	Panicle length	Number of spikelets/panicle	Percent fertile spikelets	Percent pollen fertility
Replication	1	18 06	29.17	59.29	20.70	87.59	0.66	91.20
Genotype	7	399.41 **	397.14 **	45.39 *	17.32*	2819.94*	461.41**	854.33 **
Error	7	5.49	26.37	8.75	2.31	594.86	19.64	32.52
CV (%)		2.2	5.3	27.7	6.3	13.8	22.8	36.6

[a] * and ** = significant at 5 and 1 % level, respectively.

Table 2. Mean performance of CMS lines for some agronomic characters.[a] Western Uttar Pradesh, India, 1990 WS.

CMS line	Days to 50% flowering		Plant height (cm)		Tillers (no.)		Panicle length (cm)		Pollen fertility (%)	Spikelets1 panicle (no.)		Fertile spikelets (%)		
												Unbagged		Bagged
	A	B	A	B	A	B	A	B	A	A	B	A	B	A
IR46829	105.0	96.0	81.3	94.8	7.3	13.3	20.0	21.8	0.0	117.2	102.3	0.0	70.5	0.0
IR54752	118.0	117.0	102.0	104.8	10.3	11.4	25.2	28.3	10.3	191.6	194.5	20.0	48.2	18.5
IR54753	117.0	109.0	120.0	110.5	9.0	11.1	27.6	28.0	31.0	164.1	219.5	39.9	57.4	30.2
IR54754	110.0	101.0	90.3	98.0	9.8	11.0	23.8	25.6	0.0	189.9	163.7	2.7	63.8	0.0
IR54758	109.0	106.0	100.5	110.8	9.6	8.2	22.2	26.6	0.0	186.0	180.9	11.4	57.7	0.0
Pragathi	109.0	102.0	105.4	98.7	7.7	10.8	26.3	24.7	43.6	217.6	151.4	23.3	50.5	20.5
Pushpa	121.0	115.5	97.4	104.5	9.7	12.7	27.7	29.0	46.8	217.6	201.1	40.8	51.7	35.6
V20	76.0	69.0	75.0	81.1	22.2	9.0	21.1	2.1	0.0	128.3	93.2	17.7	72.8	0.0
Mean	108.2	102.0	96.6	100.4	10.7	10.9	24.2	25.7	16.4	176.3	163.2	19.5	59.2	13.1
LSD (0.05)	5.5	4.1	12.1	3.5	7.0	6.6	3.5	2.3	13.4	57.6	35.0	10.4	12.9	13.2
LSD (0.01)	8.2	6.0	17.9	5.1	10.3	9.7	5.3	3.4	19.9	85.1	51.7	15.4	19.1	18.6

[a]A = CMS line, B = maintainer of CMS line (A).

Using potassium chlorate ($KClO_3$) to distinguish indica-japonica hybrids from indica and japonica parents

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Phenol reaction of the hull can be used to distinguish indica from japonica varieties but not indica-japonica hybrids from their parents because the hybrids show a positive reaction as indicas. We tested whether the multigenic inheritance for $KC1O_3$ tolerance in rice seedlings can be used to distinguish indica-japonica hybrids from their parents.

We soaked 100 seedlings with plumules of 0.5-1.0 cm for each of six indica-japonica hybrids (F_1) and their parents in 1% $KC1O_3$ solution for 24 h, then washed and stored them at 30 °C for 4-5 d. The experiment was replicated twice. Degree of $KC1O_3$ injury for each seedling was scored on a scale of 0-3 (see table). Percentage of seedlings injured was estimated using injury index:

$$\text{Injury Index} = \frac{S\,(\text{score} \times \text{seedling no.})}{\text{the largest score} \times \text{total seedling no.}}$$

Reaction score and injury index of hybrid and parent rice seedlings after $KC1O_3$ treatment.

Hybrid or parent	Seedlings (no.)	Seedlings (no.) with given reaction score[a] 0	1	2	3	Injury Index[b] (%)
Indica						
CE 64	203			53	150	91.3 a
Xiangai	200			74	126	87.7 a
Ks-9	200			27	173	95.5 a
w6154s	208			118	90	81.1 a
Hybrid						
Ce 64102428	201		110	83	8	45.7 b
Xiangai/02428	197		159	33	5	406 b
Ks-91029	208		117	91	3	49.4 b
w6154s/02428	200		156	39	5	41.5 b
w6154s/029	198		130	67	1	44.9 b
Ce 641029	205		145	56	4	45.7 b
Japonica						
02428	200		200			0 c
029	200		200			0 c

[a]0 = normal growth without any Injury, 1 = partial chlorosis at the margin of the first euphyllum, 2 = yellowing with partial rolling of the first euphyllurn, 3 = withering of whole seedling. [b]In a column, values followed by a common letter are not significantly different at the 1 % level.

Analysis of variance with a complete random design was used to test for significant differences.

The three seedling types differed distinctly in their tolerance for $KC1O_3$.

Japonica parents were tolerant of $KC1O_3$ and indica parents sensitive. Most of the hybrids reacted moderately, giving an injury index (40-50%) intermediate between their indica and japonica parents.

Results suggest that tolerance of seedlings for $KC1O_3$ can be used to test whether the type is a true hybrid or a pure indica or japonica. ■

An attempt to develop male sterile (ms) lines in photoperiod-sensitive rice cultivars of Cambodia

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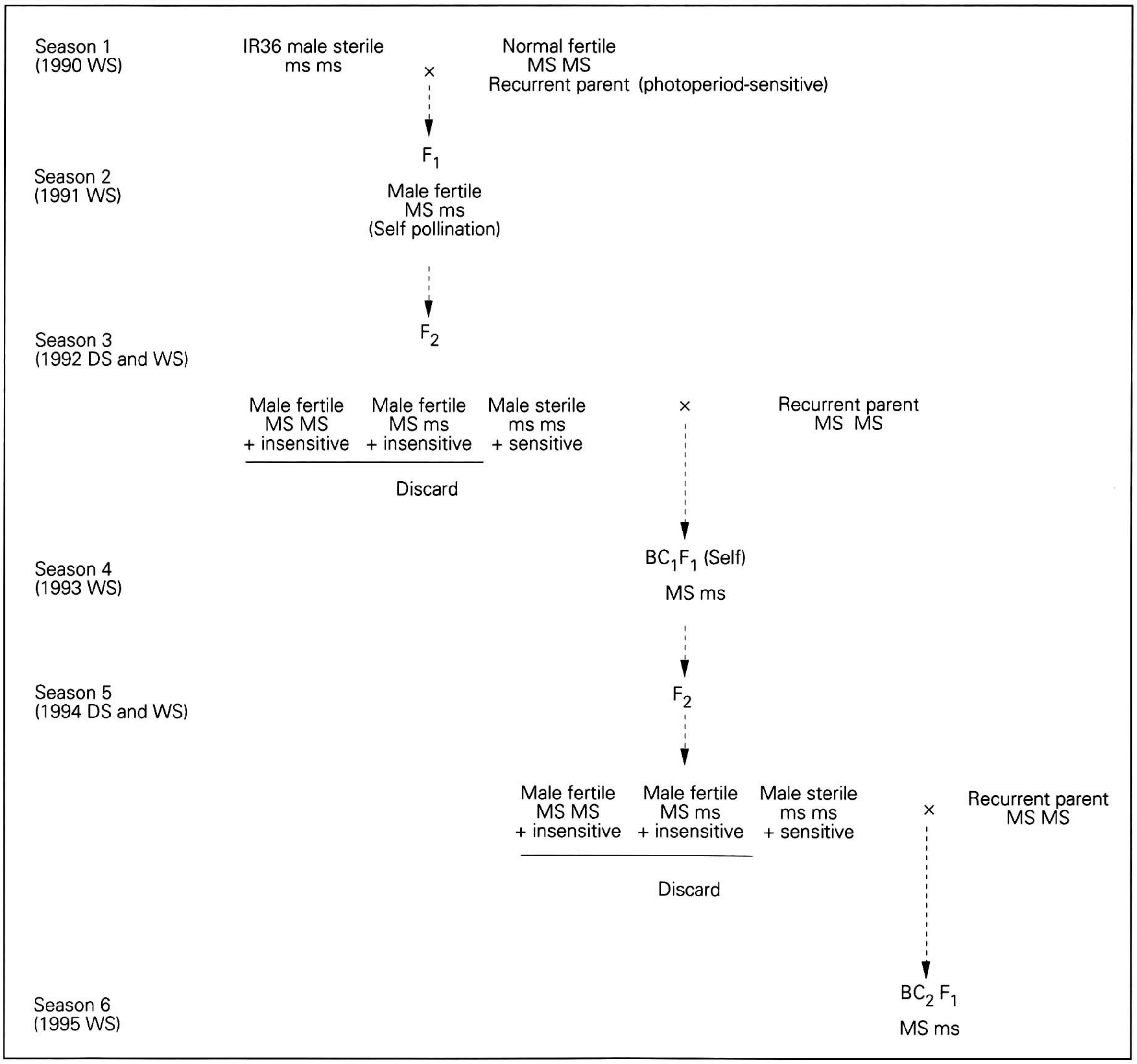
We are transferring the ms gene from IR36 ms line, an early-maturing, dwarf that is susceptible to sheath rot and not very suitable for a rainfed lowland breeding program, to well-adapted, photoperiod-sensitive Cambodian rice varieties through a backcrossing a program started in 1990. Our aim is to develop varieties for rainfed lowland environments through ms-facilitated recurrent selection.

Traditional photoperiod-sensitive varieties Neang Mon 1-027-3-1-2-1-1, Chhuthana 1-078-1-1-3, and Somaly 2-023-6-2-2-1-1-1 were crossed with IR36 ms plants during 1990 wet season (WS). F_1 plants (Ms ms) were grown in 1991 WS and allowed to self-pollinate. F_2

Segregation for photoperiod sensitivity in R_1F_2 generation. Cambodia, 1992.

Cross	Plants		P(3:1)
	Photoperiod-insensitive (no.)	Photoperiod-sensitive (no.)	
IR36 ms/Neang Mon 1-027-3-1-2-1-1	435	165	0.25-0.10
IR36 ms/Chhuthana 1-078-1-1-3	449	160	0.50-0.25
IR36 ms/Somaly 2-023-6-2-2-1-1-1	450	144	0.75-0.50



Scheme to develop photoperiod-sensitive ms lines.

populations were seeded in 1992 dry season (DS) on 2 Mar to allow segregation for photoperiod sensitivity.

Photoperiod-insensitive and -sensitive plants segregated in a 3:1 ratio, indicating that a single dominant gene governs photoperiod sensitivity in all three crosses (see table). We classified the segregants that flowered until Aug as photoperiod-insensitive and those that flowered in Sep and later as photoperiod-sensitive. In 1992 WS, desirable photoperiod-sensitive ms segregants wet crossed with respective recurrent parent: to get BC_1F_1 generation. The scheme for developing photoperiod-sensitive ms lines is presented in the figure. ■

Isolation of maintainers and restorers for cytoplasmic male sterile (CMS) lines

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We crossed 21 short- and medium-duration indica cultivars with eight CMS lines (see table) during Jul-Oct 1990 to identify maintainers and restorers. F_1 hybrids were grown in the field during Nov 1991-Feb 1992.

Pollen sterility was determined from florets in the upper third of the panicle before dehiscence; pollen grains were stained with I_2-KI. Cultivars with >95% pollen and spikelet sterility were classified as potential maintainers; those with 5-95%, as partial restorers; and those with <5%, as effective restorers. Maintainers were more frequent than restorers (see table).

IR62829 A/Co 45, IR62829 A/Co 43, IR58025 A/IR50, MS37 A/IET117S2, and Mangala A/IR62 had 100% pollen sterility. These crosses are being used in a backcross program to develop new CMS lines, Co 43, Heera, and MS210 were identified as restorers (see table) and are being used to develop new hybrid combinations. ■

Restorers and maintainers for CMS lines. Coimbatore, India, 1991-92.

CMS line [a]	Potential maintainers	Effective restorers	Partial restorers
IR62829 A (100.0)	Co 43, Co 45	–	ADT36
IR58025 A (99.7)	IR50	Co 43	T2099, 3043, Co 45, IET7511, Aruna
TNAU1 A (99.5)	Co 45, MO 9	Co 43	4308, TM4309, Annada, MO 7
V20 A (100)	TM4309, IR60		Co 43
IR46828 A (99.2)	–	Heera	–
MS37 A (99.8)	IR30864, IET1 1752	MS210	–
IR54755 A (98.9)	IET11752	–	–
Mangala A (99.6)	IR62	–	–

[a] Figures in parentheses show spikelet sterility under bagged conditions.

Grain quality

An upland rice line with low protein in Japan

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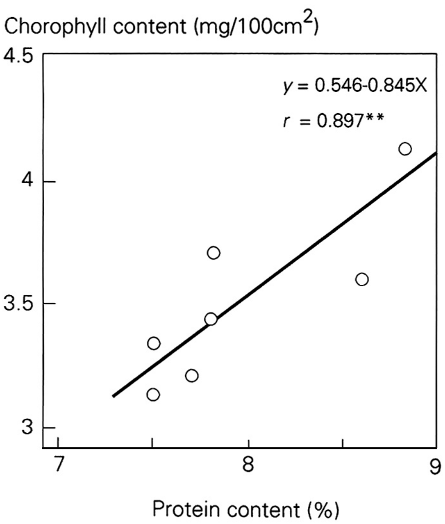
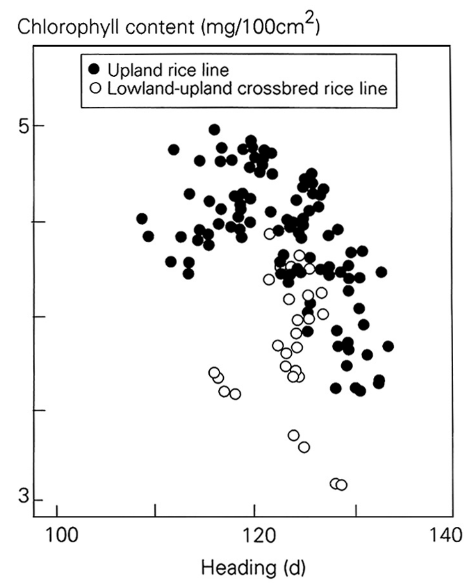
Polished grain from upland rice, which is high in protein and difficult to process, is used mainly for rice crackers in Japan. Processors have been eager for the development of a lower protein upland rice.

We compared the contents of leaf chlorophyll and protein of polished rice in seven lowland-upland crossbred rice lines. These contents were highly correlated ($r = 0.897^{**}$). Selection for leaf chlorophyll content can therefore be



1. Correlation between leaf chlorophyll and grain protein contents in upland rice lines.



2. Correlation between chlorophyll content of leaf and heading period in upland and lowland-upland crossbred rice lines.

used effectively to breed for grain protein (Fig. 1).

We grew 149 breeding lines of upland, lowland-upland derivatives, and lowland lines cultivated at an Ibaraki upland field in 1992. Chlorophyll content averaged 4.39 mg/100 cm^2 for upland rice and 4.03 mg/100 cm^2 for lowland-upland crossbred lines, which were significantly higher than the 3.73 mg/100 cm^2 for lowland rice.

A negative correlation was observed between chlorophyll content and days to heading (r = -0.448**). Early-maturing lines generally had higher protein content than late-maturing lines, although we found early-maturing lines with lower protein content in lowland-upland crossbred lines (Fig. 2). We think that the low protein content was inherited from their lowland rice parents, although they have upland rice plant type, are tolerant of drought, and resistant to blast. These lowland-upland crossbred rice lines produce grain that is easy to process for rice crackers. The lines are also resources for breeding. ■

Grain quality of rice harvested at different maturities

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Harvesting rice at optimum maturity is important for obtaining high milling recovery and good cooking quality. We grew six commercial varieties in nonreplicated 600-m^2 plots during the 1989 and 1990 cropping seasons to study the effect of maturity stage on grain quality. The crop was kept flooded. The 50% flowering date was recorded. subplots of 6 m^2, replicated three times, were harvested from 27 to 42 d after flowering (DAF) at intervals of 3 d. Samples were sun-dried and milled 2 mo after harvest using Satake Rice Husking Machine Model THU-35A and Burrows McGill Polisher No. 3. Milled whole grains were cooked in excess water.

Grain maturity stage greatly affected rice quality (see table). We observed high total milled rice and head rice recovery with more elongation and less bursting/curling of grains upon cooking when the crop was harvested at 20-23% moisture. This level coincides with 33-36 DAF in all of the varieties except Basmati 198, which took 39 d.

Head rice recovery was low at both early and late maturity stages. Total milled rice and elongation ratio and bursting/curling upon cooking improved with delay in harvesting date up to 20-23% moisture, after which they leveled off. ■

Effect of harvesting rice at different stages of maturity on grain quality. RRI, Kala Shah Kaku, Lahore, Punjab, Pakistan. 1989 and 1990.[a]

Days to harvesting after 50% flowering	Moisture at harvest (%)	Milled rice recovery (% of rough rlce dry weight)		Elongation ratio on cooking	Bursting/ curling upon cooking (%)
		Total milled rice	Head rlce		
27	27.8	68.02 c	49.62 d	1.702 d	11.90 a
30	25.3	69.13 b	52.75 bc	1.798 c	10.27 b
33	22.9	70.18 a	54.48 a	1.860 b	9.02 c
36	20.3	70.40 a	54.62 a	1 900 ab	8.38 cd
39	17.9	70.42 a	53 75 ab	1.908 ab	8.27 d
42	15.5	70.28 a	51.87 c	1 913 a	8.25 d
CV (%)	–	0.7	2.7	2.3	6.5
LSD (0.05)	–	0.59	1.71	0.05	0.72

[a] Means in a column followed by a common letter are not significantly different at the 5% level by DMRT.

Relationship of Basmati 370 grain quality to soil and environment

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We conducted a pot experiment to study how soil and environment affect quality attributes and aroma development in Basmati 370. The crop was grown at Daska, a traditional rice-growing area, and Multan, a nontraditional rice-growing area of southern Punjab, during 1989 and 1990 dry seasons. See table for treatments. We evaluated the samples 3 mo after harvest.

Values for kernel length and 1ength:breadth ratio were high in the Daska soil and environment sample (see table). Protein content was about the same across treatments. All samples had intermediate amylose and gelatinization temperature. Elongation and volume expansion ratios upon cooking were highest and aroma strongest in rice from Daska soil and environment. Aroma was very poor in some samples and absent in the rice from Multan soil and environment.

We can conclude that rice from Daska soil and environment was better in cooked-rice cohesiveness and aroma than were any of the other samples. Aroma is the result of soil, environment, and plant type interaction. ■

IRRN REMINDER

Routine research. Reports of screening trials of varieties, fertilizer, cropping methods, and other routine observations using standard methodolies to establish local recommendations are not accepted. Examples are single-season, single-trial field experiments. All field trials should be repeated across more than one season, in multiple seasons, or in more than one location as appropriate. All experiments should include replications and an internationally known check or control treatment.

Effect of soil and environment on quality attributes and aroma development in Basmati 370. Punjab, Pakistan, 1989 and 1990 dry seasons. [a]

Treatment [b]	Physical dimensions			Chemical properties			Cooking characteristics				
	Kernel length (mm)	Kernel breadth (mm)	Length: breadth ratio	Protein content (%)	Amylose content (%)	Alkali spreading value	Elongation ratio	Water absorption ratio	Volume expansion ratio	Cohesiveness score [c]	Aroma score [d]
Daska soil and environment	6.9 a	1.7 a	4.1 a	7.7 a	23.5 a	5.0 a	1.9 a	4.1 a	5.5 a	5.0 a	5.0 a
Multan soil and environment	6.6 a	1.8 a	3.7 a	7 8 a	21.5 a	4.2 a	1.6 a	3.9 a	4.8 a	3.0 c	1.0 c
Daska soil and environment	6.7 a	1.7 a	4.0 a	7.8 a	22.0 a	4.3 a	1.7 a	4.1 a	4.9 a	3.5 b	1.5 b
Multan soil and Daska environment	6.7 a	1.7 a	3.9 a	7.7 a	23.2 a	4.5 a	1.7 a	4.1 a	4.9 a	3.5 b	1.5 b
Pots transferred from Daska to Multan at PI [b]	6.7 a	1.7 a	3.9 a	7.7 a	22.5 a	4.5 a	1.7 a	4.1 a	4.8 a	3.5 b	1.6 b
Pots transferred from Daska to Multan at PE [c]	6.7 a	1.7 a	3.9 a	7.8 a	22.2 a	4.5 a	1.8 a	3.9 a	4.8 a	3.5 b	1.6 b
Pots transferred from Multan to Daska at PI [b]	6.6 a	1.7 a	3.9 a	7.7 a	22.6 a	4.6 a	1.7 a	4.0 a	4.8 a	3.5 b	1.6 b
Pots transferred from Multan to Daska at PE [c]	6.6 a	1.8 a	3.7 a	7.8 a	22.3 a	4.5 a	1.7 a	4.0 a	4.9 a	3.5 b	1.5 b

[a] Results are av of 2 seasons. Means in a column followed by a common letter are not significantly different at the 5% level by DMRT. [b] PI = panicle initiation stage, PE = panicle exsertion stage. [c] Cohesiveness: 5 = well separated, 1 = pasty. [d] Aroma: 5 = strong, 1 = absent

Influence of degree of milling on grain quality characteristics of Basmati 385

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We studied the effect of varying milling pressure on grain quality characteristics of Basmati 385, a commercially grown, fine-grain rice variety. The standard pressure used to mill Basmati 385 is 3.0 lb for 30 s.

Rice was dehulled using Satake Rice Husking Machine Model THU-35A. The hull percentage averaged 22.0. Brown rice samples, weighing 800 g, were milled at 10 pressures between 0.5 and 5.0 lb (0.5 lb increments) using McGill Polisher No. 3. Milling time was 30 s for each trial. The polished full grains were then cooked in excess boiling water. The experiment was repeated five times.

The percentages of total milled rice and head rice decreased gradually as milling pressure increased (see table). Cooked grain length was maximum (14.2

Grain quality characteristics of Basmati 385 at different milling pressures. [a] **RRI, Kala Shah Kaku, Lahore, Punjab, Pakistan.**

Milling pressure (lb)	Milling recovery: Total (% of rough rice)	Milling recovery: Head rice (% of rough rice)	Milled rice: Whiteness (%)	Milled rice: Cooked grain length (mm)	Milled rice: Bursting upon cooking (%)	Milled rice: Water absorption ratio	Milled rice: Volume expansion ratio	Milled rice: Protein content (%)	Oil content of bran (%)
0.5	71.5 a	60.8 a	36.0 h	13.6 d	7.0 a	2.45 d	3.50 d	9.2 a	20.95 a
1.0	71.4 a	60.6 a	36.3 g	13.7 d	6.0 b	2.66 c	3.59 cd	9.0 b	20.60 ab
1.5	71.4 a	60.4 a	36.6 f	13.8 cd	5.5 b	3.00 a	3.72 ab	8.7 c	20.58 b
2.0	71.4 a	60.2 ab	36.8 e	14.0 abc	4.3 c	3.00 a	3.82 a	8.5 d	20.25 bc
2.5	70.9 ab	59.5 b	37.0 d	14.2 a	3.5 cd	3.03 a	3.76 ab	8.3 e	20.10 cd
3.0	70.5 bc	58.1 c	37.4 c	14.2 a	3.5 cd	2.97 a	3.70 b	8.1 f	20.00 cd
3.5	70.4 bc	56.4 d	37.5 c	14.1 ab	3.0 d	2.90 ab	3.70 b	8.1 f	20.00 cd
4.0	70.2 bc	56.0 d	37.7 b	14.1 ab	2.5 e	2.87 ab	3.65 bc	8.0 f	19.90 cd
4.5	69.9 c	54.5 e	38.0 a	14.0 abc	1.5 f	2.75 bc	3.53 d	8.0 f	19.85 d
5.0	69.7 c	53.0 f	38.0 a	13.9 bc	1.0 f	2.75 bc	3.57 d	8.0 f	19.80 d

[a] Means in a column followed by a common letter are not significantly different at the 5% level by DMRT

mm) at 2.5 and 3.0 lb pressure. The bursting of grains upon cooking decreased and the degree of whiteness of polished grain increased with increased milling pressure. The highest protein content in milled rice (9.2%) and oil content in bran (20.95%) were recorded at the lowest pressure, whereas the lowest values were recorded at the maximum pressure. The water absorption ratio and the volume expansion ratio were maximum at the intermediate milling pressures of 2.0 and 2.5 lb.

The results indicate that no single milling pressure optimizes all of the desirable grain quality characteristics. Milling pressures of 2.5-3.0 lb appear to be suitable for Basmati 385. ■

Changes in milled rice cooking quality after storage as rough or milled rice

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We compared the cooking quality of fine-grain strain 4048 after storage as either milled or rough rice. Half of a sample was milled; the other half was left rough. The samples were stored in separate cloth bags for 12 mo during 1990-91 at ambient temperatures of 16-38 °C in the RRI Rice Technology Laboratory.

We milled a portion from the stored rough rice sample every month. Cooking quality tests were performed on both the freshly milled rice sample (from stored rough rice) and the stored milled rice. To ensure a uniform degree of milling, all samples were polished using the same pressure and time period.

Values for cooked grain length and elongation ratio were higher for grain stored as milled rice than for grain stored as rough rice (see table). The bursting of cooked grain, volume expansion ratio, water absorption ratio, and losses of solids from rice during cooking (gruel) were higher for grain stored as rough rice than for that stored as milled rice.

Rice stored as milled grain improved in cooking quality as it aged and had greater elongation, less bursting, and less loss of solids than rice stored as rough grain. ■

Cooking quality of rice stored as milled or rough rice. RRI, Kala Shah Kaku, Lahore, Punjab, Pakistan, 1990-91.

Cooking characteristic of milled rice	Freshly harvested [a]	Stored for														CV (%)	LSD value
		2 mo		4 mo		6 mo		8 mo		10 mo		12 mo		Mean[b]			
		Rough	Milled	Rough	Milled	Rough	Milled	Rough	Milled	Rough	Milled	Rough	Milled	Rough	Milled		
Cooked grain length (mm)	14.10	14.30	14.40	14.70	14.90	14.90	15.10	15.20	15.40	15.50	15.60	15.70	15.80	14.91 b	15.01 a	0.4	0.07
Elongation ratio	1.89	1.91	1.93	1.97	1.99	1.99	2.02	2.03	2.06	2.07	2.09	2.10	2.11	1.99 b	2.01 a	0.4	0.01
Bursting of grain upon cooking (%)	8.0	7.1	6.7	6.0	5.2	5.7	4.0	5.5	3.1	5.2	2.6	5.0	2.0	6.1 a	4.5 b	15.7	1.08
Volume expansion ratio upon soaking	1.25	1.26	1.26	1.27	1.27	1.28	1.27	1.28	1.28	1.29	1.28	1.30	1.28	1.28 a	1 27 b	0.4	0.004
Volume expansion ratio upon cooking	2.71	2.90	2.87	3.15	3.04	3.25	3.20	3.33	3.29	3.44	3.32	3.57	3.38	3.19 a	3.12 b	1.5	0.06
Water absorption ratio upon soaking	1.18	1.19	1.18	1.19	1.19	1.21	1.20	1.21	1.20	1.22	1.21	1.23	1.21	1.20 a	1.19 b	0.4	0.004
Water absorption ratio upon cooking	2.20	2.28	2.26	2.33	2.30	2.40	2.35	2.55	2.49	2.63	2.57	2.72	2.65	2.44 a	2.40 b	0.7	0.004
Loss of solids in washing water (%)	1.3	1.0	0.9	0.8	0.7	0.7	0.6	0.6	0.4	0.6	0.3	0.5	0.3	0.8 a	0.7 b	8.6	0.08
Loss of solids in gruel (%)	6.8	6.1	5.8	5.4	4.8	4.3	3.9	4.0	3.7	3.9	3.4	3.7	3.3	4 9	4.6	2.5	0.16

[a] Values for rough and milled rice were the same. [b] Means in a row followed by a common letter are not significantly different at the 5% level by DMRT

Yield potential

Genetic variability in anatomical root traits of Indian upland rice with reference to drought resistance

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Anatomical root traits such as size of air spaces, number and size of vascular bundles, size of xylem vessels, compactness of pith, and thickness of sclerenchymatous cell layers greatly influence yield potential and adaptability of genotypes to drought.

Root samples of 118 upland rice genotypes were fixed in formalin-aceto-alcohol fixative. Fine transverse root sections were cut with a microtome (Model SP1120 SIPCON) and double-stained with safranin and fastgreen. Permanent slides were prepared and cell sizes measured.

We observed remarkable genetic variation in size of air spaces. Fifteen of the genotypes (including Bagri, Bendi, and Sakun) have small air spaces (60-90 nm), 59 have medium air spaces (90-120 nm), and the rest have large air spaces (more than 120 nm). Roots with small air spaces can readily absorb oxygen present in soil during the initial stages of drought. Genotypes with small air spaces may be useful in breeding programs for drought resistance.

We observed considerable genetic variability in number and size of vascular bundles. Thirty-one genotypes have tetraxylery roots, 47 have pentaxylery roots, 29 have hexaxylery roots, 7 have septaxylery roots, and 4 have octaxylery roots. Small increases in xylem vessel diameter cause large drops in drought resistance. Small vascular bundles have a better regulatory mechanism than large vascular bundles. Varieties Hansraj A, Jhona 349, Sarya, Beni, Poongar, N22, and Narendra-1 have more vascular bundles with small vessels (24-50 nm) than other varieties and can therefore withstand a drastic water deficit situation.

Pith impedes water loss through various cells and stores food under water stress conditions. Forty of the genotypes studied (including Chingudri, Dhani, Karhani, Tinpakia, and Turha) have highly compact pith and can be used for breeding drought-tolerant lines.

Sclerenchyma tissue provides strength to roots and plays a vital role in adaptiveness to drought conditions. Genotypes varied little in sclerenchyma thickness: only N22 has two cell-thick sclerenchyma.

None of the genotypes studied have all the ideal features for drought resistance, although all have a few advantageous traits for drought resistance. Findings can be used as a basis for future breeding programs. ■

Pest resistance—diseases

A close linkage between the blast (Bl) resistance gene *Pi-ta*^{2} and a marker on chromosome 12 in japonica rice

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The B1 resistance gene *Pi-ta*^{2} belongs to the chromosome 9 linkage group on the current linkage maps. But I found the locus to have a close linkage relation to a marker on chromosome 12.

I used three genetic stocks in this research. Pi No. 4 has B1 resistance gene *Pi-ta*^{2}, which is a multiple allele of the *Pi-ta* locus. This resistance gene was introduced into the japonica line from the indica variety Tadukan. Sekiguchi-Asahi is a spontaneous mutant line with the recessive gene *sl* for the leaf spot character. The *sl* locus was reported to be linked to the *Pi-ta*^{2} locus (with a recombination value of about 9.5%). but its chromosomal location has not been identified.

87F5-19 is a linkage tester of Kyushu University, Japan, that has a marker gene *spl-1* located on chromosome 12 and shows large, reddish brown spots on leaves. The university's research group identified the *spl-1* locus using primary trisomics and reciprocal translocation lines.

In a greenhouse, seedlings of the parental lines, F_1, and F_2 were inoculated at the 4- to 5-leaf stage by spraying with an aqueous spore suspension of about 3×10^5 conidia/ml. The isolate used as the inoculum, A179-142, belongs to Japanese race 037, which is avirulent to the *Pi-ta*^{2} gene. Disease reactions were scored about 7 d after inoculation.

The leaf spots of Sekiguchi-Asahi looked similar to those of 87F5-19 in color, size, and shape. All F_1 (n = 5) and F_2 (n = 198) plants from the cross Sekiguchi-Asahi/87FS-19 had leaf spots similar to those of the parental lines without artificial inoculation. Thus, I concluded that *sl* and *spl-1* were allelic at the single locus on chromosome 12.

Inoculated seedlings clearly segregated into resistant and susceptible classes (see table). The segregation of the F_2 population derived from the cross Pi No. 4/87F5-19 gave a good fit to a 3 resistant: 1 susceptible ratio for B1 resistance ($\chi^2 = 0.160$, $0.60 < P < 0.70$, df = 1), and to a 3 normal: 1 mutant for the leaf spot character ($\chi^2 = 1.138$, $0.25 < P < 0.30$, df = 1). The recombination value between *Pi-ta*^{2} and *spl-1* loci was 5.0 + 1.3 (%) calculated by the maximum likelihood method ($\chi^2 = 2.285$, $0.50 < P < 0.60$, df = 3). Therefore the *Pi-ta*^{2} locus was estimated to be located near the *spl-1* locus on chromosome 12. ■

Segregation of the genes for Bl resistance (*Pi-ta*^{2}) and leaf spot character (*spl-1*) in the F_2 population of Pi No. 4/87F5-19.[a]

Blast resistance	Leaf spot character		
	Normal	Mutant	Total
Resistant	212	10	222
Susceptible	5	73	78

[a] χ^2(linkage) = 251.426 (P < 0.001, df = 1).

Allelism between blast (Bl) resistance genes *Pi-4a*(t) and *Pi-ta*

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Twenty-two near-isogenic lines (NILs) carrying single genes for complete resistance to Bl were previously developed at IRRI. The recurrent parent was the highly susceptible indica cultivar CO 39. The donor parents were the resistant indica cultivars Tetep and 5173 and japonica cultivars Pai-kan-tao and LAC23. NILs were divided into six groups based on their reaction patterns to IRRI test isolates. The resistance gene in C101PKT, one of the NILs belonging to group III, was designated *Pi-4a*(t). We found that *Pi-4a*(t) was identical to the known Bl resistance locus *Pi-ta.* All of the NILs in group III were shown to carry *Pi-ta.*

To compare resistance genes in the NILs with previously described Bl resistance loci, we conducted allelism tests between C101PKT and Kiyosawa's differentials (KDs), a set of cultivars carrying 12 known resistance genes. We also conducted allelism tests between NILs belonging to group III and KDs.

Seedlings of parental lines and F_2 plants were grown in a greenhouse and inoculated at the fifth- to sixth-leaf stage by spraying with an aqueous spore suspension of 5×10^4 conidia/ml. The pathogen isolates used for developing the NILs, IK81-3 (101), IK81-25 (102), and 43 (105), were also used in these experiments. Disease reactions were scored about 7 d after inoculation.

Table 1. Reaction of parental lines and F_2 populations to isolate IK81-3 (101).

Parental line and F_2 population	Reaction to IK81-3[a]			Goodness of fit	
	R	S	Total	Ratio	χ^2
CO 39 (S line)	0	19	19		
C101 PKT [*Pi-4a* (t)]	20	0	20		
F2 CO 39/C101 PKT	91	31	122	3:1	0.01 ns
104PKT (S line)	0	18	18		
K 1 (*Pi-ta*)	12	0	12		
F_2K 1/C104PKT	177	44	221	3:1	3.05 ns
C104PKT (S line)	0	17	17		
Pi No. 4 (*Pi-ta*^{2})	16	0	16		
F_2Pi No. 4/C104PKT	143	39	182	3:1	1.24 ns
Crosses with NILs in group III					
F_2 K 1/					
C101 PKT	420	0	420	1:0	
C101TTP-1	408	0	408	1:0	
C101TTP-2	413	0	413	1:0	
C101TTP-3	–	–	–		
C101TTP-4	236	0	236	1:0	
C101TTP-6	441	0	441	1:0	
C102TTP[b]	192	0	192	1:0	
C105TTP-1[c]	201	0	201	1:0	
C105TTP-2L23[c]	119	0	110	1:0	
C105TTP-4L6[c]	216	0	216	1:0	
F_2 Pi No. 4/					
C101PKT	392	0	392	1:0	
C101TTP-1	221		221	1:0	
C101TTP-2	201	0	201	1:0	
C101TTP-3	107	0	107	1:0	
C101TTP-4	220	0	220	1:0	
C101TTP-6	214	0	214	1:0	
C102TTP[b]	206	0	206	1:0	
C105TTP-1[c]	220	0	220	1:0	
C105TTP-2L23[c]	179	0	179	1:0	
C105TTP-4L6	–	–	–		

[a] R = resistant, S = susceptible. [b] Isolate IK81-25 (102) was inoculated. [c] Isolate 43 (105) was inoculated.

Table 2. Reaction pattern of K 1, Pi No. 4, and NILs belonging to group III. [a]

Line	Test Isolates[b]				
	101	102	103	104	105
Kiyosawa's differentials					
K 1 (*Pi-ta*)	R	R	S	S	R
Pi No. 4 (*Pi-ta*^{2})	R	R	R	R	R
NILs in group III					
C101PKT [*Pi-4a* (t)]	R	R	S	S	R
C101TTP-1	R	R	S	S	R
C101TTP-2	R	R	S	S	R
C101TTP-3	R	R	S	S	R
C101TTP-4	R	R	S	S	R
C101TTP-6	R	R	S	S	R
C102TTP	R	R	S	S	R
C105TTP-1	R	R	S	S	R
C105TTP-2L23	R	R	S	S	R
C105TTP-4L6	R	R	S	S	R

[a] R = resistant, S = susceptible. [b] 101 = IK81-3, 102 = IK81-25, 103 = PO6-6, 104 = PO3-82-51, 105 = 43

None of NILs in group III gave susceptible recombinants in the crosses with K 1 (*Pi-ta*) and Pi No. 4 (*Pi-ta*^{2}) at the F_2 generation (Table 1). These results showed that resistance genes in K 1, Pi No. 4, and the NILs in group III are allelic or closely linked. Both K 1 and Pi No. 4 have resistance genes at the *Pi-ta* locus, and it has been reported that Pai-kan-tao (the donor parent of C101PKT) has *Pi-ta.* The reaction pattern of C101PKT and other NILs in group III to five IRRI test isolates was the same as for that of K 1 (*Pi-ta*) (Table 2). These results indicate that *Pi-4a*(t) was identical to *Pi-ta,* and that all of the NILs in group III have *Pi-ta.* ■

Characterization of weakly virulent bacterial strains associated with rice bacterial blight (BB) or leaf streak (BLS) in southern India

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We classified 70 Indian strains of *Xanthomonas oryzae* pv. *oryzae* (Xoo) from major rice-growing areas in India into races and six serological groups on the basis of their reactivity to a panel of six monoclonal antibodies (mAbs). We retested with a high-titer clone of mAb *Xco-1* and found that the strains of serogroups V and VII (which did not react earlier) gave very weak to moderate enzyme-linked immunosorbent assay values (OD = 0.05 to 0.4) with *Sco-1* and therefore became part of serogroups I and II, respectively. Only two of the 70 strains did not react to *Xco-1.* A mAb-designated *Xco-* T was made to target them. This study reports on these T strains, T1 and T2, which have been characterized through plant inoculations, tests for phenotypic characteristics, and mAb and DNA probes.

Table 1. Serological classification of 87 Indian strains of *Xoo* with monoclonal antibodies (mAbs) and reactions with Xoor and T mAbs.

mAb	Serological group of *Xoo*			*Xoor*
	I	II	V	
X1	+	+	+	+
Xco-1	+	+	–	–
Xco-2	+	–	–	–
Xco-5	–	–	–	–
Xco-T (225)	–	–	+[a]	+
Xco-T (226)	–	–	+	–
Xccola	–	–	–	+
Strains (no.)	67	18	2[b]	8

[a] Xoo strain PX086 (serogroup I) and USA strain X1-5 (serogroup III) showed positive reactions with the mAb
[b] T strains (T1, T2)

Following inoculations, the T strains showed very low virulence to rice and did not cause BB symptoms on any of the differential rice cultivars after clip-inoculation. However, on swab-inoculation, we observed mild BB on IR8 and occasional streaks on DV8S. Strains were re-isolated from these mild BB and BLS symptoms 14 d after inoculation.

T strains react with a genus-specific mAb for *Xanthomonas* and share some surface antigens with strains of *Xoo* and *X. o.* pv. *oryicola (Xoor)* (BLS pathogen) (Table 1). The mAb clone 225.66.2.1, generated to a T strain, reacted with *Xoo* strains PXO86 and *X1-5* and eight strains of *Xoor.* Likewise. some of their phenotypic characteristics were similar to *Xoo* while others were similar to *Xoor* (Table 2). In several characteristics, the T strains gave the same responses as the low-virulent Xoo strain X1-5 from Texas, USA (Table 2).

Table 2. Phenotypic characteristics of *Xoo, Xoor,* and weakly virulent bacterial strains from rice in India.

Phenotypic characteristic	*Xoo* (17 strains)	*Xoor* (8 strains)	T1, T2
Acetoin production	–	–	–
Growth on L-alanine	–	+	+
Growth in presence of cupric nitrate (0.001 %)	–	–	+
Growth on vitamin-free casamino-acid (0.2%)	–[a]	+	+
ß-glucosidase production	+	+	+
Phenylalanine deaminase production	–[a]	+	–
Tyrosinase production	–[a]	–	+

[a] Strain X1-5, a strain from Texas, USA, of a low-virulent *Xoo* was an exception.

Genomic DNA of the T strains (T1, T2), a virulent *Xoo* strain from India (A3857), a low-virulent strain from the USA (X1-8) and *Xoor*- strains (BLS792, BLS298, BLS303) were compared by Southern blot analysis. The four DNA probes used were the plasmids pJEL101 and pTnX1, which contain repetitive, mobile DNA elements; *pBSavrXa10,* which has a cloned avirulence gene from *Xoo;* and two *Eco* RI fragments (8.3 and 5.2 Kb, isolated from plasmid p23-44 and containing part of the *hrp* genes from *Xoo.*

The hybridization patterns of the T strains were clearly different from the patterns observed for the other strains. The pTnX1 probe did not hybridize with DNA from T1, T2, or X1-8. The cloned avirulence gene *(pBSavrXu10)* hybridized with DNA from T1 and T2, but with far fewer bands than those observed in the *Xoo* and *Xoor* strains. X1-8 did not hybridize with *pBSavrXa10.* Fewer bands of the T strains and X1-8 DNA hybridized with *hrp* genes and PJEL101 than were observed in the *Xoo* and *Xoor* strains; patterns for X1-8 and T1 and T2 clearly differed. Therefore, the genome organization of the T strains is clearly different from the Indian *Xoo* strain, the *Xoor* strains, and the USA strain (X1-8) from *Xoo.*

This study indicates that these two low-virulent bacterial strains associated with rice cannot be satisfactorily placed into current taxonomic groups using the available tests for phenotypic characteristics, molecular probes, and plant inoculations. Such strains might represent an evolutionary phase between BB and BLS pathogens of rice. Alternatively, they may belong to a completely different pathovar that has become associated with rice by chance. Although their importance is uncertain, the strains need to be monitored carefully for changes in their virulence to rice. ■

Reaction of promising rice cultivars to gall midge (GM) in coastal Karnataka, India

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GM *Orseolia oryzae* (Wood-Mason) is the most important pest of rice in the coastal region of Dakshina Kannada, Karnataka State. We screened 55 promising cultures for resistance during 1990-92 wet seasons (WS).

Cultures were transplanted in 4-m rows spaced at 20 cm. We recorded number of tillers and silver shoots SO d after transplanting for 10 randomly selected hills per row. Twenty entries were resistant (see table). ■

Reaction of promising rice cultivars to GM infestation in the field. Karnataka, India, 1990-92 WS.

Av percentage of tillers as shoots	Lines
0-5	IET9689, IET10260, IET10770, IET11162, IET10747, IET10775, IETl2489, IET10765, IET10247, IET10867, IET10312, IET7428, IET9552, IET10418, IET11396, IET10765, Shakti, Phalguna, KKP6, KKP2
5-10	IET6461, IETl1089, IET11122, IET11465, IET7830, IET7303, IETl0751, IET10864, IET10668, IET3039, IET7956, MO 4, Cul 170, Cul 168, KMS83-1, GMR17
10-20	IET10333, IET11452, IET10735, IET10318, CTH1, MO 5, MO 6, MO 7, Cul 204, Cul 126, Cul 170, Cul 93, Cul 153-1, Cul 22332-2, Cul 200, Annarpurna, Bharathi
20 or more	IET10748, Jaya (check)

Rice cultures resistant to rice gall midge (GM) biotypes 1 and 4 under artificial infestation in greenhouse

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At least four distinct GM biotypes exist in India. We have been rearing biotypes 1 and 4 (both prevalent in AP) under strict greenhouse isolation conditions. Biotype 1 (the original Hyderabad population) has been maintained on TN1 at DRR since 1976. Biotype 4 was built up from the endemic population of Srikakulam district, AP, and is maintained on Phalguna rice, which is resistant to biotype 1 and susceptible to biotype 4.

We evaluated 1,295 elite breeding lines from DRR-coordinated national yield and observational nurseries against the two biotypes. The standard screening

Advanced breeding lines of rice showing resistance to GM biotypes 1 and 4 in greenhouse, DDR, Hyderabad, AP, India, 1988-90.

Line	Designation	Cross	Source of resistance against	
			Biotype 1	Biotypes 1 and 4
IET10743 IET10742 IET11377	CR309 selections	Orumundakan/ CRM6-106		Orumundakan
IET11375	CR308-38	Orumundakan/ Damodar		Orumundakan
-	CR308-408	Orumundakan/ Damodar		Orumundakan
-	CR311-34	Orumundakan/ Dasal		Orumundakan
-	CR311-134	Orumundakan/ Dasal		Orumundakan
-	CRM24	Orumundakan mutant		Orumundakan
IET9709 IET9710 IET9711 IET9853 IET9854 IET10300	RP2068 selections	Swarnadhan/ Velluthacheera		Velluthacheera
IET10746 IET10831 IET10849 IET11104	R296 selections	CR157-3921 OR57-21		Ptb10
-	CR157-912	Vllaya/Ptb10		Ptb10
	RP1528-1237-39	CR97-1550/ARC7328		Ptb21
IET11483	RTN14-1-1-1	IR36/CR57-MR1523		Ptb21
IET11384	RTN121-1-1-1-1-1	CR57-MR1523/IR36// RTN68		Ptb21
IET11385	RTN332-4-2-1	CR57-40/RTN711		Ptb21
IET11452	RTN29-1-1	CR57-MR1523/IR36		Ptb21
-	WGL 47805	BPT3301/CR57-MR1523		Ptb21
IET10744	CR386-23-5-4	ARC6650/CR94-721-3		ptb18 Ptb21
IET10412	CR407-6-1	CR94/Ratna		Ptb21
IET12348	CR404-14-1	CR94-1512-6/Usa 2-21		Ptb21
-	RP2629-44-33-21	IET8682/IR60		Ptb21
IET10371	Pusa 510	IR36/Pusa 167		Ptb21
IET11164	R281-12	Poorva/IR8608-298		Ptb21
IET10885	TNAU842805	TNAU9426-6/IR50		Ptb21
IET12364	MTU6203	MTU4570/IR50		Ptb21
IET10247	OR633-7	Jajati/Ob677	Ob677	
IET11508 IET11517	RP2543 selections	Rasi/IRP1579-39	Siam 29	
IET12873	RP2547-130-272	ARC5723/ARC6650// RP1579-38	Siam 29	
	RP2547-100-255	RP1579-38	Siam 29	
	RP2547-111-259	RP1579-38	Siam 29	
IET10451	OR487-30-3	T90/IR8/RPW6-13// Siam 29	Siam 29	
-	OR447-20-8	IR8/Siam 29// Parijat///Rasi	Siam 29	
IET11514	RP1959-56- 88-426-30-52	Swarnadhan/Phalguna	Siam 29	
-	RP2541-8642-357	Swarnadhan/RP1579-36	Siam 29	

table continued on next page

Table continued.

	Designation	Cross	Source of resistance against	
			Biotype 1	Biotypes 1 and 4
IET12523 IET12524 IET12525	RP2231 selections	Phalguna/ Velluthacheera	Siam 29	Velluthacheera
IET10762	RP2432-68-11-9	IR36/IET7916	Siam 29	Ptb18, Ptb21
IET11470	RP1607-1240-42	Phalguna/MR1523	Siam 29	Ptb18, Ptb21
–	RP2434-45-3-2	IR50/IET7918	Siam 29	Ptb18, Ptb21
IET10891	RP2235-179-16-10	Phalguna/IR50	Siam 29	Ptb18, Ptb21
IET12871	WGL 46753	Surekha/WGL 16145	Siam 29, Eswarakora	–
IET10850 IET10851	R321 selections	Samridhi/IR36	Eswarakora	Ptb18, Ptb21
IET10517	CR401-6-1	Vijaya/CR904		?
IET10314	WR6-120-10	IR62/Parmel		?
IET10312 IET10313	CR380 selections	CRII/Ratna		?
IET10407	TNAU801790	CR41/CO 39		?
IET12349	CR30-20-1	IR8/Sigadis		?
–	RR217-1	IR17491-5-4-3/ IR2415-90-4-3// IR9129-209-2-2		?

test was used under greenhouse conditions from 1988 to 1990, and replicated four times. Sixty cultures were found resistant to both biotypes (see table). None of the biotype 4-resistant cultures were susceptible to biotype 1, but all of the cultures susceptible to biotype 1 were also susceptible to biotype 4.

Resistance to both biotypes was contributed mainly to the lines by Orumundakan, Velluthacheera, Ptb10, Ptb21, and combinations of two or more donors. Nine cultures exhibiting resistance were derivatives of Siam 29, which is, like its derivative Phalguna, resistant to biotype 1 but susceptible to biotype 4. The other parents involved in cross combinations with Siam 29 and its derivatives probably contributed or modified the resistance reaction in these cultures.

Further studies on reactions of parents involved in these crosses might identify additional gene sources for resistance. ■

Pest resistance—insects

Brown planthopper (BPH)-resistant cultivars from Madhya Pradesh Rice Research Institute (MPRRI) germplasm

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Host plant resistance is an important component of pest management programs to control *Nilaparvata lugens* Stål. To stay ahead of the emergence of new insect biotypes, improved resistant cultivars with more genetic diversity must be developed.

We evaluated 900 MPRRl rice cultivars during 1990-92 to locate better sources of BPH resistance. We infested 9- to 10-d-old test seedlings and checks TN1 and Ptb33 with 1st-and 2d-instar BPH nymphs. Damage to seedlings was scored using the *Standard evaluation systems for rice* (0-9) scale. Cultivars scoring less than three were retested three to six times. Sixty-nine cultivars were

BPH-resistant cultivars from MPRRI germplasm.

Cultivar	IGKVV Acc. no.	Av plant damage score[a] (0-9 scale)	District of origin	Cultivar	IGKVV Acc. no.	Av plant damage score[a] (0-9 scale)	District of origin
Kakadi	K:2531	1.9	Bastar	Kakadiha	K:1832	1.6	Ralpur
Chhoti Kanhai	C:758	2.9	Bastar	Kali Kamod	K:224	2.4	Raipur
Kanhaiya	K:2167	2.9	Bastar	Kanthgulas	K 711 III	2.5	Raipur
Dodki	D:1015	1.2	Bastar	Bhatha Dhourl	B:2876	1.1	Raipur
Farsa Phool	F:16	0.1	Bastar	Dhumki	D:1114	1.5	Raipur
Bhata-Gada-Khuta	B:803 II	2.3	Bastar	Dokalam	D:279	1.1	Ralpur
Gada Khota	G:978	1.7	Bastar	Kankadiya	K:1699	2.9	Raigarh
Hinga	H:435	0.7	Bastar	Dokalam	D:455 III	2.0	Raipur
Jalki	J:287III	1.3	Bastar	Hathi Panjada	H:218	0.2	Raipur
Kabari	K:2312	2.8	Bastar	Hasa	H:56	2.4	Raipur
Kabari	K:2388	2.5	Bastar	Jagnath Prasad	J:55 II	2.1	Raipur
Kanhaiya	K:2413	2.3	Bastar	Jaybay Rang	J:432	0.0	Raipur
Kappe	K:1592	2.3	Bastar	Karhani	K:556 II	17	Raipur
Bas Bhira	B:2655	2.6	Bastar	Karhani	K:1173	1.7	Raipur
Barangi	B:1862	1.3	Bastar	Khatia Pati	K:60	1.9	Raipur
Basangi	B:2682	0.6	Bastar	Kalam	K:1167 I	2.7	Sarguja
Bhainspath	B:61 I	2.0	Bastar	Kalamdani	K:1163	2.6	Sarguja
Kalamdani	K:2478	1.8	Raigarh	Dhouri	D:8011	3.0	Sarguja
Kankadiya	K:430	1.6	Raigarh	Karhani	K:1911	2.6	Sarguja
Kandradiya	K:446 II	1.5	Raigarh	Kanai Khondharo	K:1885	2.4	Bilaspur
Dokalam	D:455 II	1.5	Raipur	Kanak	K:1741	2.4	Bilaspur
Dhouri	D:1043	0.7	Raigarh	Kankadiya	K.652	2.4	Bilaspur
Dhouri	D:1163	2.0	Raigarh	Kapursar	K:1798	2.7	Bilaspur
Dhouri	D:1167	2.0	Raigarh	Karapari	K:164	2.3	Bilaspur
Bhatha Dhouri	B:1651	1.6	Raigarh	Dhori Sulti	D:1070	1.9	Bilaspur
Gang Puriha	G.809	2.0	Raigarh	Ganga Prasad	G:760	3.0	Bilaspur
Dahi Barhi	D:1771	20	Raigarh				

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Cultivar	IGKVV Acc no.	Av plant damage scoria (0-9 scale)	District of origin
Gopal Prasad	G:778 II	1.8	Bilaspur
Girmit	G:570	1.7	Balaghat
Girmit	G:572	2.7	Balaghat
Kansari	K:1761	1.1	Sidhi
Galra	G:718	2.5	Sidhi
Gadur Sela	G:699	0.6	Rajnandgaon
Gadur Sela	G:701	2.9	Rajnandgaon
Ganja Kali	G:702	2.2	Rajnandgaon
Kari Barhi	K:666	2.8	Rapandgaon
Kanak	K:1741	2.4	Shahdol
Barhi	B:1253 I	2.2	Mandla
Barhi	B:1253 II	2.5	Mandla
Hiranakhi	H:161	2.8	Mandla
Basmati	B:409	2.6	Hoshangabad
Wasmati	W:9 I	0.6	Muraina
Kakadisar	K:544	2.8	Seoni
TN1 (susceptible check)		9.0	
Ptb33 (resistant check)		1.8	

[a] Based on SES.

found resistant to BPH (see table). Most of them are from Bastar and Raipur districts. Results indicate that the germplasm maintained at MPRRI (about 20,000 accessions) is a rich source of resistance to BPH.

An insect-feeding test on bromocresol-treated filter paper was also conducted. Insect feeding was judged by the amount of honeydew deposited by a female in 24 h on resistant cultivars Hinga, Kappe, Dhouri 1043, Dhouri 1163, Jaybay Rang, Khatia Pati, Kanak, Ganja Kali, Hiranakhi, and EB 17. Feeding rate was 0.17-65 mm^2 per female in 24 h, which was much lower than the 173-235 mm^2 per female feeding on TN 1. On the resistant check PTB33, the rate was 49 mm^2 per female.

Hinga 435 and Dhouri 1043 had low plant damage scores and feeding rates of 65 and 53 mm^2 per female, respectively, suggesting that the genotypes have the ability to maintain vigor at those feeding rates. However, no correlation between plant damage score and feeding rate on Minga 435 and Dhouri 1043 was observed. ■

Stress tolerance—excess water

Amount of volatile aldehydes released by rice plants after submergence

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During the initial phase of rice seed germination, the production of volatile aldehydes is significantly lower in high-vigor seeds than in medium- and low-vigor seeds.

We conducted an experiment to learn if a relationship exists between plant volatile aldehyde production and submergence tolerance. Seedlings of 10 rice varieties (see table) with varying degrees of submergence tolerance based on seedling survival were grown under greenhouse conditions. At 70 d after seeding, they were completely submerged for 6 d.

To determine aldehyde production, a 50-ml beaker containing 10 ml of 0.2% (wt/vol) 3-methyl-2benzothiazolinone-hydrozone (MBTH) was placed inside a large bottle containing a 5-g sample of chopped tissues from nonsubmerged and submerged plants. Each bottle was fitted with an airtight screw cap to prevent gas leaks.

After 48 h, volatile aldehyde trapped by the aldehyde-absorbing reagent MBTH was determined. A 3-ml aliquot of MBTH was collected from each bottle, put into a test tube containing 2.5 ml of 0.23% (wt/vol) ferric chloride solution, and incubated for 10 min. We then added 2.5 ml of absolute acetone to the tube and closed it with a tightly fitting cork. After 30 min, the absorbance of the reaction mixture was read at 635 nm. Formaldehyde solutions were used as standards.

The results showed that tissues from previously submerged plants released 0-8 times more volatile aldehydes than tissues from nonsubmerged plants.

Amount of volatile aldehydes produced by 70-d-old rice plants after 6 d submergence.

Variety	Survival (%)[a]	Volatile aldehydes produced (ml gas/100 g): Submerged (control)	Submerged for 6 d	Increase over control[b] (%)
Submergence-tolerant				
FR13A (check)	80	16.0	21.0	5.0 (31)
Sabita	75	9.0	14.0	5.0 (55)
Moderately submergence-tolerant				
Sureh	65	4.1	17.0	12.9 (309)
Patnai 23	60	4.3	4.5	0.2 (4)
Jogen	45	4.3	21.4	17.1 (396)
Mahsuri	45	18.4	28.8	10.4 (56)
Submergence-susceptible				
Pankaj	40	4.0	17.0	13.0 (329)
Swarnadhan	35	18.4	32.1	13.7 (75)
Biraj	35	13.3	21.2	7.9 (59)
IR42 (check)	25	5.4	42.5	37.1 (687)
Mean	50	9.7	22.0	12.2
SE	5.5	1.9	3.1	3.0
LSD (0.05)	28	9.5	16.1	15.5

[a] Data taken after 12 d complete submergence at 60 DAT. [b] Figures in parentheses are percentages.

Tissues of IR42 that had been exposed to submerged conditions released the most aldehyde of all the samples (see table).

The correlation coefficients (r^2) between survival percentage and amount of aldehyde produced after submergence was 0.64*; that between survival percentage and increase in aldehyde production was 0.66**.The significant negative relationship between survival percentage and aldehyde production after submergence (y = 40.24 - 0.36 x) might be useful in identifying superior donors for submergence tolerance.

Future research will include determining the types of volatile aldehydes produced by rice plants during submergence. ■

Stress tolerance — adverse temperature

Physiological screening of rice for low temperature tolerance

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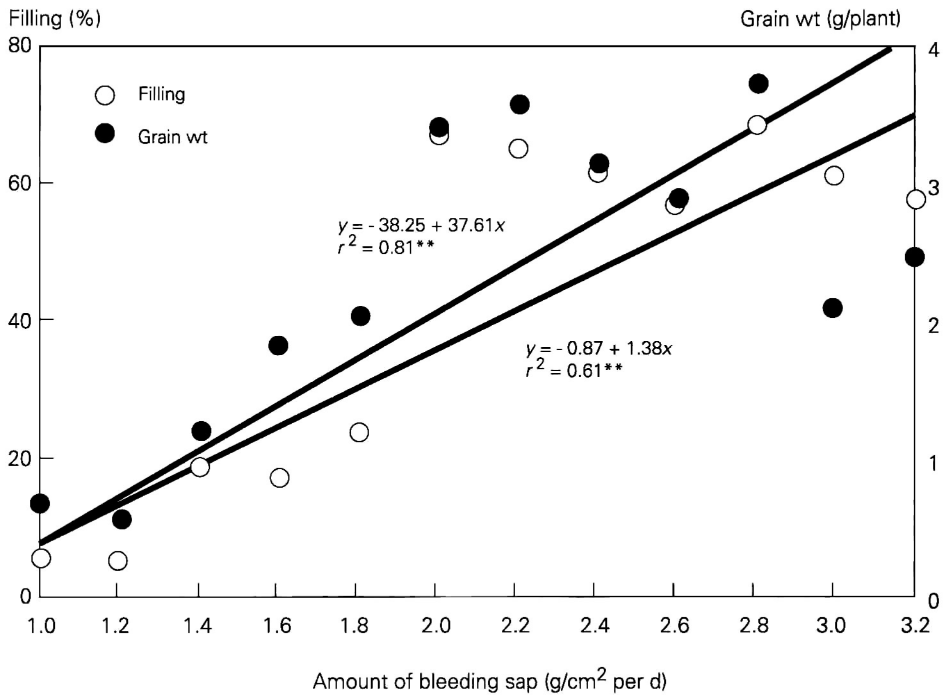
A potential way to increase the tolerance of the rice plant for cold damage is to breed for cold-tolerant varieties. This requires a rapid and reliable way to identify cold-tolerant parents for use in a breeding program. This study evaluated the relationship between the amount of bleeding sap from the main rice culm and cold tolerance of cultivars. We also tried to establish the amount of sap as a criterion for cold tolerance selection in rice.

Twelve japonica rice cultivars were grown in 4-liter plastic pots that each had 3.5 kg soil (0.4 g N, 0.1 g P, and 0.2 g K



Relationship among bleeding sap of seedlings, spikelet filling, and grain weight.

Effect of low temperature treatment (15°C) on the amount of bleeding sap from the main culm and relative percent reduction of spikelet filling of rice plants grown in a phytotron.[a]

Variety	Amount of bleeding sap (g/cm^2 per d) after various days of cold treatment							Cold tolerance score[b]	Fertility (%) at 25-30°C	Fertility (%) at 15°C	Relative reduction (%)
	1	2	3	4	5	6	Av				
Lijanxingtuanhegu	2.9 c	2.7 c	2.6 b	2.7 a	25 b	25 b	27 a	2	78	69	12
Panlong 1	3.5 c	3.8 b	2.3 b	1.7 c	1.3 d	2.2 b	25 a	2	77	62	20
Zhaotongmarxiegu	3.1 c	2.9 c	2.6 b	2.1 b	3.2 a	3.3 a	29 a	2	80	61	23
Kunmingxiaobeigu	4.0 b	3.0 c	1.6 c	1.9 b	1.1 d	1.4 d	22 b	2	81	67	17
Banjimang	4.7 a	3.8 b	2.5 b	2.0 b	2.0 c	2.6 b	3.0 a	3	75	58	22
Gendiao 3	4.0 b	5.6 a	2.1 b	0.7 e	0.9 d	1.2 d	2.4 a	2	72	66	20
Yungen 9	4.4 b	4.0 b	3.0 a	2.0 b	0.5 e	1.8 c	26 a	3	90	57	37
79-219	3.5 c	2.2 d	1.3 c	1.5 c	1.3 d	1.3 d	1.8 c	5	71	17	76
Shomewakai	2.1 d	1.6 e	1.4 c	2.4 a	1.9 c	1.9 c	1.9 c	5	96	24	75
Yomaxiro	3.0 c	2 7 c	1.6 c	0.6 e	1 2 d	0.8 e	1.7 c	6	96	19	81
Towata	2.4 d	1.5 e	0.7 d	0.8 e	0.3 e	1.6 c	1.2 d	7	96	5	95
Nihonbarai	1.1 d	0.9 f	1.3 c	1.0 d	1.2 d	0.9 e	11 d	8	93	6	94
Mean	3.2	2.9	1.9	1.6	1.5	18	2.1	3.9	85	42	48

[a] Within columns, means followed by a common letter are not significantly different at 0.05 level by DMRT. [b] Based on *Standard evaluation system for rice,* (IRRI, 1980), where a score of 1 = most tolerant and 9 = most sensitive at seedling stage

per kg soil) in a greenhouse. Each cultivar had six pots with 5 seedlings/pot. The soil was kept flooded until harvest.

Ten seedlings were used for the bleeding sap measurement. At the 7-leaf stage, tillers were removed and the main culm was cut 8 cm above the soil. A cotton of known weight was wrapped around the tip of the cut stem and covered with a small plastic bag. The main culm was then placed in a growth chamber at 15 °C for 6 d. Light intensity was 250 µmol/m^2 per s and relative humidity, 80%. Bleeding sap from the main culm was measured every 24 h by subtracting the initial weight of the cotton from the final weight and expressed as weight per unit surface area of the cut end. The other plants were grown under normal temperature up to meiosis, then exposed to 15 °C for 10 d in the growth chamber. The remaining 10 plants were grown under normal conditions until maturity.

Cold-tolerant varieties had higher amounts of bleeding sap than cold-sensitive varieties, and the sap decreased with prolonged exposure to low temperature. Cold-sensitive varieties had higher relative reductions in percent fertility (see table). Spikelet filling percentage and grain yield per plant were positively correlated with the amount of bleeding sap (see figure).

The correlation coefficients between cold tolerance score and amount of bleeding sap under low temperature treatment for 1-6 d (based on values in the table) are 0.51, 0.57, 0.58, 0.29, 0.13, and 0.16, respectively. The r^2 for average amount of bleeding sap versus scale of cold tolerance is 0.81.

Results suggest that the average amount of bleeding sap under low temperature treatment (15 °C) for 6 d could be used as one of the physiological criteria for cold tolerance selection at tillering stage. The selection threshold of bleeding sap should be 2.0 g/cm^2 per d. ■

Stress tolerance — adverse soils

Foliar Spraying of K in rice in coastal saline soils

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Integrated rice and prawn culture is popular on Pokkali soils. Flash floods and ingression of sea water through tidal currents are problems. Pokkali soils are medium in available N, high in P, and medium to high in K. Sodium ions in the soil are suspected to hinder the absorption of K through rice roots. A direct source to sink translocation of K should increase K utilization, raise grain yield, and impart some salinity tolerance to the plant by excluding Na from the shoot. The ability of a cultivar to accumulate K in its shoot correlates well with salt tolerance.

In this study we aimed to provide adequate ionic K concentration in the shoot and to facilitate direct movement of K from the leaf to the grain.

Soil at RRS has pH of 3.5-4.5. Ten rice varieties and cultures were raised in 2- × 1-m field plots without fertilizer. A 3% foliar spray of KC1 was applied 1 wk before and 1 wk after panicle initiation to half of each plot. We harvested 10 plants at random from the treated and untreated halves of each plot. Panicle characters, grain yield, and accumulation of Na and K in the grain were estimated (see table).

Grain yield was highest in treated culture 857 (a hybrid of Vyttila 2/IR5). Vyttila 1, cultures 704 and 708, Neeraja, and CSR 13 had increased yields with treatment. The K-Na ratio was highest in Neeraja when treated, although its grain had only traces of Na when untreated. Neeraja has some mechanism to exclude Na accumulation in its tissue. Results indicate rice definitely responds to foliar K sprays and this response differs among varieties. ■

Effect of foliar spraying of K on rice grown on Pokkali soils. Vyttila, Kerala, India.

Variety	Grain (no.)		Chaff (%)		100-grain wt (g)[b]		Gram yield (g/plant)		Difference in yield (g)	Grain content K (%)		Grain content Na (%)		K-Na ratio	
	Treated[a]	Control	Treated	Control	Treated	Control	Treated	Conrol		Treated	Control	Treated	Control	Treated	Control
Vyttila 3	65.5	93.3	19.9	12.9	3.41	2.87	9.38	18.92	(–)9.54	0.46	0.46	1 80	2.25	0.255	0.204
Culture 701	88.9	78.7	24.6	10.9	3.58	3.82	23.02	15.92	15.08	0.58	0.52	1.40	2.50	0.414	0.208
Culture 869	109.2	161.3	26.3	34.6	3.91	3.56	38.46	51.76	(–)13.30	0.50	0.56	1.40	1.15	0.357	0.486
Culture 904	90.2	87.9	15.2	14.9	3.64	3.32	28.70	43.76	(–)15.06	0.50	0.54	1.50	1.45	0.333	0.275
Vyttila 1	82.4	88.9	23.4	18.9	2.76	3.30	27.88	12.80	15.08	0.48	0.52	1.35	1.00	0.384	0.520
Culture 651	66.2	128.1	22.4	22.5	2.68	2.64	11.50	33.86	22.36	0.48	0.40	1.25	1.40	0.384	0.285
Culture 708	87.2	93.0	13.4	17.8	3.26	3.35	35.74	15.48	20.26	0.46	0.50	1.85	1.50	0.248	0.333
Culture 857	138.1	136.8	27.6	27.7	3.35	3.24	88.22	43.08	45.14	0.40	0.48	1.40	2.00	0.285	0.240
CSR13	120.1	115.7	41.5	27.1	2.78	2.12	27.16	20.32	6.84	0.44	0.52	1.40	1.50	0.314	0.346
Neeraja	115.6	131.4	20.2	18.0	2.39	2.32	38.66	36.20	2.46	0.52	0.20	1.80	Trace	0.650	0.200

[a] Follar spray of 3% M.O.P KCl. [b] Mean value of 10 plants.

Two promising IRRI rice hybrids named in Vietnam

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Two promising IRRI rice hybrids have been named UTL 1 and UTL 2 by CLRRI and released for regional testing in some provinces in Vietnam. UTL 1 is hybrid IR58025 A/IR29723-143-3-2-IR (IR646 15 H) and UTL 2 is IR62829 A/ IR29723-143-3-2-IR (IR64616 H).

UTL 1 has a growth duration of 117-120 d and is 115 cm tall; UTL 2 has a shorter duration (110 d) and is 90 cm tall. These hybrids significantly outyielded check varieties MTL 58, MTL 61, and IR64 during four seasons of tests at CLRRI (Table 1). In addition, they possess good grain quality compared with Chinese-developed hybrids Tap Ciao 3 (TG3) and Quang Uu Thanh (QUT). Grain quality of UTL 1 is comparable to that of IR64, which is one of Vietnam's preferred varieties for export (Table 2).

UTL 1 and UTL 2 showed resistance to major insect pests and diseases under field conditions in Cuu Long Delta. Both, however, were susceptible to bacterial blight in the wet season if N fertilizer was applied at rates above 80 kg N/ha.

The newly named hybrids are being tested in northern Vietnam. UTL 1 has shown yield potential as high as that of the Chinese hybrids being grown in northern Vietnam, but its grain quality is preferred. CLRRI is producing UTL 1 and UTL 2 seed to meet the demands of provincial agriculture departments. ■

Table 1. Yield and standard heterosis of IRRI-bred hybrids released by CLRRI, Omon Cantho, Vietnam.

Season[a]	Yield (t/ha)			LSD (0.05)	Standard heterosis (%)	
	UTL 1	UTL 2	Check		UTL 1	UTL 2
1990 WS	7.6	67	5.3 (MTL 58)	0.8	43.4	26.4
1990-91 DS	6.0	6.1	5.0 (MTL 61)	0.4	20.0	22.0
1991 WS	4.6	4.9	3.7 (IR64)	0.7	24.3	32.4
1992 WS	4.9	5.5	4.90 (IR64)	–	0.0	12.2

[a]WS = wet season, DS = dry season.

Table 2. Grain quality characteristics of hybrids UTL 1 and UTL 2. Mekong Delta, Vietnam.

Characteristic	Hybrid				Check
	UTL 1	UTL 2	TG3	OUT	IR64
Kernel length (cm)	7.2	6.1	6.2	6.3	7.6
Kernel breadth (cm)	1.9	2.0	2.4	2.5	2.2
Length-breadth ratio	3.7	3.1	2.5	2.6	3.4
Milling percentage	80	78	77	77	77
White rice percentage	68	67	63	64	65
Head rice recovery (%)	38	37	35	53	48
White belly (grade)	5	5	9	9	5

Performance of VX83 in Vietnam

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Variety VX83 was selected from the cross IR8/IR22//IR19746-11-33 in a 10× 10 complete diallel crossing set. VX83 has been recommended for the late spring, early summer, and summer-autumn rice crops in intensified farming systems in Vietnam. Using VXX3 makes it possible to expand areas under winter crops such as maize, sweet potato, soybean, potato, and other vegetables.

VX83 yielded more grain than checks CR203 and CN_2 across two seasons, three yr, and six locations (see table). ■

Performance of VX83 and checks.[a] Vietnam, 1989-91.

Site	Entry	Grain yield (t/ha)		
		1989	1990	1991
Duyenthai	VX83	5.8	5.8	5.7
	CR203	5.5	5.6	4.4
	CN_2	4.0	3.9	3.7
Van Binh	VX63	5.2	4.9	5.2
	CR 203	5.1	4.9	4.0
	CN_2	3.8	3.8	3.6
INSA	VX83	5.3	5.2	5.2
	CR203	5.2	5.1	4.0
	CN_2	4.0	4.0	3.8
Cam Dien	VX83	5.2	5.0	5.2
	CR203	5.1	4.1	4.4
	MT32	4.1	3.6	–
Thieu Yen	VX83	–	5.0	5.0
	CR203	–	4.7	4.2
Phu Loc	VX83	–	4.9	5.0
	CR203	–	4.8	4.2

[a] Checks = CR203, CN_2, and MT32.

Integrated germplasm improvement—rainfed lowland

Performance of new rice cultivars in monsoon season in central Kerala, India

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Performance and adaptability of new rice cultivars Makam, Remya, Kanakam (Moncompu), and Jayathy (Pattambi) were studied in central Kerala under several on-farm lowland situations varying from irrigated transplanted to rainfed dry sown. Soils ranged from sandy to clayey loam. Trials were conducted in 1991 and 1992 kharif (monsoon) seasons. Eight replications were laid out in fields of eight farmers at each location (Table 1).

The cultivars outyielded the checks at all locations, showing their adaptability to a range of conditions. Agronomic traits and general characteristics of the cultivars are in Table 2.

Table 1. Grain yield at several locations in central Kerala, India, 1991 and 1992 kharif.

Variety	Yield (t/ha)				
	1991				
	Kannambra	Avinissery	Karukkully	Kalady	Mean
Makam	6.4	5.7	3.9	3.5	4.9
Remya	6.1	5.5	4.0	3.6	4.8
Kanakam	5.6	5.7	3.6	3.4	4.6
Jayathy	6.3		(white rice not preferred)		
Matta Triveni (check)	4.7	4.9	–	–	–
Jyothy (check)	–	–	3.1	2.6	–
Pavizham (check)	–	–	3.3	3.1	–
LSD (0.05)	0.4	0.5	0.3	0.6	
	1992				
	Alathur	Kozhalmannam	Wadakkanchery	Aluva	Mean
Makam	5.3	4.9	3.9	4.8	4.7
Remya	4.2	4.1	4.3	4.6	4.3
Kanakam	5.2	4.9	4.6	4.1	4.7
Jayathy	5.2	5.0	3.7	4.1	4.5
Jyothy (check)	4.7	3.3	3.4	4.0	3.9
LSD (0.05)	0.5	0.5	0.6	0.3	

Table 2. Agronomic traits of new rice cultivars under on-farm conditions, central Kerala, India, 1991 and 1992 kharif.

Variety	Pedigree	Kernel characters	Maturity (d)	Plant height (cm)	Panicles (no./hill)	Panicle length (cm)	1,000-grain wt (g)
Makam	MO 9 (ARC6650/Jaya)	Red short bold	120	83	6.2	21.0	23
Remya	MO10 (Jaya/PTB33)	Red short bold	119	88	5.7	24.7	30
Kanakam	MO 11 (IR1561/PTB33)	Red medium bold	121	87	5.0	26.0	30
Jayathy (1727)	PTB46 (Triveni/IR2061)	White	119	95	6.4	25.0	25

Integrated pest management—disease

Sheath rot (ShR) disease of rice in Punjab, Pakistan

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Dark brown lesions of diverse size and shape on flag leaf sheaths and partially emerged panicles in Basmati 385 were observed during 1990. Isolations from infected plant parts revealed the presence of *Sarocladium oryzae.*

To fulfill the requirements of Koch's postulates for pathogenicity, flag leaf sheaths were injected with 10-d-old culture 8-10 d before panicle emergence during 1991. Symptoms similar to those occurring under natural infection conditions were observed. Incidence was 79% in inoculated control and 15% in uninoculated control. Reisolation of infected tillers from both treatments confirmed *S. oryzae* to be the causal organism.

ShR incidence has increased with the cultivation of early-maturing, high-yielding, and susceptible Basmati 385. The highest disease incidence under natural infection conditions was 56.6% on Basmati 385, 27.1 % on Basmati 370, 17.5% on Basmati 6129, and 25% on 4048 line. This is the first report of the disease in Punjab, Pakistan. ■

Crop and resource management

Integrated fertilizer management

Effect of granular N fertilizers on growth and grain yield of rice

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We studied the effect of granular N fertilizers on the growth, grain yield, and nutrient use efficiency of rice under irrigated conditions during the 1991 dry season (DS) at the DRR Experimental Farm. Soil is a Vertisol with pH 8.3, CEC 49.2 meq/100 g soil, 0.01 % total N (modified Kjeldahl method), and 6 ppm available P (Olsen's method). The experimental plots, except control, were fertilized uniformly with 90-26.4-41.5 kg NPK/ha.

Fertilizers studied were prilled urea (PU) of 350-400 prills/g wt, large granule urea (LGU) of 4-6 granules/g wt, urea supergranules (USG) of 1 g wt each, diammonium phosphate (DAP) of 28-32 granules/g wt, large granule diammonium phosphate (LDAP) of 7-10 granules/g wt, and single superphosphate (SSP) (see table). DAP, LDAP, and SSP were applied basally; PU and LGU in two splits; and USG was placed in the root zone 7 d after transplanting.

Large granular treatments (USG + LDAP) had significant increases in growth and grain yield and were superior to all other treatments except USG + SSP. We observed promising results in all treatments with LDAP, irrespective of N source. Grain yields with LDAP treatments were 5.5-6.4 t/ha, compared with 4.8-6.1 t/ha with SSP treatments.

The response of grain yield to N and also the unit response per kg of NPK was high in treatments receiving point placement of N as USG and basal dose of LDAP.

It can be inferred that rice responds better to granular N and P fertilizers than to PU and SSP. Placement of N as USG in the root zone and basal application of P and part of the N as LDAP gave the best results for growth, yield performance, and nutrient use efficiency in rice under DS irrigated conditions. ■

Grain yield and nutrient response as influenced by granular fertilizers, 1991-92 dry season (rabi).

Treatment[a]	Grain yield (t/ha)	N response (kg grain/ kg N)	Nutrient response (kg grain/ kg nutrient)
Control	2.9	-	-
PU + SSP	4.8	20.8	9.3
PU+ DAP	5.2	25.2	11.3
PU + LDAP	5.6	30.5	12.7
LGU + SSP	5.2	26.3	11.9
LGU + DAP	5.1	24.9	11.2
LGU + LDAP	5.5	28.8	13.0
USG + SSP	6.1	35.7	16.0
USG + LDAP	6.4	39.0	17.6
LSD (0.05)	0.4		
CV (%)	5.7		

[a] All treatments, except control, received 90 kg N/ha, 26.4 kg P/ha, and 33.2 kg K/ha.

Fertilizer management—inorganic sources

Modern varieties (MVs) yield more than traditional varieties (TVs) in Cambodia regardless of fertilizer use

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Modern varieties and associated technologies were evaluated in a series of on-farm adaptive trials (OFAT) initiated by CIRP in 1990. Farmers conducted the trials using their own resources and style of crop management. They did not receive inputs or insurance against crop failure to ensure that test varieties were exposed to the same constraints they would encounter when adopted by farmers. Some farmers did not apply fertilizer or manure because the inputs were unaffordable or unavailable. Those using fertilizers applied a maximum of 60 kg N/ha and 30 kg P/ha.

Farmers were provided with 1 kg seed each of IR66, IR72, and Kru (IR13429-150-3-2-1), which had been identified as superior early rice varieties. Each farmer provided 1 kg seed of the best local short-duration variety to serve as a check. Checks represented most of the common

Yield of IR66, IR72, and Kru compared with local checks in OFAT in 1990 WS (51 locations), 1991 DS (39 locations), 1991 WS (90 locations), and 1992 DS (80 locations).

Variety	With fertilizer		Without fertilizer	
	Yield (t/ha)	% over check	Yield (t/ha)	% over check
	1990 WS			
	23 locations		*28 locations*	
IR66	3.3	14	2.5	0
IR72	3.1	7	2.5	0
Kru	2.9	0	3.0	17
Check	2.9	0	2.5	0
	1991 DS			
	22 locations		*17 locations*	
IR66	5.4	26	3.6	3
IR72	4.9	14	3.6	3
Kru	4.8	12	3.6	3
Check	4.3	0	3.5	0
	1991 WS			
	60 locations		*30 locations*	
IR66	3.1	11	3.1	15
IR72	3.0	7	3.2	19
Kru	3.1	11	3.1	15
Check	2.8	0	2.7	0
	1992 DS			
	36 locations		*44 locations*	
IR66	5.1	24	4.3	13
IR72	4.7	15	3.9	3
Kru	4.8	17	4.1	8
Check	4.1	0	3.8	0

TVs of Cambodia. Each variety was planted in a 100-m^2 plot. Crops were grown under rainfed or irrigated conditions in 15 provinces. Farmers recorded variety characteristics and chose varieties on the basis of performance. In most cases, farmers chose to adopt MVs regardless of whether they used fertilizer.

IR66, IR72, and Kru outperformed checks regardless of fertilizer application (see table). The differences in yield between varieties and checks were greater in the dry season (DS) than in the wet season (WS). Yields were larger where farmers applied fertilizer.

We conclude that MVs can perform as well as or better than TVs with and without fertilizer inputs. Farmers are more likely to adopt MVs that can adapt to a range of nutrient supply environments. In Cambodia, the use of new MVs has spread to 20,000 ha during the past 2 yr. ■

Fertilizer management—organic sources

Adhatoda vasica (asuro): a superior indigenous green manure species for rice in the hills of Nepal

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Adhatoda vasica (asuro) is a gregarious, thickly branched, evergreen woody shrub with medicinal, pesticidal, fungicidal, and manurial properties. The nonleguminous species grows well and produces dense foliage in the warmer regions of Nepal up to elevations of 1300 m above sea level.

Farmers in the hills of Nepal traditionally use the foliage of asuro and other indigenous plants to supply nutrients for their wetbed rice nurseries. Asuro quickly decomposes when incorporated into the soil. Tissue analysis found that asuro contains 4.3% N, 0.88% P, and 4.49% K.

We studied the green manuring potential of asuro and compared it with another indigenous nonlegume, *Eupatorium odenophorium* (banmara), chemical fertilizer (60-30-30 kg NPK/ha), and farmers' rate of compost (10 t/ha) in irrigated transplanted rice (Khumal-4 at Shera and Keware, Manakamana-1 at Yampaphat), during the 1991 rice season (Jun-Nov). The experiment was laid out in a randomized complete block design with five replications at each of three locations. Fresh biomass of asuro and banmara, compost, and fertilizers were incorporated into soil at puddling.

Pooled analysis of variance revealed a highly significant treatment difference for grain yield across locations. Mean yield was highest with asuro (4.8 t/ha) (see table). Banmara and chemical fertilizer showed no difference. Asuro's high yield is because of the high nutrient content in its foliage. These results agree with farmer reports that asuro is the best indigenous species for green manuring.

Hard or soft wood cuttings of asuro can be propagated easily. Asuro makes a good live fence and is a good source of nectar for honey bees. ■

Comparative performance of *Adhatoda vasica* green manure with other nutrient sources at locations in Western Hills, Nepal, 1991.

Treatment	Rice yield[a] (t/ha)			
	Shera (1250 m)	Keware (1200 m)	Yampaphat (450 m)	Mean
Compost (10 t/ha)	2.7	3.5	4.4	3.6
60-30-30 kg NPK/ha	4.0	3.4	4.7	4.0
Adhatoda vasica (15 t/ha)	5.2	3.9	5.3	4.8
Eupatorium odenophorium (15 t/ha)	3.6	3.6	4.3	3.9
Mean	3.9	3.6	4.7	4.2
SE for treatment (T)	0.3	ns	0.1	0.1
SE for location (L)				0.1
SE for T × L				0.2

[a] At 12% moisture

Crop management

Residual effects of phosphorus on deepwater rices (DWR) submerged at intermediate water depths and by flash flooding

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We studied the effect of P fertilizer at 0, 8.8, 17.6, 26.4, and 35.2 kg P/ha on semidwarf, long-duration (165 d), photoperiod-sensitive rice cultivar CR1016 under intermediate deep water (15-50 cm) and simulated flash flooding conditions in 1987-89. Crops were sown at 400 seeds/m^2 at 20-cm row spacing in dry soil before the onset of monsoon rains. They were fertilized with a common basal dose of 60 kg N and 16.6 kg K/ha in the plow furrow. Soil was alluvial, sandy-clay-loam in texture, with 0.09% total N, 22 kg available P/ha, and 128 kg available K/ha.

Crops were grown in the same plots all 3 yr without disturbing the layout plan and with minimal shifting of soil across plots. P treatments in 1988 were applied to the same plots as in 1987 to study the cumulative effect of P. P fertilizer was not applied in 1989 to find out the residual effect.

The experiment was laid out in a split-plot design (submergence levels as main plots and P levels as subplots) with three replications. Water depth was 15-50 cm during most of the cropping period, except when flash floods were created in specially constructed cement tanks. Plants were submerged up to 80 cm for 10 d in 1987 and 1988 and partially submerged up to 70 cm for 7 d in 1989.

Grain yield decreased due to submergence. The magnitude of decrease

Effect of different P levels on grain yield of rice under flash flooding (submerged) and natural intermediate deep water conditions (unsubmerged), Cuttack, India.

P level (kg/ha)	Grain yield (t/ha)								
	1987 (Direct effect)			1988 (Cumulative effect)			1989 (Residual effect)		
	Submerged	Unsubmerged	Mean	Submerged	Unsubmerged	Mean	Submerged	Unsubmerged	Mean
0	2.3	5.2	3.7	0.8	2.7	1.8	2.6	3.3	2.8
8.8	3.1	5.2	4.1	2.4	3.3	2.9	3.3	3.5	3.4
17.6	3.4	5.1	4.3	2.3	3.4	2.9	3.2	3.6	3.4
26 4	3.2	5.3	4.3	2.4	3.7	3.1	3.3	3.6	3.4
35.2	3.2	5.1	4.2	2.7	3.8	3.3	3.3	3.6	3.5
Mean	3.0	5.2		2.1	3.4		3.1	3.5	
LSD (0.05)									
Submergence levels		0.9			0.7			0.6	
Plevels		0.3			0.4			0.2	
(Interaction)		0.5			ns			ns	

was more in 1987 (2.2 t/ha) and 1988 (1.3 t/ha) than in 1989 (0.4 t/ha) because of the varying depth and duration of crop submergence (see table). P proved beneficial when the crop was subjected to flash flooding or when it was grown in the same plots and could take advantage of residual P effects.

The interaction between submergence and P levels was significant in 1987 but not in 1988 and 1989. P fertilizer up to 17.6 kg P/ha in 1987 increased grain yield under submerged conditions but not under unsubmerged conditions. Effect of P was observed under both conditions in 1988, though it was more pronounced under submerged than unsubmerged condition, possibly due to the cumulative effect of P. Grain yield increased significantly under both conditions in 1989, thus confirming the residual effect of P, though effects of 20-80 kg P/ha treatments were similar.

Results indicate that fertilizing with 8.8-17.6 kg P/ha is essential for DWR submerged by flash flooding at the early vegetative stage. Residual effects of P under excess water situations need consideration when calculating P fertilizer doses on a long-term basis. ■

Integrated pest management — diseases

Leaf blast (Bl)-leaffolder (LF) interactions in lowland rice

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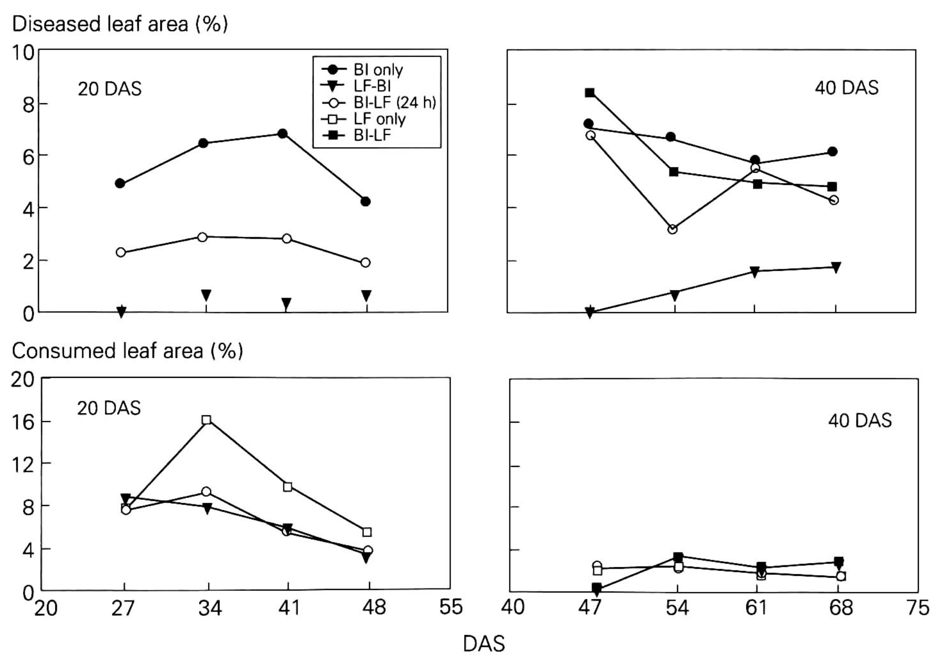
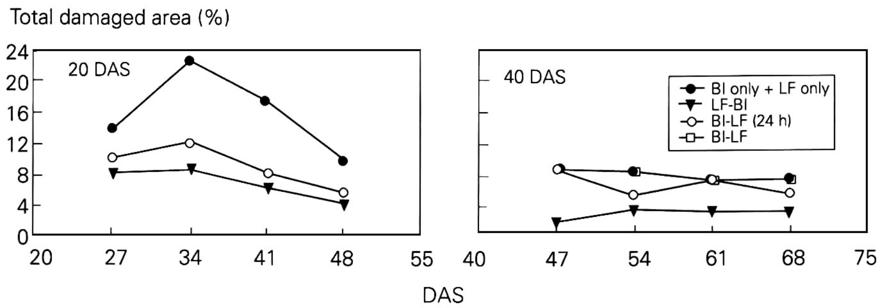
The individual and combined development of B1 *(Pyricularia grisea)* and LF *(Cnaphalocrocis medinalis)* were measured in glasshouse experiments as B1 severity and LF consumption during Aug 1990-Mar 1991 using direct seeded IR72 in plastic trays under lowland conditions. Treatments of an uninoculated check, single B1 inoculation, single LF infestation, and combinations of subsequent LF infestation at 7 d after B1 inoculation (Bl-LF), subsequent B1 inoculation at 7 d after LF infestation (LF-BI), and subsequent LF infestation after B1 inoculation within 24 h (Bl-LF [24 h]) were applied at 20 and 40 d after sowing (DAS) using randomized complete block design with three replications.

An inoculum suspension of isolate PO6-6 containing 100,000 spores/ml was sprayed onto plants with an atomizer attached to a vacuum pump. Inoculation

1. Diseased and consumed leaf area of IR72 in trials at 20 and 40 DAS.





2. Total damaged area of IR72 in trials at 20 and 40 DAS.

was inside a wooden chamber lined with wet jute sacks and covered with plastic sheets.

Two 2d-instar LF larvae were placed on the youngest leaf of each plant using a wet fine camel's hair brush. Each seedling was then enclosed in a mylar cage with nylon mesh on top.

Diseased leaf area (DLA) and consumed leaf area (CLA) were traced on clear acetate plastic sheets and run through a leaf area meter (LICOR, model LI-3000) for four consecutive weekly samplings after treatment application. Total damaged area was determined by adding DLA and CLA.

Reduced DLA showed that LF consumption had an antagonistic effect on B1 development in the trials at 20 and 40 DAS (Fig. 1). DLA in the LF-B1 treatment was significantly lower than in the single B1 inoculation treatment in the 20 DAS trial. In the 40 DAS trial, the LF-B1 treatment produced significantly lower DLA relative to the other treatments. B1 inoculation at 7 d after LF infestation appears to slow B1 development at pest infestation times of 20 and 40 DAS (Fig. 1).

An antagonistic effect between B1 and LF was observed in CLA in the 20 DAS trial where the combination treatments of LF-B1 and B1-LF (24 h) showed significantly lower CLA than the single LF infestation treatment at 34, 41, and 48 DAS. B1-LF combination treatment, however, produced a significantly higher CLA than the single LF infestation treatment at 54, 61, and 68 DAS in the 40 DAS trial. This suggests that B1 development might have a synergistic effect on LF consumption at 40 DAS, when LF infestation starts at 7 d after B1 inoculation (Fig. 1).

Total damaged area showed a less than additive interaction between B1 and LF in the 20 DAS trial. Total damaged areas in the combination treatments were significantly lower than in the summed single B1 and LF treatments (Fig. 2).

In the 40 DAS trial, no significant differences were observed for total damaged areas among combination treatments of B1-LF and B1-LF (24 h) and the summed single B1 and LF treatments. However, the LF-B1 combination treatment produced a significantly lower total damaged area compared with the other combination treatments and added single B1 and LF treatments. This implies an antagonistic interaction of LF and B1 when B1 was inoculated at 7 d after LF infestation (Fig. 2).

Our results show that at 20 DAS. B1 and LF interact antagonistically, in which B1 decreases LF consumption. In addition, LF consumption decreases DLA when B1 is inoculated at 7 d after LF infestation. At 40 DAS, LF consumption antagonires B1 development when B1 is inoculated at 7 d after LF infestation, while a synergistic effect of B1 on LF consumption occurs when LF infestation starts at 7 d after B1 inoculation. ■

Seed dry-heat treatment against transmission of *Pseudomonas fuscovaginae,* causal agent of bacterial sheath brown rot of rice (BSR)

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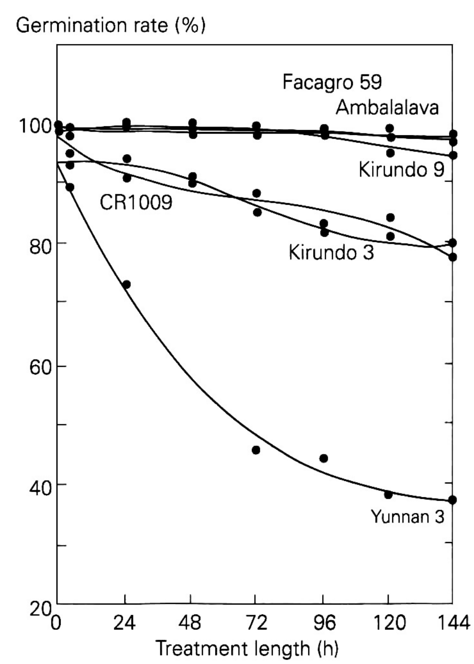
BSR is a major constraint to growing rice in Burundi's swamps at elevations of more than 1,300 m. BSR is transmitted on seed.

Effect of seed age on ability to germinate before and after heat treatment (6 d at 65 ± 1°C) for Yunnan 3. Burundi, 1992.[a]

Seed harvest	Germination rate (%)	
	Before treatment	After treatment
May 1992	90 ± 2	79 ± 8
Jun 1991	51 ± 7	1 ± 2
May 1991	47 ± 9	3 ± 3
Jun 1990	3 ± 3	0 ± 0
Jun 1989	0 ± 0	–

[a] Mean of 5 × 20 seeds.

Decrease of viability during dry heat treatment (65 ± 1 °C). Each point was obtained from 5 × 20 seeds.



Results of a study at the Centro Internacional de Agricultura Tropical indicated that seed can be cleaned completely by exposing it for 6 d to a dry heat of 65°C. This treatment was lethal when first applied to Burundi-cultivated Yunnan 3. Further studies using six cultivars showed that indicas Ambalalava, Facagro 59, and Kirundo 9 endured the treatment without problems but that viability progressively decreased among the .japonicas. After 6 d of the treatment, viability decreased by about 20% for CR1009 and Kirundo 3 and more than 60% for Yunnan 3 (see figure). Results confirmed that heat treatment eradicated *P. fuscovaginae* from the aced (data not shown).

The discordance in germination for Yunnan 3 in the tests was attributed to seed age. The natural germination rate dropped by half for year-old seed, and the sensitiveness to heat increased so that less than 5% of the seeds germinated after the treatment. After 2 yr, the few seeds still viable were killed by temperature (see table). Seed moisture levels were also tested. but they did not affect germination ability.

The effects of disinfecting seeds for BSR in the fields at rice maturity were minimal because of the apparently ubiquitous distribution of the bacteria; their survival in the ground, on crop residues, and on other cultures and weeds; and their easy transmission among plants. Heat treatment—subject to a few precautions—is recommended to prevent the spread of BSR during germplasm exchange. ■

Relationship between tungro (RTD) infection and water level in direct seeded rice

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IRRI

Infection rate of RTD in direct seeded rice has been reported to be less than in transplanted rice. We examined tungro virus infection in rice direct seeded in different water depths in 1992 wet season.

The 3- x 7-m plots were laid out in split-plot design (main plot = water depth, subplot = variety) with four replications. Ten varieties, two of which were coated with the oxygen-release chemical Calper to improve crop establishment, were broadcast at 200 seeds/m^2 onto puddled fields. Water depths of 0, 5, and 10 cm were maintained for 21 d, after which flooding was a uniform 5 cm. Rice plants emerged from 0 cm water at 3-5 d after seeding (DAS), from 5 cm at 6–9 DAS, and from 10 cm at 6-10 DAS. Carbofuran granule was applied at 1 kg active ingredient (ai)/ha at 1 and 34 DAS, and 2,4-D emulsifiable concentrate (EC) at 0.8 kg ai/ha at 28 DAS. Weed infestation in nonflooded plots was about 7 times higher than in flooded plots at 28 DAS (240 vs 1700 weeds/m^2).

RTD incidence was scored visually at 56 DAS. We determined infection of rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV) by collecting 24 samples in a W-pattern from each replication at 78 DAS and indexing by enzyme-linked immunosorbent assay. RTD symptoms were not observed in nonflooded plots, but were severe in flooded plots. More plants were infected with RTBV and RTSV in flooded plots than in nonflooded plots (see table). Three varieties showed low infection rate and may harbor resistance to the vector. Results indicate that susceptible varieties incur higher RTD infection in direct seeded rice culture with flooding than without flooding. ■

Tungro incidence and percentage of infection of RTBV and RTSV in direct seeded rice in different depths of water.[a]

Variety	Tungro incidence[b] (score)			RTBV (%)			RTSV (%)		
	Water depth (cm)								
	0	5	10	0	5	10	0	5	10
ASD 1	0.0 bU	7.8 aUV	6.5 aVW	2 bW	28 aWX	80 aWX	32 aW	96 aW	94 aW
ASD 1 (coated)	0.0 bU	6.0 aVW	7.0 aUV	2 bW	21 aXY	71 aWX	41 aW	91 aW	99 aW
Chin-Chan	0.0 bU	0.8 aY	0.8 aY	8 bW	53 aWX	81 aWX	39 aW	93 aW	100 aW
IR50	0.0 bU	6.5 aVW	6.5 aUV	0 cW	32 bXY	97 aW	4 bY	94 aW	99 aW
IR50 (coated)	0.0 bU	6.5 aVW	7.0 aUV	1 bW	30 aXY	69 aWX	13 bXY	91 aW	96 aW
Caloro/Blue Rose	0.0 bU	8.8 aU	8.5 aU	1 bW	88 aW	95 aW	35 aW	98 aW	96 aW
IR31802-48-2-2-2	0.0 bU	5.3 aW	4.8 aW	3 bW	37 aWX	63 aWX	24 aWX	71 aW	71 aWX
CO 25	0.0 aU	0.3 aZ	0.0 aZ	3 bW	21 aXY	57 aWXY	17 bXY	35 aW	51 abXY
IR36	0.0 bU	2.0 aX	1.8 aX	0 bW	40 aWX	52 aXYZ	7 bXY	88 aW	86 aW
Farangey	0.0 aU	0.0 aZ	0.0 aZ	0 bW	3 abZ	9 aYZ	4 aY	2 aX	17 aZ
IR41996-50-2-1-3	0.0 aU	0.0 aZ	0.0 aZ	3 aW	5 aYZ	7 aZ	8 bY	27 aW	32 aXY
BR1870-89-1-1	0.0 aU	0.0 aZ	0.0 aZ	0 bW	3 abZ	15 ayZ	3 aY	3 aX	9 aYZ
Mean of top nine	0.0 b	4.9 a	4.8 a	2 c	39 b	74 a	24 b	84 a	88 a
Mean of bottom three	0.0 a	0.0 a	0.0 a	1 b	4 ab	10 a	5 b	11 a	19 a

[a] Means having a common letter in columns (UVWXYZ) and sections of row (abc) are not significantly different at the 5% level by DMRT. [b] Visual scoring: 0 = no infection, 1 = trace to » 1 %, 2 =» 5%, 3 = » 10%, 4 = » 20%, 5 = » 30%, 6 = » 40%, 7 = » 60%, 8 = » 80%, 9 = » 100%.

Variation in appressoria and infection process of *Sclerotium oryzae,* which causes stem rot of rice

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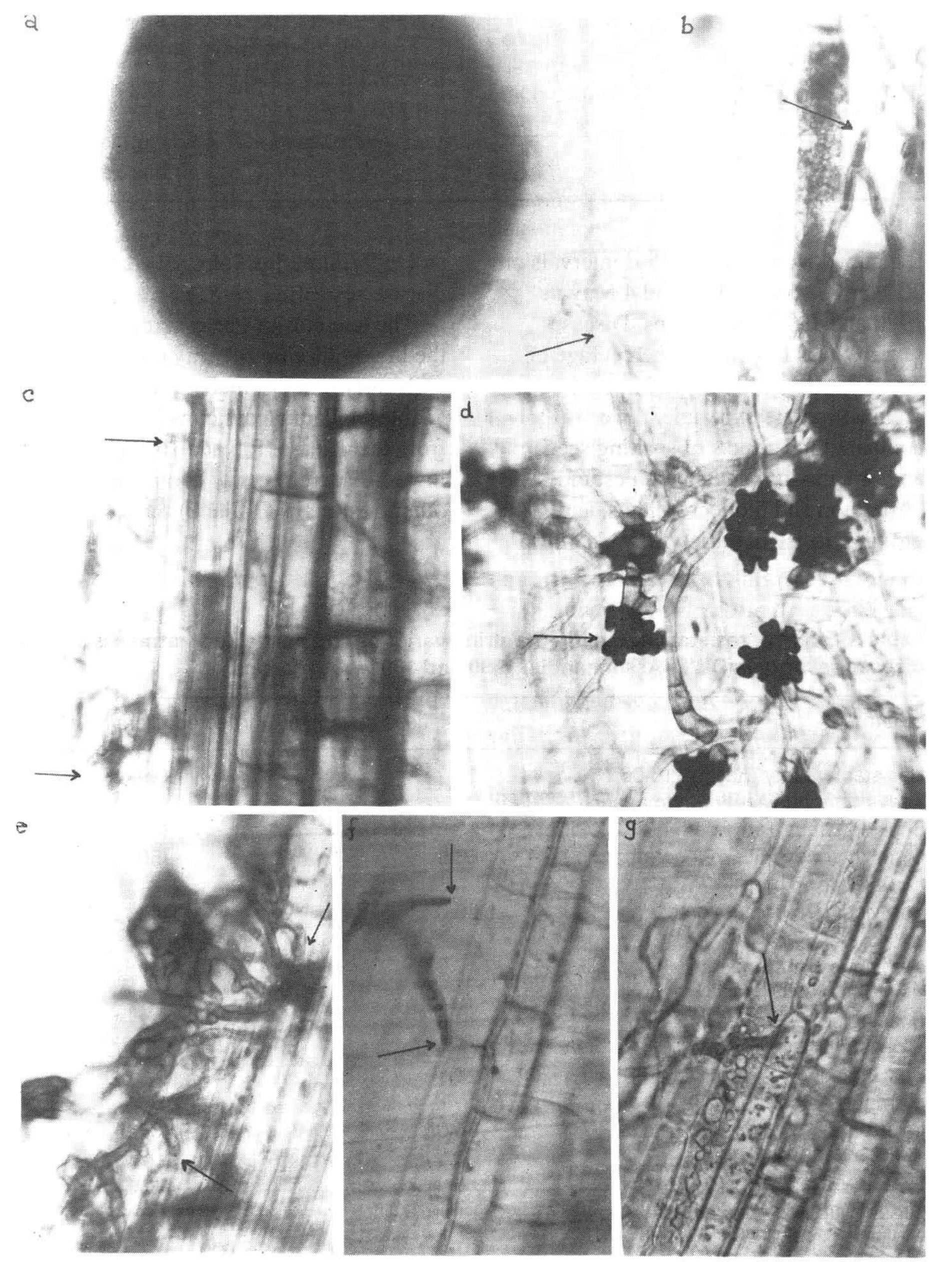
Fifteen isolates of pathogen *S. oryzae* were collected from around India and studied to determine the variation in appressoria produced. we also investigated the pathogen's mode of penetration, invasion, and establishment on rice.

Healthy pieces of stems of susceptible cultivar, TN1, were surface-sterilized with 0.1% mercuric chloride, washed with sterile distilled water three times. and inoculated with a sclerotium at the middle of the internode. Inoculated stem pieces were placed in a humid chamber and incubated at 28 ± 2°C. Samples were taken at 4-h intervals from 24 to 72 h after incubation, killed, and fixed in FAA solution made of 10 ml formaldehyde (37-40%), 50 ml ethyl alcohol (95%), 5 ml glacial acetic acid, and 35 ml distilled water.

We used the whole mount method to study specific infection stages. Peelings of inoculated portions were collected at intervals and passed through 50 and 30% alcohol followed by distilled water, stained in 0.1 % aqueous aniline blue for 2 min, and dehydrated through 30, 50, 70, 90%), and absolute alcohol for 2 min at each grade. Peelings were then cleared in a xylene-alcohol series of 1:3, 1:1, 3:1, and pure xylene, and mounted in Canada balsam.

Sclerotia germinated 12-24 h after inoculation at the stem surface. Several branched, septate hyphae proliferated, possibly by utilizing nutrients in the sclerotium and/or at the surface of the stem, and formed a loosely interwoven mycelial mat (Fig. a). The mycelial mat, having direct contact with the host surface, started to swell and formed appressoria (Fig. b). The mycelium became closely septate and culminated into an appressorium when it came into



Development of *S. oryzae* on the stem of TN1 (600x). a) Germinating sclerotia, b) growth of pathogen on host surface after 12-24 h, c) swelling of hyphae and initiation of appressoria formation, d) appressoria and subcuticular hyphae, e) development of infection peg from appressoria and penetration into epidermal cell, f) penetration by germ tube through cuticle, and g) hyphae ramifying in parenchymatous tissues of host.

Description of appressoria produced by *S. oryzae* isolates.

Isolate	Color of appressoria	Range in the dimensions of appressoria (mm)[a]		Lobes/ appressorium (no.)[a]
		Length	Width	
Hyderabad (Andhra Pradesh)	Dark brown	13-29	7-23	8
Kapurthala (Punjab)	Dark brown	12-28	10-23	8
Titabar (Assam)	Brown	14-30	11-25	6
Kapurthala (Punlab)	Dark brown	12-28	10-23	8
Coimbatore (Tamil Nadu)	Brown	14-31	13-29	5
Madurai (Tamil Nadu)	Light brown	11-29	9-24	10
Kaul (Haryana)	Light brown	13-26	9-25	9
Lakhimpur (Uttar Pradesh) (UP)	Dark brown	15-33	12-29	8
Sitapur (UP)	Light brown	14-28	10-24	7
Pantnagar (UP)	Light brown	12-28	10-24	7
Pantnagar (UP)	Dark brown	13-29	11-26	8
Pantnagar (UP)	Dark brown	14-29	11-26	6
Pantnagar (UP)	Dark brown	15-30	12-29	9
Pantnagar (UP)	Light brown	15-32	11-28	8
Pantnagar (UP)	Light brown	14-30	9-26	7
Pantnagar (UP)	Light brown	12-30	8-26	7

[a]Av of 50 appressoria.

contact with the host surface (Fig. c). All the isolates produced lobate, multicellular appressoria (Fig. d) that varied in color, size, and number of lobes/appressorium (Table 1).

The appressoria were observed to form infection pegs which penetrated directly through the cuticle into the epidermal cell and produced subepidermal mycelia (Fig. e). In some cases, an infection cushion did not form; hyphae penetrated directly through the host surface (Fig. f) and then ramified in parenchymatous tissues. As the hyphae thickened and branched, the host cell disintegrated and the host tissue became damaged extensively (Fig. g). ■

Managing ufra disease in deepwater rice (DWR) in Assam, India

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Ufra disease, caused by *Ditylenchus* angustus, is a major biotic constraint in DWR in Assam. We compared the effects of several management practices on disease severity under field conditions in a preidentified ufra-infected area. Experiments were laid out in a randomized block design with three replications.

Seeds of popular (but highly ufra-susceptible) local DWR variety Rangabao were sown at 15-d intervals on 20 Mar, 4 Apr, 19 Apr, and 4 May in 1990 and 1991 wet seasons. Disease severity was recorded as percentage of infected tillers/hill (Table 1).

In a separate experiment, we compared the effects of soaking seeds and/or spraying plants with pesticides hostathion and monocrotophos, and growing resistant variety Rayada 16-06 and early-maturing variety Padmapani on disease severity.

The late-sown (4 May) crop suffered the lowest disease severity compared with early- and normally sown crops (Table 1). Padmapani completely escaped from the disease. Rayada 16-06 had the lowest disease severity compared with other treatments (Table 2). ■

Table 1. Effect of sowing date on ufra disease severity in DWR. Assam. India, 1990 and 1991 wet seasons.

Sowing date	Disease severity (% infected tillers/hill)	
20 Mar	91.7	(73.3)[a]
4 Apr	82.0	(64.9)
19 Apr	33.6	(35.4)
4 May	22.0	(8.0)
LSD (0.05)	(4.8)	

[a] Figures in parentheses are angular transformed values.

Table 2. Effect of resistant and early-maturing varieties and pesticide treatments on ufra disease severity in DWR. Assam, India, 1990 and 1991 wet seasons.

Treatment	Disease severity [a] (% infected tillers/hill)		
Resistant variety (Rayada 16-06)	10.7	(19.6)[b]	b
Early-maturing variety (Padmapani)	0	(4.1)	a
Soaking seeds with hostathion 0 2% for 6 h	38.5	(38.6)	d
Soaking seeds with monocrotophos 0.2% for 6 h	58.5	(50.2)	ef
Spraying with hostathion 0.20% (45 and 80 DAS)[c]	49.0	(44.7)	de
Spraying with monocrotophos 0 2% (45 and 80 DAS)	47.9	(44.1)	de
Soaking seeds + spraying with hostathion 0.2%	13.9	(22.3)	b
Soaking seeds + spraying with monocrotophos 0 2%	25.1	(30.4)	c
Control	65.0	(54.0)	f
LSD (0.05)		6.7	

[a] In a column, mean values with the same letter are not significantly different at the 5% level. [b] Figures in parentheses are angular transformed values. [c]DAS = d after sowing

Farmers' perceptions of rice pest problems and management tactics used in Vietnam

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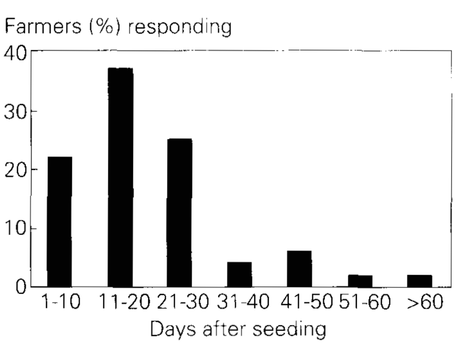
A May 1992 survey of 685 farmers in the Mekong Delta showed that they perceived the brown planthopper (BPH) to be the most important rice pest problem followed by sheath blight (ShB), rice leaffolders (LF), stem borers (SB), caseworms (CW), rice blast (BI), leaf yellowing (LY), rice bugs, other defoliators, and thrips.

Farmers reported that pests could be controlled only by pesticides. The main insecticides they used for BPH control were carbamates (58%), although organophosphates, such as methamidophos, methyl parathion, monocrotophos, diazinon, and pyrethroids were also used (see table). For LF control, the main chemicals used were methyl parathion and methamidophos (36%), carbamates (2 1 %), and pyrethroids (20%).

Distribution of first sprays by rice farmers in southern Vietnam.



Rice pests in order of importance and pesticides used on them by farmers in Vietnam, May 1992.

Pesticide	Pests in rank order									
	BPH	ShB	LF	SB	CW	BI	LY	Defoliators	Bugs	Thrips
Farmers' perception (%) of importance of pests										
	59	12	8	7	4	3	3	3	2	1
Farmers (%) using each pesticide										
Monocrotophos	2	0	9	5	17	0	0	10	13	9
Diazinon	2	0	2	45	2	0	0	5	0	2
Methyl parathion	9	0	21	13	20	0	0	28	17	44
Methamidophos	5	0	16	6	13	0	0	24	13	9
BPMC	40	0	15	6	14	0	0	18	13	15
MIPC	18	0	6	3	5	0	0	5	8	5
Cartap	7	0	10	6	7	0	0	1	4	5
Carbofuran	1	0	1	1	1	0	0	0	0	0
Ethofenprox	5	0	3	3	3	0	0	0	0	1
Buprofezin	2	0	0	0	0	0	0	0	0	0
Cypermethrin	3	0	3	4	12	0	0	4	13	2
Cypermethrin + phosalon	1	0	0	1	1	0	0	0	0	0
Deltamethrin	4	0	9	6	4	0	0	4	21	5
Alphamethrin	1	0	4	1	2	0	0	3	0	2
Endosulfan	0	0	0	0	0	0	0	0		
Diclorvos	0	0	1	1	0	0	0	0	0	0
Benomyl	0	7	0	0	0	14	0	0	0	0
Hetacomazole	0	30	0	0	0	14	0	0	0	0
Benomyl + copper sulfate	0	29	0	0	0	38	100	0	0	0
Validamycin	0	33	0	0	0	33	0	0	0	0
Edifenphos	0	3	0	0	0	0	0	0	0	0

Farmers considered ShB *(Rhizactonia solani)* and BI *(Pyricularia oryzae)* to be the most important disease problems. They used fungicides, such as validamycin and benomyl + copper sulfate, as their main control measures.

Farmers' insecticide use patterns included early season applications of broad-spectrum organophosphates for leaffeeders (see figure). Methyl parathion and methamidophos were the main chemicals used during the seedling and tillering stages. Carbamates, such as BPMC and MIPC, were mainly used during the booting, flowering, and milk grain stages; BPH was the primary target.

The survey showed that broad-spectrum organophosphates are widely used by farmers in the Mekong Delta. Pest targets were mainly leaffeeders that infest the crop in the early season. These early sprays may not have been necessary because the rice crop can often compensate for early leaf defoliation. Early applications of broad-spectrum insecticides may actually cause ecological disruptions that tend to favor BPH development. Farmers generally believe, however, that the defoliators are important pests and chemical controls are needed.

Farmer participatory research, extension campaigns. and training programs that help farmers realize these early sprays may not be beneficial should be explored further. ■

Parasitization of *Tagosodes orizicolus* and *T. cubanus* in northeastern Colombian ricefields

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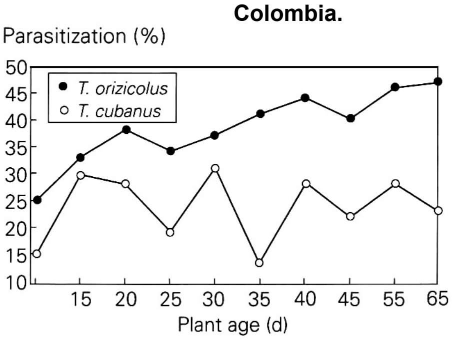
Biological control of pests in integrated pest management (IPM) programs requires precise information on occurrence and effectiveness of natural enemies in attacking the pests. We studied *T. orizicolus* and *T. cubanus* parasitization in commercial irrigated ricefields at five locations representative of rice-growing areas of Norte de Santander Department, Colombia. On each farm, a field was selected at planting time and sampled at randomly selected sites every 7 d. A sample consisted of 40 sweeps taken in 20 sites/field. A sweep was a stroke with the net in either direction; one sweep was taken with every forward step. Samples were placed in plastic bags and brought to the laboratory for study. *Tugosodes* spp. were selected, sorted by species, and examined for evidence of parasitization by *Elenchus* sp. (Strepsiptera:Elenchidae).

Parasitization percentage for *T. orizicolus* and *T. cubanus* in ricefields. Norte de Santander, Colombia.



Analysis of weighted-least-squares estimates for probability of parasitization of *T. orizicolus* and *T. cubanus* in ricefields. Norte de Santander, Colombia.

Parameter	Estimate	Estimated SE	χ^2	P
Intercept	0.2500	0.0086	851.62	0.0001
Plant age	0.0018	0.0003	31.60	0.0001
Species	0.0198	0.0086	5.32	0.0211
Plant age x species	0.0018	0.0003	31.32	0.0001

Data were subjected to analysis of variance. Percent parasitization was calculated for each species. We used a linear model for repeated measurement analysis (PROC CATMOD, SAS) to calculate the probability of parasitization for each species and plant age.

Significant differences in parasitization at each plant age and for species were found (see table). Plant age × species interaction was significant, indicating each species responds differently, to parasitoid attacks and percentage of parasitism depends on plant age. The probability of parasitization (PP) was estimated as

T. orizicolus PP = (0.00190) (plant age)
T. cubanus PP = (-0.00180) (plant age)

PP for *T. orizicolus* increases with plant age while that for *T. cubanus* is not affected (see figure). This information will be useful to define IPM strategies for *T. orizicolus* and to help understand the effect of natural enemies in controlling *T. orizicolus* populations. ■

Hydrellia wirthi Korytkowski: a new rice pest in Colombia

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In Valle del Cauca Department. Colombia, *Hydrellia grisea* (F.) is a sporadic rice pest. Farmers usually apply carbofuran at planting to prevent seedling damage. A pyrethroid combined with a herbicide is applied later. In spite of this frequent insecticide use, little is known about the pest's biology in Colombia.

Hydrellia larvae and pupae were collected in the field. Individual pupae were placed on a petri dish in the laboratory. As adults emerged, they were placed in alcohol. Samples of larvae, pupae, and adults were identified at IRRI as *Hydrellia wirthi* Korytkowski. This is the first report of the pest in rice in Colombia. *H. griseola* was not recovered in the study.

Whether *H. wirthi* causes damage and affects yield as *H. griseola* does is not known. Action thresholds for use in integrated pest management in Colombia need to be reviewed for *H. griseola* and established for *H. wirthi.* ■

Colombian ricefield spiders

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Little is known about the role of spiders in controlling insect pests of rice in Latin America.

Reports have been conflicting on number and taxonomic identity of spider species in Colombian ricefields. This study aimed to identify the spider specimens in commercial irrigated ricefields in Valle del Cauca Department, Colombia. Spiders were collected with a standard sweep net, although some species were collected with an aspirator. Sampling started 5 d after panicle emergence; fields were sampled weekly

Spiders from irrigated ricefields. Valle del Cauca Department, Colombia, 1990-91.

Taxon	Locality
Anyphaenidae	
Anyphaena (near) *affinis*	Ginebra, Jarnundi, Paso de la Torre
Araneidae	
Alpaida trispmosa (Keyserling)	Jarnundi, Paso de la Torre
Alpaida vendiae (Keyserling)	Paso de la Torre
Argiope argentata (F.)	Caloto, PalmIra, Ginebra, Jamundi, Paso de la Torre
Argiope trifasciata (Forskal)	Palmira, Ginebra, Paso de la Torre
Cyclosa walckenaeri (O. Pickard-Cambridge)	Jarnundi, Paso de la Torre
Eriophora sp.	Ginebra, Jarnundi, Paso de la Torre
Eustala fuscovittata (Kerserling)	Jamundi, Paso de la Torre
Gasteracantha cancriformis (L.)	Caloto, PalmIra, Ginebra, Jamundi Paso de la Torre
Gea heptagon (Hentz)	Jamundi, Paso de la Torre
Neoscona moreli (Vinson)	Jarnundi, Paso de la Torre
Clublonidae	
Cheiracanthium inclusum (Hentz)	Jamundi, Paso de la Torre
Linyphiidae	
Centromerus sp.	Palmira, Ginebra, Jamundi, Paso de la Torre
Lycosidae	
Pardosa near *saxatilis* (Hentz)	Palmira, Ginebra, Jarnundi, Paso de la Torre
Pardosa milvina (Hentz)	Jarnundi, Paso de la Torre
Oxyopidae	
Oxyopes salticus (Hentz)	Caloto, PalmIra, Ginebra, Jamundi, Paso de la Torre
Tetragnathidae	
Tetragnatha straminea Emerton	Palmira, Ginebra, Jamundi, Paso de la Torre
Tetragnatha sp.	Palmira, Jarnundi, Paso de la Torre
Metidae	
Leucauge argyra (Walkenaer)	Palmira, Ginebra, Jarnundi, Paso de la Torre
Leucauge sp.	Jarnundi
Theridiidae	
Chrysso pulcherrima (Mello-Leitao)	Palmira, Paso de la Torre
Theridula gonygaster Simon	Palmira, Ginebra, Jarnundi, Paso de la Torre
Thomiisidae	
Misumenops pallida Keyserling	Ginebra, Jamundi, Paso de la Torre
Misumenoides paucispinosus Keyserling	Jamundi, Paso de la Torre
Synaemops rubropunctatum Mello-Leitao	Ginebra, Jamundi, Paso de la Torre
Salticidae	
Paraphidippus sp	Palmira, Jarnundi
Phidippus clarus Keyserling	Palmira, Ginebra, Jamundi, Paso de la Torre

until harvest. Experts in Brazil, USA, and the Philippines identified them.

Twenty-seven species belonging to 23 genera and 11 families were identified (see table). The most abundant families in descending order were Teragnathidae, Salticidae, and Lycosidae. Araneidae was the family with the most species (10) from eight genera. Studies are underway to determine the importance of these species in controlling rice pests. ■

IRRN REMINDER

Multiple submissions. Normally, only one report for a single experiment will be accepted. Two or more items about the same work submitted at the same time will be returned for merging. Submitting at different times multiple notes from the same experiment is highly inappropriate. Detection will result in the rejection of all submissions on that research.

Integrated pest management—other pests

Ground golden snail *Ampullarius (Pomacea) canaliculata* as fertilizer increases rice yield

R. R. Aquino, University of Southern Mindanao, Kabacan, Cotabato, Philippines

Golden snails are abundant in the Philippines, causing much damage to lowland rice plants. Golden snails must be picked and placed on roads or in areas without water to eliminate them from ricefields.

Masses of golden snail were gathered, crushed, and sun-dried for 3-4 d. Crushed snails were then hammer-milled and basally applied as organic fertilizer to direct seeded IR74 at 0, 0.25, 0.5, and 0.75 (/ha during wet (WS) and dry seasons (DS) on a clay loam soil in lower Paatan, Kabacan, Cotabato, Philippines. Results were significant. An increase in yield of about 50%) at 0.75 t/ha equivalent application rate over the control was attributed to the ground snail fertilizer, which has 94.78% dry matter, 16.49% crude protein, and 2.54% ether extract.

The procedure eradicates the pest and increases rice yield.

Effect of different levels of ground golden snail on yield of irrigated rice.[a]

Application rate (t/ha)	Mean yield (t/ha)	
	WS	DS
0.25	3.7 a	4.8 b
0.50	4.9 b	5.0 b
0.75	5.4 c	53 c
Control	3.6 a	3.8 a

[a] In a column, means followed by the same letter are not significantly different at the 5% level by DMRT Four replications

Water management

Yield and water use efficiency of newly developed rice mutants under different water management practices

A. A. Hassan and A. A. Sarkar, Agricultural Engineering Division, Bangladesh Institute of Nuclear Agriculture (BINA), P.O. Box 4, Mymensingh, Bangladesh

We tested the effects of water management on newly developed rice mutants BINA 4-39-15-13 and BINA 4-5-17-19. Practices tested were continuous ponding (5 ± 22 cm water) and application of 5 cm water at 3, 5, and 7 d after disappearance of ponded water (DAP).

At final land preparation, each plot was fertilized uniformly with a basal dose of 60 kg N/ha as urea, 26.4 kg P/ha as triple superphosphate, 33.2 kg K/ha as muriate of potash, 10 kg S/ha as gypsum, and 4 kg Zn/ha as zinc oxide. Another 20 kg N/ha (as urea) was topdressed, half at active vegetative phase and half at flowering.

The experiment was laid out in a split-plot design. Forty-five-d-old seedlings were planted in a sandy loam soil at the BINA farm the first week of Feb 1992. Irrigation was applied in main plot treatments (5- x 6-m plots) and in rice mutant subplot treatments (5- x 3-m plots). We applied 3-5 cm water to all treatment plots for the first 2 wk to allow for crop establishment and then irrigation treatments were followed. BINA 4-39-15-13 was harvested the third week of May, and BINA 4-5-17-19 was harvested 15 d later.

Continuous ponding required about 214%) more water for irrigation than the other treatments, but produced only 13, 15, and 15% more grain than when 5 cm water was applied at 3, 5, and 7 DAP, respectively (see table).

BINA 4-5-17-19 produced significantly more grain (8.1t/ha), straw, and tillers/ plant, than BINA 4-39-15-13 (7.5 t/ha). The 7 DAP treatment required the least water and had the highest water use efficiency (see table) and is recommended for areas where water is costly. Yield, however, was 1.1 t/ha less than under continuous ponding. ■

Number of irrigations, water requirement, and water use efficiency of rice mutants under different water management practices. BINA Farm, Mymensingh, Bangladesh, 1992 dry season.

Treatment	Irrigation (no.)	Amount of irrigation water[a]	Water requirement (cm)	Grain yield (t/ha)	Straw yield (t/ha)	Water use efficiency (kg/ha per cm)
Continuous ponding (5 ± 2 cm water)	Almost every other day	220	273.95	8.6	7.0	36.10
Application of water 3 DAP[b]	7	70	87.95	7.7	6.4	86.98
Application of water 5 DAP	7	70	87.95	7.5	6.2	85.04
Application of water 7 DAP	5	60	77.95	7.5	6.9	95.95

[a] Includes 30 cm of water for crop establishment. Amount of rainfall is 17.95 cm. [b]DAP = d after disappearance of ponded water

Farming systems

Identification of recommendation domains for technology generation and transfer in rice culture

M. Wijeratne, Agricultural Economics Department, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka

We conducted a study to identify the recommendation domains for the technology generation and transfer processes in the coastal rice-growing agroecological zone of Matara district. Sri Lanka. Exploratory studies were carried out during 1990-91 wet season and 1991 dry season to understand prevailing production conditions. A random sample of 291 farmers were surveyed using a pretested questionnaire to identify production problems.

Saline soil, acidic soil. water deficit. and excess water were identified as problems. All vary according to elevation.

The area was classified into three domains: upper (>1 msl), intermediate (1-0 msl), and lower (>0 ms1). An index (based on a scoring procedure) was constructed to estimate intensity of the problem. Farmers were located on this scale. Scores were divided into four categories. Actual score for a particular problem was presented as a percentage and assigned an intensity category (see table).

Study locations can be classified into three recommendation domains on the

Three recommendation domains based on production conditions. Matara district, Sri Lanka.

Recommendation domain	Farmers (no.)	Sample size (no.)	Intensity of problems (%)			
			Soil acidification	Soil salinization	Water deficit	Excess water
Upper	2562	126	76-100 (very high)	na	76-100 (very high)	na
Intermediate	1771	89	26-50 (moderate)	na	51-75 (high)	
Lower	1504	76	0-25 (low)	51-75 (high)	na	51-75 (high)

[a] na = not applicable

basis of constraints prevailing in rice production. The upper domain experieces severe water deficit and soil acidification whereas the lower domain has excess water and soil salinization. Technology generation processes, such as varietal improvement programs, need to make location-specific recommendations for the identified domains. ■

Postharvest technology

Delay in threshing and mode of beating effects on milling recovery

A. Ali, M. A. Karim, L. Ali, S. S. Ali, M. Jamil, and A. Majid, Rice Research Institute, Kala Shah Kaku, Lahore, Punjab, Pakistan

Harvested rice in the Punjab, Pakistan, is usually left in the field to dry in loose bundles for a few days before threshing. We assessed how a delay in threshing affected milling recovery of commercial varieties KS282 (medium grain) and Basmati 385 (fine grain) from 1988 to 1990. We compared the traditional hand-threshing techniques of beating rice against a bund. steel drum, or wooden log.

The rice was harvested at the optimum maturity stage and left in the field in loose bundles of uniform size (40 plants, with about 20 tillers/plant) for 0. 2.4, and 6 d before threshing. The difference in day and night temperature was about 15°C, which resulted in repeated drying and wetting of the rice. Rice samples were sun-dried to the optimum moisture content and milled.

Threshing grain on the day of harvest gave the highest head rice recovery and the lowest broken rice (see table). The recovery decreased with delay in threshing. The differences between delays of 0 and 2 d were not significant in either variety (see table). Differences in mode of beating did not significantly affect milling recovery. ■

Milling recovery at different threshing times and modes of beating. Punjab, Pakistan, 1988-90. [a]

Delay in threshing after harvesting (d)	Head rice (%)					Broken rice (%)				
	Beating on bund	Beating on steel drum	Beating on wooden log	Mean	Decrease in head rice	Beating on bund	Beating on steel drum	Beating on wooden log	Mean	Increase in broken rice
					KS282					
0	55.7	56.0	55.6	55.8 a	–	15.0	14.6	16.0	15.2 a	–
2	55.3	55.7	54.9	55.3 a	0.5	15.7	15.8	17.0	16.2 a	1.0
4	53.0	53.5	52.7	53.1 b	2.7	17.4	18.0	18.6	18.0 b	2.8
6	49.6	49.0	49.5	49.4 c	6.4	21.0	22.0	21.2	21.4 c	6.2
Mean	53.4 a	53.5 a	53.2 a	–	–	17.3 a	17.6 a	18.2 a	–	–
					Basmati 385					
0	53.0	52.5	53.3	52.9 a	–	17.0	16.7	16.8	16.8 a	–
2	52.1	52.0	52.5	52.2 a	0.7	17.3	18.0	17.7	17.7 a	0.9
4	49.6	50.4	51.0	50.3 b	2.6	20.0	19.8	18.0	19.3 b	2.5
6	47.0	47.2	46.5	46.9 c	6.0	23.0	22.6	22.6	22.7 c	5.9
Mean	50.4 a	50.5 a	50.8 a	–	–	19.3 a	19.3 a	19.2 a	–	–

[a] Results are av of 3 yr Means in a column followed by a common letter are not significantly different at the 5% level

Announcements

Outstanding young women in rice science award

The Outstanding Young Women in Rice Science (OYWRS) Award is the foremost international recognition of the important contributions women are making to rice research and agriculture. The biennial ward was established in 1990 by IRRI to encourage the participation of women in rice research and to promote their professional development.

Presentation of award

The 1994 presentation will be part of the International Rice Research Conference (IRRC), tentatively set for April 1994 in Los Baños, Laguna, Philippines. Awardees receive a recognition plaque and a travel grant to attend IRRC. Each awardee must present a scientific paper on her research.

Criteria

The award is presented to individuals who are 40 years of age or younger (born on 1 Jan 1954 or later for the 1994 program) and actively conducting research in any endeavor of rice science in a public or private institution in the five regions of the world's major rice-producing areas. Recipients are selected by regions: Africa, South Asia, West Asia, Southeast Asia, and Latin America and the Caribbean. Awards are made without regard to race, color, religion, national origin, or political persuasion of nominees.

Procedure

Nomination. Each nomination must be submitted by the head of the employing research institution or agency. This must include a description of the individual's current rice research work and previous accomplishments (not to exceed 1,000 words).

The nomination must be accompanied by

- copies of two of the individual's published papers or technical reports issued between 1989 and 1992,
- a copy of the curriculum vitae or biodata statement,
- a copy of the certification of birthdate,
- five copies of a current photograph, black and white or color, suitable for reproduction (minimum size: 2 x 2 inches or 5 x 5 cm), and
- recommendations from three references to support the nomination.

Selection. A Search Committee appointed by the IRRI Director General evaluates the nominations. Selections are based on the originality and relevance of the nominee's rice research and the scientifically rigorous manner in which it has been conducted. The decisions of the committee are final. No award will be made for any region in which the nominees fail to demonstrate excellence in rice research.

Each nomination will be acknowledged when received by the Search Committee. The awardees will be officially notified by letters from the Director General of IRRI to the head of their employing institution.

Submission. All nominations, including documents and recommendations, much be received by the Search Committee by 5:00 p.m., I Feb 1994. Incomplete submissions will not be accepted. All nomination materials become property of IRRI and will not be returned.

Nominations should be sent to
Dr. T. Hutchcroft, Chairperson
Outstanding Young Women in Rice Science Award
c/o Information Center
International Rice Research Institute
P.O. Box 933,
Manila 1099, Philippines.

Further information on the nomination procedure may be requested from the address above, fax: (63-2)818-2087, or tel: (63-2)818-1926. ■

Three IRRI public awareness videos now available

Rice: a tool for peace
The constraints facing the future of rice production are illustrated in this video. It examines the dire need to increase rice yields and outlines IRRI's contributions to this extraordinary mandate. Running time: 27 minutes

Creating rices for the 21st century
Creating rices focuses on IRRI's strategic research initiatives on behalf of the world's rural rice farmers and urban rice consumers. Created for International Centers Week 1992, this video also won a 1992 Golden Arc Merit Award from the Agricultural Relations Council. Running time: 16 minutes.

Long-term pesticide exposure: a study of Filipino farmer health
Based on the work of IRRI economist Prabhu Pingali, this video explores the history of pesticide use by Filipino farmers in three rural communities. With first-person stories of chronic pesticide exposure and the ensuing health problems associated with such exposure, this video charts the studies that have prompted Dr. Pingali to conclude that pesticide use in the Philippines has cost farmers both their health and their health-care money. The video includes discussion of integrated pest management as a viable alternative to pesticide use. Running time: 17 minutes

All are available from IRRI for US$20, which includes first class postage and handling. ■

Rice Dateline[a]

1-2 Jun	FAO-IRRI Workshop on Small Farm Equipment, IRRI *G.R. Quick,IRRl*
1-6 Jun	International Network on Soil Fertility and Sustainable Rice Farming (INSURF) Site Visit and Planning Meeting, Beijing, China *E.L. Arugon. IRRI*
14-15 Jun	Iran-IRRI Planning Meeting, IRRI *G.S. Khush. IRRI*
25-26 Jun	Rice-Fish Farming System Workshop, Sukamandi, Indonesia *V.R. Carangal IRRI*
9-13 Aug	First Asian Conference of Agricultural Economists, Seoul, Korea *Y.B. Choc, ASAE* Korea Rural Economic Institute 4-102 Hoegi-dong, Dongdaemum-leu Seoul 130-050, Korea
30 Aug-3 Sep	Asian Rice Farming Systems Meeting, Korea *V.R. Carangal. IRRI*
30 Aug-3 Sep	Annual Work Plan Meeting of the Interregional Research Program on Methane Emission from Ricefields, IRRI *H.U. Neue, IRRI*

30 Aug-11 Sep	15th Congress of the International Commission on Irrigation and Drainage, The Hague, The Netherlands *Congress Secretariat* Holland Organizing Centre 16 Lange Voorhout 2514EE The Hague The Netherlands
1-3 Sep	Annual Work Plan Meeting of the IRRI-EPA Methane Project, IRRI *H.U. Neue, IRRI*
6-22 Sep	Training Course for the Interregional Research Program on Methane Emission from Ricefields, IRRI *H.U. Neue, IRRI*
20-22 Sep	Outposted Staff Meeting, IRRI *F.A. Bernardo/G.L. Denning, IRRI*
27 Sep-1 Oct	International Workshop on Crop-Animal Interactions, Khon Kaen, Thailand *V.R. Carangal, IRRI*
27 Sep-15 Oct	Effective Irrigation Management, Southampton. United Kingdom *Course Administrator* Effective Irrigation Management Short Courses Institute of Irrigation Studies University of Southampton, Southampton SO9 5NH, UK
28 Sep-15 Oct	Lowland Development Short Cours, Delft. The Netherlands *The Registrar* International Institute for Infrastructure, Hydraulic and Environmental Engineering Delft. The Netherlands
11-15 Oct	Sheath Blight Disease Management Workshop, Beijing, China *T.W. Mew, IRRI*
11-15 Oct	Collaborative Research Meeting among Indochina countries, Myanmar, and Thailand Vientiane, Lao DPR *J.M. Schiller/G.L. Denning, IRRI*

[a] IRRI contacts: International Rice Research Institute, P.O. Box 933, Manila 1099, Philippines. Fax: 632-2-818-2087.

IRRI group training courses for 1993

The IRRI Training Center is offering a variety of courses on rice-related subjects in 1993. Courses are held at IRRI headquarters unless otherwise noted. For information about a course, contact the Head, Training Center, International Rice Research Institute, P.O. Box 933, Manila 1099, Philippines. Fax:63-2-818-2087. ■

Date	Course	Trainees
23 Aug-1 Oct	Irrigation and Water Management	25
11 Oct-3 Dec	Rice Production Research, Thailand[a]	25
4 Oct-26 Nov	Rice Biotechnology[a]	15
4 Oct-5 Nov	Rice Seed Health	8
4 Oct-26 Nov	Integrated Pest Management Course	25
15-26 Nov	Gender Analysis[a]	25
25-26 Nov	Research Management[a]	15

[a] Special project-funded courses.

Call for news

Individuals, institutions, and organizations are invited to tell readers about upcoming events in rice research or related fields for the Rice Dateline. Send announcements to the Editor. IRRN, International Rice Research Institute, P.O. Box 933, Manila 1099, Philippines. ■

Rice literature update reprint service

Photocopies of items listed in the *Rice literature update* are available from the IRRI Library and Documentation Service. Reprints of original documents (not to exceed SO pages) are supplied free to rice scientists of developing countries. Rice scientists elsewhere are charged US$0.20 for each page or part of a page copied, plus postage. Payment should be in check or money order, payable to Library and Documentation Service, IRRI.

Address requests to Library and Documentation Service, IRRI, P.O. Box 933, Manila 1099, Philippines. Fax: (63-2) 817-8470, electronic mail: IN%"postmaster@IRRI.CGNET.COM" ■

Irrigation and drainage congress

The 15th Congress of the international Commission on Irrigation and Drainage will be held in The Hague, The Netherlands, 30 Aug-11 Sep. Water management in the next century is the theme. The 7th International Exhibition on Irrigation, Drainage, and Flood Control takes place during the congress.

For information, contact the Congress Secretariat, Holland Organizing Centre, 16 Lange Voorhout, 2514EE The Hague, The Netherlands. Tel: 31 70 3657850, telex: 20010, fax: 31 70 3614846. ■

Training courses

USDA *international training courses for 1993-94.* The United States Department of Agriculture is sponsoring courses on agricultural production and technology, extension and rural development, management, human resources development, and organizational development, natural resources, and policy and economics in 1993-94.

Training courses are held in the USA and in other countries. Courses are open to the staff of agricultural and rural development institutions and organizations worldwide. Course content is targeted toward developing and middle-income countries and the newly emerging democracies.

Women are strongly encouraged to attend the training courses. For more information, contact Course Director, USDA/OICD/DRD/MCD, Room 3110 South Building, Washington, D.C. 20250-4300, telex: 7400228 CDOP UC, fax: 202-690-1960, tel: 202-690-1836.

Institute of Irrigation Studies short courses. The Institute of Irrigation Studies is offering the following short courses:
Development and the Environment (31 Aug-17 Sep 1993), Effective Irrigation Management (27 Sep- 15 Oct 1993), and International Course on Computer Applications in Irrigation (1 0 Jan-4 Feb 1994).

For further information, contact Course Administrator, RMIP Short Course, Institute of Irrigation Studies, University of Southampton, Southampton, SO9 SNH, United Kingdom. Tel: 0703 593728, fax: 0703 677519.

Training and communication planning courses
Short courses on planning, management, evaluation, training, audiovisuals, and communications are being offered by the Development Training and Communication Planning (DTCP) Programme of the United Nations Development Programme (UNDP). Participants receive practical knowledge and skills for application in rural development projects and programs. Three-, four-, and six-week courses are held from August to December 1993.

For advance course reservations and inquiries, contact the Training Coordinator, DTCP/UNDP, 5th Floor. Bonifacio Building, University of Life Campus, Meralco Avenue, Pasig. Metro Manila, Philippines. Tel: (632) 631-1271 to 4, fax (632) 631-1275, telex: 29018 DTCP PH.

Courses on lowland development and modernization of irrigation. Lowland development, 28 Sep- 15 Oct, and Appropriate modernization and management of irrigation systems. 2-26 Nov, are being offered by the International Institute for Infrastructure. Hydraulic and Environmental Engineering (IHE), Delft, The Netherlands. Courses are designed for senior professionals.

For applications and more information, contact the Registrar of IHE. P.O. Box 3015,2601 DA Delft, The Netherlands.

Photosynthesis and productivity training course. The *11th Training Course on Photosynthesis and Productivity in a Changing Environment* will be held 25-26 Jan 1994 at King Mongkut's Institute of Technology Thonburi, Bangkok, Thailand. The course is aimed at young scientists and teaches and demonstrates the latest field and laboratory techniques for use in Southeast Asia and the Pacific region.

Applicants from Thailand should contact Assoc. Prof. M. Tanticharoen, School of Bioresources and Technology, King Mongkut's Institute of Technology Thonburi, Bangmod, Rasburana, Bangkok 10140. Tel: 66(2) 4270039 ext. 7000, fax: 66(2) 4278077, telex: 72383 KMITT TH.

Applicants from other Southeast Asia and Pacific countries should contact Prof. D. Hall, Division of Life Science, Kings College London, University of London, Campden Hill Road, London, W8 7AH, UK. Tel: 44(71) 333 4317. Fax: 44(71) 937 7783. Telex: 8954102 BBSLON G. ■

Climate Change and Rice Symposium

An international symposium on climate change and rice will be held at IRRI on 14-18 Mar 1994. The meeting will review the broad issues of global climate change and its effect on agriculture. The symposium will also provide a forum to summarize research on the specific impact of climate change on rice and rice ecosystems.

Papers on production and emission of trace gases by rice soils and the effects of UV-B, CO_2, and temperature on rice will be presented by 27 invited speakers. Other participants are encouraged to present posters on these topics.

For details, contact K. T. Ingram. Climate Change and Rice Symposium, IRRI, P.O. Box 933, Manila 1099, Philippines, tel: (63-2) 818 1926, x3751 730, fax: (63-2) 818-2087, E-mail: in%"k.ingram@cgnet.com" ■

New publications

An introduction to the grasses. G. P. Chapman and W. E. Peat. To order, contact CAB International, Wallingford, Oxon OX10 8DE, UK. Tel: (0491) 32111. Fax: (0491) 33508. Telex: 847964 COMAGG G).

Reproductive adaptation of rice to environmental stress. Y. Takeoka et al. Development in Crop Science, Vol. 22. Contact Elsevier Science Publishers, P.O. Box 211, 1000 AE Amsterdam, The Netherlands. In USA and Canada, contact Elsevier Science Publishing Co. lnc., P.O. Box 882, Madison Square Station, New York, NY 10159, USA.

Rice in Latin America: improvement, management, and marketing. F. Cuevas-Perez, editor. Published by the International Center for Tropical Agriculture (CIAT) and IRRI. Send orders to Distribution Office, CIAT, A.A. 67 13, Cali, Colombia.

Sowing beyond the state: NGOs and seed supply in developing countries. E. Cromwell and S. Wiggins with S. Wentzel. Contact the Overseas Development Institute, Regent's College. Inner Circle, Regent's Park. London NW1 4NS, UK.

World inventory of soil emission potentials. N. H. Batjes and E. M. Bridges. editors. Contact E. M. Bridges, International Soil Reference and Information Center, P.O. Box 353, 6700 AJ. Wageningen. The Netherlands. ■

News about research collaboration

A new farming system for South America's acid-soil savannas

A new system of growing rice and improved pastures together has spread over 6,000 ha of under-used South American savannas in less than 2 yr, reports Dr. I. Sanz, International Center for Tropical Agriculture (CIAT) agronomist.

Crops grow poorly on the acid-soil infertile savannas that cover about 123 million ha. or 6% of the continent. The rice-pasture system was made possible by the 1991 release of Oryzica Sabana 6, the first high-yielding rice variety to tolerate acid savanna soils. The upland variety was bred at CIAT and released by the Colombian Institute of Agriculture.

"Farmers plant Sabana 6 in rows, then broadcast pastures of grasses and N,-fixing legumes. also developed at CIAT," Sanz explains. Four months later. farmers harvest the rice, which pays for land preparation costs and. after another 3 mo, they graze the pastures. An animal gains about 174 kg in a year compared with 95 kg on native grasses. and herds can increase sixfold. The system is spreading from Colombia to Brazil and Venezuela.

The project is funded by the Inter-American Development Bank. ■

Improving rainfed lowland cultivars: diversity of CIAT, IRRI germplasm pays off

Thanks to the distinct ecosystems of Latin America and Asia, rice scientists have a good base of rice germplasm from which to develop hardy new varieties for the rainfed lowlands.

Rice breeders in Ubon, Thailand. who are members of the Rainfed Lowland Rice Consortium. screened some 1,100 rices from the rice breeding programs of the International Center for Tropical Agriculture (CIAT). Colombia, and IRRI, found two distinct and complementary groups of genetic material. Each provides traits that are useful for farmer varieties. IRRl's rices-mainly bred from Asian cultivars-offer resistance to brown planthopper and green leafhopper pests and tungro disease. They also have high-yielding ability and good grain quality. CIAT's rices developed primarily from African varieties-are resistant to blast and have the deep roots essential for drought resistance.

National program breeders are using the IRRI and CIAT germplasm to develop high-yielding. pest- and disease-resistant rices that grow well under adverse rainfed lowland conditions. ■

Satellite survey finds potential ricelands in Cambodia

About 500,000 more hectares of land are suitable for rice cultivation in Cambodia than originally thought, *The Cambodia Times* reported in December 1992.

Results of a satellite survey initiated by the Cambodia-IRRI Rice Project (CIRP) revealed 3 million ha can be converted to riceland, compared with the 2.5 million ha indicated in the 1967 rice map, the *Times* said. It quoted Dr. H. Nesbitt, CIRP project leader, as saying "Now only 1.7 million ha are producing rice. This means the total area...is expandable, resulting in an additional yield of 2 million tons." A shortage of up to 200,000 t annually has plagued Cambodia in the past 5 yr.

The new rice map was developed by CIRP and the Mekong Committee, with funding by the Australian International Development Bureau (AIDAB). ■

West Sumatran manufacturers to build IRRI-designed machinery

A German development agency is urging equipment manufacturers in West Sumatra, Indonesia to build IRRI-designed agricultural machinery. reports Dr. G. Quick, head of the IRRI Agricultural Engineering Division.

The German Agency for Technical Cooperation (GTZ) purchased a HT-1 hydrotiller; a two-furrow, animal-draft plow; a rice micromill: and a transplanter for its Assistance to the Indonesian Agricultural Machinery Industry (ATIAMI) project. Local manufacturers are being urged to adapt the IRRI designs to Sumatran conditions. The ATIAMI project encourages and supports the development of small farm-equipment manufacturing in West Sumatra.

"There is need to grow more rice in Sumatra," says Quick. "But rice farming by hand is labor-intensive, and West Sumatran farm youths are heading for the glittering lights and promise of the city. Local farmers will increasingly rely on machinery as they strive to meet the region's need for rice." ■

Will IPM work in the Philippines? National agencies, FAO, and IRRI investigating

Integrated pest management (IPM) has received considerable hype but there is not much data on just how well it works. Dr. D. Bottrell, IRRI entomologist and project research leader, reports that scientists of the Philippine Rice Research Institute (PhilRice), the Philippine Department of Agriculture, the Food and Agriculture Organization of the United Nations (FAO), and IRRI are collaborating on a 2-yr project to determine the technical requirements, the training needs, and the benefits of IPM.

Farmer groups, policymakers, and researchers interested in pest management in rice will use the results to improve crop protection. Bottrell says.

"This is the first time we will compare IPM and current pest control practices on a village scale." Bottrell says. Three villages in Nueva Ecija. Central Luzon, are participating. About 40 farmers in one village have been trained to apply IPM practices over the next four cropping cycles. A second group of farmers in a neighboring village will continue their current pest control practices using routine insecticide spraying. A third group, the control, will use routine pest control practices except during the first 40 d of the crop cycle when pesticides will not be sprayed. ■

Pinning down the rice blast fungus

An atlas of blast fungal families found in different regions of the world is being developed at Purdue University, USA, in collaboration with the International Center for Tropical Agriculture (CIAT) and IRRI. The Rockefeller Foundation is sponsoring the project.

The fungal population is grouped into numerous Families; 14 have been found in Colombia. Certain families attack only certain varieties of rice. In turn, specific rices resist only certain fungal families. Once scientists identify which rice genes are resistant to which fungal families, they can breed those genes into appropriate varieties and develop truly resistant rices. ■

New politics, new economics: IRRI helps build Vietnamese expertise in economics research

It's a whole new ball game for Vietnamese agricultural economists, reports Dr. P. L. Pingali, IRRI agricultural economist. "With the shift from collective agriculture to an individual-oriented contract system, Vietnam's agricultural economists must draft a new game plan. They will need tools for setting research priorities, assessing technological change, and preparing policy options."

IRRI is helping strengthen Vietnam's capability in agricultural economics research. The 2-yr project is funded by a grant of the International Development Research Centre of Canada.

Project economists are gathering information on farm characteristics and rice production practices, learning how farmers in the Mekong and Red river deltas have responded to the recent changes in policy and institutional arrangements, and studying the impact of the reforms on rice productivity and sustainable rice exports.

IRRI scientists helped organize the Vietnam Society of Agricultural Economists, Pingali said, and, with assistance of a former IRRI graduate student now at Cantho University, prepared a Vietnamese textbook on econometrics. The new book is being tested in courses at several of the country's agricultural universities. ■

New technology evaluation network organized

The future of two of the oldest networks coordinated by IRRI — the Asian Rice Farming Systems Network (ARFSN) and the International Network on Soil Fertility and Sustainable Rice Farming (INSURF)—was discussed in a joint meeting of the networks in Vietnam in Oct 1992. Participants, recognizing that ARFSN and INSURF are evolving, agreed to establish a new evaluation network called the Crop and Resource Management Network.

The new network will facilitate a more rigorous evaluation of nongermplasm technologies, such as improved production systems, diversification, reduced chemical pesticide use, more efficient use of labor and water, gender-sensitive technologies, and agricultural tools and machineries.

Research activities of ARFSN and INSURF will be merged with IRRI's research programs, and some will be shifted to collaborating national agricultural research systems or consortia members. ■

Environment and IPM seminar in Cambodia

Policymakers in Cambodia met with rice experts and scientists from neighboring countries and international agencies to deliberate policy issues on chemical use in rice production in Cambodia. The seminar, *Environment and IPM,* sought to ensure increased rice production using environment-friendly practices.

Taking part were experts and scientists from Indonesia, Thailand, Vietnam, Philippines, Japan, the Food and Agriculture Organization of the United Nations (FAO), the International Development Research Centre (IDRC), the International Institute of Biological Control, the United Nations Technical Assistance Council, and IRRI. The seminar was held in Chamcar Daung Agricultural Institute in Phnom Penh, Cambodia, in Jan 1993, and organized by IRRI, FAO, and IDRC.

Participants urged that multilateral and development assistance agencies carefully review their policies and projects on agricultural development assistance to Cambodia to produce clear guidelines restricting pesticide use. Research studies indicate that using more insecticide destroys predator insects and creates new pest problems. The seminar group unanimously agreed that government authorities and agencies must review policies and guidelines when introducing insecticides.

They emphasized that the Cambodian Government needs to develop pesticide regulations on importation, distribution, and use. It was also agreed that agricultural organizations—both government and nongovernment—will cooperate in the campaign for increased awareness on IPM in lieu of chemical inputs and encourage efforts that will enhance natural control in rice environments. ■

World Inventory of Soil Emission Potentials (WISE) Program

Scientists in the World Inventory of Soil Emission (WISE) program are studying the global impact of the role of soil in producing and regulating emissions of potential greenhouse gases. The WISE Program is developing a world soil data base for use as a source of information on potential methanogenic soils, including rice soils. This data base will allow scientists to calculate a more precise figure of soil's potential for generation of methane than is currently available.

The WISE Program is based at the International Soil Reference and Information Centre (ISRIC). Wageningen, The Netherlands. The Frauenhofer Institute in Germany, the Nagoya University in Japan, and IRRI are also working on the program.

The WISE program leaders have asked researchers in this field to supply data on measurements of soil production and emissions of methane on soils in both rice and natural wetland ecosystems around the world. These data will be used to derive an expert system on methane production and emission which will permit geographical extrapolation.

For more information about the WISE program and current publications, contact E. M. Bridges, ISRIC, P.O. Box 353, 6700 AJ, Wageningen, The Netherlands. ■

Pest surveillance and forecasting workshop in Malaysia

Specialists in rice pest management reviewed and strengthened the role of pest surveillance and forecasting systems (PSFS) in rice pest management decisions at a workshop in Dec 1992 at the Muda Agricultural Development Authority in Alor Setar, Malaysia. They identified data, data collection. and information needs in pest surveillance to improve decisionmaking.

Taking part in the workshop. which was sponsored by the Rice IPM Network, were 60 Malaysian extension and research personnel from the Department of Agriculture, Malaysian Agricultural Research and Development Institute. and the Muda Agriculture Development Authority. ■

INGER: acclaimed by international agricultural research centers and donors worldwide

The International Network for Genetic Evaluation of Rice (INGER) and other genetic resource activities of IRRI have been rated the most valuable of all IRRI activities. About 150 individuals from institutions in South and East Asia, West Asia, North Africa, sub-Saharan Africa, and Latin America evaluated IRRI's work in a 1992 survey conducted by the Executive Secretary of the Technical Advisory Committee of the Consultative Group on International Agricultural Research. Respondents also rated INGER as an IRRI activity that should be continued in the future. ■

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