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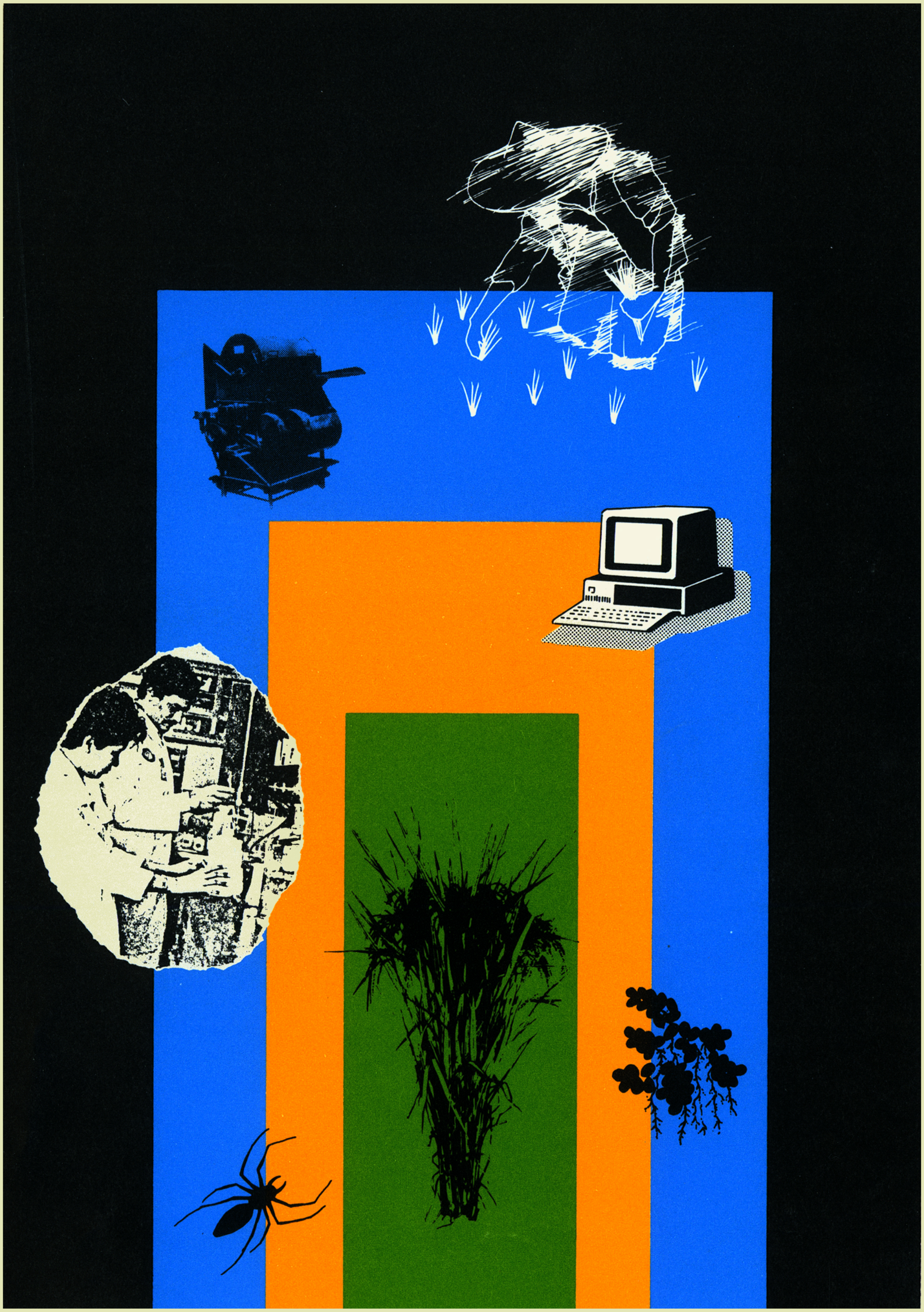

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IRRN GUIDELINES

The *International Rice Research Newsletter* objective is:

"To expedite communication among scientists concerned with the development of improved technology for rice and for rice-based cropping systems. This publication will report what scientists are doing to increase the production of rice, inasmuch as this crop feeds the most densely populated and land-scarce nations in the world ... IRRN is a mechanism to help rice scientists keep each other informed of current research findings."

The concise reports contained in IRRN are meant to encourage rice scientists and workers to communicate with one another. In this way, readers can obtain more detailed information on the research reported

Please examine the Criteria. guldelines, and research categories that follow.

If you have comments or suggestions. please write the editor, IRRN, IRRI, P.O. Box 933, Manila, Philippines. We look forward to your continuing interest in IRRN.

Criteria for IRRN research reports

- has international, or pan-national, relevance
- has rice environment relevance
- advances rice knowledge
- uses appropriate research design and data collection methodology
- reports appropriatc, adequate data
- applies appropriate statistical analysis, using appropriate statistical techniques
- reaches supportable conclusions

Guidelines for contributors

The *International Rice Research Newsletter* is a compilation of research briefs on topics of interest to rice scientists all over the world. Contributions to IRRN should be reports of recent work and work-in-progress that have broad interest and application. Please observe these guidelines in preparing submissions:

- The report should not exceed two pages of double-spaced typewritten text. No more than two figures (graphs. tables, or photos) may accompany the text. Do not cite references or include a bibliography. Items that exceed the specified length will be returned.
- Include a brief statement of research objectives and project design. The discussion should be brief, and should relate the results of the work to its objectives.
- Report appropriate statistical analysis.
- Provide genetic background for new varieties or breeding lines.
- Specify the environment (irrigated, rainfed lowland, upland, deep water, tidal wetlands). If you must use local terms to specify landforms or cropping systems, explain or define them in parentheses.
- Specify the type of rice culture (e.g., transplanted, wet seeded, dry seeded).
- Specify seasons by characteristic weather (wet, dry, monsoon) and by months. Do not use national or local terms for seasons or, if used, define them.
- When describing the rice plant and its cultivation, use standard, internationally recognized designators for plant parts and growth stages, environrnents. management practices, etc. Do not use local terms.
- When reporting soil nutrient studies, be sure to include standard soil profile description, classification, and relevant soil properties.
- Provide scientific names for diseases, insects, weeds, and crop plants; do not use common names or local names alone.
- Survey data should be quantified (infection percentage, degree of severity, sampling base, etc.).
- When evaluating susceptibility, resistance, tolerance, etc., report the actual quantification of damage due to stress used to assess level or incidence. Specify the measurements used.
- 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) or per row (g/row) for small-scale studies.
- Express all economic data in terms of the US$. Do not use national monetary units. Economic information should be presented at the exchange rate $:local currency at the time data were collected.
- Use generic names, not trade names, for all chemicals.
- When using acronyms or abbreviations, write the name in full on first mention, following it with the acronym or abbreviation in parentheses. Thereafter, use the abbreviation.
- Define in a footnote or legend any nonstandard abbreviations or symbols used in a table or figure.

Categories of research reported

GERMPLASM IMPROVEMENT
- genetic resources
- genetics
- breeding methods
- yield potential
- grain quality and nutritional value
- disease resistance
- insect resistance
- drought tolerance
- excess water tolerance
- adverse temperature tolerance
- adverse soils tolerance
- integrated germplasm improvement
- seed technology
- research techniques
- data management and computer modeling

CROP AND RESOURCE MANAGEMENT
- soils and soil characterization
- soil microbiology and biological N fertilizer
- physiology and plant nutrition
- crop management
- soil fertility and fertilizer management
- disease management
- insect management
- weed management
- managing other pests
- integrated pest management
- water management
- farm machinery
- environmental analysis
- postharvest technology
- farming systems
- research methodology
- data management and computer modeling

SOCIOECONOMIC AND ENVIRONMENTAL IMPACT
- environment
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GERMPLASM IMPROVEMENT

Genetics

Genetic parameters of submergence tolerance in some rainfed lowland rices of Bangladesh

M. S. Pathan and N. M. Miah, Plant Breeding Division, Bangladesh Rice Research Institute, Gazipur 1701, Bangladesh

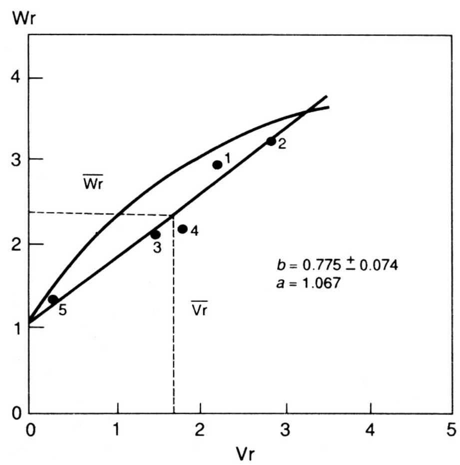
We used five rainfed lowland rice cultivars—one resistant, two moderately resistant, and two susceptible to submergence (FR13A, Dudmona, Kumragoir, Nizersail, and BR5)—to make one-way diallel crosses without reciprocal in 1983-85.

The ratios of submergence tolerance showed that dominant components were highly significant (see table), indicating the important role of additive as well as dominant genes. The dominance ratio $(H_1 / D)^{1/2}$ of 0.55 (partial dominance) was also supported by graphic analysis (see figure). The proportion of the gene in the parents ($H_2/4H_1$) showed some degree of gene asymmetry in favor of recessive alleles, as evidenced by the negative sign of F. The dominant and recessive genes were in unequal proportions in the parent (ratio 0.51).

Genetic parameters of submergence tolerance and their ratios. Gazipur, Bangladesh, 1983-85.

Genetic parameter	Estimates[a]
D (additive)	4.031** ± 0.038
H_1 (dominance)	1.229** ± 0.278
H_2 (dominance)	1.291** ± 0.229
h^2 (dominance)	1.356** ± 0.104
F (additive, dominance, and gene asymmetry)	–1.444 ± 0.238
E (environment)	0.042 ± 0.006
$(H_1/D)^{1/2}$ (average dominance)	0.552
$(H_2/4H_1)$ (gene asymmetry)	0.263
h^2/H_2 (number of gene blocks)	1.050
$\frac{\frac{1}{2}D + \frac{1}{2}H_1 - \frac{1}{2}H_2 - \frac{1}{2}F}{(\frac{1}{2}D + \frac{1}{2}H_1 - \frac{1}{2}H_2 - \frac{1}{2}F) + E}$ (narrow-sense heritability)	0.880

[a] **Significant at the 0.01 level.



Covariance (Wr)/variance (Vr) regression of submergence tolerance. Parents are 1) BR5, 2) Nizersail, 3) Kumragoir, 4) Dudmona, and 5) FR13A.

The ratio of h^2/H_2 was 1.05, suggesting involvement of at least 1 major gene or a group of genes having partial dominance. The Vr, Wr graph analysis shows that the parents FR13A possesses the most resistant alleles and BR5 and Nizersail possess susceptible alleles for submergence tolerance. The high narrow, sense heritability (0.88) showed the importance of additive gene action in submergence tolerance. □

Combining ability of upland rice progenitors

E. P. Guimarães, EMBRAPA/Centro Nacional de Pesquisa de Arroz e Feijão (CNPAF), Caixa Postal 179, 74000 Goiânia, GO, Brazil

In the 1987-88 season, 140 F_2 upland rice populations were evaluated in the CNPAF breeding program; 79 were discarded due to neck blast (Bl) susceptibility.

To study combining ability, the progenitors crossed at least 7 times were chosen from the total 63 used to make

Combining ability of upland rice progenitors. CNPAF, Brazil, 1987-88.

Progenitor	Populations (no.)		Populations (no.) with phenotypic variability			Neck Bl	
	Selected	Discarded	High	Medium	Low	Average	Range
Araguaia	8	1	1	8	0	4.2	3.0-6.0
A8-204-1	10	0	3	6	1	4.8	4.0-6.0
Cuiabana	8	0	1	6	1	4.1	3.0-5.0
IRAT216	10	0	3	6	1	5.1	3.0-6.0
Cabapu	7	2	4	3	2	5.2	3.0-7.0
CNA4640	7	2	2	5	2	5.3	3.0-8.0
CNA5180	7	2	4	3	2	5.2	3.0-7.0
IAC82-276	6	1	0	1	6	5.0	3.0-7.0
CNA4157	2	5	3	1	3	6.9	6.0-8.0
Mut. Makouta 41-1-3	3	4	1	0	6	5.3	4.0-7.0
TOm 1-3	2	5	7	0	0	6.7	5.0-8.0
Apura (indica group)	1	10	11	0	0	6.9	6.0-8.0

the F_2 populations. The parameters evaluated were a) number of populations selected, b) phenotypic variability, and c) neck B1 score.

Good combining progenitors had the majority of the crosses selected, showed medium to high phenotypic variability, and had neck B1 scores not above 6 in any cross. Araguaia, A8-204-1, Cuiabana, and IRAT216 were included in this group (see table). A second group with a lower combining ability included Cabacçu, CNA4640, CNA5180, and IAC82-276. CNA4157, Mut. Makouta 41-1-3, and TOm 1-3 showed poor combining ability.

A few single cross progenitors from the indica group were combined with japonicas, but the preliminary data did not show good results. The crosses produced very high phenotypic variability and susceptibility to neck B1. ☐

Breeding methods

Segregation of aroma character in F_2 hybrid rice grain

Bai Delang and Zhou Kunlu, Hunan Hybrid Rice Research Center (HHRRC), Changsha, Hunan, China

F_2 seeds from five F_1 rice hybrids derived from aromatic CMS line Xiang xiang IIA and five restorer varieties were tasted to identify aroma. Segregation was 15 nonaromatic: 1 aromatic grain (see table), indicating that aroma in the CMS line was controlled by 2 recessive genes. Absence of either gene resulted in nonaromatic grains.

The F_1 hybrids do not have an aroma during growth, but seed processing releases their aroma. ☐

Segregation of aroma in F_2 seeds borne by hybrids. HHRRC, Hunan, China.

Hybrid	Scented seed (no.)	Nonscented seed (no.)	1 = 15 χ^2	P
Xiang Xiang II A/PH137	67	933	0.27	>0.50
Xiang Xiang II A/26 Zhai Zao	59	941	0.15	>0.50
Xiang Xiang II A/Ming Tei 63	65	935	0.07	>0.75
Xiang Xiang II A/Ce 64	58	942	0.34	>0.50
Xiang Xiang II A/F 200	60	940	0.07	>0.75

$$\chi^2 = \sum_{i}^{k} \frac{(UQ - EI - ½)^2}{E}$$

Performance of two rice hybrids under upland conditions with and without fertilizer

O. Suherman and I. T. Corpuz, Maros Research Institute for Food Crops, South Sulawesi, Indonesia

Experimental rice hybrids V41A/ IR54 and V4lA/Sadang, developed for imgated conditions in Indonesia, were compared with maintainer V20B, male parent Sadang, conventional upland varieties Tondano and C22, very short-duration rainfed lowland variety IR58, and promising upland variety IR9575 Sel. The experiment was in a split-plot design with three replications. Fertilizer treatments were the mainplots and rice entries the subplots.

The trial was conducted 19 Nov 1987-20 Mar 1988 at Bontobili experimental farm, under agroclimatic zone B_2 (7-9 mo with monthly rainfall more than 200 mm, and 2-3 mo with monthly rainfall less than 100 mm). Soil is Ultic Haplustalf, fine mixed, isohyperthermic. It has clay loam texture; pH 5.7; available P ($Bray_1$) 39 ppm; 0.6, 8.8, 2.5, 0.2, and 0.3 meq exchangeable K, Ca, Mg, Na, and Al/ 100 g soils, respectively; and 0.1% total N and 1.8% organic

Performance of rice hybrids and conventional varieties under upland conditions, with and without fertilizer. Bontobili, South Sulawesi, Indonesia, 1987-88 wet season.

Entry	Plant height at harvest (cm)		Panicles (no,/m^2)		Filled grains (no./panicle)		Grain yield (t/ha at 14% moisture)	
	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer	With fertilizer	Without fertilizer
V41A/IR54	93.0	82.0	263	205	83	72	2.4	1.9
V41A/Sadang	98.7	81.7	263	223	87	76	1.8	1.7
V20B	73.1	72.3	367	196	74	72	2.1	1.6
Sadang	102.3	82.7	291	204	79	79	2.2	1.7
Tondano	122.7	106.7	259	177	84	75	2.7	2.0
IR58	73.7	67.0	373	185	78	51	2.2	1.8
C22	145.0	118.3	252	191	95	93	2.4	1.9
IR9575 Sel	129.3	101.7	253	179	124	113	3.4	2.2
Mean	104.8	89.1	280	195	88	79	2.39	1.86
CV (%)								
(a)	7		16		12		19	
(b)	8		13		11		16	
LSD (5%)								
(a)	7.9		48		ns		0.5	
(b)	9.1		37		11		0.4	

matter content.

Applying 135-40-50 kg NPK/ha as urea, TSP, and KC1 respectively, significantly increased plant height of tall conventional varieties and hybrids. Plant height of dwarf varieties V20B and IR58 was not significantly affected. The two rice hybrids were more susceptible to rice blast disease with 135 kg N/ha. The other entries were not affected by blast. Yields of hybrids V41A/IR54 and V41A/Sadang were significantly lower than that of IR9575 Sel (see table). Therefore, these hybrids are not suited to upland conditions. □

Compatibility of six rice varieties with indica and japonica varieties

Xiao Jinghua, Hunan Hybrid Rice Research Center (HHRRC), Changsha, Hunan, China

Although the F_1 hybrids of indica/japonica crosses show semisterility, some rice varieties crossed with indica and japonica varieties produce fertile F_1 plants. These are known as wide compatible varieties (WCVs). We crossed CP-SLO$_{17}$, CP-SL0$_{19}$, 02428, Lunhui 422, Peiai 64, and SMR with six indica and six japonica testers.

The cultivars showed obvious differences in compatibility with indica and japonica varieties (see table). CP-SLO$_{17}$ and CP-SLO$_{19}$ were found to be WCVs. Cultivars 02428 and Lunhui 422 were more compatible with japonica than with indica varieties. Peiai 64 and SMR were more compatible with indicas, and were not designated WCVs. □

Fertility of F1 spikelets in crosses of some rice cultivars and indica and japonica testers. HHRRC, Hunan, China, 1987.

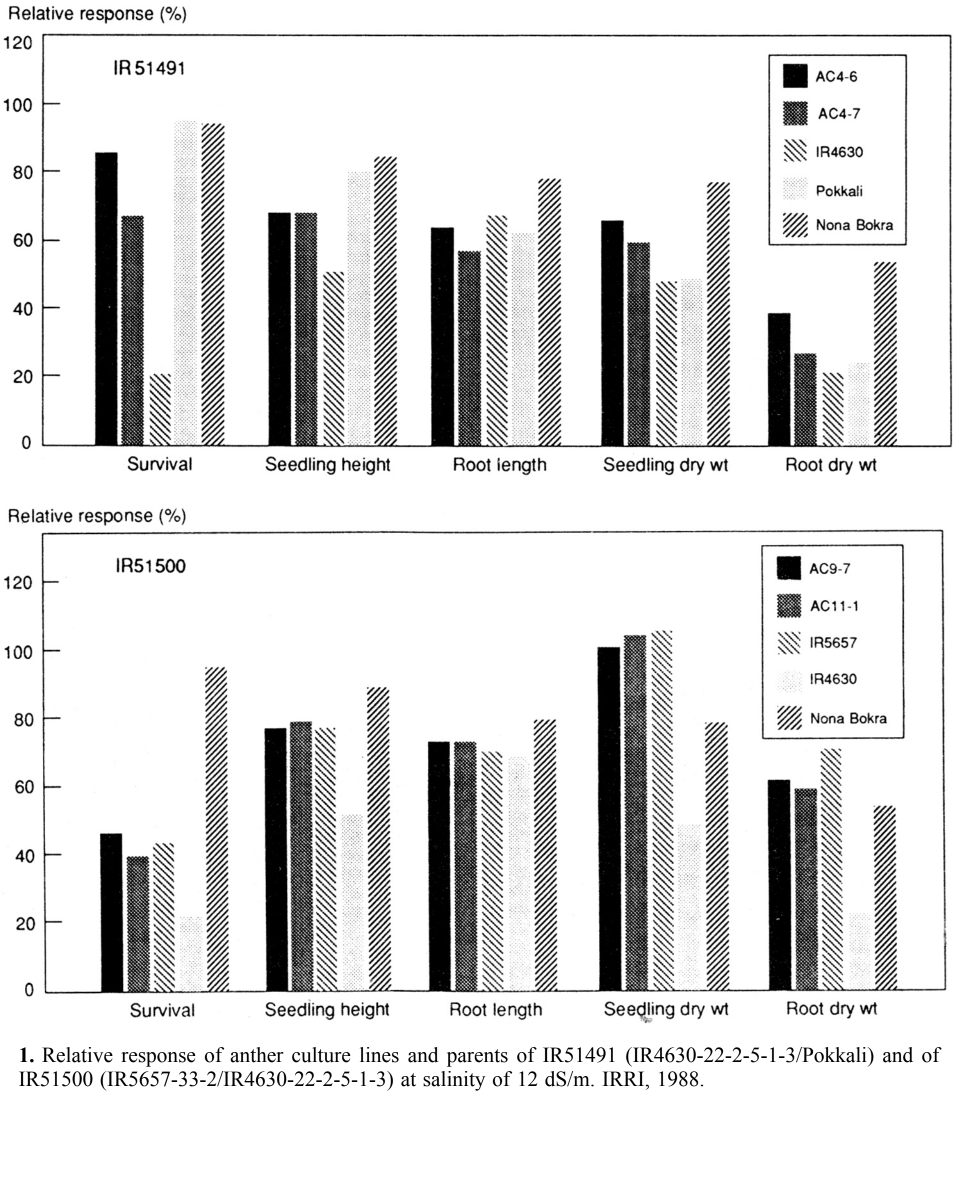
Combination	F_1 spikelet fertility (%)	
	Mean	Range
CP-SLO$_{17}$/indica	81.2	68.5-91.3
CP-SO$_{17}$/japonica	85.4	78.4-92.0
CP-SLO$_{19}$/indica	80.0	73.3-86.5
CP-SLO$_{19}$/japonica	81.2	72.0-87.2
02428/indica	68.2	53.2-84.3
02428/japonica	84.2	78.4-92.4
Lunhui422/indica	74.2	68.5-89.4
Lunhui422/japonica	85.8	80.4-94.4
Peiai 64/indica	86.5	78.1-89.6
Peiai 64/japonica	60.3	41.2-85.3
SMR/indica	86.4	76.3-92.1
SMR/japonica	72.2	62.3-84.4
Indica/japonica	34.3	4.4-53.2

Salt tolerance of anther culture-derived rice lines

F. J. Zapata, M. Akbar, D. Senadhira, and D. V. Seshu, IRRI

Four dihaploid lines produced through the anther culture of IR51491 (IR4630-22-2-5-1-3/Pokkali) F_1 and IR51500 (IR5657-33-2/IR4630-22-2-5-1-3) F_1, and their parents were evaluated for salt tolerance, using water culture technique in the phytotron glasshouse at 29/21 °C (day/night temperature) and 70% relative humidity. Cultivars Pokkali and Nona Bokra were the tolerant checks.

IR51491 was designed to incorporate the semidwarf trait of IR4630-22-2-5-1-3 (Pelita I-1/Pokkali//IR2061-464-2/IR1820-52-2) into salt-tolerant Pokkali. IR51500 was designed to incorporate high-yielding traits into IR4630-22-2-5-1-3. The semidwarf IR4630 has compact tillering, poor



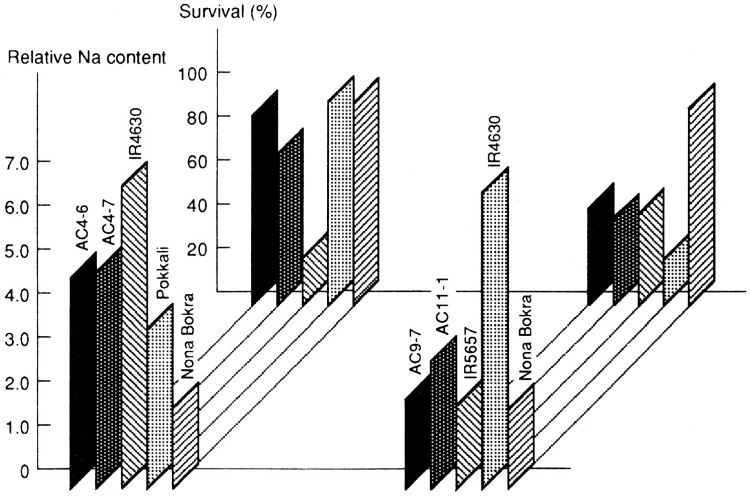
1. Relative response of anther culture lines and parents of IR51491 (IR4630-22-2-5-1-3/Pokkali) and of IR51500 (IR5657-33-2/IR4630-22-2-5-1-3) at salinity of 12 dS/m. IRRI, 1988.

panicle exsertion, and grain sterility, and does not possess high salt tolerance.

F_1 plants were anther cultured and two dihaploid lines of each cross were produced. The lines are semidwarf, with better agronomic traits than IR4630-22-2-5-1-3. Ten plants of each line or variety per replication were used.

Pregerminated seeds were salinized at an EC of 12 dS/m with 1:1 ratio of NaCl and $CaCl_2$ and the salinity level maintained for 1 mo. Survival ranged from 21% for IR4630 to 94% for Pokkali (Fig. 1). Anther culture line IR51491-AC4-6 was quite tolerant of salinity, comparable with Pokkali and Nona Bokra.

In general, root length and root weight were more affected by salinity. IR51491-AC4-6 and IR51491-AC4-7 had longer and heavier roots than their parents IR4630 and Pokkali (Fig. 1). IR51500-AC9-7 and IR51500-AC11-1 were superior to their parents IR4630 and IR5657 in seedling height and root length. IR51500-AC9-7 and IR5 1500-AC11-1 had heavier roots than tolerant check Nona Bokra.



2. Relative Na content and survival of anther culture lines IR5 149 1 and IR51500 and their parents at salinity of 12 dS/m. IRRI. 1988.

Apparently, relative Na content was inversely related to percentage survival (Fig. 2). Pokkali and Nona Bokra, considered tolerant, showed the highest survival rate and low relative Na content; IR4630, a moderately tolerant variety, had the lowest Na content. This suggests that the principle of salt tolerance in rice may be due to the ability of the plant to minimize Na absorption.□

Natural outcrossing of cytoplasmic male sterile line IR54752A in Indonesia

Satoto and B. Sutaryo, Plant Breeding Division, Sukamandi Research Institute for Food Crops, Subang, West Java, Indonesia

We studied the effect of number and distance of pollinator on the outcrossing rate of IR54752A during 1986-87 wet season, using a split-plot design with three replications. The main plot consisted of 2 levels of pollinator—1 and 6 rows. The subplot consisted of 4 pollinator distances—20, 40, 60, and 80 cm. IR54752B was seeded at the same rate 4 d later than IR54752A to synchronize flowering.

Five plants from each treatment were sampled before flowering. Row direction was arranged to be with the prevailing wind direction at flowering.

Number of pollinators did not significantly affect seed set and numbers of filled grains (Table 1). Hence, using one row of pollinators will be more advantageous than others, because the cytoplasmic male sterile population can be further increased. Pollinator distance did not significantly affect seed set percentage or filled grains per plant. Filled grains per plant tended to decrease with distance (Table 2).

Table 1. Seed set and filled grains/plant on cytosterile line IR54752A by pollinator number.[a] Sukamandi, Indonesia, 1986-87 wet season.

Pollinator number	Seed set (%)	Filled grains (no.)
1	5.7 a	65.6 a
6	6.4 a	89.0 a
CV (%)	19.3	49.5

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

Table 2. Seed set and filled grains/plant on cytosterile line IR54752A by pollinator distance.[a] Sukamandi, Indonesia, 1986-87 wet season.

Pollinator distance (cm)	Seed set (%)	Filled grains (no.)
20	6.3 a	85.2 b
40	6.2 a	83.6 b
60	6.4 a	83.4 b
80	5.3 a	57.1 a
CV (%)	21.4	17.8

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

Pollination at 80 cm depended on wind velocity. Low seed set probably was caused by the natural outcrossing in IR54752A.□

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Yield potential

Effect of seedling age on Basmati growth and yield

M. Ashraf and S. Mahmood, Rice Program, National Agricultural Research Centre, P.O. Box 1031, Islamabad, Pakistan

Transplanting depends on a farmer's resources, particularly the availability of irrigation water, labor, and other farm inputs. However, nurseries are invariably seeded from the last week of May to the first week of Jun. Optimum age for transplanting Basmati seedlings is considered to be 25-35 d.

We assessed the effect of transplanting overage seedlings on yield of Basmati 370 and Basmati 385. Yield and yield attributes declined significantly with seedling age (see table). The yield decline was partly attributable to fewer productive tillers/ hill and fewer spikelets/panicle. ☐

Yield and yield attributes of overage seedlings of 2 Basmati varieties. Islamabad, Pakistan.

Seedling age (d)	Basmati 370				Basmati 385			
	Productive tillers/hill (no.)	Spikelets/ panicle (no.)	Yield (t/ha)	Yield decrease (%)	Productive tillers/hill (no.)	Spikelets/ panicle (no.)	Yield (t/ha)	Yield decrease (%)
30	12.4	152.4	2.8	–	9.7	196.2	4.6	–
45	10.4	151.6	2.4	15.1	9.7	186.5	4.2	9.8
60	8.4	138.1	1.3	31.0	8.5	177.3	3.1	33.6

Relationship of transplanting time and grain yield of Basmati 385

M. Ashraf, S. Mahmood, M. Munsif, and M. Yousaf, Rice Program, National Agricultural Research Centre, P.O. Box 1031, Islamabad, Pakistan

Basmati varieties cover about 85% of the total acreage in Kaalar. Usually transplanting is at the start of the monsoon, within a very short optimum period. But time of transplanting depends on a farmer's resources.

With the release of Basmati 385, we conducted an experiment to determine its optimum transplanting time. The trial was in a randomized complete block design with three replications. The crop was kept flooded.

Delayed transplanting significantly reduced grain yield (see table). Highest yield was from plots transplanted 1 Jul, with progressive declines as transplanting was delayed. Yield decreased 49% from 1 Jul to 15 Aug, at a rate of 58 kg/d per ha. Yield attributes also showed progressive decline with delay in transplanting. The decrease in yield was partly the result of decrease in productive tillers/hill and in spikelets/panicle. ☐

Yield and yield-contributing characters of Basmati 385 as affected by transplanting date. Islamabad Pakistan.

Transplanting date	Productive tillers/hill (no.)	Spikelets/ panicle (no.)	Yield (t/ha)	Yield index[b]
15 Jun	11.5 a	194.2 a	4.9 a	93
1 Jul	10.3 a	210.2 a	5.3 a	100
16 Jul	10.5 a	189.6 a	4.4 b	84
31 Jul	9.8 b	178.8 b	3.8 c	72
15 Aug	8.7 b	161.1 c	2.1 d	51

[a] Means in a column followed by the same letter are not significant at the 5% level by DMRT. [b] Index taking the yield for 1 Jul plot as 100.

Variability in rice grain-filling duration

D. Senadhira and Li Guo Fu, Plant Breeding Department, IRRI

Duration of grain filling, defined as the time from flowering to maturity, ranges from about 30 d in the tropics to about 65 d in temperate zones. The variation is considered to be due to temperature difference, not to a varietal character. Modern indica varieties developed for the tropics produce extremely high yields under temperate conditions. A primary reason for increased yield is a 2-3 wk extension of grain-filling duration.

We examined Bg 90-2 and Bg 380 with longer ripening duration and 19 other varieties with varied agronomic characters for grain-filling duration in dry season 1987 at IRRI. Seeds were sown on wetbed and 4-wk-old seedlings transplanted at 1 plant/hill in 7.2- × 0.9-m plots with 30- × 20-cm row spacing. The experiment was in a randomized complete block design with three replications.

Fertilizer was applied basal at 60–40-40 kg NPK/ha. Plots were fully protected against weeds, pests, and diseases.

Panicles were tagged at flowering, when about 5% of spikelets had dehisced anthers. Ten tagged panicles taken at random from each test plot every 4 d from 0 to 46 d after tagging were ovendried at 48°C for 3 d. Filled and unfilled grains were removed by hand, counted, and weighed.

Increase in grain weight was calculated, adopting Richard's function.

The correlations between grain-filling duration and other agronomic traits were calculated.

Differences in grain-filling duration among the 21 varieties tested were highly significant. Bg 90-2 had the longest, at 40 d; PP2462/ 11 had the shortest, at 16 d (see table). Bg 380 and Bg 90-2 were similar, and differed significantly from all others tested.

Because there was no appreciable difference in mean daily temperature, solar radiation, and daylength during grain filling, the variability found cannot be attributed to environmental factors.

Grain-filling duration showed a highly significant positive correlation with days to 50% heading ($r = 0.70$) and a negative correlation with rate of filling ($r = 0.81$). Correlation coefficients of grain filling and grain numbers per panicle and 100-grain weight were not significant.

We believe that Bg 90-2 and Bg 380 inherited their longer grain-filling duration from Taichung Native 1. □

Grain-filling rate and duration and some agronomic traits of 21 rice varieties. IRRI, 1987 dry season.

Variety	Days to 50% heading	Grains/ panicle (no.)	Grain filling[a]	
			Rate (10 mg/panicle per d)	Duration (d)
SSD106	57	65	9.8 b	18 h
Bg 750	57	42	12.2 a	17 h
PP 2462/11	67	62	13.0 a	16 h
Bg 276-5	73	123	9.1 bc	19 gh
Bg 367-4	75	172	7.5 cd	23 fg
Bg 34-8	79	119	5.9 ef	27 cdef
lR50	83	108	6.5 de	24 fg
IR36	83	93	7.9 cd	23 fg
Seeraga Samba	87	219	3.4 hi	26 def
IR64	88	107	8.6 bc	24 efg
IR26	98	172	4.6 fgh	33 b
IR54	101	160	4.7 fgh	33 b
Bg 380	102	169	4.4 fghi	38 a
Bg 90-2	110	176	4.2 fghi	40 a
Bg 573	115	344	3.6 ghi	25 ef
H4	119	143	5.3 efg	32 b
Bg 11-11	125	264	2.8 i	31 bc
IR42	128	124	5.1 efgh	29 bcde
Bg 400-1	128	57	5.6 ef	30 bcd
Remadja	136	123	8.6 bc	24 fg
IR48	138	139	9.6 b	24 fg

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

Grain quality and nutritional value

Grain properties of IR36-based starch mutants

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Properties of brown rice (1987 wet season crop) of 12 starch mutants with IR36 background were compared with those of IR36. All rices had lighter and less dense grain than IR36 (see table).

Sugary and shrunken mutants had the lowest starch content, but sugary had the highest content of total free sugars. About 50% of the measured starch content of the sugary mutant was actually phytoglycogen. Protein contents were high, and the amylose extender (ae) mutant showed the highest lysine content, followed by dull 2035.

In protein per seed, the sugary mutant had the lowest protein value, but dull EM47 was highest followed by dull

Brown rice properties of IR36 and its starch mutants. IRRI, 1987 wet season.

Entry	Mutant description	100-grain wt (g)	Density (g/cm^3)	Composition (% wet basis)				Protein/ seed (mg)	Lysine (g/16.8 g N)	Lysine/ seed (µg)	Crude fat (% wet basis)	Apparent amylose[a] (% dry basis)	GT (°C)
				Starch + free sugars	Total free sugars	Reducing sugars	Crude protein						
IR36	(control)	1.8	1.54	73	2	0.3	11	2.0	3.9	78	1.5	22 (26)	73.5
82GF	Sugary	0.6	1.29	57[b]	9	1.5	16	1.0	4.1	41	5.5	0 (0)	>80[c]
EM20	Shrunken	1.1	1.22	61	2	0.3	16	1.6	4.2	66	4.8	15 (22)	73.5
2064	Amylose extender	1.8	1.38	68	2	0.4	10	1.8	4.7	85	1.9	34 (44)	77
EM36	Floury-2	1.5	1.36	68			12	1.8	4.1	74	2.2	10 (13)	72.5
ESD7-3(0)	Floury-1	1.8	1.28	71			10	1.8	4.1	74	1.7	19 (23)	74
2035	Dull	1.7	1.40	68			13	2.2	4.5	99	1.4	6 (8)	73
2057	Dull	1.3	1.40	71			12	1.6	3.9	62	1.4	5 (7)	73
2077	Dull	1.5	1.40	70			14	2.1	4.1	86	1.5	9 (11)	72
2120	Dull	1.4	1.38	69			12	1.7	3.8	65	1.6	6 (8)	74
EM-12	Dull	1.4	1.39	65			13	1.8	3.9	70	1.6	6 (8)	74.5
EM-47	Dull	1.7	1.39	70			14	2.4	3.6	86	1.5	5 (6)	66
EM-90	Dull	1.5	1.40	73			11	1.7	3.7	63	1.3	6 (7)	72.5

[a]Amylose content on starch basis in parentheses. [b]Includes phytoglycogen. [c]A few normal granules gelatinized between 57 and 62 °C.

2035, dull 2077, and IR36. Lysine per seed was highest in dull 2035, followed by dull 2077, dull EM47 and ae and IR36. Fat content was high in sugary and shrunken grains.

All mutants except ae had lower apparent amylose content in brown rice than IR36. Gelatinization temperature (GT) of the samples were intermediate except for dull EM47 and ae.

The extremely high GT value for the sugary mutant may be due to the effect of its high sucrose level on GT. Corresponding starch mutants based on Kinmaze showed similar trends in starch properties. A sample of the ae mutant of Kinmaze had 31 % apparent amylose in defatted brown rice. □

Quality characteristics of some new aromatic rices

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We compared milling and cooking performance of 13 aromatic rice lines and Basmati 370. All samples were grown under similar environmental conditions and tested 2 mo after hand harvesting.

Brown rice recovery varied widely (see table). All lines except NIRRI-PTB-11 and NIRRI-PTB-138 (PL) had higher brown rice yields than Basmati 370; NIRRI-PTB-22 had the highest yield. Head rice yield of NIRRI-PTB-22 was also highest. NIRRI-PTB-140 had more than 40% brokens. NIRRI-1-10643-1-65 had exceptionally long grains. Three lines had higher length:breadth ratios (L/B) than Basmati 370. Six lines had amylose as high as or higher than that of Basmati 370.

Cooked NIRRI-PTB-140-6 had the highest LB, followed by NIRRI-PTB-138 (PL). The elongation ratio of S41 was higher than that of Basmati 370. □

Milling and cooking characteristics of some aromatic rices. Ludhiana, India.

Variety or line	Milling recovery (% of rough rice)			Milled rice					
	Brown rice	Milled rice	Head rice	Protein (%)	Amylose (%)	Length of raw rice (mm)	Length:breadth		Elongation ratio[a]
							Raw rice	Cooked rice	
NIRRI-PTB-11	76.1	70.0	55.0	9.7	21.7	6.7	3.94	3.88	1.45
NIRRI-PTB-20	78.3	72.0	47.0	8.5	26.3	6.7	3.53	3.36	1.25
NIRRI-PTB-22	80.4	74.0	64.2	9.2	19.9	6.8	3.40	3.60	1.32
NIRRI-PTB-23	78.4	72.1	55.7	8.8	19.0	6.6	3.88	3.64	1.38
NIRRI-PTB-36	79.9	73.5	41.9	9.4	24.5	6.7	3.19	3.58	1.39
NIRRI-PTB-138 (PL)	77.5	71.3	47.7	9.8	18.1	7.7	4.05	4.42	1.38
NIRRI-PTB-138 (MS)	74.7	68.7	50.8	8.3	17.2	7.5	3.95	3.75	1.20
NIRRI-PTB-140	78.9	72.6	32.5	9.6	16.3	7.5	4.17	4.21	1.35
NIRRI-PTB-140-6	78.8	72.5	54.1	9.6	15.4	7.9	4.65	4.50	1.37
NIRRI-PTB-145	80.2	73.8	54.6	10.2	12.7	7.3	4.29	3.88	1.38
NIRRI-PTB-170	79.4	73.0	47.8	9.4	18.1	6.9	3.29	3.76	1.36
S41	79.9	73.5	43.5	9.0	19.0	7.0	3.89	4.07	1.57
NIRRI-1-106-4-3-1-65	79.5	73.1	48.7	8.4	18.1	8.3	4.61	4.03	1.46
Basmati 370	78.0	71.7	42.6	9.8	19.0	7.7	4.28	4.37	1.53
Mean	78.6	72.2	49.4	9.3	18.9	7.2	3.97	3.93	1.39

[a]Length of cooked milled rice ÷ length of raw rice.

Disease resistance

Sources of multiple resistance to rice blast (Bl) and bacterial blight (BB) in Nepal

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Rice Bl caused by *Pyricularia oryzae* and BB caused by *Xanthomonas campestris* pv. *oryzae* have been observed widely in the tropical and subtropical regions of Nepal, the country's major rice-producing areas. Breeding for varieties with multiple resistance to these diseases would be easier and quicker using sources with multiple resistance.

To identify such sources, varietal reactions to Bl and BB in Kankai,

Sources of multiple resistance to rice Bl and BB in Nepal, 1985-87.[a]

Variety	Reaction to Bl		Reaction to BB	
	Average	Range	Average	Range
Janaki	2.3	0.0-3.0	1.5	0.0-3.0
Laxmi	2.1	0.0-3.0	2.4	1.5-3.0
KAU1727	1.7	0.0-3.0	3.1	3.0-3.4

[a]Scoring according to *Standard evaluation system for rice* scale: 0-9. [b]Scored 21 d after inoculation.

Tarahara, Parwanipur, Rampur, and Surkhet screening nurseries in 1985-87 were reviewed.

In the tests, 848 entries were evaluated for Bl resistance and 644 for BB resistance: 366 (43.2%) were resistant to Bl and 61 (9.5%) to BB. Of these, 13 lines/varieties had resistance to both diseases.

Janaki, Laxmi, and KAU1727 showed high field resistance to both pathogens at all sites (see table) and might be useful parental materials. Janaki and Laxmi are released varieties. ☐

Resistance of upland rice varieties to pale yellow mottle virus (PYMV) disease in Sierra Leone

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PYMV disease occurs sporadically in Sierra Leone, and its incidence is increasing. Several plots in the eastern and northern provinces have had fairly high levels of infection, and the potential for considerable yield loss is high.

We tested eight released varieties and promising lines for resistance to PYMV under upland conditions at Kenema in the eastern province. Varieties were sown in 10-m^2 plots in a randomized complete block design with 4 replications. One set of varieties was inoculated 3 wk after seeding with sap from blended infected leaves. One set was not inoculated. All treatments received standard fertilizer application and cultural management.

ROK16 was resistant to the virus; Tox 502-SLR, IRAT8, and Lac 23 gave intermediate responses (see table). Despite its intermediate rating, Lac 23 had a significant yield reduction (54%). PN623-3, Tox 516-12-SLR, ROK3, and ROK15, all rated as susceptible, gave significant yield reductions (84-97%).☐

Response of 8 rice cultivars to inoculation with pale yellow mottle virus disease. Sierra Leone, 1983-84 wet season.

Treatment	Mean yield (t/ha)	Yield loss (%)	Mean height (cm)	Stunting (%)	Reaction[a]
ROKl6	2.9		112		
ROK16 + virus	2.7	9	110	1.8	R
Lac 23	2.3		112		
Lac 23 + virus	1.1	54	106	5.4	I
ROK3	2.2		124		
ROK3 + virus	0.3	88	96	22.6	S
Tox 502-SLR	1.7		112		
Tox 502-SLR + virus	1.4	19	104	7.1	I
PN623-3	2.4		110		
PN623-3 + virus	0.3	88	70	36.4	S
IRAT8	1.6		93		
IRAT8 + virus	1.3	20	78	16	I
Tox 516-12-SLR	2.8		65		
Tox 516-12-SLR +virus	0.4	84	42	35.4	S
ROK15	2.9		109		
ROK15 + virus	0.1	97	74	32.1	S
LSD (0.05)	522		10		
CV (%)	19.3		6.4		

[a]R = resistant: no infection, or faint and barely discernible leaf mottling. I = intermediate: mild leaf streaking or mottling with or without stunting. S = susceptible: evident chlorosis and leaf mottling with mild to severe stunting.

Development of a japonica rice variety with blast (Bl) and bacterial blight (BB) resistance

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Resistances to Bl and BB are not as strong in japonica rice varieties as in indica varieties. We used indica variety Tetep and japonica variety Toride 1 as Bl-resistant parents and made crosses with traditional high-yielding japonica variety Aijing 23 that has BB resistance.

Japonica variety Chengte 232 derived from Aijing 231/Ailoqing/Toride 1///Aijing 23//Nonghong 23/Tetep has been released. In artificial inoculation tests, it was resistant or moderately resistant to 13 of 14 local strong *Pyricularia oryzae* isolates and 5 *Xanthomonas campestris* pv. *oryzae* races (Table 1). It has 139-d duration in

Table 1. Reaction[a] of Chengte 232 to 14 *P. oryzae* isolates and *S. campestris* pv. *oryzae* races. Hangzhou, China.

Variety	Reaction[b] to Bl														Reaction[b] to BB				
	A1	A61	A63	B1	B15	C3	C13	C15	D1	D3	E1	E3	F1	G1	188	186	98	35	149
Chengte 232	R	R	R	MR	R	R	MR	R	R	MR	R	S	R	R	R	R	R	R	R
Nonghu 6	S	MR	S	S	S	S	S	S	S	S	S	S	S	S	S	S	MR	MR	R
Tetep	S	R	S	R	R	S	R	R	R	R	MR	R	R	R					
Aijing 23	S	S	S	S	S	S	S	S	S	S	S	S	S	S	MR	MR	R	R	R

[a]R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible. [b]Grouping or race number based on Chinese differentials.

the late season and yields 6.8 t/ha, 8.42% more than widely grown Nonghu 6 and with better grain quality (Table 2).

Chengte 232 also is being used to generate indica/japonica rice hybrids. The F_1 of Chengte 232 (japonica)/26 Zezhao (indica) yielded 11.3 t/ha. □

Table 2. Some agronomic characteristics of Chengte 232. Hangzhou, China.

Variety	Duration (d)	Plant ht (cm)	Panicles (no./m^2)	Grains (no./panicle)	Panicle length (cm)	1000-grain wt (g)	Yield (t/ha)
Chengte 232	139	88.2	418.29	83.1	16.2	24.0	6.8
Nonghu 6	144	97.7	454.27	73.3	15.1	23.2	6.3

Insect resistance

Influence of male sterile and normal cytoplasm on expression of resistance to thrips

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Reactions to rice thrips *Stenchaetothrips biformis* among cytoplasmic male sterile and their maintainer lines seem to differ under field conditions at TNAU. We evaluated nine sets with male sterile and normal (fertile) cytoplasm for resistance in Jun 1988.

Seeds of each line were sown in 1-m-long rows, with 5 replications. Resistant check Ptb 33 and susceptible check TN1 were sown at random.

Reaction of cytoplasmic male sterile and restorer lines to thrips. Tamil Nadu, India.

Line	Damage rating[a]
V20A	1 a
V20B	1 a
Erjiunan A	9 b
Erjiunan B	9 b
IR46829A	9 b
IR46829B	1 a
IR46830A	1 a
IR46830B	9 b
IR46831A	9 b
IR46831B	1 a
IR48483A	9 b
IR48483B	1 a
MS37A	1 a
MS31B	1 a
Madhu A	9 b
Madhu B	1 a
Pragathi A	9 b
Pragathi B	9 b
Ptb 33 (resistant check)	1 a
TN1 (susceptible check)	9 b

[a] Mean of 5 replications. Separation of means by DMRT at the 5% level.

Thrips incidence was severe 20 d after sowing. When all TN1 seedlings were dead, entries were rated for thrips damage on the *Standard evaluation system for rice* 1-9 scale.

Resistance to thrips differed significantly (see table). Male sterile lines IR48483A, IR46829A, IR46831A, and Madhu A scored susceptible, but their corresponding maintainer lines scored resistant, indicating cytoplasmic-based expression of susceptibility to thrips. Male sterile lines V20A, IR46830A, MS37A, and Mangala A have high resistance to thrips that could be utilized in developing resistant hybrids. □

Genes conditioning resistance to brown planthopper (BPH)

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Although rice varieties with seven monogenic genes for resistance to BPH *Nilaparvata lugens* (Stål) have been identified at IRRI, little is known about their reactions to other BPH populations. We evaluated varieties with *Bph 1, bph 2, Bph 3, bph 4, bph 5,* and *Bph 6* genes and a variety with *bph 2 + Bph 3* genes for resistance and for fecundity, hatchability, growth, development of nymphs and increase in BPH population in Tamil Nadu, India.

IR747-B2-6 (*Bph 1*), Mudgo (*Bph 1*), ASD7 (*bph 2*), Ptb 18 (*bph 2*), Rathu Heenati (*Bph 3*), Babawee (*bph 4*), ARC10550 (*bph 5*), Swarnalata (*Bph 6*), Ptb 33 (*bph 2 + Bph 3*), and TN1 (no resistance gene) were sown in 40-cm rows in 60- × 45- × 10-cm wooden trays. At 7 d after sowing, seedlings were thinned to 15/row and infested with 8 2d-instar nymphs/seedling. Trays were covered with fine fiberglass mesh cages. Treatments were replicated five times. When susceptible TN1 was dead, varieties were graded for damage.

To determine fecundity and hatchability, three pairs of newly emerged brachypterous males and females were caged on 30-d-old potted plants of test varieties. Five replications were arranged in a randomized complete block design (RCBD) in a water-filled iron tray. Nymphs emerging represented the number of viable eggs produced by the females. After nymph emergence, leaf sheaths were dissected under a 20× binocular microscope and unhatched eggs counted.

To determine growth and development, 10 1st-instar nymphs were caged on 30-d-old potted plants of each test variety, with 5 replications in a RCBD. Growth was measured by the number of nymphs that became adults and the time taken. Insect growth index was calculated as the percentage of nymphs developing into adults to the mean developmental period in days.

To determine population increase, 30-d-old potted plants of each variety were infested with 4 pairs of newly emerged brachypterous males and females per pot, with 5 replications in a RCBD. Nymphs and adults were counted 20 d after infestation.

Rathu Heenati, Babawee, ARC105504 Swarnalata, and Ptb 33 rated resistant in seedbox screening (see table). Mudgo and Ptb 18 were moderately resistant. IR747-B2-6 and ASD7 were susceptible.

Fecundity and egg hatchability were significantly higher on susceptible TN1 and IR747-B2-6 and ASD7 than on

Damage to rice varieties infected with BPH in a free-choice test, and BPH fecundity, egg hatchability, nymph growth and development, and Population increase on 10 rice varieties with different genes for resistance.[a] Tamil Nadu, India.

Variety	Resistance gene	Damage rating	Fecundity (no. eggs/ female)	Hatchability[b] (%)	Nymphs becoming[c] adults	Development (d)	Growth index (%)	Population increase (no./cage)
IR747-B2-6	*Bph 1*	9.0 a	525 c	93 e	94 d	12.7 a	1.4 d	512 c
Mudgo	*Bph 1*	5.4 b	290 b	62 d	62 c	13.4 b	4.6 c	270 b
ASD7	*bph 2*	9.0 a	537 c	94 e	94 d	12.7 a	7.4 d	515 c
Ptb 18	*bph 2*	5.8 b	298 b	63 d	64 c	13.3 b	4.8 c	275 b
Rathu Heenati	*Bph 3*	1.0 c	122 a	46 bc	44 ab	14.9 c	2.9 ab	99 a
Babawee	*bph 4*	1.0 c	123 a	46 bc	40 ab	14.7 c	2.7 ab	106 a
ARC10550	*bph 5*	1.4 c	121 a	48 c	46 b	14.8 c	3.1 b	100 a
Swarnalata	*Bph 6*	1.0 c	116 a	44 ab	42 ab	14.9 c	2.8 ab	103 a
Ptb 33	*bph 2* + *Bph 3*	1.0 c	118 a	41 a	38 a	15.1 d	2.5 a	101 a
TN1	(no resistance gene)	9.0 a	535 c	93 e	96 d	12.6 a	7.6 d	515 c

[a] Av of 5 replications. Separationof means in a column by DMRT at the 5% level. [b] Three newly emerged males and females were caged on 30-d-old plants. [c] Ten newly emerged 1st-instar nymphs caged on 30-d-old plants.

Rathu Heenati, Babawee, ARC10550, Swarnalata, and Ptb 33. Significantly more nymphs became adults on susceptible TN1, IR747-B2-6, and ASD7. Nymph development was delayed and growth indices were lower on moderately resistant and resistant varieties. The population increase was 2-4 times higher on TN1, IR747-B2-6, and ASD7 than on Rathu Heenati, Babawee, ARC10550, Swarnalata, and Ptb 33.

Evidently, *Bph 1* and *bph 2* genes do not confer resistance against the BPH population in Tamil Nadu. Minor genes probably contribute to a moderate level of resistance in monogenic varieties Mudgo (*Bph 1*) and Ptb 18 (*bph 2*). Varieties with *Bph 3, bph 4, bph 5, Bph 6*, and *bph 2* + *Bph 3* genes had high levels of resistance to the BPH population in Tamil Nadu. □

Mass-rearing of rice hispa *Dicladispa armigera* Olivier and testing of BR varieties for resistance

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We developed a simple technique to rear rice hispa in the greenhouse. The mass-reared insects were used to test resistance of 15 BRRI rice varieties.

Hispa beetles were collected from ricefields, sorted by sex, and released on potted 30-d-old BR3 rice plants inside 1.8- × 0.6- × 0.6-m fine-mesh wire cages for oviposition. After 34 d, plants with eggs were transferred to another cage for development of grubs. Grubs developing in the leaves were easily visible. Plants were sprinkled with water intermittently during daytime by means of a fine sprinkler until most grubs approached the pupal stage.

Grubs usually developed in 2 wk and turned brownish at pupation. Plants with pupae were transferred to another

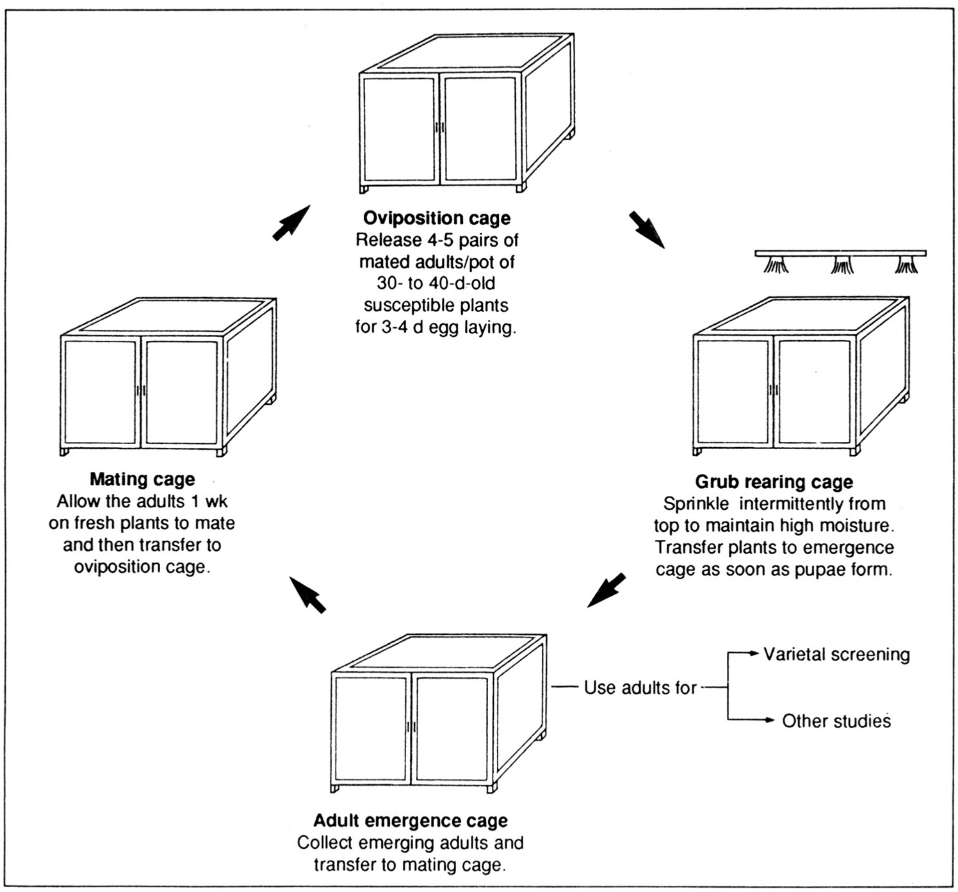

Diagram for mass-rearing of hispa on rice plants. BRRI.

cage for adult emergence (34 d). For mating, emerged beetles were confined in another cage with healthy plants 1 wk.

Four to five mated pairs per pot were released on 30-d-old plants in the egg-laying cage (see figure) for 3-4 d. The cycle was repeated to obtain hispa beetles of about the same age.

With limited facilities, we were able to obtain 80% grub survival and rear 400-600 beetles in each hatch. Each generation took about 4 wk. Hispa grubs required high amount of moisture for development. Egg hatching and grub survival were greatly affected if the plants were not sprinkled with water. Egg deposition and grub survival were more satisfactory on 30- to 40-d-old plants.

To determine varietal reactions, one seedling each of 15 BR varieties (BR1 to BR16, except BR13) and susceptible check TN1 were planted at random in a 60- × 40- × 10-cm wooden seedbox at 10-cm spacing, with 3 seedboxes as replications. When plants were 30 d old, each seedbox was covered with a rectangular fine-mesh wire cage on a water-filled tray and infested with 3 greenhouse-reared hispa beetles per plant. Leaf damage was graded 7 d after infestation, when TN1 plants had more than 50% leaf damage.

All test varieties had high damage, indicating susceptibility to hispa beetles. □

Evaluation of rice germplasm against rice leaffolder (LF) in the greenhouse

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We developed a method to identify *Cnaphalocrocis medinalis* (Guenée) resistance donors in the greenhouse. The test is based on scraping of leaf chlorophyll by larvae.

One 5th-instar larva was caged on each 45-d-old plant (5 plants/ test variety) for 48 h. Leaf area damage was measured by placing the leaf on mm^2 graph paper on a light table and counting the squares visible through the translucent damaged area. Damaged area averaged 326 mm^2 for susceptible check TN1 and 161.3 mm^2 for resistant check Ptb 12.

We evaluated more than 100 rice lines using this method. The lowest leaf damage was 71 mm^2 in Choorapundy, the highest was 403 m^2 in Company Chittari. The table lists rice varieties with less than 200 mm^2 damage. They can be rated as resistant to moderately resistant. □

Rice varieties registering low leaf area damage from rice LF *C. medinalis* in the greenhouse. Hyderabad, India.

Variety	Damaged leaf area (mm^2)
Choorapundy	71.0
Gorsa	94.6
Ptb 33	113.8
Ptb 19	118.3
T10	125.0
ARC10660	129.4
Kula Peruvela	148.2
Balam	151.2
Chempan	151.2
ET5742	167.4
W1263	167.5
Chemban	170.4
Co 29	172.0
Darukasail	181.8
ARC7064	187.0
MO I	189.6
T1406	191.8
Ptb 12 (resistant check)	161.3
TN1 (suscepfible check)	326.0

Adverse temperature tolerance

Screening for cold tolerance in Burundi

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Rice has been cultivated for many centuries by Baswahili populations along Lake Tanganyika, in swampy areas (780 m) or in upland areas from lake level to 1,300 m. The typical upland rices are called Pandabilima (that which escapes toward the mountain) in Swahili.

Sterility induced by low temperatures in Burundi.

Variety	Origin	Sterility (%)
B2978b-Sr2-6-2-2	Indonesia	37.4
B2980b-Sr2-6-2-3-2	Indonesia	45.1
B2982b-Sr62-3-1-4	Indonesia	63.9
B2983b-Sr85-3-2-4	Indonesia	65.2
Barkat (K78-13)	Bangladesh	32.3
Br51-315-2B-39-1-1	Bangladesh	97.2
Br220-1-1	Bangladesh	95.1

Table continued

Variety	Origin	Sterility (%)
Br319-1	Bangladesh	100
Chan Wang Ku (1539)	China	88.7
IR2061-522-6-9	IRRI	83.4
IR5716-18-1	IRRI	75.2
IR7167-33-2-3-3-1	IRRI	78.1
IR9202-6-1-1	IRRI	72.1
IR9202-33-4-2-1	IRRI	70.9
IR13155-60-3-1-2-1	IRRI	80.6
IR15579-85-2-3	IRRI	92.7
IR15579-135-3	IRRI	69.3
IR15889-32-1	IRRI	67.7
IR18476-55-2	IRRI	67.5
IR22723-RR-4-2	IRRI	70.7
IR22623-RR-4-3	IRRI	81.6
IR24312-RR-19-3-B	IRRI	83.2
K288	India	82.6
K438	India	49.0
K443-106	India	87.0
Kaohsiung Sen Yu 252	Taiwan	87.2
NR10041-66-3-1	Nepal	70.8
RP1848-54-2-3-1	India	77.7
RP1848-109-2-1-1	India	66.2
RP1931-68-4-1-2	India	90.0
Se Lin R (4767)	Proc.	97.6
Shoa Nan Tsan	Proc.	79.7
Stejarree 45	USSR	32.2
Swat I	Pakistan	74.7
YR1641-GH12-5-1GH4	Korea	90.2
YR2379-47-2	Korea	93.7
Yunnan 3	China	12.9

The greater area of the swamp is between 1,400 and 2,000 m altitude. Low night temperatures (sometimes below 11 °C) affect spikelet fertility.

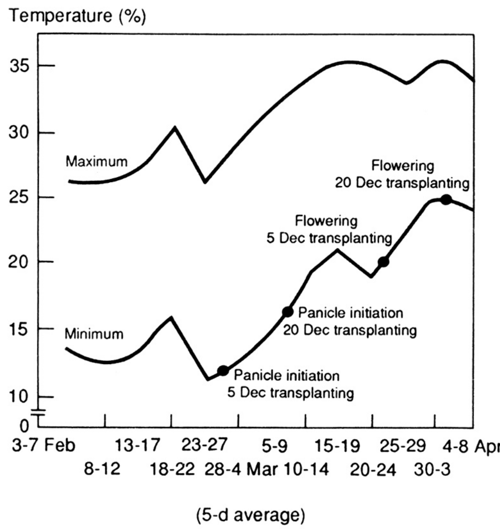
We have isolated a variety from China, Yunnan 3, that yields well (3.5 t/ha) in the swamps at 1,400-1,650 m. But it is a typical japonica variety, while the local land races are indica type and nonglutinous. It also has partial sterility, noncoordinated tillering, long cycle, and susceptibility to *Pseudomonas fuscovaginae* and *Pyricularia oryzae.*

IRRI breeding lines and Yunnan 3 were screened for low temperature tolerance in the Akagoma swamp (1,510 m) Dec-Jun. Percent sterility varied widely (see table).□

Effect of low temperature on yield and some agronomic characters of rice

N. M. Miah and M. S. Pathan, Plant Breeding Division, Bangladesh Rice Research Institute (BRRI), Gazipur 1701, Bangladesh

We studied the effect of low temperature on 10 rice genotypes in irrigated rice, 1984 boro season. Two trials were conducted in the same plot. The first trial was seeded 31 Oct and transplanted 5 Dec 1983. The second trial was seeded 15 Nov and transplanted 20 Dec. Spacing was 25- × 15-cm in 5.4-m^2 plots, in a randomized complete block (RCB) design with 5 replications. Fertilizer was applied at 80-26.4-33.2-100-2.3 kg N, P, K, gypsum, and Zn/ha and normal management practices were followed.



Temperature at different crop stages, Feb-Apr 1984, BRRI, Bangladesh.

In the first trial, low temperature in Feb 1984 (see figure) coincided with panicle initiation. Low temperature resulted in significantly longer growth duration, shorter plants and panicles, lower number of panicles/ hill, higher spikelet sterility, and lower grain yield (see table). □

Effect of time of transplanting on yield and yield components in 2 irrigated transplanted rice trials.[a] BRRI, Gazipur, Bangladesh, 1984 dry season.

Entry	Duration (d)		Days to flowering		Plant height (cm)		Panicles (no./hill)		Panicle length (cm)		Spikelet sterility (%)		1000-grain weight (g)		Yield (t/ha)	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
BG35-2	171	163	150	142	71	87	10	11	22.6	23.4	26	13	23	24	3.7	4.9
BG367-4	169	163	146	140	80	90	9	11	18.4	19.0	22	19	19	19	3.5	4.7
MRC603-3-3	179	170	156	146	80	87	13	14	22.0	24.0	19	21	22	24	4.4	4.0
IR13429-196-1	172	164	150	141	74	78	11	11	22.0	22.6	21	19	22	23	3.8	4.2
IR36	181	170	158	147	72	75	12	14	19.7	20.8	20	17	20	21	4.2	5.5
IR50	170	160	144	137	63	73	14	14	18.5	20.0	28	22	20	20	4.1	4.9
IR9729-67-3	168	154	140	131	71	77	10	12	19.5	22.0	27	24	22	22	3.2	4.5
IR9828-91-2-3	177	169	154	145	69	75	13	15	19.4	21.4	18	17	21	21	3.8	4.0
Taichung sen yu 285	175	167	152	143	89	97	9	9	25.0	24.6	15	14	26	26	4.4	5.5
BR1	166	156	141	134	65	79	14	13	18.4	20.1	38	25	21	21	2.7	4.0
Average	173	164	149	141	73	82	11.5	12.4	20.5	21.8	23.4	20.1	21.6	22.1	3.8	4.6
t-value[b] (df8)	13.2**		17.8**		6.37**		3.1 *		4.5**		2.5**		2.2[ns]		5.2**	

[a] 1 = 31 Oct seeding, 2 = 15 Nov seeding. [b]Significant at the 5% (*) and 1% (**) levels of probability.

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Adverse soils tolerance

Performance of selected varieties and advanced generation genotypes in rainfed lowland iron-toxic soil

M. J. Abraham and D. K. Pandey, Plant Breeding Division, ICAR Research Complex for North Eastern Hills Region, Shillong 4, Meghalaya, India

We screened 4 varieties and 13 advanced breeding lines for adaptability to P-deficient and Fe-toxic rainfed lowland valley soil at Barapani (980 m mean sea level 26°N and 92°E). Soil was acidic with pH 5.3,0.74% organic C, 1 ppm available P, 53 ppm available K, 71 ppm exchangeable Al, and 242 ppm Fe.

Forty-day-old seedlings were transplanted at 20- × 20-cm spacing, 1 seedling/hill, in 7 2-m-long rows in a randomized complete block design with 4 replications. A control set was transplanted in nontoxic soil with pH 5.3, 1.12% organic C, 8 ppm available P, 57 ppm available K, 94 ppm exchangeable Al, and 97 ppm Fe.

Visual symptoms of toxicity (bronzing of the leaves) were recorded at the boot leaf stage. RCPL 87-5 (Pawnbuh/Mirikrak) was most susceptible and RCPL 87-8 (Mirikrak/IET1444) most tolerant.

Fe toxicity reduced plant height 20%, panicle length 16%, number of productive tillers 60%, and yield 77% (see table). The primary factor responsible for yield reduction was the substantial reduction in productive tillers per plant. Varietal differences were significant for all characters. Interaction was significant only for grain yield. ☐

Performance of 17 rice varieties under Fe-toxic (T) and nontoxic (NT) soil conditions in Meghalaya, India.

Variety	Productive tillers (no.)		Grain yield/ plant (g)	
	NT	T	NT	T
Gobind	16.5	5.7	6.8	2.0
Prasad	15.8	6.2	6.2	2.6
MC-3-1-4-2	9.6	4.4	14.0	4.0
RCM8	11.9	5.5	5.5	2.1
RCM7	10.4	3.7	5.2	1.2
DR92	10.4	4.4	23.6	4.4
RCPL 57	9.0	4.0	16.0	4.0
RCPL 87-1	8.0	4.1	14.2	4.8
RCPL 87-6	8.2	3.4	12.9	2.7
RCPL 87-2	10.3	3.8	14.5	3.4
RCPL 87-7	10.1	3.8	18.7	3.3
RCPL 87-8	12.2	4.6	30.4	6.9
RCPL 87-5	12.4	3.4	24.2	4.1
RCPL 87-3	9.0	3.2	20.2	3.6
RCPL 87-4	7.7	3.4	13.0	3.6
IET110	10.1	3.4	19.8	3.1
Ngoba (check)	9.6	4.7	18.8	5.2
Mean	10.7	4.2	15.5	3.6
LSD	1.1	3.4	2.0	5.9

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Integrated germplasm improvement

IR62, evaluated for second crop in Tamil Nadu

S. Palanisamy, W. W. Manuel, S. M. Lal, and K. Natarajamoorthy, Paddy Breeding Station (PBS), Tamil Nadu Agricultural University, Coimbatore 641003, Tamil Nadu, India

We evaluated IR62 (PTB33/IR30//IR36) in the second crop late samba season (Sep-Nov sowing) 1986-87 and 1987-88 in 10 trials laid out in randomized replicated plots. Grain yield ranged from 4.4 to 7.0 t/ha, 6.0 t/ha average: 15.4% more than IR20 and 11.1 % more than Co 43 (see table). Duration ranged from 129 to 148 d, 136 d average.

The semidwarf (70 cm) has a moderately high number of panicles per hill (8.0). Grain is long and slender with white rice. It is resistant to green leafhopper and whitebacked planthopper, and moderately resistant to brown planthopper, leaffolder, stem borer, blast, bacterial blight, and tungro. Because of its better yield potential and multiple resistances, it has been recommended for late samba. Because IR62 is susceptible to grain shedding, timely harvest is recommended. ☐

Yield of IR62 at PBS, Coimbatore, Tamil Nadu, India, 1986-88.

Trial no.	Grain yield (t/ha)				
	IR62	IR20	Co 43	LSD (0.05)	CV (%)
			1986-87		
1	5.9	5.5	5.8	0.1	1.3
2	6.2	5.5	6.1	0.1	1.2
3	5.9	5.3	5.3	0.1	1.0
4	6.5	5.0	5.4	0.6	7.0
5	7.0	5.7	6.4	0.9	7.6
6	6.9	5.9	5.8	0.8	5.9
7	5.4	5.2	4.6	0.5	4.4
			1987-88		
8	5.5	5.1	5.3	0.7	9.2
9	4.4	3.9	3.5	0.4	5.9
10	6.2	4.8	5.8	1.0	10.1
Mean	6.0	5.2	5.4	–	–

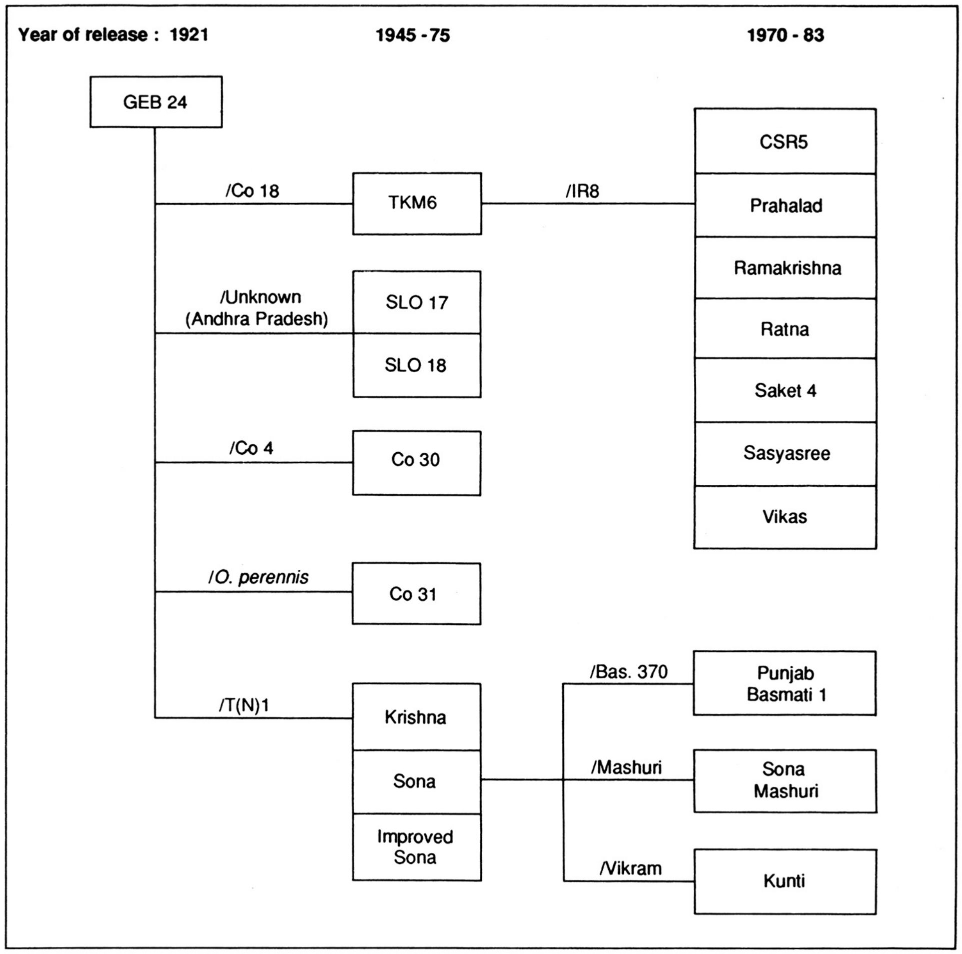
Genetic resources of GEB24

S. R. S. Rangasamy, S. Palanisamy, W. W. Manuel, S. M. Lal, and K. Natarajamoorthy, Plant Breeding Station (PBS), Tamil Nadu Agricultural University, Coimbatore 641003, Tamil Nadu, India

GEB24, also called Kitchili Samba, selected from the Andhra Pradesh local variety Konamani, was released in 1921. It is tall (120-135 cm), has 150-d duration, and is highly photoperiod sensitive. It tillers profusely, with nonshattering grain. Despite its relatively low yield potential (3.5 t/ha), it is popular mainly for its very good quality rice. Its grain is medium slender and white.

GEB24 has been used extensively in several national and international breeding programs and several modern high-yielding varieties carry its genes.

It is the ultimate maternal progenitor of 18 varieties (see figure). Eight varieties released between 1945 and 1975 are direct derivatives: TKM6 is resistant to stem borer (SB); Co 30 is resistant to blast; co 31 (the fit outcome of interspecific cross) is resistant to drought Ten varieties released between 1970 and 1983 are second-generation derivatives: Ratna is noted for SB resistance and Punjab Basmati 1, for scented rice.



Derivatives with GEB24 as maternal progenitor.

A list of 83 varieties with GEB24 features inherited paternally is available from the authors. They include 23 from Tamil Nadu, 20 from other Indian states, 28 from IRRI, and 12 from other countries. □

Masuli, most popular rice variety in Nepal

G. L. Shrestha, National Rice Improvement Programme (NRIP), Parwanipur Agriculture Station, Bara, Nepal

Rice in Nepal occupies 59% of the total cultivated land and contributes 52% of the total edible food grain. Rice employs more than 75% of the population (17.5 million) at least 6 mo a year and contributes 23% of the total gross domestic product (GDP).

In 1987, the total rice area was 1.4 million ha, production was 3 million t, with average yield of 2.1 t/ha (see table).

Area, production, and productivity of rice in different ecological regions of Nepal in 1987 (Food and Agricultural Marketing Department, Lalitpur, Nepal, 1988).

Ecologial region	Area		Production		Productivity (t/ha)
	ha	%	ha	%	
Tarai	1,049,900	73.7	2,249,090	75.2	2.1
Mid-hill	337,890	23.8	667,390	22.3	2.0
High hill	35,500	2.5	65,300	2.5	1.8
Total	1,423,290	100.0	2,981,340	100.0	2.1 (national average)

Of the 31 improved rice varieties Nepal has released during the last 20 yr, Masuli, released in 1973, is the most popular in the subtropical climatic region of Tarai, inner Tarai, and similar climatic river basin areas and valleys up to 900-m altitude. In 1987, more than 50% of the total ricelands were planted to improved varieties; Masuli covered 26.6% of the total, more than 379,506 ha. Market surveys indicate that at least 60% of the milled rice marketed in the country is Masuli.

Masuli characteristics are the following:

1. Higher grain yield under low-to-medium fertility.
2. Equally good yield under rainfed lowland.
3. Higher grain yield with late planting condition, even with 60-d-old seedlings.
4. Early maturity (within Nov), leaving time for farmers to plant winter crops.
5. Medium fine, soft, moist cooked grain quality accepted at almost all levels of society.
6. Intermediate tall, giving farmers straw for their cattle.
7. A 15-20% higher market price.
8. More than 32% head rice recovery.

Masuli has become susceptible to blast, particularly at the seedling stage. The fungicide carbendazim is used for its control. □

*The **International Azolla Newsletter** is published for researchers in the development and application of azolla in rice production. Its content focuses on discussions of current issues; it does not publish research reports. For more information, write Dr. I. Watanabe, **Azolla Newsletter** editor, IRRI, P.O. Box 933, Manila, Philippines.*

Seed technology

Variability in rice seed vigor after storage

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We evaluated 21 shortduration rices with 3 different grain characteristics—long slender, short bold, and medium bold—for germinability after 9 mo storage in 1986-87. Details on seed viability, germination percentage, coleoptile seedling length, vigor index (germination percentage × seedling length), and dry matter production are given in the table.

The medium bold seed type cultivars had higher values for coleoptile length, seedling length, vigor index, and dry matter production than long slender types. Intragroup variability for the physiological parameters was relatively higher than intergroup variability. Intragroup variability was highest in long slender genotypes, followed by the short bold. Medium bold genotypes had the least variability.

Variability in germination and dehydrogenase enzyme activity was considerably higher in long slender genotypes than in medium bold genotypes. The higher dehydrogenase enzyme activity indicates the potential vigor of stored seeds of medium bold genotypes. □

Germination of seeds of 3 genotypes after 9-mo storage, Coimbatore, India.

Genotypes	Germination (%)		Coleoptile length (cm)	Seedling length (cm)		Vigor index	Dry matter production (mg)	Dehydrogenase activity (O.D.)
Long slender	Initial	After storage		Initial	After storage			
Long slender								
T2978	100	94	2.15	41.8	35.4	3302	0.0151	0.062
T2021	95	46	1.02	40.0	32.9	1547	0.0087	0.037
T1724	100	85	2.00	40.7	32.4	2771	0.0132	0.115
HY68	95	77	1.92	37.2	32.6	2521	0.0119	0.152
T2023	95	93	1.60	37.0	30.5	2847	0.0118	0.067
T358	100	89	1.50	40.7	34.2	3059	0.0152	0.067
T1814	96	84	2.37	44.1	36.9	3105	0.0132	0.155
Mean	97	83	1.79	40.0	33.5	2736	0.0127	0.093
Short bold								
T1727	100	74	1.70	38.4	30.9	2273	0.0146	0.075
T1406	100	74	1.57	42.4	36.2	3432	0.0179	0.142
T2952	100	97	1.70	38.7	32.8	3153	0.0185	0.087
T1769	95	82	1.40	47.5	35.3	2919	0.0214	0.125
T2006	95	93	3.29	40.7	34.1	3118	0.0169	0.127
T218	92	79	1.92	34.6	29.5	2345	0.0101	0.082
T2099	100	85	2.17	37.5	32.8	2804	0.0156	0.127
Mean	97	88	1.96	40.0	33.0	2863	0.0164	0.109
Medium bold								
T828	100	90	2.65	43.1	40.5	3674	0.0151	0.087
T1668	100	88	2.82	44.5	40.3	3558	0.0176	0.092
T1824	100	87	3.17	42.7	33.9	2943	0.0155	0.115
T2297	96	84	2.50	41.5	35.8	3001	0.0181	0.097
T2832	100	96	2.65	47.9	33.6	3189	0.0153	0.082
SLO 7	100	93	2.75	37.0	35.1	3278	0.0158	0.137
T1704	100	88	2.45	44.5	37.2	3330	0.0175	0.145
Mean	99	90	2.71	43.0	36.6	3281	0.0164	0.107
LSD (0.05)		9.4	0.69		2.8	443	0.0017	0.011
(0.01)		13.0	0.94		3.9	604	0.0024	0.015

	Length (mm)	×	Width (mm)
Long slender	7.2	×	1.6
		to	
	8.9	×	1.6
Short bold	4.1	×	1.8
		to	
	6.4	×	1.8
Medium bold	6.6	×	1.9
		to	
	8.1	×	1.9

Fungi longevity on stored rice seeds

V. Tolentino and D. A. Vaughan, International Rice Germplasm Center (IRGC), IRRI

The blotter technique was used to detect and identify sporulating fungi on 25 seeds each of 8 replications of indica varieties Siam 29 (IRGC acc. no. 5473) and Peta (IRGC acc. no. 3634) that had been stored 20 yr at 2 °C, 40% relative humidity, seed moisture content of 8-9%, in the medium-term storage room of IRGC. Seeds of both varieties were harvested in the 1968 dry season.

Nine fungal genera were detected (see table). *Trichoconiella* and *Curvularia* were common on both varieties but *Fusarium, Drechslera,* and *Phyllosticta* were common only on Peta, perhaps because of genotypic differences. Germination was 78.5% for Siam 29 and 45.5% for Peta. The greater abundance of fungi on Peta may have contributed to its lower gemination.

The long-term survival of so many quiescent fungi may be a consequence of the cold, dry storage conditions. The presence of *Fusarium* sp., a genus that contains storage pathogens with short survival on seeds in storage, is surprising. Given the importance of long-term storage of germplasm in genebanks, the effect of fungi, particularly seed pathogens, on the long-term viability and germination of aged seed warrants further investigation. ☐

Genera of fungi detected on seeds of 2 rice varieties stored for 20 yr. IRGC, 1968 dry season.

Genus	Seeds infected (%)	
	Siam 29	Peta
Trichoconiella	72	62.5
Curvularia	11.5	25.0
Phyllosticta	0	23.5
Drechslera	0	14.5
Fusarium	0	10.0
Pithomyces	0	1
Penicillium	0	1
Cladosporium	0.5	0.5
Rhizopus	1	0

CROP AND RESOURCE MANAGEMENT

Soils and soil characterization

Cultural practices to reduce iron toxicity in rice

M. B. Abu, E. S. Tucker, S. S. Harding, and J. S. Sesay, Rice Research Station, Rokupr, Sierra Leone

Fe toxicity in inland valley swamps drastically reduces rice yields. Two sets of experiments in 1984 and 1985 cropping seasons in the inland valley swamp at Magbolontor studied the influence of cultural practices on reducing Fe toxicity and increasing grain yield.

Seedlings of different ages of Suakoko 8 (moderately tolerant of Fe toxicity) and Faro 15 (susceptible) were transplanted at 20, 30, and 40 d old in a randomized complete block design with 4 replications. Fertilizer was 60-40-40 kg NPK/ha. Toxicity symptoms were scored at early tillering and maximum tillering.

Symptoms were quite pronounced in Faro 15 at all seedling ages (Table 1). Younger seedlings of Suakoko 8 were more tolerant than older seedlings. Yields of Suakoko 8 were significantly higher than those of Faro 15.

Yields varied significantly between varieties and planting dates (Table 2). The results suggest that the optimal time of planting to escape serious Fe toxicity in the inland valley swamp at Magbolontor is during the first 2 wk of Jul. Planting earlier or later in the season significantly reduces yields, even in a tolerant variety. In Jul, the amount of water is too high to wash Fe off rapidly. ☐

Table 1. Effect of seedling age on Fe toxicity and grain yield. Sierra Leone, 1984-85.

Variety	Seedling age (d)	1984		1985	
		Grain yield (t/ha)	Toxicity (%)	Grain yield (t/ha)	Toxicity (%)
Suakoko 8	20	1.7	25	1.5	45
	30	2.4	25	1.9	40
	40	1.8	40	1.7	45
Faro 15	20	0.9	50	1.4	60
	30	1.0	50	1.9	55
	40	1.0	60	1.5	55
CV (%)		32.7		21.2	
LSD (0.05)		0.7		–	0.7

Table 2. Effect of planting date on Fe toxicity and grain yield. Sierra Leone, 1984-85.

	Suakoko 8		Faro 15	
	Yield (t/ha)	Toxicity (%)	Yield (t/ha)	Toxicity (%)
15 Jun 1984	1.5	30	1.2	60
15 Jun 1985	2.3	25	1.9	60
15 Jul 1984	2.4	30	1.4	60
15 Jul l985	2.8	20	2.6	60
15 Aug 1984	1.3	45	1.1	65
15 Aug 1985	2.1	45	1.9	70
CV (%)	28.3	21.5		
F test				
Treatment	S	NS		
Dates	S	S		
LSD (0.05)	655 kg/ha			

Physiology and plant nutrition

Integrated organic and inorganic fertilizer for flooded rice in Kerala, India

J. Kamalam, P. J. Tomy, and N. R. Nair, Regional Agricultural Research Station, Pattambi, Kerala, India

Azolla and rice straw are easily available organic fertilizers in Kerala. We studied the effect of inorganic N sources (prilled urea [PU] and urea supergranules [USG]) alone and in combination with azolla (3.24% N, 0.20% P, 1.28% K, and 6.2% dry matter) and rice straw (0.035% N, 0.03% P, 0.59% K, and 58% dry matter) on grain and straw yields of transplanted Jaya during 1986-87 dry season. The 12 treatments were laid out in randomized block design with 4 replications.

Soil of the experimental site is lateritic sandy clay loam with pH 5.5, 0.88% organic C, 2.53 kg available P/ha, 90.42 kg available K/ha, 35.8% coarse sand, 23.6% fine sand, 9.3% silt, and 29.3% clay. In treatments with organic fertilizer, 29 kg N/ha was supplied by organic manure and the rest by inorganic fertilizer. P was applied at 19.65 kg/ha and potash at 37.5 kg K/ha. PU was applied 1/2 as basal and 1/2 at panicle initiation. USGs were placed 10 cm deep at planting.

Grain yields with 58 kg N/ha were statistically the same as with 87 kg N/ha, except that with USG + rice straw (see table). Organic manure can easily replace inorganic fertilizer at each fertilizer level. Yields with PU and USG, alone or with azolla/rice straw, were not significantly different.

Effect of organic and inorganic fertilizers on grain and straw yields of flooded rice. Kerala India, 1986-87 dry season.

Treatment	Rate (kg N/ha)	Grain yield (t/ha)	Straw yield (t/ha)
Control	0	2.0	1.7
PU	58	2.6	2.2
PU + azolla	58	2.4	2.6
PU + rice straw	58	2.4	2.3
USG	58	2.7	2.2
USG + azolla	58	2.4	2.0
USG + rice straw	58	2.5	1.8
PU	87	2.7	2.9
PU + azolla	87	2.3	2.8
PU + rice straw	87	2.6	2.4
USG	87	2.9	2.2
USG + azolla	87	2.9	2.6
USG + rice straw	87	3.2	2.8
LSD (0.05)	–	0.5	0.4

In the case of straw yield, organic material was as good as inorganic fertilizer. Straw yield increased with increased fertilizer, perhaps due to higher vegetative growth in plots fertilized with 87 kg N/ha. □

Effect of phosphorus on growth and rice plant nutrient content

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We studied the effect of 4 levels of P on rice growth and nutrient content in a pot experiment. The alluvial soil had pH 7.8,0.63% organic C, EC 0.12%, CEC 14.25 meq/100 g soil, 0.069% total N, 0.094% total P, 3.9 ppm available P (Olsen method), and exchangeable cations Ca 34.5, Mg 2.36, K 0.38, and Na 0.89 meq/100 g soil. Basal fertilizer was 100-50 kg NK/ha. Rice seedlings (IR8 and IR6) were transplanted at 3 wk, 4 seedlings/pot, in a randomized block design with 5 treatments and 4 replications. Plant samples were dried, digested, and analyzed for N, P, K, Fe, Mn, Zn, and Cu 10 wk after transplanting.

Plant growth parameters and nutrient content at different levels of P.

P level (kg/ha)	Dry matter yield (g/pot)	Plant height (cm)	Tillers (no./plant)	Macronutrients (% dry wt)			Micronutrients (µg/g dry wt)			
				N	P	K	Fe	Mn	Zn	Cu
IR8										
0	11.25	55	7.3	2.23	0.25	2.46	49.7	40.7	114	4.63
40	15.19	80	8.5	2.47	0.27	2.57	57.3	48.5	94	6.00
80	21.75	100	12.7	2.70	0.27	2.85	76.0	52.6	79	5.80
120	27.34	110	16.8	2.85	0.30	2.97	95.0	60.0	71	5.23
160	34.25	115	20.5	2.90	0.31	2.88	125.0	76.3	48	10.43
LSD (0.05)	1.46	9	7.3	0.08	0.06	0.06	13.4	7.6	7	0.81
IR6										
0	6.35	35	5.8	1.95	0.21	2.13	70.0	48.3	121	6.60
40	10.43	53	7.5	2.18	0.22	2.23	87.7	57.4	91	7.30
80	15.74	69	11.2	2.33	0.25	2.45	108.8	65.7	84	9.10
120	22.69	78	14.7	2.41	0.25	2.59	187.7	81.0	69	13.40
160	29.21	100	18.9	2.53	0.26	2.67	227.8	98.0	36	9.30
LSD (0.05)	1.25	6	7.1	0.06	0.05	0.06	9.1	5.8	8	1.16

Dry matter, plant height, and number of tillers increased significantly with increasing P (see table). IR8 had higher response.

Concentrations of all elements were in the ranges considered adequate for plant growth. Concentrations of N, P, K, Fe, Cu, and Mn increased significantly with P. P level depressed Zn uptake. Concentrations of N, P, K, Fe, Mn, and Zn were significantly higher in IR8 than in IR6 at all P levels. □

Crop management

Performance of late transplanted rice in Assam

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We tested rice varieties against CNM539 in a trial conducted in two agroclimatic conditions at RARS in Titabar and North Lakhimpur during 1987 wet season. Five transplanting dates ranged from 10 Aug to 20 Sep, at 10-d intervals, with 30-d-old seedlings used for the first 2 dates and 50-d-old seedlings for the last 3 dates. Spacing was 20 cm × 15 cm, with 4-6 seedlings/ hill. Fertilizer was applied basal at 40-20-20 kg NPK/ ha.

At Titabar, all varieties exhibited better grain yields with 30-d-old seedlings (see table). At North Lakhimpur, yields also were better with 30-d-old seedlings; 50-d-old seedlings transplanted 10 Sep also had higher yields. While panicle number/m^2 differed with transplanting date, panicle weight was consistent.

Delayed planting up to 10 Sep did not result in much reduction in panicle number, panicle weight, and grain yield in any of the varieties tested.□

Performance of late-transplanted rice in Assam.

Planting date	Grain yield (t/ha)									
	Titabar					North Lakhimpur				
	KMJ-1-52-3	Andrew Sali	CNM539	IET725	Mean	Saragphola	Solpona	Manoharsali	CNM539	Mean
10 Aug	4.8	4.2	4.2	3.3	4.2	3.6	3.6	4.0	4.8	4.0
20 Aug	4.8	5.9	5.4	4.9	5.2	3.6	3.5	4.1	4.2	3.9
31 Aug	4.6	5.0	4.9	4.3	4.7	3.7	3.7	4.2	4.3	4.0
10 Sep	3.6	3.9	4.5	2.9	3.7	3.7	3.7	4.4	4.4	4.0
20 Sep	–	–	–	–	–	3.2	3.2	3.4	3.2	3.3
Mean	4.4	4.8	4.7	3.8	–	3.6	3.5	4.2	4.0	
LSD (0.05)	For variety 0.1 For date 0.4					Variety ns Date 0.5				

Soil fertility and fertilizer management

Response of flooded rice to zincated urea and zinc sulfate

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We studied the effect on rice yield of Zn applied as zincated urea and zinc sulfate to flooded rice soils during the 1987 wet season. Two experiments were conducted: a pot experiment using dry seeded rice variety J-104 and a Gley Yellowish soil (clay loam, with pH 7.2, 2.19% organic matter, 48-116 ppm PK (Oniani), and 1.40 ppm Zn extracted with N NH_4Ac pH 4.8), and a field experiment using dry seeded rice variety IR880 and a Gley Ferrallitic soil (sandy, with pH 6.8, 2.40% organic matter, 35-215 ppm PK, and 1.80 ppm Zn). Four treatments were studied in each trial, in a randomized block design with four replications.

In treatment 1, fertilizer was applied at 187 kg N as urea (68 basal + 68 at tillering + 51 at panicle initiation), 40 kg P as concentrated superphosphate, 50 kg K/ ha as potassium chloride in the pot experiment, and 119 kg N (34 + 51 + 34), 51 kg P, and 5 1 kg K/ ha in the field experiment (control). Treatment 2 had control fertilizer rates but used Cuban-produced zincated urea (41% N and 3% Zn) for the first 2 N fractions, for a total Zn application of 18 ppm Zn in the pot experiment and 6.2 kg Zn/ ha in the field experiment. Treatment 3 had control fertilizer rates plus soil zinc-sulfate (22% Zn) at the same Zn rate as in treatment 2. Treatment 4 had control fertilizer rates plus soil zinc sulfate basal at double the rate.

Grain yields increased significantly with Zn (see table). □

Effect of zincated urea and zinc sulfate on rice yield. [a] **Havana, Cuba, 1987 wet season.**

Treatment	Grain yield	
	g/pot	t/ha
No Zn	12.23 b	3.6 c
Zincated urea	18.00 a	6.8 a
Zn sulfate 1	14.37 ab	5.6 b
Zn sulfate 2	14.27 ab	6.2 ab

[a] In a column, means followed by the same letter do not differ significantly ($P<0.05$) by DMRT.

Response of rice to fertilizers and sitosym applications

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We studied the effect of sitosym combined with different rates of NPKS on irrigated rice (IR42) during 1981-88 wet season. A split-plot design with three replications was used, with sitosym in the main plot and NPKS in the subplots.

Soil at the experimental site at Ma'rang, Pangkep, has a silty clay texture, pH 5.6, 4 ppm available P (Bray I), CEC 10.5 meq/100 g, and 0.7, 7.6, 4.8 meq/100 g exchangeable K, Ca, Mg, respectively.

Sitosym is claimed to be a complete fertilizer containing Fe, Zn, Cu, Mn, Ca, Mg, S, P, K, protein, and vitamins. Spray application is recommended at panicle initiation at 0.5 liter diluted with 200 liters water/ha. Treatments of NPKS as urea, TSP, KCl, and ammonium sulfate are given in the table.

Application of sitosym did not significantly affect plant height, productive tillers, grain weight, filled grain, or yield. More than 150 kg urea, 100 kg ammonium sulfate, 100 kg triple superphosphate, and 50 kg KCl/ha also did not significantly increase those parameters. □

Response of IR42 to fertilizers and sitosym (S) applications.[a] Ma'rang, Pangkep, South Sulawesi, Indonesia, 1988 wet season.

Fertilizer treatment [b] (kg/ha)				Plant height at harvest		Productive tillers (no./hill)		1000-grain wt (g)		Grain yield (t/ha)		Filled grain (%)	
Urea	AS	TSP	KCl	With S	No S	With S	No S	With S	No S	With S	No S	With S	No S
150	100	100	50	105.1	108.5	16	16	22.53	22.00	6.2	5.9	92.0	94.2
150	150	100	50	108.8	110.4	17	16	21.67	22.10	6.0	6.4	93.4	91.9
200	100	100	50	110.6	110.6	14	15	22.20	22.07	6.0	6.2	93.4	92.6
200	100	100	100	108.1	107.2	17	15	22.40	22.27	6.1	6.2	91.3	91.9
200	100	150	100	105.5	109.1	15	15	22.23	22.27	6.0	5.9	92.6	92.9
200	100	200	100	102.5	106.9	16	16	22.27	22.10	6.1	5.8	92.1	92.3
		Mean		106.8	108.8	16	16	22.22	22.13	6.0	6.0	92.6	92.6
		CV (%)											
		(a)		12.1	16.8	3.4	14.8	4.3					
		(b)		3.9	9.2	2.2	8.4	1.4					

[a]Tests of means showed nonsignificant effects. Seeds and grains were at 14% moisture content. [b]Urea: 45% N, TSP: triple superphosphate (45% P_2O_5). AS: ammonium sulfate (20% N, 24% S), KCl: 60% K_2O.

Effect on rice of phorate at different N levels

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We studied the effect on rainfed rice of phorate at varying levels of N in Feb-Jun 1983. Phorate is an organophosphate insecticide (0,0-Diethyl S-[(ethylthio) methyl] phosphoro-dithioate) available as 10% granules. At 1 kg ai/ha, it controls many rice pests through a combination of systemic, contact, and fumigant insecticidal action.

The experiment was laid out in a factorial combination of 3 levels of N (0, 60, and 90 kg N/ha as urea) and 4 levels of phorate (0, 1.0, 2.0, and 3.0 kg ai/ha) in a randomized block design with 4 replications. The soil at Tamil Nadu Agricultural University (TNAU) (11°N, 77°E, and 427 m above mean sea level) was a Vertisoi (clay loam) containing 1.0% organic C, 99-8.0-254 ppm available NPK, 0.7 ppm DTPA extractable Zn, with pH 8.2 and EC 0.3 dS/m. Test variety was IR20. All plots were uniformly fertilized and kept insect free. Standard management practices were followed.

Phorate (10% granules) was incorporated at planting to ensure minimum loss. N as urea was applied in 3 splits: 50% basal, 25% at tillering, and 25% at panicle initiation.

Tiller number, leaf area index, root weight, root volume, and grain yield (see table) increased with N application up to 90 kg/ha and phorate application up to 2.0 kg ai/ha. This indicates growth-stimulating effects of phorate on rice and a synergistic phorate-N interaction.

Based on grain yield increase: costs ratio (1 kg phorate 10% granule: US$2.50; 1 kg N:US$0.50; application at US$2.90/laborer), 90 kg N/ha and 1.0 kg ai phorate/ha is optimum. □

Grain yield of IR20 rice as influenced by phorate and N level. TNAU, Coimbatore, India, 1983.

N levels (kg/ha)	Grain yield (t/ha) at phorate levels (kg ai/ha) of				Mean yield (t/ha)
	0	1	2	3	
0	2.3	3.5	3.9	3.3	3.4
60	4.2	3.6	3.8	5.3	4.2
90	4.2	5.4	5.4	4.8	5.0
Mean	3.6	4.1	4.4	4.5	

	SEm ±	*LSD (0.05)*
Nitrogen (N)	0.16	0.46
Phorate (P)	0.26	0.66
N × P	0.40	1.06

Effect of organic and inorganic nitrogen in acid sandy soil on upland rice yield

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In an experiment during the 1986 cropping season, poultry manure alone and in combination was compared with urea and calcium ammonium nitrate (CAN) in upland sandy loam and acidic soils of Amakama, Nigeria. The experimental design was a randomized complete block (RCB) with four replications.

Soil samples for analysis were taken after land preparation but before fertilizer application. Physical and chemical properties of the experimental soil are presented in Table 1. N was applied at 60 kg/ha. The poultry manure contained 0.66% N.

Poultry manure was incorporated 2 wk before planting, with 30 kg P and 40 kg K/ha applied basally. Urea and CAN were applied in 2 equal splits at 3 and 8 wk after planting. In the combinations, poultry manure at 30 kg N/ha was applied 2 wk before planting, and inorganic fertilizer at 30 kg N/ha was applied 8 wk after planting. Average monthly rainfall during crop growth was 218.8 mm.

The test crop was newly released upland rice FARO 41 (IRAT170). In the yield parameters considered, rice with poultry manure performed slightly, but not significantly, better than inorganic fertilizers (Table 2). The lack of significant difference could be attributed to considerable nutrient leaching on a sandy soil subjected to high rainfall for more than 6 mo of the year. Many and more vigorous weeds grew in poultry manure-treated plots. CAN depressed yield, even in combination with poultry manure.

The results indicate that poultry manure can be used to supplement inorganic fertilizers. Poultry manure is cheap, easier to handle than other organic manure, and more available with an increase in the number of poultry farmers.☐

Table 1. Physical and chemical analysis of experimental soil prior to planting. Amakama, Nigeria, 1986.

pH	4.6
Sand (%)	70.4
Silt (%)	10.4
Clay (%)	19.2
Organic matter (%)	1.025
N (%)	0.12
Available P (Bray I) (ppm)	50
K (meq/100 g)	0.40
Ca (meq/100 g)	0.66
Mg (meq/100 g)	0.96
Mn (ppm)	0.24
Zn (ppm)	5.8
Fe (ppm)	60.0

Table 2. Response of yield parameters to N sources.[a] Amakama, Nigeria, 1986.

N source	Tillers (no./m^2)	Productive tillers (no./m^2)	Days to 50% flowering	Plant height (cm)	Grain yield (t/ha)
Poultry manure	156	135	79	104	3.3
Urea	153	139	80	98	3.2
Calcium ammonium nitrate (CAN)	134	118	81	94	2.8
Poultry manure + urea	138	117	79	101	3.2
Poultry manure + CAN	137	133	79	79	3.1
No N fertilizer	130	120	81	79	2.6
CV (%)	14	15	–		12.0
LSD	ns	ns			ns

[a]ns = not statistically significant.

Effect of floodwater depth on ammonia volatilization loss from urea in flooded soil

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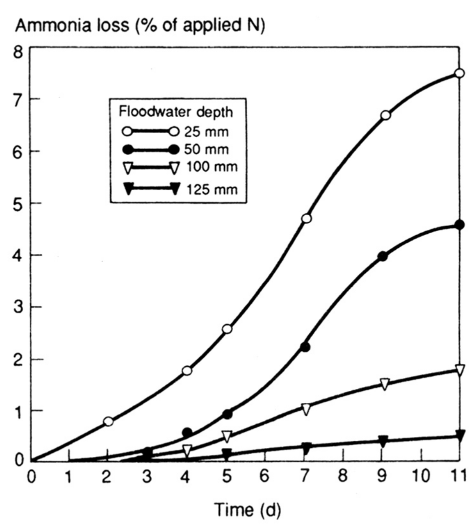
Rate of ammonia volatilization in flooded rice soils can be estimated by monitoring floodwater parameters. But water depth may itself greatly influence the floodwater chemistry, and may influence rate of ammonia loss. We studied the effect of floodwater depth on ammonia volatilization, using a forced-draft chamber technique.

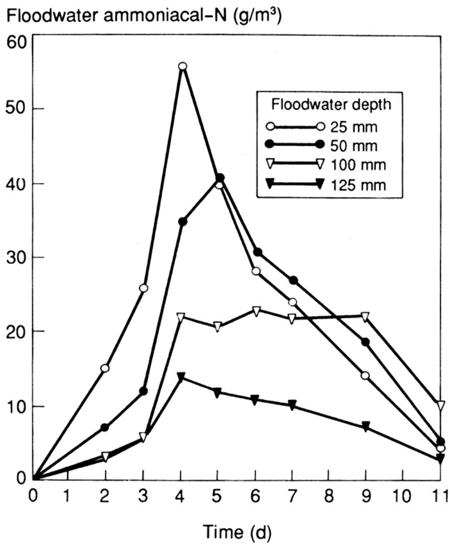
The soil was sandy loam (Typic Ustochrepts), pH 7.5, EC 0.15 dS/m, 0.32% organic C, 0.06% total N, and CEC 4.5 meq/100 g. Soil samples of 5 kg each were collected from the top 15 cm soil layer, air-dried, ground, and placed in 10-liter pots.

The soil was flooded, puddled, and allowed to preincubate with 1 cm standing water for 1 wk. It was then fertilized with 26 mg P and 50 mg K/kg, applied as single superphosphate and muriate of potash. Urea at 1.36 g N/pot (equivalent to 200 kg N/ha) was broadcast and incorporated to 5-7 cm soil depth. The pots were reflooded to 25, 50, 100, and 125 mm depths. Evaporation losses were replenished daily.

Floodwater temperature ranged from 28 to 34 °C. Two pots of each treatment were covered with chambers continuously flushed with NH_3-free compressed air. NH_3 evolved from the incubated samples was collected at



1. Effect of floodwater depth on cumulative loss of ammonia from flooded sandy loam soil, Ludhiana, India.



2. Effect of floodwater depth on ammoniacal-N concentration in the water. Ludhiana, India.

intervals using a manifold and estimated by absorbing in 2% boric acid-mixed indicator solution. Floodwater samples also were analyzed for ammoniacal- and urea-N.

Floodwater depth significantly affected rate of NH_3 volatilization in flooded Ludhiana soil (Fig. 1). At 4 d after application, 1.8% of added urea was volatilized in 25-mm-deep water, but only a trace was volatilized in deeper water. At 11 d, NH_3 volatilization was 7.5, 4.5, 1.8, and 0.5% of added urea in 25, 50, 100, and 125 mm-deep-water, respectively.

Ammoniacal-N concentration in the floodwater 4 d after urea application was greatest at 25-mm-deep water and least at 125 mm (Fig. 2). □

Efficiency of modified nitrogen fertilizers in rice on partially reclaimed saline soil

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We compared sulfur-coated urea (SCU), urea supergranules (USG), and prilled urea (PU) at 0, 29, 58, 87, and 116 kg N/ ha in rice on partially reclaimed saline soil at the Dalipnagar research farm during 1982-83 wet season. Experimental soil was loamy with pH 8.7, EC 183 dS/m at 25 °C, 0.039% total N, 135-8-214 available NPK/ha.

Treatments were PU best split, USG deep placed (10-12 cm soil depth) 1 wk after transplanting Jaya variety, and SCU broadcast and incorporated at transplanting. P and K were applied uniformly at 26-25 kg/ha. $ZnSO_4$ was applied to the nursery bed at 25 kg/ ha.

SCU and USG were significantly superior to PU at all N levels (Table 1), with a greater difference at lower N levels.

N recovery was highest with SCU (Table 2). Recovery of N decreased linearly with increase in N level. □

Table 1. Effect of source and rate of N on grain yield of rice. Dalipnagar, India, 1982-83 wet season.

N (kg/ha)	Yield (t/ha)			
	PU	USG	SCU	Mean
0	1.6	1.6	1.6	1.5
29	2.0	2.3	2.4	2.2
58	2.5	2.8	2.8	2.7
87	2.9	3.2	3.2	3.1
116	3.3	3.5	3.5	3.4
Mean	2.5	2.7	2.7	
LSD (0.05)	0.187			

Table 2. Influence of source and N rate on N recovery.

N (kg/ha)	N recovery (%)			
	PU	USG	SCU	Mean
29	42.86	63.21	69.28	58.45
58	40.10	54.30	55.75	50.05
87	39.00	46.75	47.60	44.45
116	37.00	41.55	42.15	40.23
Mean	39.74	51.45	53.69	

Composting with rice straw

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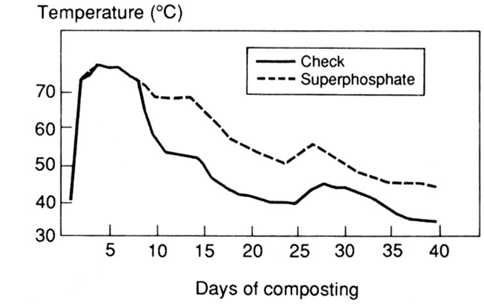
Rice straw is an important source of organic matter in rice-growing areas, but applying it directly into soil has a number of limitations. Composting appears to be an alternative.

Composting originated in upland cropping areas, where the basic raw materials are crop stovers other than rice straw and farmyard manure (primarily horse manure). We tested composting with rice straw and pig manure (pigs are the basic livestock in rice-growing areas in China).

The essential factors for composting were defined as optimal C:N ratio of around 40 in raw materials; chopped rice straw, mixed with grasses and leguminous leaves or tender tips, if available; pig manure or other farmyard manure; superphosphate at 3% of total raw material weight; appropriate moisture and aeration conditions.

The temperature at the center of the pile was raised to 70 °C across 34 d, maintained for about 1 wk, then dropped gradually (see figure). Superphosphate showed some effect on keeping temperatures high, resulting in better compost maturity. Composting was completed in 45 to 60 d when N content was 0.3-0.4% and C:N ratio was 20.

The compost was used as basal manure for double-cropped rice. Table 1 gives the recovery of nutrients, Table 2 shows effect of rice straw compost on yield. Yields with rice straw compost were comparable to yield with conventional manure.



Temperature during composting. JAAS, Nanjing, Jiangsu, China.

Table 1. Recovery of C and N.[a] JAAS, Nanjing, Jiangsu, China.

Treatment	In raw materials		In compost				
	OM (kg)	N (kg)	C:N	OM (kg)	Recovery	N (kg)	Recovery
Local manure	195	2.93	23.4	80	0.41	1.88	0.64
Superphosphate	190	2.78	28.3	108	0.57	2.10	0.76

[a] OM = organic matter.

Basic problems in using compost follow:

1) Unavoidable nutrition losses due to aeration process. Carbon losses ranged from 43 to 59%, N losses 24-36% (Table 2). The addition of superphosphate tended to reduce losses somewhat.
2) Labor to collect raw materials, prepare compost, transfer compost to field, and broadcast at 15 t/ha was estimated as 75 labor d/ha.
3) To guard against negative effect on rice seedlings, N fertilizer must be applied at 30 kg N to 10 t compost/ha. □

Table 2. Effect of rice straw compost on yield of double-cropped rice.[a]

Treatment	1st crop		2d crop	
	Yield (t/ha)	Increase (%)	Yield (t/ha)	Increase (%)
Local manure	5.8	–	4.0	–
Compost 1	5.9	2.8	4.8	19.9
Compost 2	6.0	3.5	4.5	10.9

[a] Local conventional manure = basal, N 0.153%, 45 t/ha (68.85 kg N); P_2O_5 0.148%. Compost 1 = basal, N 0.302%, 15 t/ha (45.3 kg N); P_2O_5 0.138%. Compost 2 = basal, N 0.285%, 15 t/ha (42.75 kg N); P_2O_5 0.131%. In 1st crop, basal fertilizer for all treatments = 63.75 kg N/ha, topdressed fertilizer = 86.63 kg N/ha. In 2d crop, basal fertilizer for all treatments = 91.88 kg N/ha. Soil characteristics: irrigated lowland, clay loam, pH 6.8, 3.13% OM, 0.17% N, 0.156% P_2O_5, 17.4 ppm Olsen-P, 93.1 ppm NH_4Ac-K, CEC 20.3 meq/100 g.

Disease management

Effectiveness of five fungicides on rice sheath blight (ShB)

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ShB caused by Rhizoctonia solani Kuhn has become a problem in modem high-yielding varieties in Iran. We tested five fungicides for disease control (see table).

IR28 (Amol 2) was transplanted 2 May at 18 × 22 rows in 4- × 6-m plots. Herbicide was applied at 6 liters/ha 6 d after transplanting. Fertilizer was applied at 200 kg urea, 100 kg ammonium phosphate/ha 12 May simultaneously with transplanting, and 100 kg urea/ha was applied 19 Jul. All fungicides but IBP were applied with the sprayer delivering 1,000 liters/ha, IBP was broadcast by hand. Treatments were replicated five times in a randomized complete block design.

Fungicide applications were at booting and 10 d later, at heading. Degree of damage (DD) and degree of severity (DS%) were rated at harvest 17 Sep, and 80 hills/plot were harvested the day after. Grain was dried at room temperature and weighed.

Effectiveness of fungicides on rice ShB. Bandar-Angali, Iran.

Treatment	Rate/ha	DD	DS (%)	Yield (t/ha)
Control		14.9	37	6.6
Iprodione ts 52.5PW	525 g	8	9.7	7.3
Validamycin 3% liquid	60 ml	3	7.2	7.4
Mepronil 50PW	500 g	6.8	1.1	6.9
Benomyl 50PW	500 g	5.2	12.7	6.3
IBP 17G	6800 g	2.5	6.1	7.6

IBP, mepronil, validamycin, and iprodione effectively controlled ShB. Yields were higher with IBP, validamycin, and iprodione. □

Cross-season perpetuation of bacterial blight (BB) pathogen in Haryana, India

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We studied the perpetuation of *Xanthomonas campestris* pv. *oryzae* Dye in infected leaves and artificially inoculated grains. Naturally infected leaves of variety Jaya were collected during the 1987 wet season, chopped into small pieces, and soaked in water for 30 min. The bacterial suspension was separated and injected in rice variety Jaya at 1 ml/boot. Grain was collected separately from inoculated boots and infected leaves, dried in the shade, and kept at room temperature in the laboratory.

In 1988 wet season, inoculated grains were germinated on blotter paper, in pots, and in the field. Seedlings were tested for bacterial ooze at 1 wk (from blotter paper) and 10 d (from pots and field).

Seedlings grown in pots and transplanted in the field did not produce any symptoms of kresek and leaf blight.

A bacterial suspension prepared from stored infected leaves was used to inoculate TN1, Jaya, and Basmati 370 at maximum tillering in Aug 1988. Disease developed in all three varieties.

These tests show that *X. campestris* pv. *oryzae* perpetuates only in infected leaves, not on grain. □

Pseudomonas species causing rice sheath rot (ShR) and grain discoloration (GlD)

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Four *Pseudomonas* spp. cause ShR and GlD of rice. *P. glumae* and *P. avenae* primarily cause spikelet sterility and GlD, and only slightly affect the sheath at the collar. *P. fuscovaginae* and *P. syringae* pv. *oryzicola* cause severe ShR as well as sterility and GlD. GlD symptoms caused by the different pathogenic species are virtually indistinguishable in winnowed grain samples. ShR symptoms of *P. fuscovaginae* and *P. syringae* also are similar.

We studied 153 isolates from 26 countries under quarantine conditions, to identify characteristics that clearly differentiate the species. The tests performed were pathogenicity on rice seedlings; Gram stain; indole test; fluorescent pigment production; oxidase; arginine dihydrolase; lecithinase; catalase; ripase; nitrate and 2-ketogluconate reduction; utilization of 30 carbohydrates for growth; hydrolysis of casein, aesculin, starch; gelatin liquefaction; acetoin, levan and urease production; pectin gel pitting, H_2S from TS1; acid and gas production from lactose, E-methyl glucoside, sucrose and rhamnose, potato soft rot; NaCl tolerance (5%); growth on sorbitol neutral red agar medium (used to isolate *P. avenae*) = SNR, S.P.G. medium, citrate agar, acetate agar, blood agar; methyl red reaction; hypersensitivity of tobacco; and growth at 4, 37, and 41°C. Responses of the species are presented in the table.

While the species can be readily differentiated by these tests, considerable care should be taken to determine that isolates are pathogenic on rice and that they are pure. This is particularly important for the fluorescent species.

Two nonpathogenic fluorescent species commonly isolated from rice grain, *P. putida* and *P. fluorescens,* give the same results as *P. fuscovaginae* for the key characters. We also have recovered both *P. avenae* and *P. fuscovaginae* from a single discolored grain sample. In cases where bacteria are suspected of causing GlD, both fluorescent and nonfluorescent isolates should be tested for pathogenicity. ☐

Character differentiation of isolates of *Pseudomonas fuscovaginae, P. avenae, P. glumae,* **and** *P. syringae* **pv.** *oryzicola.*[a]

Characteristic	Fluorescent		Nonfluorescent	
	P. fuscovaginae	*P. syringae*	*P. avenue*	*P. glumae*
Lipase	+	–	–	–
Gelatin liquefaction	+	+	–	d
Arginine dihydrolase	+	–	–	–
Oxidase	+	–	+	–
Utilization of				
Sucrose	–	+	–	–
Inositol	–	+	–	+
Arginine	+	–	–	+
H_2S production	+	–	–	–
NO_3 - reduction	–	–	+	+
Levan formation from sucrose	–	+	–	–
Growth at 37°C	+	–	+	+
41°C	–	–	+	+

[a]Reactions of 30 isolates of *P. avenae,* 11 isolates of *P. syringae,* 6 isolates of *P. glumae,* and 100 isolates of *P. fuscovaginae.* + = positive reaction, – = negative reaction, d = variable reaction.

Influences of rice straw, potash, and the fungicide benomyl on brown spot disease of rice

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Brown spot disease of rice caused by the fungus *Helminthosporium oryzae* and generally considered to be related to nutritional imbalances in Sierra Leone, is particularly serious in rainfed lowland rice affected by soil problems with inadequate water. In highly weathered, leached, and acid upland soils, the disease can be devastating to rice.

We studied the effect of amending upland rice soils with rice straw and potash and foliar application of benomyl on incidence of brown spot disease.

The trial was conducted at the station's upland site in Rokupr in northwest Sierra Leone, where soil cation exchange capacity ranges from 5 to 10 meq/100 g of soil and exchangeable cations are low. pH was 4.8. Annual rainfall averages 2,900 mm.

Effect of rice straw incorporation, potash application, and the fungicide benomyl on the incidence of brown spot disease of rice (variety ROK3). Rokupr, Sierra Leone, 1983 wet season.

Treatment	Mean estimated leaf area affected (%)
Rice straw ash	5.73
Rice straw half mulch, half ash	6.20
Rice straw half mulch and half ash + benomyl + K	15.97
Rice straw mulch	6.42
Rice straw ash + K	6.53
K + benomyl	17.97
K	6.60
Rice straw mulch + K	6.48
Rice straw mulch +benomyl	17.70
Benomyl	18.62
Rice straw ash +benomyl	13.42
Control	7.48
LSD (0.05)	2.00
CV (%)	10.0

Rice straw was applied at 3 t/ ha (mulched, ashed, or combined) 2 wk before seeding; muriate of potash was applied at 40 kg K20/ ha in 3 equal splits 2, 6, and 10 wk after seeding; benomyl was sprayed at weekly intervals, starting 3 wk after seeding, for a total of 4 sprayings.

All treatments received 80-17.6 kg NP/ ha, N as commercial urea was applied in 3 equal splits, P as single superphosphate basally.

Straw and potash ameliorated brown spot incidence somewhat, but the differences were not significant (see table).

Benomyl significantly increased disease incidence, most severely in plots without potash and straw.

The indications are that the causal organism of brown spot *Helminthosporium oryzae* is not only resistant to benomyl, but the compound enhances pathogen proliferation. ☐

Virulence of *Pyricularia oryzae* in coastal Andhra Pradesh

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We evaluated the pathogenic variability of the blast (B1) pathogen in microplots in irrigated ricefields in Andhra Pradesh during 1986-87. Leaf B1 samples were collected from different ricefields, in West Godavari district, an endemic B1 region, during the dry season. The experiments were conducted in raised upland beds at DRR.

Virulence was evaluated on international B1 differentials and a few selected commercial varieties. Each cultivar was sown 10 cm apart, in 5 rows, each 50 cm long, with 2 replications. Seedlings were raised with 100 kg N/ha. Irrigation was provided by running overhead sprinklers for 2 h during the day and again toward evening. Night temperatures were favorable to Bl (20-24°C). There was no background infection prior to artificial inoculation.

Three experiments were conducted simultaneously (see table): 1) five monoconidial isolates (MI) obtained from different lesions were inoculated singly to a set of varieties; 2) a conidial population derived from 100 MI from a single lesion; and 3) 500 MI obtained from 20 lesions, 4 each from 5 villages, were inoculated to corresponding sets of varieties.

MI were multiplied by transferring single spores aseptically on sterilized sorghum seeds and incubating at room temperature (24-28 °C) for 10 d. Conidial suspensions (1×10^6 conidia/ml of water) of MI were made and mixed for each experiment. Test seedlings were inoculated at 14 d by spraying spore suspension with a plastic sprayer in the evening. Inoculated nursery beds were covered with polythene sheets held on metallic frames from 1800 to 0800 h daily. B1 was scored 7 and 10 d after inoculation.

There was little variation in the populations of the pathogen. The reaction pattern exhibited in all three experiments was that of race IC-9. ☐

Reaction[a] of international B1 differentials and commercials to MI and mixture of populations of *P. oryzae.* Coastal Andhra Radesh, 1986-87.

Cultivar	IRRI accession no.	Cultivar reaction to		
		Monoconidial isolates (MI)	Mixture of MI from one lesion	Mixture of MI from 20 lesions
International Bl differential				
Raminad Str. 3	32557	R	R	R
Zenith	32558	R	R	R
NP125	32559	S	S	S
Usen	32560	S	S	S
Dular	32561	R	R	R
Kanto 51	32562	S	S	S
Shia-tia-tsao (S)	32563	S	S	S
Caloro	32564	S	S	S
International race		IC-9	IC-9	IC-9
Commercial varieties				
Rasi		MR	MR	MR
IET2508		R	R	R
IET5656		R	R	R
IR50		S	S	S
IR36		MR	MR	MR
IR64		R	R	R

[a] Based on the 1980 *Standard evaluation system for rice,* where scores 1-2 = necrotic spots (R), 3 = restricted sporulating lesions of 1-3 mm (MR), 4-9 = susceptible lesions of 1-3 cm or more (S).

Differential culture medium for *Pseudomonas* species causing sheath rot (ShR) and grain discoloration (GlD) of rice

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The four *Pseudomonas* species *(P. avenae, P. fuscovaginae, P. glumae,* and *P. syringae* pv. *oryzicola)* that cause G1D in rice cannot be reliably distinguished from one another by symptom expression on diseased plants. Even *P. fuscovaginae* and *P. syringae* pv. *oryzicola* that cause both ShR and G1D, cannot be ruled out as causal agents of bacterial grain rot when sheath symptoms are absent. The geographical distributions of these species overlap considerably.

A rapid and relatively simple method to distinguish the species would be useful in developing varietal tolerance for bacterial G1D, since lines showing significantly less susceptibility to isolates of one species may be highly susceptible to another.

Three characteristics can distinguish the four species. *P. fuscovaginae* and *P. syringae* pv. *oryzicola* produce a fluorescent blue pigment on King's B medium; *P. avenae* and *P. glumae* do not. Within each pair, the ability to use arginine for growth distinguishes the species—*P. fuscovaginae* and *P. glumae* are positive and *P. syringae* pv. *oryzicola* and *P. avenae* are negative. *P. syringae* pv. *oryzicola* also can utilize sucrose, the others cannot. These characteristics suggest components of a simple culture medium on which the four species could be differentiated.

We prepared 3 differentiating media from this basal medium: Ayers et al mineral salts medium ($NH_4H_2PO_4$, 1.0 g; KCl, 0.2 g; $MgSO_4$ $7H_2O$, 0.2 g; bromothymol blue (1.6% alcohol solution), 1.0 ml; distilled water to 11 and 12 g bacteriological agar (OXOID No. 1); pH adjusted to 7.2.

For the first differentiating medium, 1.0 g arginine was added by millipore filtration to the autoclave sterilized basal medium. For the second medium, 1.0 g arginine was added to the basal medium and then the whole was autoclaved. For the third medium, bromothymol blue was omitted from the basal medium and 1.0 g arginine added by millipore filtration. Virulent isolates of 30 *P. avenae,* 88 *P. fuscovaginae,* 10 *P. syringae,* and 6 *P. glumae* were streaked onto the different media; growth and fluorescence under black light were evaluated at 24 h. Approximately 1 ml 1.5% sucrose solution was added to plates where isolates showed no growth after 48 h and growth and fluorescence checked again after 24 h.

Only the medium with bromothymol blue and arginine added by filtration distinguished the isolates. The results are presented in the table.

Growth plus fluorescence indicated *P. fuscovaginae;* growth with no fluorescence indicated *P. glumae;* no growth for 48 h but growth following addition of sucrose indicated *P. syringae* pv. *oryzicola;* no growth following addition of sucrose indicated *P. avenae.*

Differential reactions[a] of 4 *Pseudomonas* spp. on medium with bromthymol and arginine (prepared by filtration).

Species	Arginine medium		Sucrose added[b]	
	Growth	Fluorescence	Growth	Fluorescence
P. avenae	–	. . .	–	. . .
P. glumae	+	–	. . .	. . .
P. fuscovaginae	+	+	. . .	. . .
P. syringae pv. *oryzicola*	–	. . .	+	+

[a]– = negative reaction, + = positive reaction, . . . = not applicable. [b]1 ml sucrose added only if no growth was observed after 48 h.

The isolates identified using this medium must be pure, and their origins from rice and their pathogenicity on rice certain. The agar used must be bacteriological grade. Since whether or not the pathogen produces fluorescent pigment on King's B medium will be known prior to using the arginine medium, detecting fluorescence on this medium is not essential. ☐

Early rice blast (Bl) outbreak in Nepal

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Bl caused by *Pyricularia oryzae,* is an important disease in rainy season (Jul-Nov) rice in Nepal but has not been reported in the endemic form in the prerainy season (Mar-Jul). A Bl disease survey was made in rice plots of the experimental farm and adjoining farmers' fields in Jhapa district (eastern B1-prone area) 13 May 1988 and 7 Jul 1988. Percent diseased leaf area was estimated on 100 randomly selected tillers per seedbed or per transplanted field.

Disease severity varied at seedling, maximum tillering, and dough stages (see table). Seedlings in Pusa-2-21 seedbeds were completely killed, and transplanted plants were heavily damaged by leaf and neck Bl. This variety had been grown in this area for

Bl disease severity in early rice of Nepal, 1988.

Field[a]	Date	Variety	Growth stage[b]	B1 severity (%)	
				Leaf[c]	Neck[d]
		Jhapa			
KAF	13 May	Pusa 2-21	1	100	–
KAF	13 May	Pusa 2-21	3	24	–
KAF	13 May	Pusa 2-21	3	33	–
KAF	13 May	Kankai 1	1	45	–
KAF	13 May	Kankai 1	3	12	–
KAF	7 Jul	Pusa 2-21	8	18	52
KAF	7 Jul	Pusa 2-21	8	20	68
KAF	7 Jul	Kankai 1	8	3	12
FF1	7 Jul	Pusa 2-21	8	16	48
FF2	7 Jul	Kankai 1	8	2	13
FF3	7 Jul	Kankai 1	8	2	21
		Chitwan			
FF1	9 Jun	CH45	8	<1	7
FF2	9 Jun	CH45	8	2	8
FF3	9 Jun	CH45	8	<1	3
FF4	9 Jun	CH45	8	2	13
FF5	9 Jun	CH45	8	<1	5

[a]KAF = Kankai Agricultural Farm, FF = farmer's field. [b]Growth stages based on Standard evaluation system for rice scale of 0-9: 1 = seedling or transplanting, 3 = stem elongation, 8 = dough stage. [c]Based on rating scale of 0 (0%) to 10 (100%) on 100 randomly selected tillers/field. [d]Based on, number of rotten panicle neck on 100 tillers randomly selected.

10 yr without any appreciable damage. Early rice varieties Bindeshwari, Chaite-2, and Chaite-4 had little or no disease.

In a survey of farmers' fields in Chitwan district (western Bl-prone area) 9 Jun 1988, a low level of leaf Bl and moderate level of neck Bl were observed in rice variety CH-45, a popular early variety.

More than 100 mm rainfall occurred in May 1988, compared to less than 35 mm in May 1987. The rainfall also occurred more frequently. Thus, Bl races able to attack the early varieties are prevalent in nature and cause serious yield losses in years of early rainfall. ☐

Isolation of *Pseudomonas fuscovaginae* with a semiselective medium (KBS)

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P. fuscovaginae, the causal agent of bacterial sheath brown rot of rice and first described in Japan, is now reported in several tropical countries (Burundi, Latin America, Madagascar).

Table 1. Composition of KBS medium.

Basal medium:	
Casamino acids (Difco)	20 g
Glycerol	15 ml
K_2HPO_4	1.5 g
$MgSO_4$, $7H_2O$	1.5 g
Agar	15 g
Distilled water	1l

pH 7.0-7.2 adjusted with NaOH before autoclaving for 15 min at 121°C.

Components added to the melted basal medium at 45°C:	
Cetyltrimethylammonium bromide (= Cetrimide, Labosi)	5 ml of a distilled water stock solution (20 mg/ml)
Trimethoprim (Sigma)	20 mg
Penicillin G (Sigma)	50 mg
Bacitracin (Sigma)	20 mg
Cycloheximide (=Actidione, Labosi)	50 mg

The last 4 components were mixed in 4 ml of 70% ethanol.

Symptoms are similar to those produced by other pathogens: grain discoloration, sheath necrosis, and spikelet sterility.

Isolation of *P. fuscovaginae* is difficult, particularly on older or deteriorated sampies, because of the presence of other bacteria commonly isolated from rice samples. We developed a semiselective medium (KBS) that can be used to isolate *P. fuscovaginae* on different rice samples.

Composition of the KBS medium is detailed in Table 1. Basal medium is King's medium B (KB), but the source of peptone has been changed. Proteose peptone n°3 is replaced by casamino acids. This is important because the pigment produced by some strains (particularly from Madagascar) fluoresced only weakly or not at all in ultraviolet light when bacterial growth occurred on KB medium containing proteose peptone n°3, bactopeptone, or casitone (Difco).

Plating efficiencies of 4 reference strains of *P. fuscovaginae* on KBS medium ranged from 5 to 100% after 3 d of incubation, and from 60 to 100% after 6 d of incubation at 28 °C (Table 2). Other fluorescent pseudomonads and a few other bacterial species grew on KBS medium, but development of most saprophytic bacteria and fungi was inhibited.

Table 2. Plating efficiency on KBS medium of *Pseudomonas fuscovaginae* from distilled water suspensions.

Strain	Source	Plating efficiency[a] (%)
GR 2	Madagascar	100[b]
HMB 264	Burundi	100[b]
6801	Japan	5
		60[c]
BCE 32	Colombia	100[b]

[a] Plating efficiency = colony-forming units recovered on KBS ÷ colony-forming units on KB × 100. [b] After 3 d incubation at 28°C. =After 6 d incubation at 28°C.

We used different media to isolate *P. fuscovaginae* on several hundred rice samples. KBS medium was the most useful, especially when laboratory facilities are limited. ☐

Insect management

Morphometric comparison of stridulating organs of brown planthopper (BPH) infesting rice and *Leersia grass*

R. C. Saxena and A. A. Barrion, Entomology Department, IRRI

BPH *Nilaparvata lugens* (Stål) males and females communicate prior to copulation, by means of acoustic courtship signals emitted by specialized stridulating organs located at the junction of the metathorax and abdomen on each side of the body. Each organ comprises a sclerotized meta-coxata and a petal-like abdominal sclerite extended in front of the third sternopleuron.

As a calling adult slightly vibrates its abdomen in a dorsoventral direction, the sclerite rubs against the top of the coxata, emitting discrete sound pulses, or clicks. The wave patterns, pulse repetition frequencies, and sonic spectra of acoustic signals have been found to differ significantly in BPH infesting rice and BPH infesting the weed grass *Leersia hexandra* Swartz.

To find out why acoustic signals differ in the two populations, we compared the stridulating organs (length, width, number of chitinous scales on coxata and sclerite) of males and females from each population.

We used an aspirator to collect 20 brachypterous males and 20 females from a BPH population maintained on TN1 rice plants and from a population reared on *Leersia* plants. The insects were prepared for morphological examination as follows: 1) boil in 95% ethyl alcohol in a water bath for 5 min; 2) macerate in 10% lukewarm NaOH for 15 min; 3) wash with 95% ethyl alcohol and boil in chloral-phenol (1:1 part chloral hydrate and phenol crystals) for 20 min; 4) orient and mount left and right stridulating organs on glass microslides using Hoyer's medium. Morphometric measurements were made at the 100x objective of a phase contrast microscope fitted with a linear, graduated ocular micrometer. Calibrated micrometer units were converted into microns.

The petal-like sclerites were smaller in males than in females in both rice- and weed-infesting BPH, but the rice insects possessed significantly shorter and wider sclerites than those on *Leersia* (see table). The number and length of chitinous scales in males and the length of chitinous scales in females of both rice BPH and *Leersia* BPH differed significantly. Males had significantly fewer and smaller chitinous scales than females.

Thus, variations in acoustic signals between the two sympatric populations of BPH can be attributed to morphometric differences in their stridulating organs.☐

Dimensions of petal-like sclerite, and the number and size of chitinous scales on the sclerite in males and females of *N. lugens* infesting rice (RBPH) and *L. hexandra* plants (LBPH).[a] IRRI, 1988.

Sex	Sclerite dimension						Chitinous scales on petal-like sclerite								
	Length (µ)			Width (µ)			Number			Length (µ)			Width (µ)		
	RBPH	LBPH	Difference	RBPH	LBPH	Difference	RBPH	LBPH	Difference	RBPH	LBPH	Difference	RBPH	LBPH	Difference
Male	103 b	112 b	-9**	57 b	49 b	8*	117 b	99 b	18**	11 b	10 a	1**	6 b	5 b	1 ns
Female	141 a	133 a	8**	72 a	61 a	11**	125 a	125 a	0 ns	13 a	10 a	3**	7 a	6 a	1 ns

[a]Av of 20 specimens of each sex. In a column, means followed by a common letter are not significantly different at the 5% level by DMRT. **, *, and ns = significant at 1% level, 5% level, and no significant differences by LSD test.

Carbofuran-induced rice leaff older (LF) resurgence

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LF (*Cnaphalocrocis medinalis*) is a major pest of rice in the Sambalpur district of Orissa. We evaluated five insecticides against this pest in a field trial during the 1988 wet season. Susceptib1e Jaya was transp1anted in 20-m^2 plots at 20- × 15-cm spacing in a randomized block design with 4 replications. Locally recommended chemical fertilizers were applied at 10 and 50 d after transplanting (DT).

LF damage was high at heading. At 85 DT, leaves with at least one-third of the leaf area damaged were removed from random-selected 20 hills in each plot. Plots treated with carbofuran had higher leaf damage than the check plot (see table), perhaps indicating LF resurgence. All other treatments had lower LF damage. Cartap was most effective in controlling LFs.☐

Effect of insecticides on LF control in rice.[a] Sambalpur, Orissa, India, 1988 wet season.

Insecticide	Rate (kg ai/ha)	Damaged leaves (no./plant)	Grain yield (t/ha)
Cartap 4G	1.5	1.5	4.6
Carbofuran 3G	1.0	33.0	3.6
Ethoprofos 10G	1.0	10.9	4.0
Decamethrin + buprofezin (Dadeci 5.9 EC)	0.09	5.8	4.2
Phosalone 35 EC	0.5	9.2	3.8
Untreated check	–	20.4	3.5
LSD (0.05)		11.2	0.6

[a]Mean of 4 replications.

Incidence of two grain suckers in irrigated and upland rice

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Of the insect pests that attack rice in West Africa. internal stem feeders (lepidopterous and dipteran stem borers) cause the most damage; grain sucking bugs are next in importance.

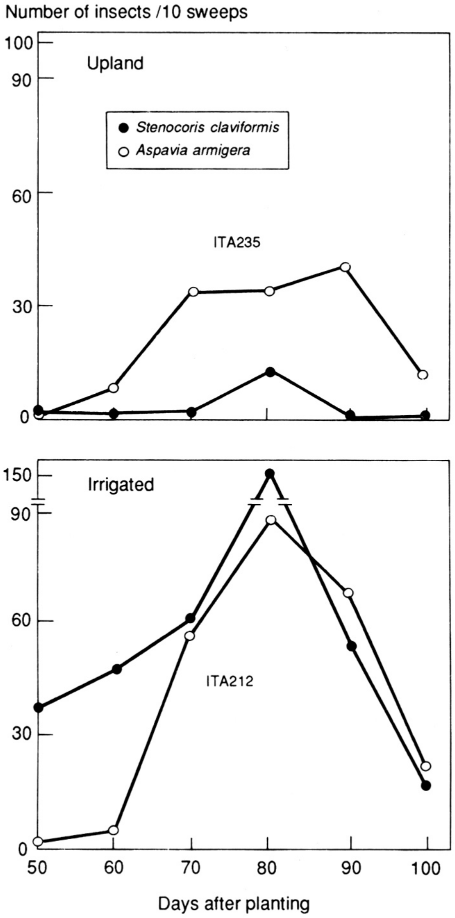
Among the 15 species of grain suckers known, *Aspavia armigera* F. (Pentatomid) and *Stenocoris claviformis* Ahmad (Coreid) are important. Damaged grains have diffuse brown spots at the point of feeding. Heavily damaged grains are either empty or only partially filled.

The adult *Aspavia* is brown with a yellow spot at each comer of the triangular shield. Its prothoracic plate has a pointed projection at each side of the dorsal side. The *Stenocoris* is similar in appearance to the Asian grain sucking bug *Leptocorisa.*

We studied the relative abundance of these two species in irrigated and upland rice.

For irrigated rice, 21-d-old seedlings of ITA212 were transplanted at 20- × 20-cm spacing in a 50- × 50-m plot. For upland rice, ITA235 was dibbled at 4-5 seeds spaced 25 × 25 cm. Plot sue was 50 m^2. Both crops were planted in mid-Jun 1986. Management practices followed standard recommendations. Sampling with 10 net sweeps per plot at 10 d intervals started at 50 d after transplanting (DT) and continued to 100 d.

In irrigated rice, more *Stenocoris* were found up to 80 DT (see figure). At 90 and 100 DT, the *Aspavia* population



Field populations of 2 grain sucking bugs in irrigated and upland rice, in relation to crop phenology.

was slightly higher than that of *Stenocoris.* In upland rice, *Aspavia* was the predominant species through all growth stages. □

Systemic and foliar applications of neem seed bitters (NSB) to control green leafhopper (GLH) and rice tungro virus (RTV) disease

R. C. Saxena, A. Kareem, E. L. Palanginan, and M. T. Malayba, Entomology Department, IRRI

In laboratory and greenhouse trials, NSB applied systemically or as a foliar spray has been found effective against GLH and RTV and was safe to rice pest predators. In 1987 wet season, we tested its efficacy on GLH- and RTV-susceptible IR42 rice planted at IRRI.

Two application methods were used: 1) Roots of 21-d-old seedlings were soaked in a 5,000 ppm NSB solution for 12 h before transplanting, and 2) systemically treated seedlings were sprayed with 10,000 ppm NSB solution (emulsified with 250 ppm Citowett) at 1-wk (8 times) or 2-wk (4 times) intervals beginning 5 d after transplanting (DT). In control plots, untreated seedlings were sprayed with monocrotophos (0.75 kg ai/ ha) or water with 250 ppm Citowett at 1-wk intervals beginning 5 DT. All sprays were applied at 8 liters/ ha, using an ultralow volume applicator. Treatments were in 40-m^2 plots with 4 replications.

Field, populations of GLH nymphs and adults and the predators mirid *Cyrtorhinus lividipennis* and spiders were recorded visually 50, 60, and 70 DT on 20 randomly selected hills/plot. Percent RTV infection in hills in each plot (excluding border rows), based on visual symptoms of yellowing and stunting in infected plants, was recorded 25, 45, and 65 DT.

GLH population at 50 DT was significantly lower in NSB- or insecticide-sprayed plots (see table). By 60 and 70 DT, the pest population had decreased in insecticide-treated plots. Populations of the predatory mirid and spiders decreased more in insecticide-treated plots than in neem or control plots.

RTV infection at 45 and 65 DT was significantly lower in insecticide- and neem-treated plots than in control plots. □

Yield; populations of GLH, predatory mirid, and spiders; and RTV infection in field plots planted to RTV-susceptible IR42 treated with neem seed bitters (NSB) or insecticide.[a] IRRI, 1987 wet season.

Treatment	GLH (no.) /20 hills			Mirid and spiders (no.)/20 hills			RTV infection (%)			Yield (t/ha)
	50 DT	60 DT	70 DT	50 DT	60 DT	70 DT	25 DT	45 DT	65 DT	
NSB 5,000 ppm (systemic)	16 b	19 b	17 b	22 a	24 a	33 a	1 a	15 a	27 a	2.8 b
NSB systemic + NSB 10,000 ppm sprayed fortnightly	11 a	13 b	13 b	22 a	25 a	31 a	2 ab	13 a	25 a	3.3 ab
NSB systemic + NSB 10,000 ppm sprayed weekly	10 a	15 b	18 b	23 a	23 a	31 a	1 a	13 a	23 a	3.2 ab
Monocrotophos (0.75 kg ai/ha) sprayed weekly	10 a	4 a	3 a	7 b	9 b	13 b	2 ab	12 a	16 a	3.6 a
Citowett (250 ppm) – water solution (control) sprayed weekly	15 b	21 b	14 b	25 a	28 a	39 a	3 b	24 b	37 b	2.7 b

[a] Av of 4 replications. Separation of means in a column by DMRT at the 5% level.

Farm machinery

Low-cost treadle pump for supplementary irrigation of rainfed farms

B. Prastowo and I. U. Firmansyah, Agricultural Engineering Division, Maros Research Institute for Food Crops (MORIF), Indonesia

We developed four low-cost treadle pump models in cooperation with the IRRI Agricultural Engineering Department, Philippines. The pumps are designed to lift water from tubewells, dug wells, or creeks for supplementary irrigation of upland crops after wet season rice.

Portable models MA05 and MA06 utilized the pump housing, cylinder liners, and valves of locally available commercial hand pumps. MA05 is designed for nonpressurized delivery of water intended for furrow irrigation. Pressurized model MA06 could be used to irrigate individual plants, using a flexible delivery hose.

To further lower costs, two nonportable models utilizing commercial cylinder liners imbedded in concrete were developed. In these pumps, two lines are joined by a suction port and placed in the bottom of a wooden mold before pouring concrete. For nonpressurized model MA07, the discharge spout is incorporated in the mold. For pressurized model MA08, the discharge port is welded to the suction port.

The table compares the pump models and local water-lifting buckets. With appropriate time of planting, one pump can provide supplementary irrigation for about 0.25 ha of soybean or mungbean after wet season rice. The pressurized model can be used to pump water to an elevated tank for household use. Women or children can easily operate the pump, giving farmers more time for other field activities. □

Comparison of MORIF water pumps, Dragon Pump, and bucket systems. Maros, Indonesia, 1987.

	MORIF pumps				Dragon	Buskett (4 lt)
	MA05	MA06	MA07	MA08		
Price (Rp)[a]	56,000	67,000	40,000	43,000	40,000	–
Weight (kg)	20	25	57	60	20	–
Height (cm)	125	120	39	38	75	–
Width (cm)	50	58	25	32	25	–
Length (cm)	99	118	58	28	90	–
Max suction lift (m)	7	7	7	7	7	–
Max pressure head (m)	–	10	–	10	7	–
Max capacity (liters/s)	1.17	0.87	1.32	1.08	0.5	0.6
Type of delivery[b]	NP	P	NP	P	optional	–
Model	PILB-1	PILT-1	PIBB-2	PIBT-2	–	–

[a]Labor and material costs. US$1 = Rp 1600. [b]P = pressurized, NP = nonpressurized.

ANNOUNCEMENTS

New IRRI publications

Sustainable agriculture—green manure in rice farming
Annual report for 1987
A farmer's primer on growing soybean on riceland (Tagalog)
A farmer's primer on growing cowpea on riceland (Tagalog)

ERRATUM

Intercropping of pulses with rainfed rice at South Coastal Orissa, India, by P. N. Sahu, A. K. Padhi, and N. Dash. 13 (3) (Jun 1988), 48.

In the table, figures for the return to rice + peanut should be $209 under Main crop and $567 under Total.

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