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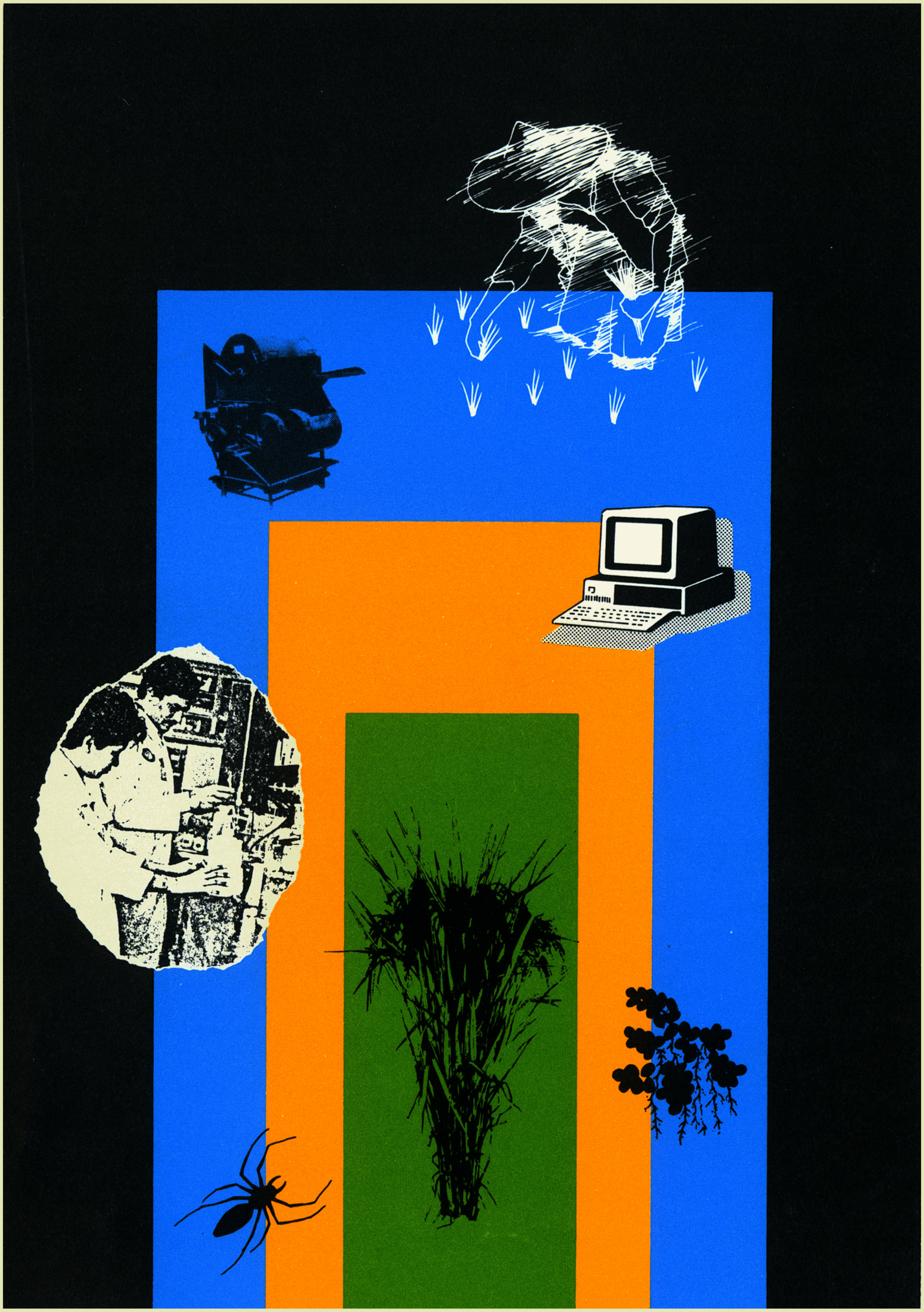

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IRRN GUIDELINES

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-scare 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, guidelines, 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 appropriate. adequate data
- applies appropriate analysis, using appropriate statistical techniques
- reaches supportable conclusions

Guidelines for contributors (revised)

The International Rice Research Newsletter is a compilation of brief reports of current research on topics of interest to rice scientists all over the world. Contributions should be reports of recent work and work-in-progress that have broad, pan–national interest and application. Only reports of work conducted during the immediate past three years should be submitted.

Research reported in IRRN should be verified. Single season, single trial field experiments are not accepted. All field trials should be repeated across more than one season, in multiple seasons, or in more than one location, as appropriate. All experiments should include replication and a check or control treatment.

All work should have pan-national relevance.

Reports of routine screening trials of varieties, fertilizer, and cropping methods using standard methodologies to establish local recommendations are not accepted.

Normally, no more than one report will be accepted from a single experiment. Two or more items about the same work submitted at the same time will be returned for merging. Submission at different times of multiple reports from the same experiment is highly inappropriate. Detection of such submissions will result in rejection of all.

Please observe the following guidelines in preparing submissions:

- Limit each report to two pages of double-spaced typewritten text and no more than two figures (graphs, tables, or photos).
- Do not cite references or include a bibliography.
- Organize the report into a brief statement of research objectives, a brief description of project design, and a brief discussion of results. Relate results to the objectives.
- Report appropriate statistical analysis.
- Specify the rice production environment (irrigated, rainfed lowland, upland, deepwater, tidal wetlands).
- Specify the type of rice culture (transplanted, wet seeded, dry seeded).
- Specify seasons by characteristic weather (wet season, dry season, monsoon) and by months. Do not use local terms for seasons or, if used, define them.
- Use standard internationally recognized terms to describe rice plants parts, growth stages, environments, management practices, etc. Do not use local names.
- Provide genetic background for new varieties or breeding lines.
- For soil nutrient studies, be sure to include a 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.
- Quantify survey data (infection percentage, degree of severity, sampling base, etc.).
- When evaluating susceptibility, resistance, tolerance, etc., report the actual quantification of damage due to stress that was used to assess level or incidence. Specify the measurements used.
- Use generic names, not trade names, for all chemicals.
- Use international measurements. Do not use local units of measure. Express yield data in metric tons per hectare (t/ha) for field studies and in grams per pot (g/pot) or per specified length (in meters) row (g/row) for small scale studies.
- Express all economic data in terms of the US$. Do not use local monetary units. Economic information should be presented at the exchange rate US$:local currency at the time data were collected.
- When using acronyms or abbreviations, write the name in full on first mention, followed by the acronym or abbreviation in parentheses. Thereafter, use the abbreviation.
  Define any nonstandard abbreviations or symbols used in a table or graph in a footnote or caption/legend.

Categories of research published

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

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

ENVIRONMENT

SOCIOECONOMIC IMPACT

EDUCATION AND COMMUNICATION

RESEARCH METHODOLOGY

CONTENTS

GERMPLASM IMPROVEMENT

Genetics

Diallel analysis at critical growth stages of rice

N. D. Majumder, S. C. Rakshit, and D. N. Borthakur, P. Box 436, P.O. Junglighat, Port Blair 744103, A & N Islands, India

We investigated the genetics of P tolerance across critical growth stages. IR28, IR29, and IR30 and local varieties Khonorullo, Mirikrak, Pawnbuh, and Ngoba were crossed in a diallel fashion without reciprocals.

The F_1 and parental lines were sown in P-deficient soil (available P = 5 ppm, pH = 5.0, soil:water = 2:5), in a randomized block design with three replications. Data on days to germination, flowering, maturity, and duration between flowering and maturity were analyzed following Griffing model 1, method 2.

Differences between the parental and the F_1 lines were significant (see table). Involvement of both additive and nonadditive gene actions was shown by a significant variance of general combining ability (gca) and specific combining ability (sca).

Estimates of gca and sca effects for duration of critical growth stages in diallel crosses.[a] Port Blair, India.

	Days to germination	Days to flowering	Days to maturity	Days from flowering to maturity
Parent[b]		*gca effect*		
IR28	-0.81**	-4.53**	-3.74**	0.74*
IR29	-0.03	1.24**	4.74**	3.42**
IR30	-0.85**	-2.53**	-2.34**	0.13
Khonorullo	0.19**	-0.95**	-3.67**	-2.53**
Mirikrak	0.60**	4.04**	-5.73*	-1.71**
Pawnbuh	-0.25**	1.40**	3.44**	2.01**
Ngoba	1.15**	9.40**	7.30**	-2.06**
Sji	0.07	0.29	0.28	0.37
S (gi - gj)	0.10	0.44	0.42	0.56
		sca effect [c]		
	IR28/Khonorullo (-0.49*)	IR28/Khonorullo (-6.23**)	IR28/Mirikrak (-2.75**)	IR28/IR29 (-2.11*)
	IR28/Ngoba (-1.46**)	IR29/Mirikrak (-6.21**)	IR29/Pawnbuh (-4.70**)	IR28/Mirikrak (-2.28*)
	IR29/Mirikrak (-1.68**)	IR29/Pawnbuh (-4.34**)	IR29/Ngoba (-8.55**)	IR29/Khonorullo (-11.85**)
	IR29/Pawnbuh (-0.83**)	IR29/Ngoba (-7.34**)	IR30/Khonorullo (-9.51**)	IR30/Ngoba (-4.03**)
	IR29/Ngoba (-2.23**)	IR30/Khonorullo (-9.23**)	Mirikrak/Pawnbuh (-18.23**)	Khonorullo/Mirikrak (-3.01**)
	Khonorullo/Pawnbuh (-1.06**)	IR30/Pawnbuh (-6.88**)	Pawn/Ngoba (-6.95**)	Mirikrak/Pawnbuh (-6.85**)
	-	Khonorullo/Ngoba (-6.45**)	-	Pawnbuh/Ngoba (-8.20**)
	-	Mirikrak/Pawnbuh (-11.36**)	-	-
Sij	0.19	0.83	0.81	1.07

[a] *, ** = significant at the 5% and 1% levels, respectively. [b] Ngoba had the highest P uptake followed by Mirikrak, IR29, IR28, Khonorullo, Pawnbuh, and IR30. [c] Only important combinations.

In days to germination, the parents were in two groups: 3 d (IR28, IR30, Khonorullo, and Pawnbuh) and 5 d (IR29, Mirikrak, and Ngoba). Earliness was dominant, but no hybrids were earlier than 3 d. In some crosses, the good general combiners Khonorullo, Mirikrak, and Ngoba, with significant positive gca effects, showed delayed germination. Other nonfixable components revealed less chance of isolating recombinants for early germination.

On the basis of early germination, the parental lines could be arranged as IR28 > IR30 > Mirikrak > Khonorullo > IR29 > Pawnbuh > Ngoba. Early × late crosses showed the dominance of earliness, supported by significant negative sca estimates. Late germination of early × early crosses and their significant positive sca estimates indicate the presence of nonallelic interaction.

Parents with significant gca effects were good combiners, revealing additive action. The gcas of parental lines IR28, IR30, Khonorullo, and Mirikrak were in a negative direction.

Proportionately, higher nonfixable components for days to flowering and maturity indicate that improvement of the trait would require quite high selection pressure; however, they indicate little significance for genetic improvement of the character. ■

Inheritance of flag leaf fresh weight in rice

Z. M. Ling, Y. S. Peng, H. W. An, and Y. L. Yuan, Agronomy Department, Beijing Agricultural University, Beijing, China

Leaf fresh weight (FW) is one indicator of leaf water status. We studied the inheritance of the flag leaf FW in upland rice varieties IAC25, Acc. 36151, Qinai, and Qinnong 2 and lowland rice cultivars Heijiang 8, Hanjiu, N86-18, and Sachiminori. The F_1, F_2, F_3 and their parents were dry seeded in upland. Flag leaf FW during heading was measured indirectly at 1400-1600 h (Beijing summer time) using a beta ray gauge (Model XQ-02A).

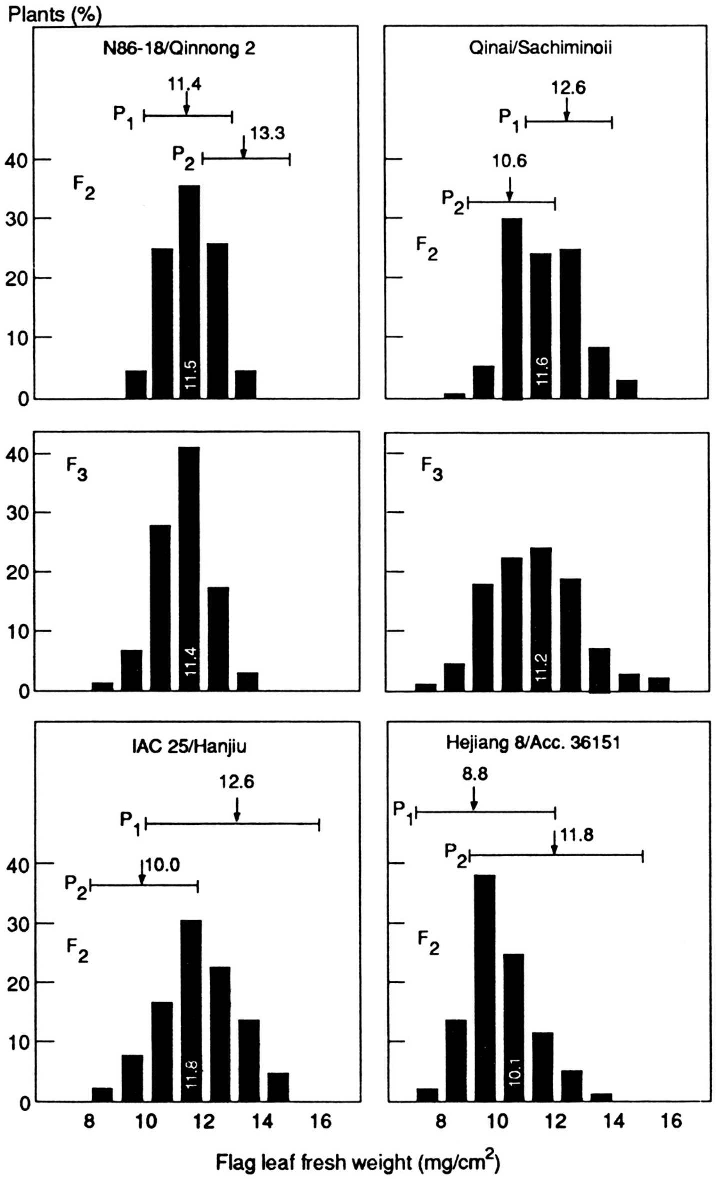
F_2 and F_3 distributions tended to be continuous, suggesting that flag leaf FW in rice is controlled by multiple genes (see figure).

In the crosses N86-18/Qinnong 2 and Qinai/Sachiminori, the correlation coefficients (r) of flag leaf FW between F_2 and F_3 populations were not significant, and their heritability in a broad sense [(h_b^2)] estimated by linear regression coefficient (b) was 0.1478 and 0.1620, respectively (see table).

Estimated by the formula

$$h_b^3 = \frac{V_{F2} - 1/2\,(V_{p1} + V_{p2}),}{V_{f2}}$$

the h_b^2 of the flag leaf FW in cross IAC25/Hanjiu was 0.4284, and that in cross Heijiang 8/Acc. 36151 was 0.1521. The low h_b^2 implies that little progress would be expected of selection for this character in early generations. ■



Distribution and means of parent, F_2, and F_3 plants far flag leaf fresh weight in 4 crosses, Beijing, China.

***r* and h_b^2 of flag leaf FW between F_2 and F_3 populations. Beijing, China.**

Cross	r	Sr	t	t 0.05,28	h_b^2
N86-18/Qinnong 2	0.3429	0.1775	1.9318	2.048	0.1478
Qinai/Sachiminori	0.2301	0.1893	1.2512	2.048	0.1620

Breeding methods

Effect of *Luffa cylindrica* Roem exudate on plantlet induction from rice anthers

Zhang Chengmei and Zhang Zhenghua, Crop Breeding and Cultivation Institute, Shanghai Academy of Agricultural Sciences, Shanghai, China

We investigated the effect of towel gourd extract in the growth medium on inductive efficiency and differentiation frequency of green plantlets in rice anther culture. Test materials were seven japonica and four indica varieties.

Basal induction medium N6, with 2 mg 2,4-D/liter and 60 g sucrose/liter, pH 5.8, was used. The exudate was obtained by cutting the gourd stem. Exudate concentrations were 0, 10, 15, 20, and 25%.

Calli 2-3 mm in diameter were transferred to the differentiation medium (Murashige and Skoog's basal salts with 2 mg kinetin/liter, 0.5 mg NAA/liter, 0.5 mg IAA/liter, and 3% sucrose, pH 5.8).

Callus formation in media with exudate appeared 30-45 d after plating;

Effect of *Luffa cylindrica* exudate in induction medium on callus induction and plant regeneration in rice anther culture.[a] Shanghai, China.

Exudate (% vol/vol)	Callus induction (%)	Plant regeneration (%)
Japonica (mean of 7 varieties)		
0	8.56 b	56.70 c
10	12.26 b	69.85 b
15	14.42 a	85.57 a
20	16.69 a	83.10 ab
25	9.29 b	68.93 b
Indica (mean of 4 varieties)		
0	5.41 b	27.05 b
15	6.96 ab	44.84 ab
20	7.01 a	45.48 a

[a] In a column within a subspecies, numbers with a common letter are not significantly different at the 5% level.

without exudate, callus formation appeared 45 d after plating.

Using 15-20% towel gourd exudate in the induction medium increased anther culture efficiency in both japonica and indica rices.

Callus formed in that medium also had high plant regeneration (see table). Green plantlet regeneration reached about 90% in japonicas and improved significantly in indicas. Callus weights in the medium with 15-20% exudate were 5.7-18% higher than callus weight of the check after 10 d subculture. Fresh and dry weights of green plantlets increased by 2 and 89%, respectively. ■

Yield potential

Relationship of seedling shoot and root lengths and root number to rice yield and yield attributes

S. Ramasamy, S. Krishnusamy, and G. S. Thangamuthu, Agronomy Department, Tamil Nadu Agricultural University, Coimbatore 41003, India

We studied the effect of simulated seedling damage from uprooting and transplanting on performance of transplanted rice during late winter 1988-89 (variety IR64) and summer 1989 (IR50). The soil available N, P, and K were 286, 36, 219 kg/ha in the winter and 258, 47, 186 kg/ha in the summer.

Half the seedlings for the winter crop received 2 kg diammonium phosphate (DAP: 10% N, 46% P)/40 m^2 10 d after sowing (DAS). Seedlings were transplanted 25 DAS. Treatments were no pruning, pruning roots to 1 cm, clipping shoots to 4 cm, and both root pruning and shoot clipping.

For the summer experiment, a uniform dose of 100:50:50 kg NPK/ha was applied. Seedlings measured on the average 22 cm shoot height and 6.5 cm root height, with 21 roots/seedling, and 0.07 g total dry weight. Treatments were no pruning, pruning roots to 1 cm, and moving some roots to leave 5, 10, or 21 roots.

In the winter crop, phosphate increased seedling height and weight but did not affect yield attributes or yield.

Root pruning increased plant height, tiller number, leaf number, and total dry matter.

Growth at 40 d after transplanting was reduced by shoot clipping (Table 1).

Seedlings with 10 roots produced more dry matter and grain yield than higher or lower root numbers (Table 2).

It appears that loss of roots and root injury caused by pulling seedlings do not affect plant performance, and may actually be beneficial. ■

Table 1. Effect of root pruning and shoot clipping on agronomic characteristics of the late winter rice crop. Tamil Nadu, India, 1988–89.

Treatment	Initial dry wt (mg/plant)	40 d after transplanting			
		Plant ht (cm)	Tillers (no/hill)	Leaves (no./hill)	Dry matter (g/hill)
No DAP					
Control	51.9	40.4	8.0	15.6	2.90
Root pruning	47.4	44.2	8.0	16.0	3.49
Shoot clipping	27.5	33.2	5.8	10.6	1.35
Root pruning + shoot clipping	23.0	34.1	6.0	10.8	1.49
With DAP					
Control	59.1	42.1	7.4	18.2	2.88
Root pruning	56.1	43.8	8.2	20.2	3.18
Shoot clipping	28.0	33.4	4.8	12.0	0.98
Root pruning + shoot clipping	24.9	34.4	4.6	12.4	0.98
LSD (P = 0.05)					
Fertilizer (F)	-	ns	ns	1.0	0.10
Treatment (T)	-	2.1	0.3	1.4	0.15
F * T	-	2.6	0.4	2.0	0.21

Table 2. Effect of root pruning on rice yield. Tamil Nadu, India, summer 1989.

Treatment	Productive tillers (no./hill)	Total dry matter (g/hill)	Grain yield (g/hill)
Without root pruning			
5 roots	13.4	35.25	19.70
10 roots	14.5	36.60	21.47
21 roots (all)	13.8	32.20	18.00
Mean	14.1	34.68	19.72
With root pruning			
5 roots	14.2	36.20	19.87
10 roots	15.0	36.35	22.52
21 roots (all)	14.1	32.60	19.23
Mean	14.4	35.05	20.54
LSD (P = 0.05)			
Root pruning (P)	0.3	ns	0.66
Root numbers (R)	0.4	2.25	0.81
P * R	0.5	3.18	1.14

Influence of low light intensity on production of high-density (HD) grain

J. Ahmed, Rice Research Station, Chinsurah, West Bengal, India

Low light intensity is an important constraint to wet season rice yields in the tropics. Because grain weight is the major yield component, we studied the effect of low light intensity on the production of HD grain.

Ten long-duration rice varieties were transplanted in shaded (50% normal light intensity artificially maintained from 30 d after transplanting to maturity) and unshaded plots. Grain grade index was determined as percentage of fully filled grains at 1.20 specific gravity divided by spikelets/panicle.

All varieties performed better in light than in shade, with a large difference in number of HD grains and yield (see table). Higher grain yield in unshaded plots was due primarily to high panicle numbers, spikelet/hill, and 1,000-grain weight.

CN505, Patnai 23, CN540, and NC499 had higher HD grain indexes in unshaded than in shaded plots. The difference was marginal in CN704 and in Latisail. NC492, CN704, and IR42 produced a high proportion of HD grain in the shade. This indicates varietal differences in grain filling under low light conditions. ■

Influence of low light intensity on grain grade index and yield components of 10 rice varieties. West Bengal, India.

Variety	Panicles (no./hill)		Spikelets (no./panicle)		Grade-grade index (%)		1000-grain weight (g)		Grain yield (g/hill)	
	Normal	Low light	Normal	Low light	Normal	Low light	Normal	Low light	Normal	Low light
NC492	5	3	162	135	70	61	30.0	25.5	19.5	4.4
NC499	7	4	183	163	67	44	16.5	14.3	10.9	6.5
CN540	5	2	161	146	65	41	25.0	23.6	18.9	4.2
IR42	6	3	179	138	63	55	20.4	18.8	20.7	12.5
Patnai 23	5	3	188	137	60	44	26.2	25.3	20.0	6.0
CN505	6	4	159	123	61	34	18.5	16.3	7.6	4.1
CNM539	8	5	211	156	61	54	16.1	14.9	18.5	4.7
NC678	4	2	207	120	58	41	28.0	24.7	16.2	4.1
CN704	6	4	212	157	58	56	21.6	20.0	14.2	3.7
Latisail	7	3	155	132	56	53	24.9	23.7	13.2	6.0
					Angular transformation					
LSD (0.05)	1.10	0.99	4.78	3.86	1.86	3.52	2.22	2.12	2.12	1.63
(0.01)	1.58	1.41	6.87	5.54	2.67	5.06	3.20	3.05	3.04	2.35
CV (%)	20.17	28.76	12.32	10.31	3.51	7.87	21.25	21.33	27.43	46.35

Characters associated with yield in rices tolerant of low phosphorus

N. D. Majumder (present address: Central Agricultural Research Institute, Port Blair 744101, India), S. C. Rakshit, and D. N. Borthakur, ICAR Research Complex, Shillong 793004, India

We crossed low P-tolerant IR28, IR29, and IR30 and local varieties Khonorullo, Mirikrak, Pawnbuh, and Ngoba in diallel fashion without reciprocals. The 21 cross combinations and their parents were direct seeded in P-deficient upland lateritic soil (5 ppm available P, pH 5.0, soil:water 2:5).

The experiment was laid out in a randomized block design with three replications. Plants were spaced at 20 × 20 cm between rows and plants. Fertilizer was applied at 20-30 kg NK/ha.

Eighteen characters had significant positive correlation with grain yield (see table). Higher genotypic correlations (r_g) of most characters revealed the influence of nonheritable factors on the phenotypic correlation. ■

Genotypic and phenotypic correlations of some characters with grain yield in low P-tolerant rices. [a]

Character	Correlation coefficient with yield	
	Phenotypic level (r_p)	Genotypic level (r_g)
Plant height	0.482**	0.489**
Panicle-bearing tillers	0.414*	0.416*
Panicle length	0.429*	0.467*
Main branches/panicle	0.538**	0.570**
Grains/plant	0.925**	0.927**
Grain density	0.404*	0.401*
1,000-grain weight	0.472*	0.505**
Panicle weight	0.972**	0.975**
Root length	0.616**	0.821**
Root volume	0.720**	0.806**
Fresh root weight	0.701**	0.765**
Fresh shoot weight	0.671**	0.685**
Dry root weight	0.437*	0.453*
Dry shoot weight	0.679**	0.707**
% panicle-bearing tillers (on total litter)	0.377*	0.457*
Grain:straw weight	0.686**	0.719**
Harvest index	0.638**	0.654**
Flag leaf area/plant	0.794**	0.856**

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

Pest resistance – diseases

A simple method for detecting genetic variation in *Xanthomonas campestris* pv. *oryzae* (Xco) by restriction fragment length polymorphism (RFLP)

A. K. Raymundo, R. J. Nelson, E. Y. Ardales, M. R. Baraoidan, and T. W. Mew, Plant Pathology Department, IRRI

We analyzed genetic differences among isolates of *X. c.* pv. *oryzae,* the causal agent of bacterial blight, using the restriction enzyme *Pst*I. When *Pst* I-digested genomic DNA samples were subjected to electrophoresis and stained with ethidium bromide, a few high-molecular-weight DNA fragments formed distinctive patterns for different isolates.

These patterns could be used to distinguish groups of isolates. In most cases, isolates with a particular RFLP type are members of a single race.

RFLP analysis has been found useful for differentiating isolates and races of

Xco. Previous studies used the Southern blotting technique, in which EcoRI-digested DNA was transferred to a solid support and probed with labeled DNA fragments.

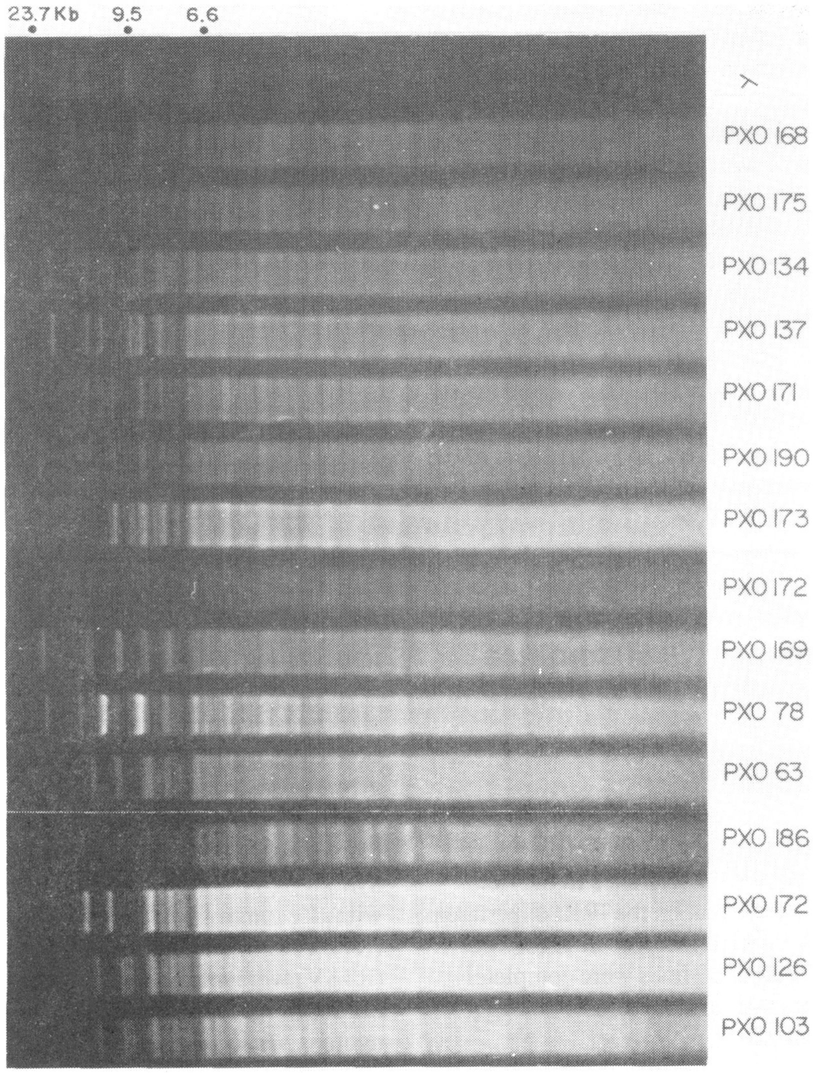
The advantage of the method we used is that the relatively small number of large DNA fragments resulting from *Pst*I digestion allows RFLPs to be detected without Southern blotting. Expensive and laborious blotting, probe synthesis, hybridization, washing, and probe detection procedures are avoided.

RFLP analysis of Xco using *Pst*I involves extraction of the bacterial DNA, digestion of DNA with the restriction enzyme, gel electrophoresis, and DNA visualization. All of these procedures are done according to standard protocols. The figure shows a gel containing *Pst*I-digested genomic DNA of selected isolates of Xco Race 2. Polymorphism is evident among the fragments that are more than 6 kilobases long.

We are using this method to examine a collection of Philippine isolates of other races of Xco. Polymorphic bands of high molecular weight have been observed for isolates of Races 2, 4, and 6.

For most of the Race 1 isolates and several Race 3 isolates, the genomic DNA was not cut by *Pst*I. DNA from these isolates can, however, be cut with other restriction enzymes.

Test DNA (from bacteriophage lambda) added to the samples can be digested by *Pst*I, indicating that the DNA of these Xco isolates is modified in a way that prevents digestion by *Pst*I. It happens that a restriction enzyme isolated from Xco, named *Xor*I, also recognizes the sequence that is acted on by *Pst*I. This may be the reason the site is apparently modified in some strains of Xco.



Gel containing *Pst*I digested genomic DNA of selected isolate of *X.c.* pv. *oryzae* race 2.

The results obtained using this method of RFLP analysis are consistent in general with results of other RFLP studies for Xco, except for the undigested types seen in Races 1 and 3. In a similar study for *X. c.* pv. *oryzicola,* RFLPs are also revealed by digestion with *Pst*I.

Using a fast, simple method of detecting polymorphism in Xco and *X.c.* pv. *oryzicola* may help rice pathologists determine the population structure of these pathogens and characterize the variability among some of the races. This could help pathologists and breeders identify heterogeneous sets of strains, which can be used to develop rice varieties with broad-based resistance.

Although the method is not useful for differentiating among Race 1 and some Race 3 isolates in Philippine populations of the pathogen, it has good specificity for other races, including Race 2, currently the dominant race in the Philippines.

The relatively low effort and expense required for analysis could also make this method a useful tool in epidemiological studies. ■

A disease rating scale for screening rice genotypes for resistance to sheath blotch

U. Bhan and S. C. Ahuja, Indian Agricultural Research Institute, New Delhi 110012, India

We screened 26 rice genotypes for reaction to sheath blotch (*Pyrenochaeta oryzae* Shirai ex Miyake) under artificial epiphytotic conditions.

Entries were transplanted in three 5-m-long rows each with 15 cm between plants and 20 cm between rows. At 80 d after transplanting, each plant was inoculated by inserting between the sheath and culm a one-inch-long *Typha* piece colonized with *P. oryzae.* Infected tillers, lesion length vertical spread), penetration to lower sheath (horizontal spread), and pycnidia formation were evaluated 21 d after inoculation.

Individual parameters placed all the genotypes in extreme categories. We therefore pooled the parameters and devised a new scale.

Rating	Description
1	0-10% tillers infected; lesion length on first sheath 0-15 mm; no pycnidia formation.
2	10-20% tillers; lesion on first sheath 15-30 mm; lesion length on second sheath <20 mm; 5-10% blotch area having pycnidia.
3	20-30% tillers infected; lesion length on first sheath 30-45 mm; lesion on second sheath 20-30 mm long; 10-25% blotch area covered with pycnidia
4	30-40% tillers infected; first sheath lesion 45-60 mm long; lesion length on second and third sheaths >30 and >20 mm, respectively; 25-50% blotch area studded with pycnidia
5	>40% tillers infected; lesion length on third sheath >20 mm; specks on culm and node; 50% blotch area bearing pycnidia

Using this scale, genotypes were grouped as resistant (ratings 1 and 2), moderate (rating 3), and susceptible (ratings 4 and 5). HAU3800-1, HPU804, and RP2151-33-4 were resistant (see table). ■

Reaction of 26 rice genotypes to sheath blotch inoculation (pooled parameters). Haryana Agricultural University Rice Research Station, Kaul, India.

Reaction	Rice genotypes
Resistant (rating 1-2)	HAU3800-1, HPU804. RP2151-33-4
Moderate (rating3)	HAU47-3780-33, HAU47-3855-1, IET7641, IET7662, IET7753, IET7758, RP2151-27-1, RP2151-140-1
Susceptible (rating4-5)	HAU101-60, HAU101-88, HAU3855-1, HAU47-6045-1, IR13420-6-3-3-1, IR17494-32-1-1-3-3, IR19660-181-3-3-3, IR19661-23-3-2-2, IET4141, RP2151-76-1, IET7668, IET7752, RP2151-21-1, HKR101, Palman 579

Resistance of selected breeding lines to green leafhopper (GLH) and rice tungro (RTV)

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We used artificial inoculation to screen 29 breeding lines for resistance to GLH and RTV.

To screen for GLH resistance, pregerminated seeds were sown in rows in 60-× 40- × l0-cm seedboxes. Seedlings were infested with five 3d-instar nymphs/seedling 7 d after sowing and scored when susceptible check TNl seedlings died.

To screen for RTV resistance, 10-d-old seedlings were exposed for 1 d to 2 viruliferous GLH adults/seedling (GLH had fed 3 d on RTV-infected TN1 plants). RTV infection was scored 20 d after inoculation.

Resistance to RTV was not necessarily associated with GLH resistance (see table). IR35366-62-1-2-2-3, IR45138-115-1-1-2-2, IR45136-131-2-1-1-3, IR49517-41-1-6-2-3, and IR52280-117-1-1-3 were highly resistant to GLH and RTV. IR41996-163-2-1-2, IR49455-71-3-2-3-2-2, IR50363-8-1-1-3, IR50363-61-1-2-2, and IR50376-80-1-1-2-2 were highly resistant to GLH but susceptible to RTV. IR28239-94-2-3-6-2 and IR41985-111-3-2-2-2 were susceptible to GLH but resistant to RTV. ■

Reactions of selected IR lines to GLH and RTV. Aduthurai, India.

Line	GLH damage score (SES)	RTV[a] (%)
IR28239-94-2-3-6-2	9	10 (3)
IR35366-62-1-2-2-3	3	5 (2)
IR41985-98-3-1-3-2	5	15 (4)
IR41985-111-3-2-2-2	9	25 (5)
IR41993-131-2-3-1	3	35 (6)
IR41996-12-2-2-3	7	45 (7)
IR41996-50-2-1-3	3	25 (5)
IR41996-99-1-5-2	9	40 (6)
IR41996-118-2-1-3	3	45 (7)
IR41996-163-2-1-2	1	60 (7)
IR41999-139-1-1-2-3	1	b b
IR42000-211-1-2-2-3	7	25 (5)
IR42068-22-3-3-1-3	0	b b
IR45138-115-1-1-2-2	0	5 (2)
IR45136-131-2-1-1-3	0	l0 (3)
IR47761-27-1-3-6	1	60 (7)
IR49455-71-3-2-3-2-2	1	50 (7)
IR49457-33-1-2-2-2	3	40 (6)
IR49460-54-2-2-2-3	5	35 (6)
IR49492-38-2-2-2	3	45 (7)
IR49517-15-2-2-1-2-2	1	b b
IR49517-23-2-2-3-3	1	b b
IR49517-41-1-6-2-3	1	5 (2)
IR50363-8-1-1-3	1	55 (7)
IR50363-61-1-2-2	1	40 (6)
IR50376-80-1-1-2-2	3	45 (7)
IR50404-57-3-2-3	1	30 (5)
IR51009-62-3-3-3	5	15 (4)
IR52280-117-1-1-3	3	5 (2)
TN1 (susceptible check)	9	90 (9)
TKM9 (susceptible check)	b	85 (9)
ADT36 (susceptible check)	b	85 (9)

[a]Values in parentheses = RTV damage rating by the *Standard evaluation system for rice* (SES). [b]Not tested.

New donors for green leafhopper (GLH) and rice tungro virus (RTV) resistance

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We grew more than 100 land races selected for RTV tolerance in the field from Bihar, India, on the IRRI experimental farm for seed increase in 1987 wet season. About 30 lines were completely free from visible symptoms of RTV infection.

In 1988, we screened those lines for resistance to GLH *Nephotettix virescens* (Distant), in free-choice and no-choice tests. During 1989 dry season, six lines found to be GLH-resistant in the no-choice test were evaluated for RTV infection using artificial inoculation in the greenhouse.

Ten seedlings/earthen pot were grown in mylar cages. Viruliferous GLH nymphs fed 2-3 d on rice plants infected with rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV) were released for 24 h on 2-wk-old seedlings for inoculation, at two nymphs per seedling.

Inoculated plants were kept in an insect-proof screenhouse. One month after inoculation, seedlings were indexed by enzyme-linked immunosorbent assay.

No line showed visible symptoms of RTV. All lines were resistant to RTSV; RTBV infection varied from 40 to 85% (see table). Ratakita 1, RAUSRR15, and TCA227 had no RTBV + RTSV infection. Varieties resistant to GLH were predominantly infected with RTBV alone.

Crosses made to incorprate resistance to GLH and RTV can serve as new sources of resistance. ■

Reaction of selected rice lines from Bihar, India, to GLH, RTBV, and RTSV. IRRI, 1987.

Line	Plants tested (no.)	GLH reaction[a]	Infection[b] (%)	
			RTBV + RTSV	RTBV
Ratakita 1	53	1	0.0	45.3
RAUSRR15	42	3	0.0	76.2
RAUSRR18	54	3	1.4	42.6
TCA4-1	35	3	8.5	40.0
TCA227	41	3	0.0	85.4
TCA269	20	3	30.0	40.0

[a] No-choice test. [b]All lines had zero RTSV infection. Standard evaluation system for rice scale 1 to 9. Susceptible TN1 scored 9; resistant IR29 scored 3.

Detection of tungro viruses after inoculation

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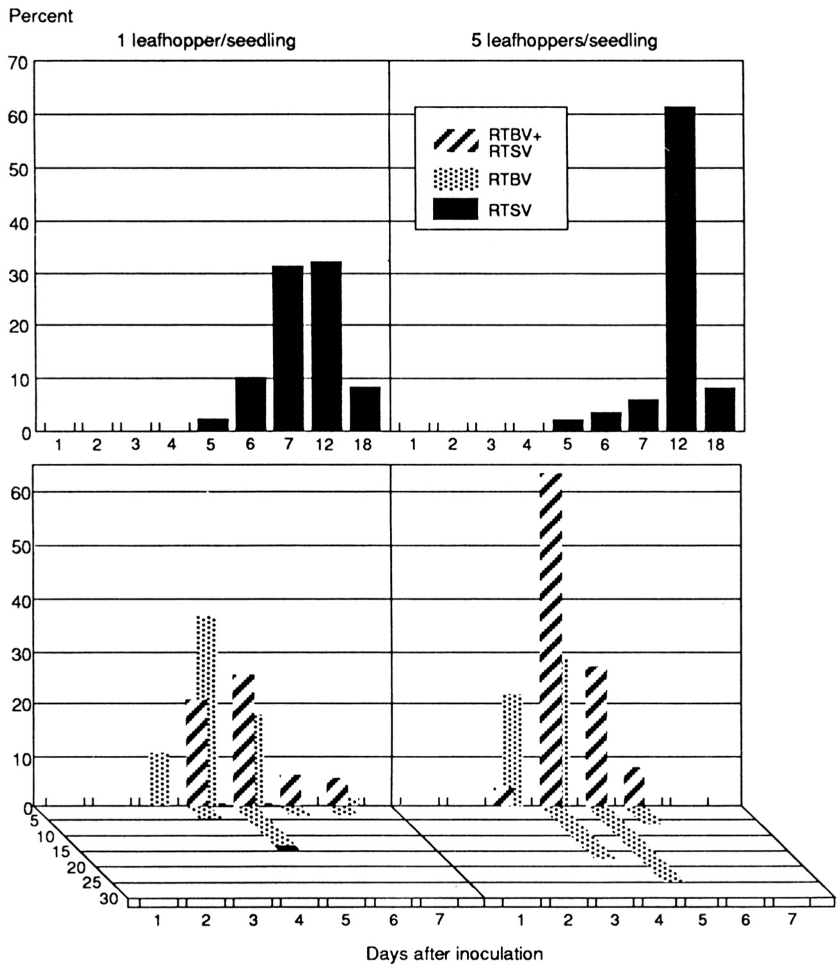
We examined how soon rice tungro bacilliform (RTBV) and spherical viruses (RTSV) can be detected by enzyme-linked immunosorbent assay (ELISA). Adult green leafhoppers *Nephotettix virescens* were given 3 d acquisition feeding on TN1 Plants infected with both RTBV and RTSV or with RTSV alone and introduced on 21-d-old TN1 seedlings in the greenhouse at 1 or 5 insects/ seedling for 24-h inoculation (90 seedlings inoculated with each virus source with a given number of leafhoppers).

Leaves 10-15 mm long were sampled daily to 7 d after inoculation (DAI) and at 12 and 18 DAI.

Initial detection of RTBV was at 3 DAI. At 4 DAI, the number of plants in which both viruses were newly detected increased sharply, then gradually decreased thereafter (see figure).

RTSV alone was initially detected 4 DAI in seedlings inoculated by 5 leafhoppers and 5 DAI in seedlings inoculated with 1 leafhopper. Maximum detection of RTSV was 7-12 DAI.

These results indicate that multiplication of RTSV alone is slower than when plants are infected with both viruses. ■



Detection of RTSV alone, RTBV alone, and RTBV + RTSV in 21-d-old TN1 seedlings inoculated 1 or 5 *Nephotettix virescens* in the greenhouse. Bars below the base line show percentage of plants in which RTBV or RTSV was detected first as single infection, then as double infection.

Upland rice genotypes resistant to blast (Bl) disease in West Sumatra

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In 1987, we developed a method for screening B1 resistance in the field and evaluated 437 upland rice genotypes from Indonesia, CIAT (Colombia), EMBRAPA (Brazil), and IRRI (Philippines) six times within 2 yr. Under heavy disease pressure, 176 showed a high degree of resistance (see table). Many of them showed attributes of slow susceptibility under epiphytotic conditions in the field.

The materials are being used in our upland rice breeding program to improve the Bl resistance of local cultivars. ■

Upland genotypes showing Bl disease resistance in the field. Sitiung, West Sumatra, Indonesia, 1987.

Origin	Entries (no.)	Genotypes (no.) with given disease rating[a]		
		R (1-5%)	I (6-25%)	S (>25 %)
CIAT, Colombia	198	126	38	34
EMBRAPA, Brazil	16	15	1	0
Indonesia	91	0	10	81
IRRI, Philippines	132	35	64	33
Total	437	176	113	148
Local checks:				
C22 (S): 100% dead				
Danau Laut Tawar (R): 3, 4 (25%)				

[a] Disease severities evaluated according to disease damage index keys to estimate damage caused by major diseases of upland rice. R = resistant, I = intermediate, S = susceptible.

Pest resistance — insects

Evaluation of rice cultivars for resistance to leaffolder (LF)

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We screened 81 rice cultivars from the Directorate of Rice Research, Hyderabad, for LF resistance 1986-87.

Entries were direct seeded in 4 - × 1.05-m plots with two replications. Recommended agronomic practices were followed.

LF infestation was heavy 70 d after sowing, when the crop was in the booting to flowering stage. Susceptible check Brown gora had 90% infestation. Damaged and undamaged leaves of each test entry were counted in 1 m^2 of each replication, and averages calculated. Percentage damaged leaves was converted into 0-9 point scale:

$$\text{Scale} = \frac{\text{\% damaged leaves in test cultivar}}{\text{\% damaged leaves in susceptible check}}$$

In 1986, RP1714-111-7-3-2 and OR811-2 had no LF damage. In 1987, RD2599-150-18-8-5 and RAU156-56 had no damage.

Reactions of most cultivars changed in 1987. RP1714-111-7-3-2 and OR811-2, which had 0 damage in 1986, were evaluated at 3 in 1987.

Cultivars that scored 0, 1, and 3 both years could be treated as resistant and used in a crossing program (see table). ■

Cultivars that scored 0-3 for LF resistance. Ranchi, India, 1986 and 1987.

Score	Cultivars
	1986
0	RP1714-111-7-3-2, OR811-2
1	RP2217-71-73-14, RP2525-19-124, RP1888-132-24-11-8, RP2522-16-14-80. NDR119, UPR83-28, UPR83-20, NDK224, NDR222, BG367-4, and CN747-1-4
3	RP2415-203-5-1-2, RP2263-934-592-5, RP2235-35-40-50, RTN500, RP2423-5-77-16, TNAU301790, Akashi, TNAU81804, NRL502, TNAU83134, TNAU83108, NDR312-l, NR571-1, MAUSEL 10, RP2601-24-36-138, Pusa 510, JR35, OR811-10, RP2599-150-18-8-5, ADT85001, RAU151-56
	1987
0	RP2599-150-188-8-5, RAU151-56
1	OR811-10, ADT85001, RP2522-16-14-80, NDR119, UPR83-28, TNAU83108
3	RP1714-111-7-3-2, OR811-2, RP2217-71-73-14, RP2525-19-124, RP1888-132-24-11-8, UPR83-20, NDR224, NDR222, BG367-4, CN747-1-4, RP2415-203-5-1-2, RP2263-934-592-5, RTN500, RP2423-5- 77-16, Akashi, Pusa 510, RAU4071-51-13, RAU4045-2A.

Stress tolerance — excess water

Inheritance of submergence tolerance in rice

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We traced inheritance of submergence tolerance in six submergence-tolerant advanced lines crossed with susceptible IR11288-B-B-69-1. Seeds of the parents, F_1, and F_2 were sown in 5- × 5-cm plastic pots and placed in galvanized iron trays in the glasshouse. Seedlings were pulled 35 d after sowing and tillers separated to test submergence tolerance. At 10 d after separation, trays containing potted tillers were put in a tank inside the greenhouse and the plants submerged to 90 cm for 12 d. Recovery was measured 7 d after submergence.

Submergence tolerance of the F_1 and F_2 was calculated by dividing their survival by the survival percentage of the tolerant parent.

Survival in the F_1 of four crosses tended toward the tolerant parent; survival in two crosses was very poor (see table). This implies that dominance of submergence tolerance varies.

Although survival of the F_1 of BKNFR76106-16-0-1/IR11288 was very poor, the F_2 showed tolerance (which was expected). The reason for the discrepancy in the F_1 is not clear.

Survival was higher in crosses involving strongly submergence-tolerant parents that derive their tolerance from FR13A or Kurkaruppan (BKNFR76106-13-2 and IR29012-4-1-3 from FR13A and IR31406-333-1 from Kurkaruppan). Survival was lower in the crosses involving moderately tolerant parents IR21567-16-2-2 and IR8234-OT-9-2 (they presumably obtained their genes for tolerance from moderately tolerant KLG6986 and Nam Sagui 19).

Reaction to submergence of parents and F_1 and F_2 populations of crosses.

Cross	Submergence survival (%)			v^2	Ratio	Probability
	Parents	F_1	F_2			
BKNFR76106-13-2/	84.3	72	54	0.21	9:7	0.50-0.70
IR11288-B-B-69-1	0.0					
BKNFR76106-16-0-1/	80.5	19	51	1.12	9:7	0.25-0.30
IRl1288-B-B-69-1	0.0					
IR8234-0T-9-2/	73.4	65	41	9.45	7:9	0.01-0.001
IR11288-B-B-69-1	0.0					
IR21567-16-2-2/	76.0	32	35	3.50	7:9	0.05-0.10
IR11288-B-B-69-1	0.0					
IR29012-4-1-3/	81.3	72	43	0.02	7:9	0.70-0.90
IR11288-B-B-69-1	0.0					
IR31406-333-1	10.0	72	59	0.31	9:7	0.50-0.70
IR11288-B-B-69-1	0.0					

Two types of segregation ratios were observed in the F_2: 9:7 for crosses where tolerant parents derived tolerant genes from FR13A and Kurkaruppan, and 7:9 for crosses where tolerant parents derived tolerant genes from moderately tolerant KLG986 and Nam Sagui 19. These ratios can be explained by the complementary action of at least two genes. ■

Stress tolerance – adverse soils

Genetic variability in rice genotypes planted in sodic soil

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We evaluated the genetic variability and heritability of desirable traits in 56 rice genotypes sown Jul 1989 in sodic soil (pH 8.9).

Planting was done in 5-m rows with three 35-d-old seedlings/hill at 25- × 25-cm spacing. The experiment was laid out in a randomized block design with three replications. Maximum and minimum temperatures during crop duration were 32.7-27.4 and 26.4-14.9 °C.

All traits except flag leaf thickness showed a wide range of phenotypic variation (see table). The phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all traits. PCV ranged from 8.3 for days to 50% flowering to 55.4 for grain sterility.

Tillers/plant, flag leaf area, panicled plant, spikelets/panicle, filled grains/ panicle, grain sterility, biological yield/ plant, grain yield/plant, and harvest index had high values for both GCV and PCV.

Tillers/plant, panicles/plant, spikelets/ panicle, filled grains/panicle, grain sterility, biological yield/plant, grain yield/ plant, and harvest index showed higher environmental coefficient of variability (ECV). This indicates that these traits were more susceptible to environmental and agro-ecotypic factors, especially to soil sodicity and temperature variations.

Grain sterility showed higher PCV, GCV, ECV, and genetic advance (in % of mean) than other traits, indicating this trait could be used in breeding for salt tolerance. Heritability was high for all traits except grain yield/plant.

Grain sterility, spikelets/panicle, filled grains/panicle, biological yield/plant, flag leaf area, and harvest index showed higher values for genetic advance.

Panicles/plant, flag leaf area, spikelets/panicle, filled grains/panicle, sterility, and yield may be good selection criteria for screening rice genotypes for sodic soil conditions. ■

Range, mean, coefficients of variability, heritability, and genetic advance of 16 traits in 56 rice genotypes grown in sodic soils. Faizabad, India, 1989.

Trait	Range	Grand mean and SE	PCV	GCV	ECV	Heritability (%)	Genetic advance in % of mean
Plant height (cm)	67.9-145.0	90.4 p 3.2	15.9	15.3	4.3	92.7	30.4
Tillers per plant	3.4- 8.7	6.0 p 0.6	21.3	17.4	12.3	67.1	29.4
Flag leaf thickness (mm)	0.6- 1.3	0.9 p 0.02	16.7	16.3	2.0	95.7	33.0
Flag leaf area (cm^2)	18.3- 56.5	34.0 p 1.5	23.1	22.5	5.5	94.4	45.0
Days to panicle emergence	77.7-122.3	101.0 p 1.6	8.8	8.6	2.0	94.9	17.2
Days to 50% flowering	82.0-131.0	104.8 p 1.2	8.3	8.2	1.4	97.2	16.6
Days to maturity	103.0-155.0	136.8 p 1.8	9.8	9.7	1.6	97.5	19.8
Panicles per plant	2.8- 6.8	4.9 p 0.6	24.1	19.3	14.3	64.3	31.8
Panicle length (cm)	18.4- 28.1	23.5 p 0.9	9.0	7.8	4.6	74.1	13.8
Spikelets per panicle	61.7-270.7	137.2 p 13.9	33.0	30.5	14.4	85.9	58.4
Filled grains per panicle	52.0-239.3	117.4 p 14.4	32.9	29.3	15.1	79.1	53.6
Grain sterility (%)	5.0- 41.0	14.0 p 2.7	55.4	50.3	23.2	82.5	94.7
Biological yield per plant (g)	12.7- 45.3	25.8 p 3.4	33.4	29.2	16.2	76.4	52.3
Grain yield per plant (g)	6.8- 21.6	11.4 p 1.6	27.6	24.0	13.6	41.3	26.6
Harvest index (%)	29.7- 62.0	45.9 p 4.8	20.9	16.4	12.9	61.8	43.0
100-grain wt (g)	1.6- 3.3	2.6 p 0.1	13.9	13.5	3.1	92.3	23.3

Absorption of nutrients and their replaceable functions in rice varieties tolerant of and sensitive to K deficiency

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The experiment was conducted with two varieties: Xiang-Zao-Nuo 1 (XZN 1) is tolerant of K deficiency, Shuang-Gui 36 (SG36) is sensitive. Seedlings at the three-leaf stage were grown on complete and K-deficient nutrient solutions. Dry weight of seedlings was determined 34, 38, and 41 d after planting. Content of Cu, Mn, Zn, Fe, Mg, K, Na, and Ca in dried shoots was analyzed.

Seedling dry weight indicated that XZN 1 was not affected by K-deficient growth medium (Table 1). SG36 showed marked growth reduction.

XZN 1 absorbed more Cu, Mn, Fe, K, Na, Mg, and Ca from the K-deficient growth medium (Table 2). SG36 increased absorption of only Zn, Mg, Na, and Ca. Fe and K absorption by XZN 1 was higher than that by SG36, but SG36 absorbed more Zn and Na.

It appears that in XZN 1, Fe, Mn, Mg, Na, and Ca substituted for K. These clear varietal differences in adaptability to low K availability indicates that breeding for K-deficient soils should be possible. ■

Table 1. Dry weight of seedlings grown in complete and K-deficient nutrient solutions

Days after sowing	Dry weight (mg/plant)			
	XZN 1		SG36	
	Complete	Deficient	Complete	Deficient
34	34.0	36.0	36.0	29.0
38	129.0	124.0	125.0	74.0
41	135.0	135.0	135.0	88.0

Table 2. Mineral content of 38-d-old shoots.

Element	Content (% dry weight)			
	XZN 1		SG36	
	Complete	Deficient	Complete	Deficient
Cu	$2.0 * 10^{-3}$	$2.3 * 10^{-3}$	$1.8 * 10^{-3}$	$2.3 * 10^{-3}$
Mn	$9.5 * 10^{-3}$	$1.0 * 10^{-2}$	$2.4 * 10^{-2}$	$1.1 * 10^{-2}$
Zn	$2.5 * 10^{-2}$	$3.1 * 10^{-2}$	$4.3 * 10^{-2}$	$4.7 * 10^{-2}$
Fe[a]	$3.8 * 10^{-2}$	$4.4 * 10^{-2}$	$4.3 * 10^{-2}$	$3.6 * 10^{-2}$
Mg	0.40	0.65	0.58	0.77
K	3.09	1.49	2.93	0.63
Na	$6.3 * 10^{-2}$	0.24	0.12	0.76
Ca[a]	0.23	0.29	0.20	0.30

[a] Sampled 50 d after sowing.

Surveys of disease or insect incidence/severity in one environment are useful only if the information is related to other variables (e.g., climatic factors, crop intensification, cultivars, management practices, etc.). By itself, information on incidence in one environment does not increase scientific knowledge.

Integrated germplasm improvement – general

CO 45, a new, medium-duration rice variety for Tamil Nadu

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TNAU80042 (IR17492-18-10-2-2-2) is a derivative of Rathu Heenati/IR3403-267-1. It was named CO 45 and released in Jan 1990 for general cultivation in Tamil Nadu. It can be used as an alternate to IR20 and CO 43 in the second crop season (Sep-Oct).

CO 45 is 75-80 cm tall and matures in 140 d. Grain is long and slender with white rice.

It yielded an average 5.9 t/ha (10% more than CO 43) in breeding station trials 1980-81 to 1988-89. In multilocation trials 1985-86 to 1988-89, it yielded 4.1% higher than CO 43 and 14.9% higher than IR20. In adaptive research trials in 10 districts 1987-88 to 1988-89, it yielded 10% higher than CO 43. In national trials 1985 and 1987, it yielded 17% more than Jaya and Pankaj (see table).

CO 45 is resistant to green leafhopper, stem borer, blast, bacterial blight, and tungro, and moderately resistant to sheath rot (panicle exsertion is better than that of sheath rot-susceptible CO 43). ■

Performance of CO 45 in Tamil Nadu, India, 1980-89.

Location	Grain yield (t/ha)					Increase (%)			
	CO 45	CO 43	IR20	Jaya	Pankaj	CO 43	IR20	Jaya	Pankaj
Breeding station Coimbatore (1980-81 to 1988-89)	5.8	5.3	-	-	-	10	-	-	-
Multilocation trials (1985-86 to 1988-89)	4.8	4.6	4.2	-	-	4	15	-	-
Adaptive research trials (1987-88)	5.8	5.6	5.4	-	-	4	7	-	-
Adaptive research trials (1988-89)	6.2	5.4	5.2	-	-	15	19	-	-
National trials (AICRIP 1985)	5.0	-	-	4.3	-	-	-	17	-
National trials (AICRIP 1987)	5.3	-	-	-	4.5	-	-	-	18

Chandan, a multiple-resistance variety released in Andhra Pradesh

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RNR74802, a semidwarf medium-duration culture derived from Sona/Manoharsali, was released in Sep 1989 as Chandan. It is recommended for general cultivation in Andhra Pradesh.

In yield trials in 1977-87, RNR74802 averaged 5.6 t/ha. That is 35% higher than Dhanyalaxmi, 23% higher than Prakash, and 48% higher than IR32 in the wet season and 43% higher than IR32, 22% higher than Prakash, and 14% higher than Laxmi in the dry season. In farmers' field trials, it outyielded Prakash by 38%. Tellahamsa by 25%, and Samba-Mahsuri by 14%.

Chandan is photoperiod-sensitive, with 145-d duration in the wet season and 155 d (due to low night temperatures) in the dry season in Telangana region. It is resistant to brown planthopper and blast, and moderately resistant to bacterial blight, sheath blight, and gall midge.

Grain is long slender, straw glumed with small awns, 3.9 L/B ratio. Kernels are white, translucent, flinty, nonglutinous with 10.7% protein content. Cooking quality is good. Up to 55-d-old seedlings can be planted without much yield loss. ■

Integrated germplasm improvement — rainfed lowland

Performance of promising rainfed lowland rice cultivars in West Bengal

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In West Bengal, rainfed lowland rice faces occasional floods and prolonged waterlogging in the wet season. Medium-tall, stiff-strawed, and nonlodging cultivars should do better than traditional varieties.

We evaluated 10 promising lines during 1986 and 1987 wet seasons. The cultivars were transplanted 30 Aug 1986 and 4 Aug 1987 at 20- × 15-cm spacing in 18-m^2 plots, in a randomized block design. Fertilizer (60-17.6-24.9 kg NPK/ha) was basally applied at transplanting. Water depth during crop growth was 25-30 cm.

Yields and yield attributes of lowland rice varieties and cultures. West Bengal, India, 1986-87.

Cultivar	Days to 50% flowering	Grain yield (t/ha)			Straw yield (tiha)	Panicles (no./m^2)			Panicle wt (g)		
		1986	1987	Mean	1987	1986	1987	Mean	1986	1987	Mean
CR1030	112	5.2	6.0	5.6	8.9	249	303	276	2.8	3.4	3.1
Pankaj	119	4.4	6.1	5.1	8.6	245	305	225	2.8	2.9	2.9
Jagannath	115	3.7	5.4	4.5	7.4	232	297.5	265	2.2	3.1	2.7
IET7590	122	4.5	7.1	5.8	7.8	242	280	261	3.2	3.3	3.2
IET7044	119	4.4	5.2	4.8	6.6	231	254	242	3.2	3.8	3.5
CR1018	119	4.3	5.4	4.8	7.0	144	283	113	2.9	3.2	3.0
IET7592	122	4.0	6.1	5.6	9.0	205	273	239	2.8	4.5	3.7
CR1016	120	3.7	5.5	4.6	6.7	152	282	217	3.0	3.0	3.0
IE'I7598	118	4.2	5.4	4.8	6.2	232	281	256	2.6	3.5	3.1
Mahsuri	121	3.8	5.0	4.4	6.5	205	272.5	239	2.5	3.7	3.1
LSD[a] (0.05)		0.8	1.0		1.5	10	ns		0.04	ns	
cv (%)		0.8	7.6		9.3	2	12		0.7	10.6	

[a]NS = not significant.

IET7590 had the highest yield (5.8 t/ha), followed by IET7592, CR1030, and Pankaj (see table). Straw yield was highest in IET7592 (9.0 t/ha), followed by CR1030, Pankaj, and IET7590.

Panicles/m^2 was highest in CR1030 and panicle weight in IET7592. ■

Two promising high-quality rice breeding lines in Bangladesh

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We crossed C_{22} with IR9752-136-2 in 1981 at BRRI and developed BR4290-3-1-10 and BR4290-3-3-5 breeding lines. Both lines have intermediate plant height, short duration, high yield potential, and moderate resistance to lodging and tolerance for drought.

In 3 yr trials at different locations, BR4290-3-1-10 outyielded by an average 45%, local check varieties with similar growth duration (Table 1). BR4290-3-3-5 outyield local check 31%, with similar growth duration.

Both lines possess higher milling outturn, L/B ratio, and protein percentage; intermediate amylose content; and shorter cooking time than check varieties (Table 2).

In 1989 regional farmers' yield trials, the lines showed wide adaptability. ■

Table 1. Some agronomic traits and yield of 2 promising breeding lines in rainfed lowlands. Bangladesh, 1987-89.

Line	Mean plant height (cm)	Mean duration (d)	Mean grain yield[a] (tha)					Mean yield (tha)
			On station		Outreach station		On farm	
			1987 (1)	1988 (5)	1988 (3)	1989 (4)	1989 (14)	
BR4290-3-1-10	98	100	1.9	2.0	2.3	3.2	2.5	2.4
BR4290-3-3-5	103	103	2.0	1.9	1.9	2.8	2.3	2.2
BR21 (standard check)	100	103	1.6	-	2.2	2.8	2.4	2.2
Local check	105	100	1.5	1.8	0.9	2.3	1.9	1.6

[a]Numbers in parentheses give number of locations.

Table 2. Physicochemical and cooking qualities of 2 promising breeding lines.

Line	Milling outturn (%)	Chalkiness	L/B ratio	Size and shape	Amylose (%)	Protein (%)	Cooking time (min)	Tenderness
BR4290-3-1-10	72	1	3.8	MS	20.3	9.0	15.5	Soft
BR4290-3-3-5	72	0	3.5	MS	35.2	8.7	15.5	Medium
BR21 (susceptible check)	70	1	2.5	MB	27.0	7.9	18.0	Soft
Hashikalmi (local check)	71	3	2.4	MB	25.0	8.5	22.0	Soft

Heera, a super short-duration rice

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CR544-1-2, a 68 d duration selection from the cross CR404-48/CR289-1208, combines very short duration with high yield potential. It was released as Heera in 1988 for cultivation in Orissa. Heera's parentage includes PTB18, PTB21, IR8, TKM6, and Assam Rice Collection material.

When direct seeded, Heera matures in 68-70 d in the wet season and in 75-77 d in the dry season.

It has semidwarf stature and green foliage. Grains are long bold with brown-colored husk and white kernel. Dormancy is about 15 d.

Heera is drought tolerant and resistant to gall midge, green leafhopper, blast, and rice tungro virus.

Yields are 2.5-3.5 t/ha when Heera is dry seeded in rainfed fields (other varieties with similar duration yield 1-1.5 t/ha). When pregerminated seeds are dibbled in puddled soil at 15- × 10-cm spacing, yields reach 4 t/ha (Table 1, 2).

Heera is suitable for drought-prone rainfed ricefields, for late planting in eastern India, and as a short-duration catch crop in southern and western India. ■

Table 1. Performance of Heera (IET10973)[a] in All India Coordinated Yield Trials, 1987 wet season.

IET no.	Culture or variety	Duration (d)	Yield (t/ha)			
			CRRI	Chiplima	Kanke	Hazaribag
10968	CR666-28	63	1.0	1.6	1.0	1.3
10970	Kalyani 2 (CR666-36-4)	61	0.6	0.8	1.2	1.4
10972	CR544-1-1	69	2.5	2.0	1.8	3.4
10973	Heera (CR544-1-2)	67	3.1	2.0	2.6	2.8
Local check		77	2.2	1.7	2.1	2.5

[a]Direct seeded in rainfed fields.

Table 2. Performance of Heera in farmers' field demonstration plots. Cuttack, India, 1989 wetseason.

Village and district	Yield (t/ha)
Khandeita, Cuttack	3.8
Rajanagar Patna, Cuttack	3.6
Aman Pada, Cuttack	3.6
Pratap Nagari, Cuttack	3.7
Pratap Nagari, Cuttack	3.6
Mugabhanga, Cuttack	4.5
Beltukuri, Kalahandi	3.7
Palsipani, Kalahandi	3.0
Palsipani, Kalahandi	2.4
Siritol, Kalahandi	2.1

Integrated germplasm improvement — upland

TM8089, a new high-yielding, blast (Bl)-resistant upland rice

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TM8089, a derivative of the cross TKM7/IR8, is a short-duration (115 d), semidwarf (90 cm), Bl-resistant cultivar suitable for cultivation in sornavari (Apr-May), kar (May-Jun), kuruvai (Jun-Jul), and navarai (Dec-Jan) seasons in Tamil Nadu.

We evaluated TM8089 in eight station trials, six Rice Coordinated Yield Trials, seven Multilocation Trials, and 53 Adoptive Research Trials in 1984-85 and 11 trials in 1985-86. Mean grain yield was 5.5 t/ha, 6.2% higher than TKM9 and 21.8% higher than ADT36 (Table 1).

TM8089 is resistant to Bl under field conditions and moderately resistant under artificial screening (Table 2). It is moderately resistant to sheath rot and glume discoloration (Table 2). Under field conditions, we found TM8089 moderately resistant to stem borer and gall midge and resistant to rice bug. TM8089 has moderate drought tolerance. ■

Table 1. Yield performance of TM8089. Tirur, India, 1981-86.

Trial	Grain yield (t/ha)			Increase (%) over	
	TM8089	TKM9	ADT36	TKM49	ADT36
Rice Research Station, Tirur (1981-88)	5.9	5.5	4.7	7.1	25.1
Rice Coordinated Yield Trials (1982-83)	4.7	-	4.1	-	14.1
Multilocation Trials (1983-84)	5.0	-	4.3	-	15.0
Adoptive Research Trials (1984-85)	5.3	4.4	4.7	21.4	14.2
Adoptive Research Trials (1985-86)	6.6	5.6	4.7	17.9	39.0

Table 2. Reaction of TM8089 to major diseases.

Disease	Reaction [a]			
	TM8089	TKM9	ADT36	IR50
Blast				
Field screening	R	S	R	HS
Artificial screening	MR	S	R	S
Brown spot	MR	MR	-	R
Bacterial blight	MR	MR	-	S
Neck blast	0	[b]	MR	MR
Sheath rot	MR	MR	MR	MR
Glume discoloration	MR	MR	MR	MR

[a] By the Standard evaluation system for rice. [b] Not tested.

Space limitations prevent IRRN from publishing solely yield data and yield component data from routine germplasm screening trials. Publication is limited to manuscripts that provide either a) data and analysis beyond yield and yield components (e.g., multiple or unique resistances and tolerances, broad adaptability), or b) novel ways of interpreting yield and yield component data across seasons and sites.

CROP AND RESOURCE MANAGEMENT

Soils

Effect of soil texture on rice growth and yield

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We compared growth and yield of PR106 in pots in three soils of different textures: clay loam, loam, and sandy loam. Physicochemical properties of soils (determined by procedures of Chopra and Kanwar) are given in Table 1.

Recommended nutrients were applied, standard management practices followed. Plant samples were collected at tillering and panicle initiation. Yield was measured at harvest and grain samples taken for chemical analysis. N was estimated by semi-micro Kjeldahl's method, P by the procedure of Koenig and Johnson, and K by flame photometer.

Root dry matter and grain yield were significantly higher in fine-textured clay loam than in loam or sandy loam soils (Table 2). Plants grown in sandy loam soils showed poor root growth and gave lowest grain yield. The higher yield in clay loam soils can be attributed to their higher nutrient-supplying capacity (CEC 16.8). ■

Table 1. Physicochemical characteristics of the experimental soils.

	Clay loam	Loam	Sandy loam
pH (1:2)	8.1	8.3	8.5
EC (dS/m)	0.32	0.28	0.30
Organic carbon (%)	0.3 1	0.29	0.26
	Available nutrients (kg/ha)		
N	160	140	130
P	7	6	6.5
K	265	240	210
Zn (ppm)	0.51	0.55	0.53
Sand (%)	25	51	57
Silt (%)	35	27	28
Clay (%)	39	21	14
CEC meq/100 g	16.8	12.2	8.3

Table 2. Effect of soil texture on grain yield, root dry matter, and nutrient uptake by rice.

Soil type	Root dry matter (g/pot)		Grain yield (g/pot)	Nutrients removed (g/pot)		
	At tillering	At panicle initiation		N	P	K
Sandy loam	4.2	6.8	14.7	10.7	0.05	0.15
Loam	4.5	7.2	17.9	12.1	0.05	0.16
Clay loam	5.2	7.9	23.1	15.3	0.07	0.21
LSD (0.05)	0.2	0.3	1.6	1.3	0.01	0.02

Physiology and plant nutrition

Effect of cutting frequency on rice herbage yield

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We studied the effect of leaf cutting frequency on herbage yield, grain yield, and production components of deepwater rice under natural field conditions in 1988 wet season. Eight cutting frequencies and no cutting were arranged in a randomized complete block design with four replications (see table).

PG56 was sown at 120 kg seeds/ha onto plowed soil 20 May 1988. Seedling emergence was measured at end of May. The maximum water level was about 110 cm on 7 Nov 1988.

Herbage was collected by cutting at the collar level of the last fully developed leaves. The last cutting (130 d after emergence) was about 55 d before flowering.

Cutting at late growth stages and cutting more times significantly increased herbage yield. The highest dry herbage yield (2 t/ha) was with 3 cuttings at 40, 70, and 100 d after emergence.

Rice grain yield was not affected by herbage removal. Panicles/m^2 increased significantly but spikelets/panicle, plant height, and biomass yield decreased significantly with increased cuttings. Fertility and 1,000-grain weight were not affected.

The ability to increase rice herbage yield by increasing cutting for herbage without detrimental effect on grain yield could benefit animal production, especially in rice cultivars with long growth duration. ■

Effect of cutting treatments on herbage yield, grain yield, and production components of PG56. Huntra Rice Experiment Station, Ayutthaya, Thailand, 1988 wet season.

Treatment[b]	Herbage yield (t/ha)	Grain yield (t/ha)	Panicles (no./m^2)	Spikelets (no./panicle)	Fertility (%)	1000-grain wt (g)	Height at maturity (cm)	Biomass yield (t/ha)
Control (no cut)	-	2.5	124 d	100 a	90	27.41	223 a	14.5 a
One cutting, 40 DE	0.5 d	2.6	149 c	96 ab	85	27.14	214 ab	12.8 bc
One cutting, 70 DE	1.2 c	2.6	152 c	89 abc	87	28.01	202 bc	12.6 bc
One cutting, 100 DE	1.2 c	2.4	151 c	90 abc	88	28.83	201 bc	13.2 ab
One cutting, 130 DE	1.2 c	2.4	151 c	82 bcd	86	27.86	201 bc	13.0 bc
Two cuttings, 40+70 DE	1.4 bc	2.5	178 ab	75 cd	89	28.52	197 c	12.3 bc
Two cuttings, 40+100 DE	1.6 b	2.3	174 ab	72 cd	89	28.43	200 bc	12.3 bc
Two cuttings, 70+100 DE	1.9 a	2.3	162 bc	72 cd	85	28.11	194 c	11.5 c
Three cuttings, 40+70+100 DE	2.0 a	2.4	185 a	64 d	84	28.23	193 c	11.6 c

[a]In a column, means followed by the same letter are not significantly different at the 5% level by DMRT. [b]DE = days after emergence.

Fertilizer management

Effect on rice of placement depth of urea supergranules

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We evaluated the effects of placement of urea supergranules (USG) (5, 10, and 15 cm deep and broadcast prilled urea (PU) on rice yields of tall, long-duration Mahsuri and dwarf, short-duration Madhuri.

The trial was laid out in a split-plot design with four replications during 1987 rainy season.

Soil was an Entisol-Tropofluvent, alluvial, deep and flat. It was clay loam with 52.50% sand, 24.75% silt, and 22.75% clay; moderately fertile with 324.80-26.34-174.24 kg available NPK; pH 7.0; and CEC 25 meq/100 g soil. Plant spacing was 15 × 20 cm. N was applied at 38.32 kg/ha.

One 1-g granule of USG was deep-placed in the middle of each four hills in alternate rows; prilled urea was broadcast in three splits at sowing, maximum tillering, and panicle initiation in a 1:2:1 ratio.

N conversion efficiency (NCE) was computed as

$$\text{Nitrogen conversion efficiency} = \frac{\text{Yield for USG placement depth - yield for PU}}{\text{N applied (38.32 kg/ha)}} \times 100$$

Mahsuri had significantly higher yield than Madhuri, although some lodging occurred during late growth (Table 1). Mahsuri produced significantly higher panicles/m^2, panicle length and weight, filled spikelets/panicle, and 1,000-grain weight. The yield difference was probably due to Mahsuri's long duration, about 1 mo longer than Madhuri.

All depths of USG placement resulted in higher yield characters than broadcast PU; however, differences except for panicle length were not significant. The cumulative effect resulted in significantly higher grain and straw yield with USG.

Placement depth did not affect yields. Probably the fine soil texture ensured uniform availability of N to roots at all depths, with higher cation exchange capacity and less leaching loss.

In N conversion efficiency, 10 cm placement of USG was most efficient in Mahsuri, and 15 cm placement in Madhuri (Table 2). ■

Table 1. Effect of USG and prilled urea on characters and yield of rice.

Treatment	Panicle (no./m^2)	Panicle length (cm)	Panicle weight (g)	Unfilled panicles (no.)	Filled spikelets (no./panicle)	1000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
Mahsuri	354	23	43	21	306	21	2.3	4.1
Madhuri	247	21	20	34	110	15	1.6	2.4
LSD[a]	64	1.4**	11**	ns	149**	3**	0.6*	1.8**
USG depth								
5 cm	319	23	32	24	218	10	2.1	3.4
10 cm	326	22	32	23	222	18	2.1	3.6
15 cm	290	23	31	29	206	18	2.0	3.3
PU broadcast	267	20	30	33	186	18	1.6	2.7
LSD[a]	ns	1	ns	ns	ns	ns	0.4**	0.7**

[a]Significant at 5% (*) and 1% (**) levels. NS = nonsignificant.

Table 2. Nitrogen conversion efficiency for USG.

Placement depth (cm)	N efficiency (%)	
	Mahsuri	Madhuri
5	7.0	18.1
10	18.4	8.7
15	2.6	19.1

Fertilizer management – inorganic sources

Integrated phosphorus management in a rice-based cropping system

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We studied the effects of P management in a rice - rice - green gram cropping system. In first rice crop (variety IR50) Jun-Oct 1985, P at the recommended 22 kg P/ha was applied as superphosphate and rock phosphate, and no P alone and with 12 t/ha sunn hemp *Crotalaria* *juncea* L., in a randomized block design with three replications.

The second rice crop (CO 43) Nov 1985-Feb 1986 was grown in a split-plot design, with no additional fertilizer and with the recommended 26 kg P/ha as superphosphate and as rock phosphate in combination with incorporated stubble cut 10 cm and 25 cm high.

Green gram *Vigna radiata* L. Wilczek was grown Feb-May 1986 without fertilizer. A fourth crop rice Jun-Sep 1986 was grown with the treatments given the first crop rice, substituting green gram haulm for sunn hemp.

The Mussoorie rock phosphate used was analyzed as 1.48% citrate soluble P_2O_5, and 20% total P_2O_5. Soil was Typic Haplustalf with pH 8.1, 0.6% organic C, CEC 27 meq/100 g, and 16 kg available P/ha. Inorganic N and K fertilizers were applied at recommended levels.

In the first crop rice, green manure plus superphosphate gave higher yields (see table). In the second crop rice, yields were higher where the first crop had been given superphosphate with or without green manure and rock phosphate with green manure.

In the second crop rice, yield was higher with superphosphate and long stubble incorporation. Residual effects of treatments given the first rice crop on the green gram crop of treatments given the first rice crop were not significant.

Superphosphate with long or short stubble incorporation in the second crop improved green gram yield.

Yield of the fourth crop rice was significantly improved by green gram haulm incorporation; P application had no significant effect. ■

Yields of rice-based cropping system under integrated P management Coimbatore, India, 1985-86.

First crop rice Jun-Oct 1985		Second crop rice Nov 1985-Feb 1986		Third crop green gram Feb-May 1986		Fourth crop rice Jun-Sep 1986	
Treatment [a]	Grain yield (t/ha)	Treatment [a]	Grain yield (t/ha)	Treatment [a]	Grain yield (kg/ha)	Treatment [a]	Grain yield (t/ha)
G_0	4.4	G_0P_0	4.4	G_0P_0	393	G_0	4.3
G_1	5.2	G_0P_s	5.3	G_0P_s	400	G_1	5.1
LSD (0.05)	0.4	G_0P_r	4.6	G_0P_r	456	LSD (0.05)	0.5
		G_1P_0	4.9	G_1P_0	443		
P_0	4.4	G_1P_s	5.6	G_1P_s	499	P_0	4.5
P_5	5.3	G_1P_r	5.0	G_1P_r	451	P_s	4.9
P_1	4.6	LSD (0.05)	0.6	LSD (0.05)	ns	P_r	4.6
LSD (0.05)	0.5					LSD (0.05)	ns
		S_0P_0	4.7	S_0P_0	390		
		S_0P_s	5.0	S_0P_s	500		
		S_0P_r	4.9	S_0P_r	412		
		S_1P_0	4.7	S_1P_0	405		
		S_1P_s	5.4	S_1P_s	515		
		S_1P_r	5.1	S_1P_r	421		
		LSD (0.05)	0.3	LSD (0.05)	70		

[a] G_0 = no green manure, G_1 = green manure; P_0 = no phosphate, P_s = superphosphate, P_r = Rock phosphate; S_0 = 10-cm stubble incorporated, S_1 = 25-cm stubble incorporated.

Nitrogen loss by ammonia volatilization from urea and ammonium chloride in flooded soil

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Rapid hydrolysis of urea to ammonium carbonate can cause high concentrations of NH^+ -N and high floodwater pH. leading to high ammonia volatilization. In contrast, the low pH of ammonium chloride may help minimize ammonia volatilization from soils. We measured NH_3 volatilization from urea and ammonium chloride using the forced-draft chamber technique in the laboratory.

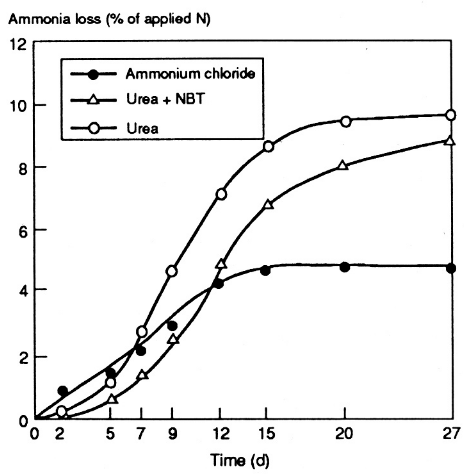
We used a set of 10-liter pots with 7 kg air-dried soil (pH 8.05, 0.32% organic C, 0.06% total N, CEC 9.5 meq/ 100 g). The soil was flooded, puddled, and allowed to preincubate with 1 cm standing water for 1 wk. Pots were fertilized with 26 mg P and 50 mg K/kg applied as single superphosphate and muriate of potash.

Treatments were urea, urea + N-(n-butyl) thiophosphoric triamide (NBT) (2% wt/wt), ammonium chloride, and no N. N was applied at 200 kg/ha.

Soil was reflooded and evaporation losses replenished daily to maintain 5 cm standing water. Water temperatures ranged from 22.5 to 27.5°C.

Two pots/treatment were fitted with chambers continuously flushed with NH_3-free compressed air. NH_3 was collected at intervals using a manifold and estimated by absorbing in 2% boric acid-mixed indicator solution. Floodwater was analyzed for ammoniacal N and pH.

N loss by ammonia volatilization was markedly affected by source of fertilizer (Fig. 1). In ammonium chloride-treated soil, ammonia volatilization was almost uniform up to 12 d after fertilizer application. With urea alone, ammonia volatilization loss appeared within 5 d and rate increased up to 12 d, then decreased. With NBT-treated urea, ammonia volatilization was low up to 7 d, then increased consid-

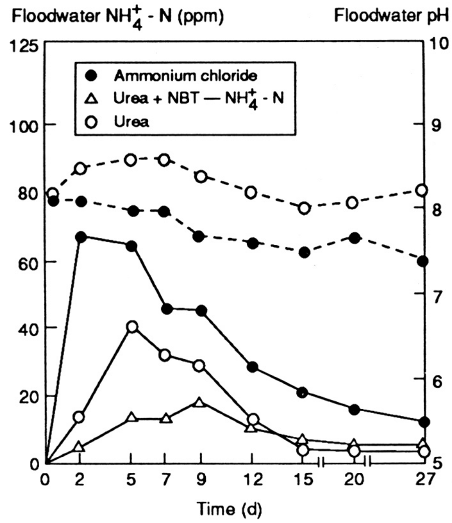


1. Effect of urea, urea + NBT, and ammonium chloride on cumulative loss of ammonia from flooded sandy loam soil, Ludhiana, India.

erably up to 20 d. At 27 d, cumulative NH_3 volatilization was 4.8% of added ammonium chloride, 8.9% of urea +NBT, and 9.6% of urea.

NH_3 volatilization of ammonium chloride was half that of urea. Treating urea with NBT delayed ammonia volatilization about 7 d, but was ineffective thereafter.

The significant difference in ammonia volatilization loss between urea and ammonium chloride fertilizer was basically due to markedly lower floodwater pH in the ammonium chloride-treated soil (Fig. 2). Floodwater ammoniacal-N concentration was quite high in ammonium-chloride treated soil, indicating that ammonia gas concentration, not ammoniacal-N concentration, caused higher NH_3 volatilization loss in urea-treated soil. ■



2. Effect of urea and ammonium chloride on floodwater pH and NH_4^+-N concentration, Ludhiana, India.

Crop management

Abscisic acid analog inhibits rice leafrolling caused by chilling

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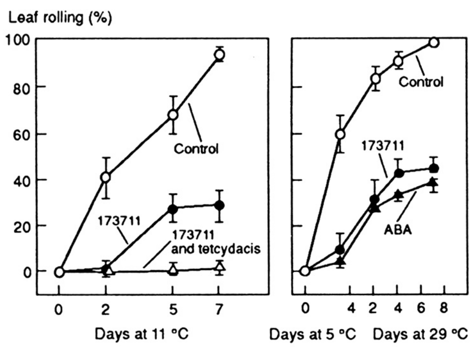
One of the first symptoms of chilling injury to rice is leafrolling. This has been demonstrated to be due to water loss, and is correlated with leaf water potential.

We studied the effect of a new abscisic acid analog on leafrolling in response to chilling. Twelve-day-old seedlings of Samgangbyeo and 24-d-old seedlings of IR36 were sprayed with 10^{-4} and 10^{-3}, mol LAB 173711 per liter (abscisic acid analog developed by BASF, FRG) and a combination of LAB 173711 and tetcyclacis (a plant growth retardant). After 24 h, seedlings were transferred to a water tank for 3 d: Samgangbyeo seedlings for a root temperature of 11 °C for 7 d and IR36 for a root temperature of 5 °C. All seedlings were transferred to 29 °C for recovery.

Completely rolled leaves were counted and percent leafrolling calculated.



Leafrolling in Samgangbyeo and IR36 seedlings teated with abscisic acid analogs and chilled.

In Samgangbyeo seedlings submerged at 11 °C, treatment reduced leafrolling (see figure). It was only ±2% with LAB 173711 + tetcyclacis, about 30% with LAB 173711 alone, and 95% with no treatment. In IR36 seedlings submerged at 5 °C, leafrolling was minimized with ABA and LAB 173711 (only 4-10% rolling, compared with about 60% with no treatment). At 29 °C, rolled IR36 leaves reached 100% in the control and less than 40% in ABA- and LAB 173711-treated plants.

The effect may be due to the anti-transpirant activity of the analog: preventing water loss by transpiration and maintaining high internal water status for the plant system minimize or reduce leafrolling and, in turn, chilling injury. ■

Effect of nursery seeding density and seedlings/hill on late transplanted rice

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Although nursery seeding rates of 30, 40, and 50 kg/ha are recommended for small-medium-, and large-grain rices, respectively, farmers in many areas tend to sow at 60-80 kg/ha for weed control. In many rainfed rice areas, late rains also mean aged seedlings are transplanted.

We studied the effect of nursery seeding density and seedlings/hill on yields of late planted wet season rice. The trial was laid out in split-plot design with three replications. Soil was sandy loam (Typic Ustochrept) with pH 7.5 (1:2) and 0.58% organic C. Seedlings 40-45 d old were transplanted at 20- × 15-cm spacing the last week of Jul.

Nursery seeding density and seedlings/hill did not affect yield. ■

Effect of nursery management on performance of inland valley swamp rice in Sierra Leone

I. Baggie, S. S. Monde, and A. B. Jalloh, Rice Research Station, Rokupr, Sierra Leone

We evaluated in 1988 wet season crop performance in an inland valley swamp of rice seedlings raised in the uplands. The soil was clay (Typic Tropaquept), with pH (water 1:1) 3.9, 6 kg Olsen's P/ha, 79 kg Olsen's K/ha, 3.2% organic C, and 0.12% total N.

ROK11 (130 d), ROK5 (145 d), and ROK10 (178 d) were planted at two seeding rates with two methods of sowing, and at two levels of fertilizer (see table). The experiment was laid out in a randomized complete block design with three replications. The nursery was systematically laid out in an upland site. Seedling vigor and vigor index (seedling length [including root] × dry weight) were evaluated 27 d after seeding.

Seedlings were transplanted at two seedlings/hill, at 0.15- × 0.2-m spacing.

All plots received 60-10.6-32 kg NPK/ha (urea, single superphosphate, and muriate of potash).

Correlations were significant between seedling vigor and tiller number at maximum tillering (0.72** and between tiller number and vigor index (0.45*) (see table). Correlations also were significant between seedling vigor and grain yield (0.68**) and vigor index and grain yield (0.48*).

The results suggest genotype interactions with seed rate and with method of sowing. Fertilizer response was uniform.

The performance of transplanted rice in inland valley swamps may be influenced by the interaction of variety, method of sowing, and fertilization and of sowing, seed rate, and fertilization. Yield differences could be related more to variety than to duration or method of sowing. ■

Effect of nursery management techniques on grain yield of some released rice varieties in an inland valley swamp. Sierra Leone, 1988 wet season.

		Grain yield (t/ha)							
		ROK11		ROK5		ROK10			
Fertilization	Sowing method	40 g seed/m^2	60 g seed/m^2	40 g seed/m^2	60 g seed/m^2	40 g seed/m^2	60 g seed/m^2	Sowing method	Fertilization
Without NPK	Row	1.6	1.6	2.0	2.0	2.0	1.4	1.7	1.7
	Random	1.8	1.3	1.9	1.7	1.7	2.0	1.7	
With 40-40-40 kg NPK/ha	Row	2.0	1.9	2.2	2.2	2.2	2.0	2.1	2.1
	Random	1.8	1.7	2.2	2.4	1.9	2.2	2.0	
Seed rate (mean)		1.8	1.6	2.1	2.1	1.9	1.9		
Variety (mean)		1.7		2.1		1.9			
	Coefficient of variation					7.2%			
	LSD[a] (P=0.05)	Variety (V)					0.1		
		Seed rate (D)					ns		
		Method of sowing (S)				ns			
		Fertilization (F)					0.1		
		V*D					0.1		
		V*S					0.1		
		V*D*S				0.1			
		V*S*F				0.1			

[a] ns = not significant.

Effect of plant spacing on ratoon rice performance

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We studied the effect of three plant spacings on ratooning ability of medium-duration varieties Ponni and Bhavani, in a factorial randomized block design. The crop was transplanted 21 Sep 1986 in sandy clay loam soil fertilized with 100-50-50 kg NPK/ha.

The main crop was harvested 110 d after transplanting, leaving 15 cm stubble. Soil between rows was trampled to control weeds and to prune older roots. The ratoon crop was irrigated at 5 cm depth. Harvest was 67 d after ratooning.

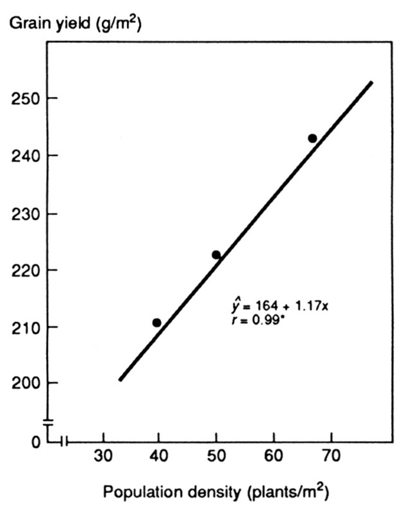
Bhavani was significantly superior in growth, yield attributes, and yield in both main and ratoon crops (see table). Spacing significantly affected yield of the main crop but had no significant influence on ratoon yield. However, productive ratoon tillers/m^2 and ratoon dry matter production were significantly higher with close spacing.

The correlation of plant density with ratoon yield was positive and significant (see figure). ■

Effect of plant spacing on main (M) and ratoon (R) rice crops in Madurai, India.

	Productive tillers (no.)		Dry matter (t/ha)		Grain yield (t/ha)		Straw yield (t/ha)	
	M	R	M	R	M	R	M	R
Variety								
Ponni	445	319	10.0	7.2	4.7	1.8	5.6	2.3
Bhavani	469	414	10.7	7.3	5.5	2.8	6.2	3.4
LSD (0.05)	17	10	0.2	0.0	0.02	0.3	0.2	0.3
Spacing								
15* 10 cm	479	407	10.7	7.8	5.2	2.4	6.3	3.0
20* 10 cm	451	363	10.4	7.0	5.0	2.2	5.8	2.8
25* 10 cm	440	330	9.9	6.8	5.0	2.1	5.6	2.7
LSD[a] (0.05)	20	12	0.2	0.1	0.02	ns	0.2	ns

[a] ns = nonsignificant.



Relationship between population density and ratoon grain yield. Madurai, India, 1986 wet season.

Effect of seedlings/hill on individual rice plant yield and yield components

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We studied the effects of seedlings/hill in medium-duration, second season irrigated rice variety E Wan 5 in Jul-Oct 1989. Thirty-day-old seedlings were transplanted at 1-5 seedlings/hill, with 40 seedlings/treatment. Ten hills in the middle of each row were sampled to measure individual plant yield and yield components.

Rate of seed set appears to be the most stable yield component, followed by 1,000-grain weight, plant height, panicle length, and harvest index (see table). The most unstable traits are grain yield/plant, total weight/plant, and panicle/plant.

Two or three seedlings/hill appears to yield best. ■

Effect of seedlings/hill on plant yield and yield components. Wuhan, China, 1989.

Seedlings/ hill (no.)	Plant height (cm)	Panicles/ hill (no.)	Panicles/ plant (no.)	Panicle length (cm)	Spikelets/panicle (no.)		Seed-set rate (%)	1000-grain weight (g)	Grain yield/hill (g)	Grain yield/plant (g)	Grain weight/hill (g)	Grain weight/plant (g)	Harvest index
					Fertile	Total							
1	79.0	5.0	5.0	18.0	74.6	83.4	89.4	24.3	9.2	9.2	15.6	15.6	0.5
2	82.2	5.6	2.8	18.7	72.7	81.3	89.4	24.4	9.9	5.0	15.6	7.8	0.5
3	81.8	7.4	2.5	17.4	74.1	82.2	90.1	23.5	12.9	4.3	21.8	7.3	0.5
4	80.4	9.0	2.3	17.0	61.5	69.9	88.0	23.7	13.0	3.2	23.4	5.8	0.4
5	84.4	10.4	2.1	17.3	58.0	66.0	87.8	23.5	14.1	2.8	26.2	5.2	0.4
Mean	81.6	7.5	2.9	17.7	68.2	76.6	89.0	23.9	11.8	4.9	20.5	8.4	0.5
CV (%)	2.5	30.4	40.1	3.7	11.5	10.5	1.1	1.8	18.2	51.6	23.2	50.1	5.5

Integrated pest management — diseases

Status of rice blast (Bl) in eastern Uttar Pradesh, India

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Rice is primarily grown as a hot-wet season (1 Jun-30 Nov) crop in eastern UP. Before the introduction of TN1, IR8, Jaya, and other high-yielding varieties, Bl affected extensive rainfed rice areas. With the introduction of modern varieties, the area under irrigation increased. Varietal resistance and less frequent moisture stress reduced early and severe Bl attack. With the consequent reduction in inoculum load and discontinued use of susceptible varieties, the area affected by Bl shrank considerably.

By mid-l970s, Bl had been confined to the submountain regions of Gonda, Bahraich, Basti, and Gorakhpur districts, (the eastern tarai). There, nearness to inoculum from Nepal and much more frequent cultivation of susceptible traditional rainfed varieties made it possible for the disease to recur each year.

The disease starts at the seedling stage (May) and eventually covers leaves, sheaths, nodes, panicle stalk, panicle node, and panicle proper. In years with several drought stress periods of 10 d or more, rainfed rice becomes uneconomic to harvest.

Our surveys of farmers' fields and experimental plots 1977-89 indicate B1 incidence in the eastern plains as well. Jarhan seedlings raised under rainfed conditions at Faizabad are infected by Jul and, in years with even short droughts, are defoliated by mid-August. Under irrigation, foliar Bl pressure remains low even on varieties that are susceptible when grown under rainfed conditions.

Neck Bl is common to all ecosystems, both in the tarai and in the eastern plains. With the introduction of neck Bl-susceptible varieties, it has become a serious problem. Bl is increasing in extent and intensity with the increase of the area under better fertility. ■

Distribution of bacterial blight (BB) in Nepal

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We surveyed 32 rice-growing districts in the Terai and important rice-growing districts in the hills to map the distribution of BB disease. Areas inspected were mostly along the national highways. Disease incidence was calculated on a 1-m^2 area at each site as number of infected leaves/hill × 100.

Table 1. Distribution of BB in Nepal, 1986-89.

District	Sites surveyed (no.)	Average field infection (%)
Jhapa	5	>50
Morang	4	>50
Sunsari	3	10-25
Dhankuta	2	10-25
Saptari	3	26-50
Dhanusa	7	10-25
Siraha	6	10-25
Mahotari	6	10-25
Sarlahi	5	26-50
Rautahat	2	10-25
Bara	13	>50
Parsa	15	>50
Chitwan	6	10-25
Nawalparasi	4	10-25
Rupandehi	7	26-50
Kapilvastu	4	10-25
Dang	8	26-50
Banke	5	10-25
Bardiya	6	10-25
Kailali	4	26-25
Kanchanpur	12	>50
Palpa	2	26-50
Syanja	3	10-25
Kaski	3	26-50
Tanahu	5	>50
Gorkha	1	<10
Kathmandu	5	>50
Bhaktapur	6	10-25
Lalitpur	4	10-25
Nuwakot	5	<10
Kabhre	4	10-25
Sindhuli	5	10-25
Total	170	

Terai districts Jhapa, Morang, Bara, Parsa, and Kanchanpur had the highest BB infection (Table 1). In the hills, Tanahu and Kathmandu districts had the highest.

Table 2. Resistance to bacterial blight of some rice cultivars grown at sites surveyed in Nepal, 1987-89.

Cultivar	Location	District	Disease reaction[a]
Masuli	Urlabari	Jhapa	MS
	Shibagunj	Jhapa	S
	Ramdaiya	Dhanusa	S
	Janakpur	Dhanusa	HS
	Lahan-6	Siraha	MS
	Hapur	Sarlahi	S
	Hariwan	Sarlahi	S
	Panwanipur	Bara	HS
	Jagamath-7	Parsa	MS
	Jagannathpur	Parsa	MS
	Saradanagar	Chitwan	MS
	Bharatpur	Chitwan	S
	Bhandara	Chitwan	S
	Gaidakot	Nawalparasi	MS
	Tharunagar	Nawalparasi	S
	Sidarthnagar	Rupandehi	S
	Paruwa	Rupandehi	S
	Parsari	Rupandehi	S
	Gularia	Bardiya	HS
	Mahendranagar	Kanchanpur	S
	Bayarghari	Syangja	S
	Raniguan	Tanahu	S
	Sindheshore-6	Sindhuli	MS
CH45	Jamuniya	Dhanusa	HS
	Naktajhil	Dhanusa	S
	Baluwa-9	Bara	HS
	Rampur Tokan	Bara	HS
	Buniyad-3	Bara	HS
	Bhaubari-4	Parsa	MS
	Jagamathpur	Parsa	HS
	Lipani birta-2	Parsa	S
	Lipani birta- 10	Parsa	HS
Himali	Bhjandara	Chitwan	HS
	Jorpati	Kathmandu	HS
	Dillibazar	Kathmandu	HS
	Bhaktapur	Bhaktapur	MS
	Battar bazar	Nuwakot	HS
	Gauribis	Nuwakot	HS
Sarju 49	Basabasai	Nawalparasi	HS
	Sidarthnagar	Rupandehi	S
	Maduali	Rupandehi	HS
	Parsari	Rupandehi	HS
	Shibapur	Kapilvastu	S
	Bade	Kapilvastu	HS
Bindeshwori	Sunwari	Sunsari	S
	Rampur Tokan	Bara	HS
	Feta-1	Bara	HS
	Liponi Mal	Parsa	HS
	Sindheshore	Sindhuli	HS
Janaki	Belbasi	Morang	S
	Monkapur	Banke	MS
	Mahendranagar	Kanchanpur	HS
	Khampacamp	Nuwakot	MR
Muturi	Simroungard	Bara	HS
	Jagmath	Parsa	HS
	Pokharia	Parsa	S
Laxmi	Padariya	Siraha	MS
	Mahendranagar	Kanchapur	S
IR24	Mahendranagar	Kanchapur	S
	Mahendranagar-16	Kanchapur	S

[a] Resistant (R) = no disease symptom in the field, moderately resistant (MR) = plants with less than 10% leaf blighted, moderately susceptible (M) =plants with 10-25% leaf blighted, susceptible (S) = plants with 26-50% leaf blighted, highly susceptible (HS) = plants with more than 50% leaf blighted.

BB-susceptible Masuli was the most extensively grown cultivar in the 23 sites surveyed (Table 2). IR24 was the only IR cultivar grown (in Kanchanpur district, western Nepal). ■

Timing of insecticide treatment for rice tungro (RTV) control

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We studied the effect of treating the nursery and transplanted seedlings with a combination of knockdown and insectistatic compounds for RTV control, using green leafhopper (GLH)- and RTV-susceptible IR22.

Eight treatments were compared: no insecticide; applying insecticides in the nursery only, at 12 d after seeding (DAS); applying 2 d after transplanting (DT) only; applying 16 DT only; applying in the nursery and 2 DT; applying 2 and 16 DT; applying in the nursery and 16 DT; and applying in the nursery, 2 and 16 DT. Plants were sprayed with cypermethrin at 25 g ai/ha and buprofezin at 500 g ai/ha.

RTV infection in the nursery was determined by enzyme-linked immunosorbent assay (ELISA) at 21 and 26 DAS. Groups of seedlings were collected at random from 42 sampling points along the length of the nursery. Each group, averaging 18 seedlings, was tested separately.

Disease transmission by 80 leafhoppers collected in the nursery by insect net at 13 DAS was also tested.

Seedlings were transplanted 26 DAS in 10-m^2 plots in a randomized complete block design with four replications. RTV infection at 14, 33, and 61 DT was determined by ELISA from 10 samples/plot, sampled in a W-pattern. Each sample consisted of 16 hills.

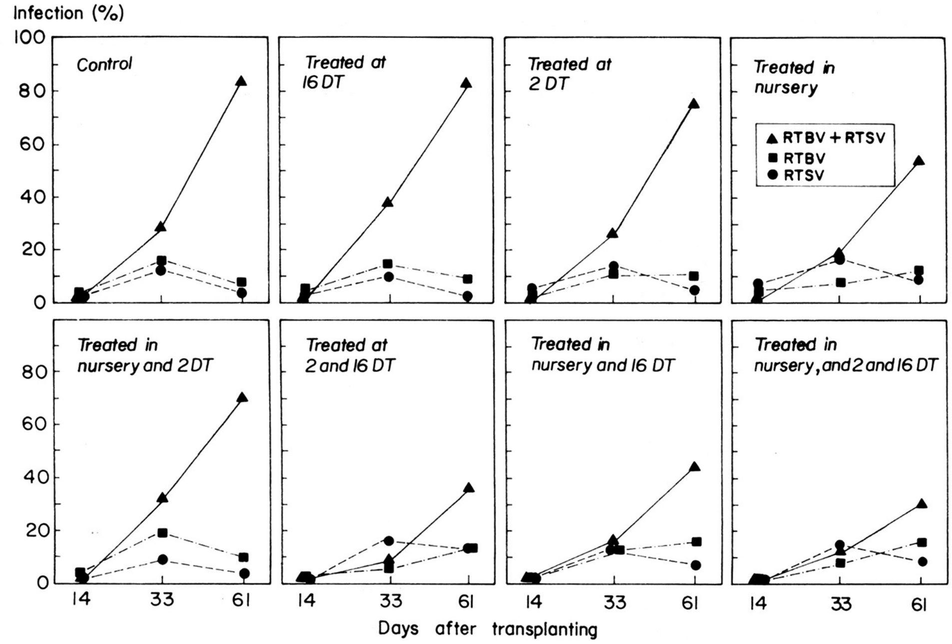
Seedlings from the untreated nursery at 21 DAS showed 4% infection by rice tungro bacilliform virus (RTBV) alone and 7% infection by rice tungro spherical virus (RTSV) done; seedlings from the treated nursery had 2% infection by RTBV alone. AT 26 DAS seedlings from the treated nursery had 2% infection by RTBV alone; those from the untreated nursery had 2% infection by RTSV alone.

No GLH were collected in the treated nursery 13 DAS. GLH were collected in the untreated nursery but no viruliferous insects were found among 80 tested.

RTV infection at 14 DT did not vary greatly among treatments (see figure). At 33 DT, lower infection of RTBV + RTSV was found in plants treated at 2 and 16 DT and in plants treated in the nursery and at 2 and 16 DT.

More significant differences in infection were observed at 61 DT. Infection in plants treated at 2 and 16 DT and those treated in the nursery and at 2 and 16 DT did not differ.

Insecticides applied during the first 2 wk after transplanting slowed RTV development, resulting in a lower level of infection even 61 DT. Insecticide application in nurseries may not be economical because there was no appreciable difference in infection between untreated seedlings and those treated in the nursery. ■



Infection of RTBV and RTSV assayed by ELISA in IR22 plants at different days after transplanting after insecticide treatments in the nursery, and at 2 and 16 DT. IRRI, 1990.

Effect of wet-dry cycles on sclerotial weight and viability of *Sclerotium hydrophilum*

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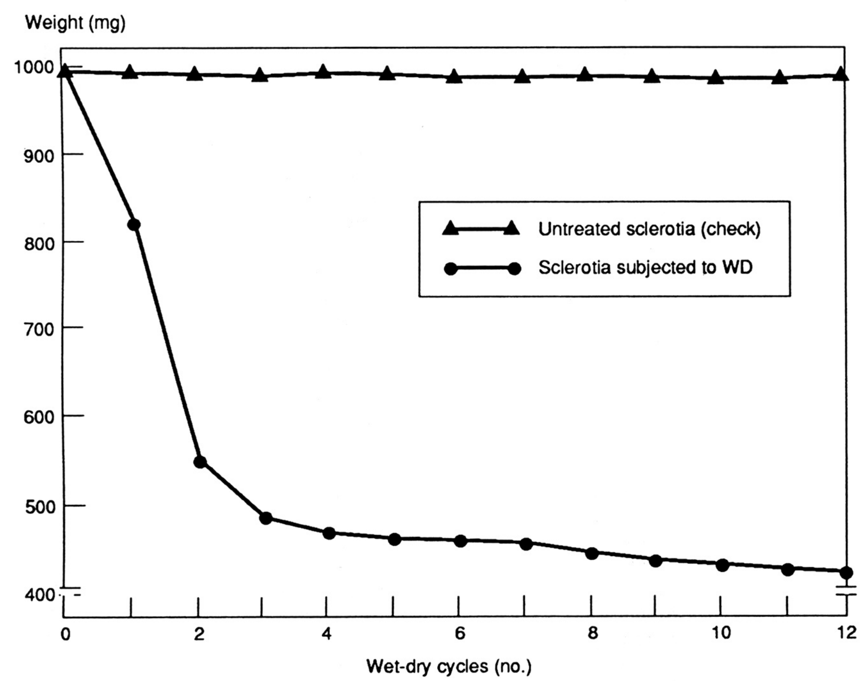
Sclerotium hydrophilum Sacc. causes rice stem rot. The fungus survives through sclerotia, which are subjected to different field conditions. We studied the effect of alternate wet-dry cycles on sclerotial weight and viability.

Sclerotia produced on rice grain-hull medium were separated, washed, and their surface water absorbed with blotters. The moisture content of the freshly harvested sclerotia was 20.5%.

These sclerotia were dried in the shade at room temperature (26-37 °C) for 24 h. Their moisture content was reduced to 11.7%.

Six dishes containing 1,000 mg dried sclerotia each were wet for 24 h by adding 20 ml water to each dish. Then they were dried in shade for 24 h, for each wet-dry cycle. One set of six dishes was given no treatment. Three dishes in each set were used to measure weight, and three to measure viability.



1. Effect of wet-dry cycles (WD) on sclerotial weight in *Sclerotium hydrophilum.*

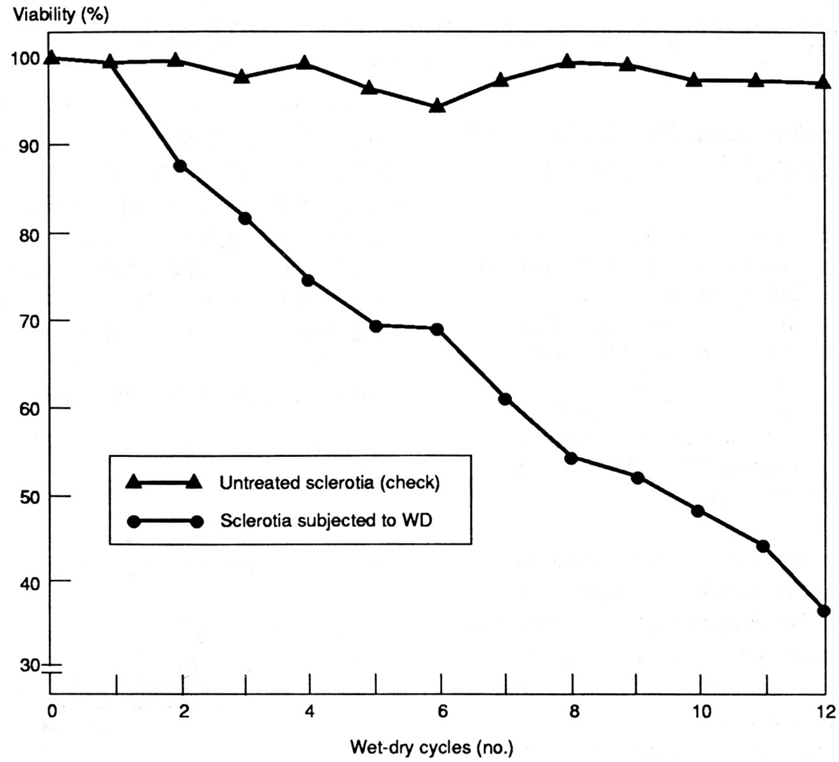
Sclerotia weight and viability of both treated and untreated sets were measured after each wet-dry cycle. For viability, sclerotia were surface sterilized with 0.05% H_gCl_2, plated on 2% water-agar amended with 1,000 ppm streptopenicillin, and incubated at 28 ± 1 °C for 3 d. The wet-dry cycles continued until sclerotial weight became constant. After the last cycle, moisture content of untreated sclerotia was 11.3%; that of sclerotia subjected to wet-dry treatment was 11.5%.

At first, sclerotia weight was reduced sharply with wet-dry treatment to about half (490 mg) by completion of the third cycle (Fig. 1). Weight stabilized after 11 cycles (428 mg).

Sclerotia viability declined gradually with wet-dry cycles, to 37% after 12 cycles (Fig. 2).

Without wet-dry cycles, sclerotia weight and viability remained constant.

The correlations between wet-dry cycle and weight (r = -0.74) and viability were negative (r = -0.99); that between weight and viability, positive (r = 0.78). ■



2. Effect of wet-dry cycles on sclerotial viability in *Sclerotium hydrophilum.*

Space limitations prevent IRRN from publishing solely yield and yield component data from fertilizer field trials that are not conducted for at least two cropping seasons or at two differing sites. Publication of work in a single season or at one site is limited to manuscripts that provide either a) data and analysis beyond yield and yield components (e.g., floodwater parameters, microbial populations, soil mineral N dynamics, organic acid concentrations, or mineralization rates for organic N sources), or b) novel ways of interpreting yield and yield component data across seasons and sites.

Natural conidia release patterns of *Pyricularia oryzae*

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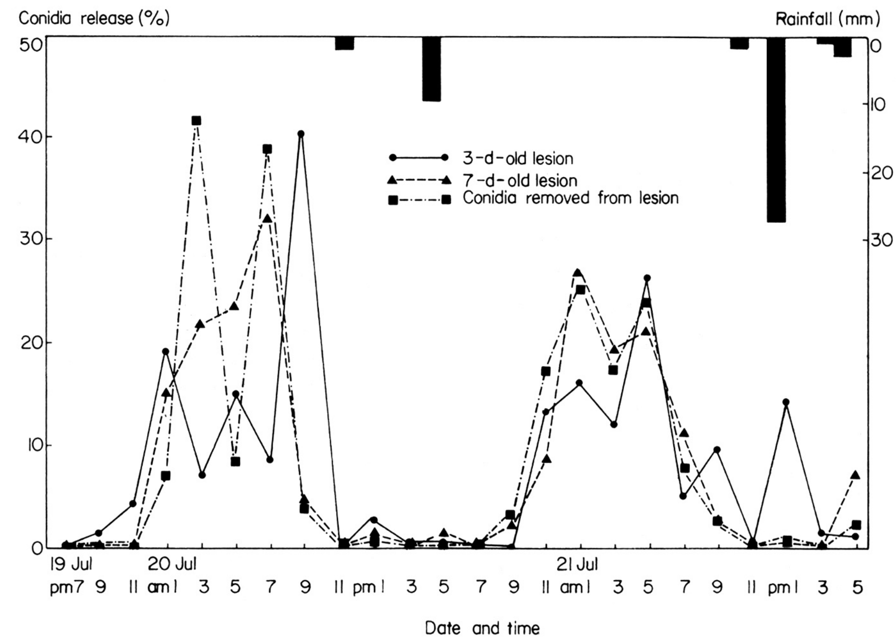
We studied successive conidia release patterns for 48 h from discrete blast lesions–3, 7, and 4 d old–19-21 Jul 1989 in Korea, using a KY-type spore trap. The weather was continuously cloudy during the experiment.

Preexisting conidia and conidiophores were brushed away with moistened cotton and the spore trap set up. On day 1, conidia release from 3-d-old lesions peaked three times, at 0100, 0500, and 0900 h (see figure). From 7-d-old lesions, conidia release peaked at 0700 h. From 4-d-old lesions, conidia release peaked at 0300 and 0700 h.

On day 2, mostly two peaks occurred 0100 and 0500 h; after rainfall, two extra peaks occurred from 3-d-old lesions, at 0900 and 1300 h. The total amount of conidia released was higher on day 2.



Successive *Pyricularia oryzae* conidia release pattern from three different types of leaf Bl lesions. Icheon, Korea, 1989.

In general, conidia release peaked between 0100-0700 h. The reason 3-d-old lesions exhibited the highest release peak later than other lesions is not yet clear.

We do see that the B1 fungus cycle is repeated diurnally, except with daytime rainfall.

Such quantitative measurements will be useful in simulation modeling for leaf Bl forecasting. ■

Integrated pest management – insects

Rice pest abundance in Bihar and Orissa States, India

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Developing improved methods of rice pest management is a component of the Indo-British Fertilizer Education Project in six states of N.E. India. Variability of the rice pest complex in different areas is associated with differences in cropping intensity, irrigation, variety, fertilizer, and pesticide use.

Rice fauna differences can be shown by comparing 1988 dry season crops in Sindri, Dhanbad District (eastern Bihar) and in Arisol, Puri District (coastal Orissa). In Dhanbad, except in isolated patches, only a wet season crop is grown; in Puri, a rainfed crop is grown in the wet season (Jul-Dec) and an irrigated crop in the dry season (Jan-May).

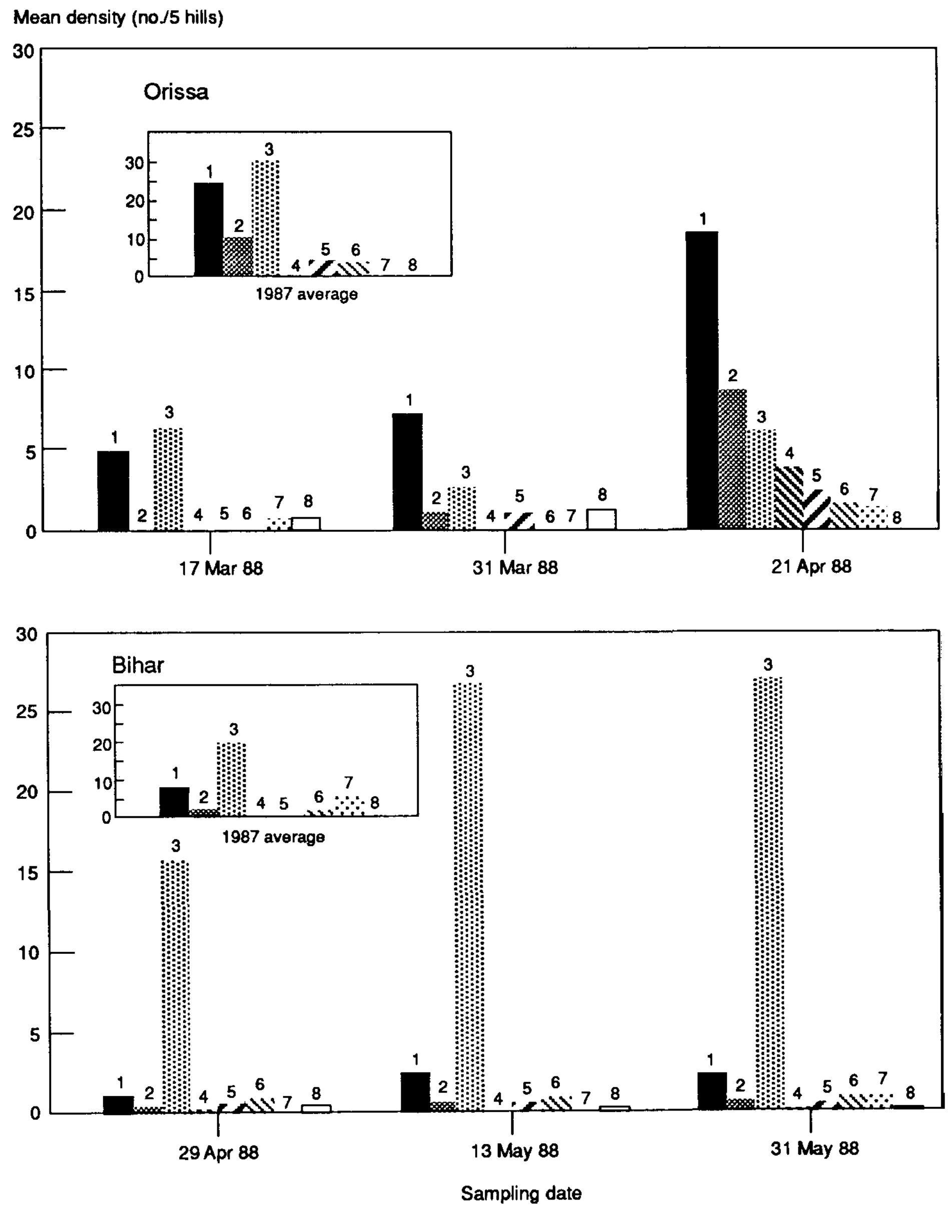
We sampled at both locations approximately 50, 70, and 90 dafter transplanting, using a D-vac suction sampler. Rice pest species found are shown in Figure 1. Populations of green leafhopper (GLH) were significantly higher at Sindri on both the second and third sampling dates. In the third sample, populations of brown planthopper (BPH), whitebacked planthopper (WBPH), and zigzag leafhopper were significantly higher at Arisol. BPH and WBPH populations tended to increase across the season, particularly at Arisol.

In general, patterns of relative pest abundance were similar most years; 1987 average densities at 50 and 70 d after transplanting are shown for comparison.

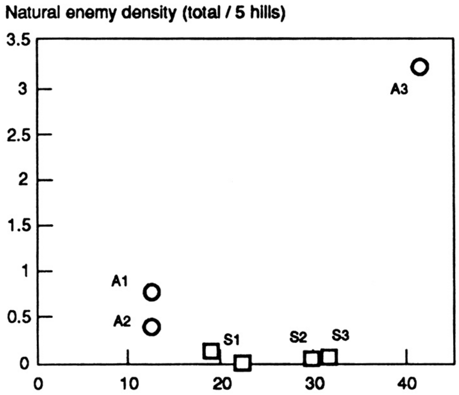
With the exception of GLH, the very low abundance of pests on the dry season (Bihar) rice crop in Sindri suggests there may be low local carryover of pests from one wet Season to the next. The GLH population may have been initiated by immigrants from double-cropping areas in neighboring West Bengal, where GLH is common in light trap catches.

Differences in rice varieties planted at the two sites are unlikely to be responsible for hopper density differences: IR36 grown in Sindri is rated as moderately resistant to BPH and resistant to GLH; CR190 grown in Arisol is rated as resistant to both pests.

The most abundant natural enemies of rice pests at both sites were *Cyrtorhinus lividipennis* and Lycosidae and Tetragnathidae spiders. There were significantly more natural enemies in Arisol than in Sindri on the third sampling date. Ratios of natural enemies to pests were much higher at Arisol, where natural enemies showed some tendency to increase in association with increasing pest density (Fig. 2). ■



1. Mean densities (n = 50) of the 8 most abundant pest species on dry season rice CR190 in Arisol and IR36 in Sindri. 1 = *Nilaparvata lugens* (brown planthopper), 2 = *Sogatella furcifera* (whitebacked planthopper), 3 = *Nephotettix* spp. (green leafhopper), 4 = *Recilia dorsalis* (zigzag leafhopper), 5 = *Cofana spectra* (white jassid), 6 = stem borers, 7 = *Leptocorisa* spp. (rice bug), 8 = *Cnaphalocrosis medinalis* (rice leaffolder).



2. Relationship between pest and natural enemy density in Arisol (A) and Sindri (S), in 3 successive samples (1, 2, and 3).

Species composition and seasonal occurrence of rice green leafhoppers (GLH) in Nepal

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Rice GLH *Nephotettix virescens* and *N. migropictus* were collected from ricefields and nurseries at six sites in Chitwan and one site each in Bara (Parwanipur) and Janakpur (Hardinath) Districts of Nepal. In Saradanagar and Mangalpur, Chitwan, samples were collected at 2- to 3-wk intervals Apr-Oct 1989; in the remaining four sites, samples were collected once, during the fourth week of Aug 1989.

Each sample consisted of insects captured by an insect net in 30-40 horizontal sweeps in an arc approximately 1 m wide. At IAAS, a general-purpose blacklight insect survey trap with a fluorescent 15-W bulb was set up very close to a ricefield and operated dawn to dusk. Leafhoppers were trapped and counted at about 1-mo intervals Jun-Dec 1989.

Composition of *N. virescens* and *N. nigropictus* collected at most sites varied considerably: numbers of *N. virescens* were much higher. The ratio of *N. virescens* to *N. nigropictus* varied from 13.8 to 41.0; the highest ratios were in Parwanipur (Bara) and Sripur (Chitwan) and the lowest in Hardinath (Dhanusha) (Table 1). Irrespective of site, the overall ratio of *N. virescens* to *N. nigropictus* was 41.0.

Table 1. Species composition, and population density of *Nephotettix* spp. collected by net sweeps in ricefields in Chitwan, Bara, and Janakpur Districts of Nepal, Aug 1989.

Locality	District	Leafhoppers [a] (no.)				Ratio [b]
		N. virescens		*N. nigropictus*		
		Range	Mean ± SD	Range	Mean ± SD	
Sripur	Chitwan	4-16	8.2±4	0-2	0.2	41.0
Gopalganj	Chitwan	3-6	4.6±1	0	0	
Shivnagar	Chitwan	5-15	8.3±3	0	0	
Jaynagar	Chitwan	7-50	18.0±16	0	0	
Saradanagar	Chitwan	7-28	11.9±5	1-3	0.5±1	23.8
Mangalpur	Chitwan	7-25	12.8±5	0-4	0.4±1	32.0
Parwanipur	Bara	7-132	89.4±22	1-5	2.2±.9	40.6
Hardinath	Dhanusha	3-6	8.3±1	2-3	0.6±1	13.8

[a] Seven to ten net-sweeping surveys of 30-40 strokes was standard at each collection site. [b] *N. virescens*:*N. nigropictus*.

Table 2. Population of *N. virescens* and *N. nigropictus* captured by net-sweeping in ricefields at Saradanagar and Mangalpur, Chitwan, Nepal, Apr-Oct 1989.

Collection date	Leafhoppers collected/30-40 sweeps (no.)							
	Mangalpur				Saradanagar			
	N. virescens		*N. nigropictus*		*N. virescens*		*N. nigropictus*	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
22 Apr	0-1	0.14 ± 3	0-1	0.43±.5	0-1	0.2 ± .4	1-3	1.7 ± 1
9 May	1-2	2.00±1	0	0.00	0-3	1.1 ± .7	0	0
24May	0-1	0.10	0	0.00	-	-	-	-
8 Jun	-	-	-	-	0	0.00	0	0
15 Jun	-	-	-	-	1-4	2.3 ± 1	0	0
22 Jun	-	-	-	-	0-1	0.75 ± .4	0	0
29 Jun	-	-	-	-	2-8	5.30 ± 2	0	0
6 Aug	1-16	5.00±4	0	0.00	1-3	2.50 ± 2	0	0
21 Aug	7-28	1.90 ± 5	0-1	0.46±.9	7-25	12.80 ± 5	1-4	0.40±.2
9 Sep	10-95	47.80±6	0-5	1.60±5	12-52	36.5 ± 6	2-5	3.10±1
9 Oct	61-139	99.90±5	2-8	3.80±4	198-355	274.4 ± 4	1-8	5.90±.5

Populations of *N. virescens* and *N. nigropictus* varied, depending on site and time of collection. At all sites, *N. virescens* was much more numerous than *N. nigropictus* (Table 2). The population of *N. virescens* was larger in Parwanipur than in Hardinath and Chitwan.

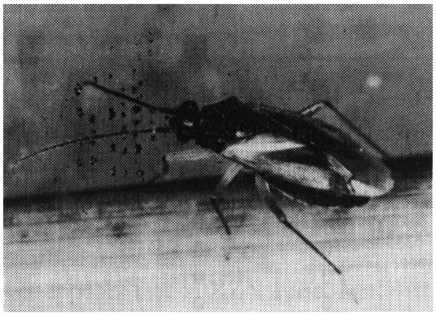
In monthly sweep-net catches at Saradanagar and Mangalpur, Chitwan, GLH numbers ranged from 0 to 355. The population increased sharply in Aug-Sep, peaked during Oct-Nov, and sharply declined in Dec.

N. nigropictus populations fluctuated at low levels at all sites, but was highest in Parwanipur. At Saradanagar and Mangalpur sites, the population had two peaks: the first in May, with a population decline Jun to mid-Aug, then another increase from Aug to peak again Sep-Oct, then a sharp decline. ■

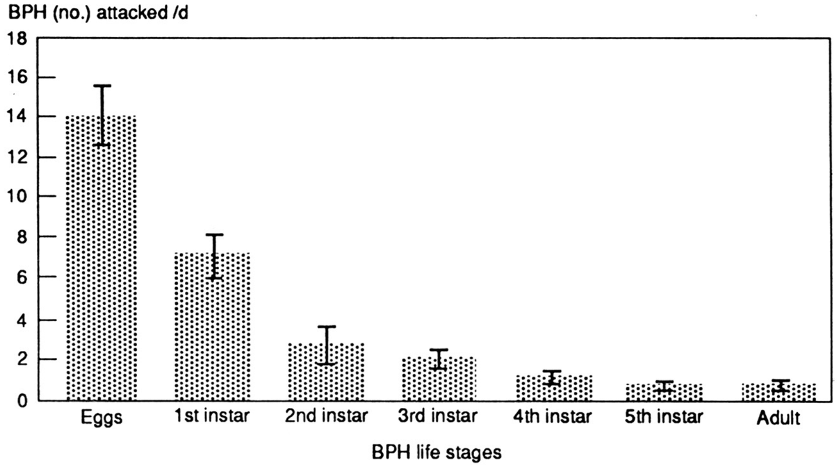
Brown mirid bug, a new predator of brown planthopper (BPH) in the Philippines

R. P. Basilio and K. L. Heong, Entomology Division, IRRI

Three species of mirids have been reported as important predators of rice planthoppers. In the Philippines, *Cyrtorhinus lividipennis* has been well discussed. Recently, a species belonging to the genus *Tytthus* was found surviving on BPH colonies in the greenhouse. It is



1. Adult female *Tytthus* sp.



2. Mean numbers of BPH attacked by *Tytthus* sp. brown mirid bug. Vertical lines on bars represent standard error.

the same size as *C. lividipennis.* While *C. lividipennis* is green, *Tytthus* sp. is yellowish green when young and brown when mature (Fig. 1).

Inside the plant tissues, *Tytthus* sp. lay eggs that hatch in 8-9 d ($\bar{X}$ = 8.75 ± 0.11). The nymphal period is 13-16 d, with five instars: 1 = 2-4 d ($\bar{X}$ = 2.18 ± 0.13). II = 2-5 d ($\bar{X}$ = 3.75 ± 0.28), III = 2-4 d ($\bar{X}$ = 2.69 ± 0.17), IV = 2-4 d ($\bar{X}$ = 2.77 ± 0.19), V = 2-4 d ($\bar{X}$ = 3.00 ± 0.13).

The female adults attack BPH eggs at an average 14 eggs/d, with a maximum of 32 eggs (Fig. 2). They also prey on nymphs, but at lower rates. ■

A method for rearing diapausing rice yellow stem borer (YSB)

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YSB *Scirpophaga incertulas* (Walker) remains in diapause for 3-4 mo during the winter in Bangladesh. Study of the diapause with the use of rice stem-cuts to house diapausing larvae is difficult: stem-cuts need to be changed frequently, because they rot or dry up; diapausing larvae are disturbed and injured during transfer to new stem-cuts; and observation of larval development and pupation is virtually impossible because the rice stem-cuts are opaque.

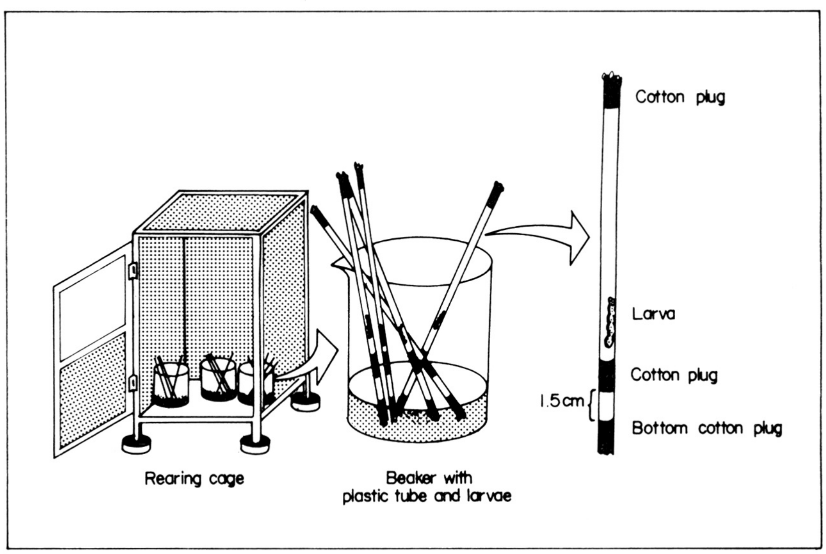
To overcome these problems, we developed a simple method for rearing diapausing larvae, using 14-cm-long transparent plastic tubes (inner diameter about 4 mm, outer diameter 4.3 mm) (see figure). Two l-cm-long cotton plugs are inserted into the tube at one end, with a 1.5 cm gap between them. One larva is introduced at the other end and the tube closed with another cotton plug.

We kept 86 tubes with larvae in three beakers wrapped in brown paper and containing a little water. The tubes stand so that the ends with double plugs remain in contact with the water. The terminal plug soaked by the water in the beaker provides the required humidity in the tube. At the same time, the second plug remains dry to help keep the larva separated from the wet plug.

The beakers are placed in an insect rearing cage in the laboratory under normal photoperiod and temperature. The water in the beakers is changed at 4- to 5-d intervals and the beakers protected from ants.

Before pupation, the larva cuts a hole through the tube wall, seals it with membrane, forms a puparium, and then pupates. The moth emerges through the hole just as it does in a rice stem.

Among 86 larvae collected in the field and placed in the tubes in November, 20 escaped within 2 d by cutting holes through the tubes. The 20 probably were not in diapause. Of the 66 remaining larvae, 46 moths (70%) emerged (24 male and 22 female) in January and February.



Method for rearing diapausing rice yellow stem borer *Scirpophaga incertulas* (Walker) in plastic tubes. Bangladesh, Nov 1989-Feb 1990.

Color of the plastic tube (blue, yellow, pink, and orange) had no significant effect on larval mortality and moth emergence. A few moths, mostly larger-size females, died inside the tubes. The larger moths need tubes a bit wider (5-6 mm). Tube walls should be thin (not more than 0.3-0.4 mm), so that larvae can cut a hole before pupation. ■

Chilo auricilius Dudgeon (Lepidoptera: Pyralidae), the correct name for the dark-headed stem borer (SB) found in the Philippines

A. T. Barrion, J. L. A. Catindig, and J. A. Litsinger, Entomology Division, IRRI

We investigated the *Chilo* SB complex in rice, maize, sorghum, and sugarcane. Tillers were dissected and larvae found were reared individually in 20- × 3.5-cm tcst tubes. Pupae were transferred to plastic petri dishes for moth emergence. The abdomen of each moth was cut, cleared in a hot 10% solution of KOH, and washed with distilled water.

In 1,316 samples from throughout the Philippines, we found *C. suppressalis* (Walker) and *C. auricilius,* but not *C. polychrysus* (Meyrick). All larvae identified earlier as dark-headed SB were the gold-fringed borer *C. auricilius. C. auricilius* comprised 73% of the *Chilo* SB found in upland rice and 97-100% of those found in maize, sorghum, and sugarcane (Table 1).

The morphological similarity of the larvae and moths of the two species had led to earlier, erroneous records of *C. polychrysus* in the Philippines. Similar confusion may exist in countries where their distributions overlap: India, Thailand, Indonesia, and Malaysia.

Table 2 compares *C. auricilius* and *C. polychrysus* on the basis of morphology, life history, and host plant range.

IRRI will accept *Chilo* moths for further comparison and identification. ■

Table 1. Composition of *Chilo* reared from 4 agricultural crops.

Crop	Borers examined (no.)	Composition (%)	
		C. auricilius	*C. suppressalis*
Rice			
Upland	482	73	27
Wetland	171	17	83
Maize	364	97	3
Sorghum	278	100	0
Sugarcane	21	100	0
Total	1316		

Table 2. Comparative moth morphology, life history, and host plant range of *C. auricilius* and *C. polychrysus.*[a]

Criterion	*C. polychrysus*[b]	*C. auricilius*
Forewing of moth (see figure)	Terminal dots and subterminal line indistinct; subterminal line white with a few silvery scales; median line distinct, oblique and pale yellow brown; discal dot highly reduced; fringe slightly glossy; hindwing whitish to dirty cream	Terminal dots large; subterminal line represented by a row of metallic scales, and close to the apical margin; median line metallic line subterminal; discal dot visible; fringe shiny golden; hindwing light brown
Larva (see figure)	Dorsal setae D_1 and D_2 in the VIII abdominal segment nearly equidistant from dorsal line; adfrontal area of head same in color as the fronto-clypeal area	Seta D_1 of VIII abdominal segment closer to the dorsal line than seta D_2; adfrontal area of head paler than fronto-clypeal area
Development (d)	30-44	37-42
Egg incubation	4-7	6-8
Larva	20-30	22-24
Prepupa	No data	1
Pupa	6-7	8-9
Fecundity (no. of eggs/female)	73-488	5-233
Longevity (d)	2-5	6-9
Host plant range		
Cyperus digitatus Roxb.	+	-
Dactyloctenium aegyptium P. Beauv.	-	+[c]
Echinochloa colona (L.)	-	+[c]
E. crus-galli ssp. *hispidula* (Retz.) Honda	+	-
E. frumentacea Link.	-	+[c]
E. stagnina (P. Beauv.)	-	+[c]
Eleusine indica Gaertn.	-	+[c]
Erianthus munja Roxb.	-	+[c]
Hemarthria (= *Rottboellia*) *compressia* (L.f.) R. Br.	-	+[c]
Hymenache pseudointerrupta C. Muell.	+	-
Ischaemum rugosum Salisb.	-	+[c]
Leptochloa chinensis (L.) Nees	-	+
Millet (name not specified)	+	-
Oryza sativa L.	+	+
Pennisetum purpureum Schum.	-	+[c]
Saccharum officinarum L.	-	+
S. spontaneum L.	-	+[c]
Sacciolepis interrupta (Willd.)	-	+[c]
Sacciolepis myosuroides (R. Br.) A. Camus	+	+[c]
Schlerostachya fusca (Roxb.) A. Camus	-	+[c]
Scirpus grossus L.f.	+	-
Setaria italica (L.) P. Beauv.	+	-
S. palliole-fusca (Schum.) Stapf & C.E. Hubb.	+	-
Sorghum bicolor Moench	-	+
S. halepense (L.) Pers.	-	+
Sporobolus diander P. Beauv.	-	+
S. indicus R. Br.	-	+[c]
Triticum aestivum L.	-	+
Zea mays L.	+	+
Zizania aquatica L.	+	-
Z. lotifolia Turez.	+	-

[a]+ = recorded host, - =no recorded host. [b]Source: Banerjie. S.N. and L.M. Pramanik, 1967. The lepidopterous stalk borers of rice and their life cycles in the tropia. pp. 103-126. *In*: The Major Insect Pests of the Rice Plant. The International Rice Research Institute. Johns Hopkins Press, Baltimore, Maryland. 729 p.; Anonymous. 1967. Rice Production Training Manual: Rice Insect Pests. IRRI, Los Baños. 182 p. [c]Source: Chaudhary, J.P. and S.K. Sharma, 1986. The stalk borer, *Chilo auricilius.* pp. 135-150. *In*: Sugarcane Entomology in India. Sugarcane Breeding Institute. Indian Council of Agricultural Research. Coimbatore, India. 564 p.

Incidence of rice stem borers (SB) in Sind

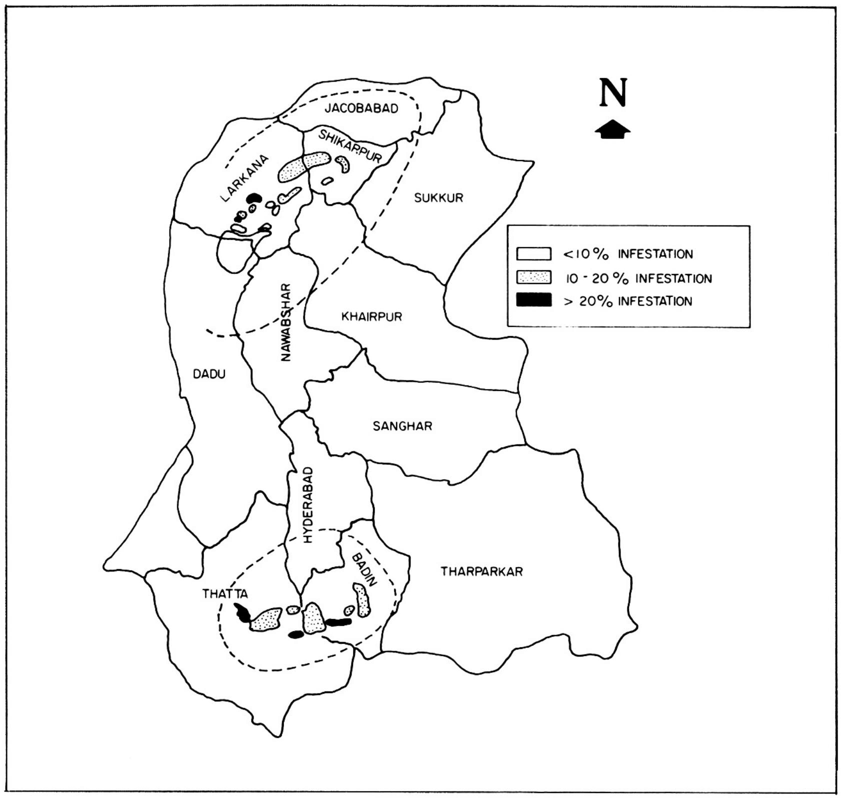
C. Inayatullah and A. Rehman, Entomological Research Laboratories, National Agricultural Research Centre, Islamabad, Pakistan

We surveyed SB in Jan 1988 and estimated tiller infestation and number of larvae in rice stubble in rice-growing areas of Sind.

Samples of rice stubbles were collected in 33 locations in Upper Sind and 20 in Lower Sind. Average tiller infestation was 19%.

Rice areas around Shikarpur, Jamra, Brohi, and Wagan in Upper Sind and around Thatta, Jatichok, Cularchi, Chandio, Telhar, and Sajawal in Lower Sind were severely infested (see figure).

Of larvae collected, only 2% were pink stem borer *Sesamia* spp.; the remainder were yellow stem borer *Scirpophaga incertulas* (Walk.) and white stem borer *S. innotata* (Walk.). ■



Incidence of rice SB in Sind.

Integrated pest management—weeds

First report of *Monochoria vaginalis* in Iran

M. M. Sharifi, Plant Pests and Diseases Research Lab., P.O. Box 133, Bandar Anzali, Iran

Monochoria vaginalis (Pontederiaceae) is a broadleaf weed distributed in Asia, Africa, and Oceania. Until now, it had not been found in Iran.

The main noxious weeds in transplanted rice in north Iran are *Echinochloa crus-galli, Cyperus difformis, Alisma plantago-aquatica,* and *Paspalum distichum.*

In Jul 1989, we collected samples of *M. vaginalis* from ricefields in Amlesh, the eastern part of Guilan Province (Fig. 1). Identification was confirmed by Dr. F. Termeh, Botanic Department of Plant Pests and Diseases Research Institute, P.O. Box 1454, Tehran.

The plant is a weed in ricefields and a new species for flora of Iran (Fig. 2). It is also the first species of Pontederiaceae in Iran.

We found this weed in about 500 ha, where it has become the main noxious weed.

It was not known whether it is indigenous or exotic, and we are investigating its origin. ■

1. Area where *Monochoria vaginalis* is found in Iran.

2. *Monochoria vaginalis* in a farmer's field.

Farming systems

Efficacy of insecticides against overwintering rice stem borer (SB) larvae

Ehsan-ul-Haq and C. Inayatullah, Entomological Research Laboratories, National Agricultural Research Centre, Islamabad, Pakistan

Recent adoption of no-tillage wheat after rice has led to concern about increased survival of stem borers between rice crops. Three stem borers hibernate in the rice stubble: *Scirpophaga incertulas, S. innotata,* and *Sesamia inferens.*

We tested the efficacy of chlorpyrifos granules 5% wt/wt at 25 kg/ha, chlorpyrifos 40 EC at 2.5 liters/ha, carbofuran 3% wt/wt at 25 kg/ha, and diazinon granules 10% G at 25 kg/ha against SB in no-tillage and conventional-tillage wheat after rice during 1988-89 at Kot Mubarik. Plot size was 5 × 8 m, with three replications.

Insecticides were applied with irrigation water on 21 Feb and 13 Mar. Larval mortality was recorded on 12 Mar and 5 Apr.

Both insecticides and tillage system had a significant effect on larval mortality. Average larval mortality was 66 ± 26% in no-tillage plots and 78 ± 29% in conventional-tillage plots. Larval mortality was high in conventional-tillage wheat because the stubbles were broken open, increasing larval contact with insecticides.

Larval mortality with insecticides was 80-84%. ■

Studies on rice-based cropping systems

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Rice is the principal crop in the tail end of Cauvery delta, Tamil Nadu. We conducted a field experiment with six rotations: rice - black gram, rice - green gram, rice - cowpea, watergrass - watergrass, rice - soybean, and rice - sesame.

The soil was clay (50% clay, 19% silt, and 31% sand) low in available N (228 kg/ha), medium in available P (21.57 kg/ha), and high in available K (348.6 kg/ha). The experiment was laid out in a randomized block design with four replications.

Economics of rice-based cropping systems for Tamil Nadu.

Rotation	Grain yield (t/ha)			Net profit ($/ha)	Benefit:cost ratio
	Crop 1	Crop 2	Total		
Rice - black gram	5.9	0.7	6.6	739	2.31
Rice - green gram	5.8	0.6	6.3	634	2.00
Rice - cowpea	5.7	0.4	6.1	560	1.76
Watergrass - watergrass[a]	8.9	6.5	15.4	140	1.04
Rice - soybean	5.5	0.6	6.1	586	1.83
Rice - sesame	5.6	0.1	5.7	489	1.58

[a]Forage yield.

Fertilizer was applied at 100:22:62 kg NPK/ha to rice and 90:20:37 kg NPK/ha to watergrass; no fertilizer was applied to black gram, green gram, cowpea, soybean, and sesame. The rice crop was irrigated; the other crops were rainfed. No protection against pests or diseases was necessary.

Highest grain yield was with rice - black gram, followed by rice - green gram and lowest with rice - sesame (see table). Watergrass - watergrass yielded more forage.

The highest net return and benefit:cost ratio was with rice - black gram, the lowest with watergrass - watergrass. ■

Farmers' herbicide application method in Koronadal, South Cotabato, Philippines

L. E. Estorninos, Jr., and K. Moody, IRRI

Some farmers in Koronadal, South Cotabato, Philippines, use chicken feathers attached to the end of a wooden stick to apply herbicides. The feathers are dipped into concentrated herbicide, which has been poured into a coconut shell. The herbicide is applied by swinging the stick in a side-to-side motion, similar to swinging the lance of a conventional sprayer. The farmers make the stick to deposit the herbicide in the water.

Farmer applying herbicide in Koronadal, South Cotabato, Philippines.

The photograph shows a farmer using this method to apply butachlor (approximately 1 liter, equivalent to 600 g ai/ha) in transplanted rice.

The farmers say the technique is easy to use, they need not buy or borrow a sprayer, and water to fill the sprayer is not needed. ■

Rice-based cropping sequence for rainfed lowlands of eastern Uttar Pradesh

G. Singh and O. P. Singh, N.D. University of Agriculture and Technology, Crop Research Station, Ghagharaghat, Bahraich 271901, UP, India

Farmers in eastern UP usually plant linseed, lentil, and wheat Dec-Apr after wet season rice. Yields are low because of lack of fertilizer and poor field preparation that results in cloddy surface soil, loss of moisture, and delayed planting. This gives poor plant stands and yields.

We studied the effect of three tillage methods and three fertility levels on three crops in dry seasons 1987-88 and 1988-89 (see table). Experimental soil was sandy to clay loam with pH 8.1, 0.35% organic C, 11 kg available P and 250 kg K/ha. The experiment was laid out in a randomized block design with three replications.

Rice variety Madhukar was transplanted at 20- × 15-cm spacing the second week of Jul with 40-20-20 kg NPK/ha. Wheat HUW234, lentil PL406, and linseed Mukta were sown the first week of Dec.

Wheat sown after rice in a well-prepared field with NP fertilizer gave the highest gross return ($634/ha), followed by lentil ($615/ha). Lentil sown in a well-prepared field with NP fertilizer had highest net return ($307/ha), followed by wheat ($288/ha). ■

Grain yield and gross and net return from dry season crops in a rice-based cropping system.[a] Uttar Pradesh, India, Dec-Apr 1987-89.

Crop sequence[b]	Grain yield[b] (t/ha)				Gross return ($/ha)			Net return ($/ha)			Benefit:cost ratio		
	Rice	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
Rice - wheat + no NP	2.4	1.69	1.12	1.22	460	424	437	153	139	139	1.49	1.48	1.46
Rice - wheat + 60 kg N/ha	2.4	2.45	1.58	1.85	593	483	517	265	177	198	1.80	1.57	1.62
Rice - What + 60 kg N + 13 P/ha	2.4	2.76	2.02	2.08	634	539	546	288	215	209	1.83	1.66	1.62
Rice - linseed +no NP	2.4	0.40	0.38	0.33	431	428	393	145	164	116	1.50	1.62	1.41
Rice - linseed + 40 N	2.4	0.60	0.66	0.48	513	534	465	216	259	176	1.72	1.94	1.60
Rice - linseed + 40 N + 8.8 P	2.4	0.72	0.75	0.57	557	567	501	251	283	204	1.82	1.99	1.68
Rice - lentil +no NP	2.4	0.53	0.40	0.48	474	426	455	191	164	180	1.67	1.62	1.65
Rice - lentil + 20 N	2.4	0.83	0.69	0.75	582	531	555	291	261	272	2.00	1.96	1.96
Rice - lentil + 20 N + 13 P	2.4	0.92	0.83	0.89	615	582	604	307	296	305	1.99	2.03	2.02

[a]TI = well-prepared field, T2 = zero tillage (Paraquat sprayed on paddy stubble 2 d before sowing.), T3 = stubble cut with shavers and seed sown behind the tine. US$I = Rs 16.32. [b]N and P in kg/ha. [c]Av of 2 yr.

Rice-based cropping sequence for irrigated fields

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Wet season rice followed by dry season wheat occupies most of the area under irrigation. We evaluated other crop sequences in 1986-87 and 1987-88 at CRS.

Soil was sandy loam with pH 8.0, 0.32% organic C, 29 kg available P, and 243 kg K/ha.

Rice variety NDR80 was transplanted at 15- × 15-cm spacing during wet season (Jul-Oct) followed by wheat cultivar HUW234, barley Azad, pea Rachna, lentil PL 406, chickpea G130, linseed Mukta, and mustard Varuna in dry season (Nov-Apr) or green gram T44, black gram T9, and maize Kanchan in summer (Apr-Jun). The experiment was laid out in a randomized block design with three replications.

Rice received 80-40-30 kg NPK/ha. All crops were grown with recommended inputs and practices.

Highest total grain yield (7 t/ha) was with rice - maize, followed by rice - wheat (6.7 t/ha) (see table). Rice - wheat had the highest gross income followed by rice - chickpea. Rice - lentil had the highest net profit ($333/ha) and benefit:cost ratio (2.08), followed by rice - wheat ($319/ha). ■

Grain yield and net income of different rice-based cropping sequences.[a] Uttar Pradesh, India 1986-88.

Crop sequence	Grain yield[b] (t/ha)			Total cost ($/ha)	Gross income ($/ha)	Net income ($/ha)	Benefit: cost ratio
	Wet season	Dry season	Summer				
Rice - fallow	3.0	-	-	209	298	89	1.42
Rice - wheat - fallow	3.0	3.7	-	412	731	319	1.77
Rice - barley - fallow	3.0	3.2	-	363	597	234	1.64
Rice - pea - fallow	3.0	1.4	-	350	653	303	1.86
Rice - chickpea - fallow	3.0	1.2	-	357	663	306	1.85
Rice - lentil - fallow	3.0	1.4	-	308	641	333	2.08
Rice - linseed - fallow	3.0	1.0	-	307	541	234	1.76
Rice - mustard - fallow	3.0	1.0	-	330	389	259	1.78
Rice - fallow - green gram	3.0	-	0.7	322	467	145	1.45
Rice - fallow - black gram	3.0	-	0.8	321	477	156	1.48
Rice - fallow - maize	3.0	-	4.0	363	543	180	1.49

[a]US$l = Rs 16.32. [b]Av of 2 yr.

Farm machinery

Spiral pump: a low-cost, rational, stream-driven water-lifting device

L. Naegel, Farming Systems Institute/UPLB; J. G. Real, Agronomy/IRRI; and A. M. Mazaredo, Agricultural Engineering Department, IRRI, College, Laguna, Philippines

The search for low-cost pumps that can be powered by renewable energy sources and built out of available materials by local craftsmen is a high research priority among agricultural engineers.

Recently the stream-driven spiral pump has been re-discovered. The pump resembles a large wheel with its axis parallel to the water surface (Fig. 1). When partially submerged in a stream, the flow rotates the wheel so that alternate slugs of water and air are scooped into the intake tube.

The heart of the pump is a coiled flexible plastic hose. The end of the hose leads into the rotating axle. By means of a wivel, water moves into a stationary water delivery pipe. During water delivcry, the individual slugs in each loop of the hose are forced against the head, resulting in buildup of differential pressure in each loop.

We built a prototype spiral pump with 2.0 m outer diameter to determine the parameters that influence its performance. To simulate different flow streams under laboratory conditions, the pump was immersed in a water tank and rotated by an electric motor. A strain gauge was attached to the axle to determine efficiency and maximum torque.

Parameters evaluated were water volume delivered per time to a defined height at a specified rotational speed, tube diameter, number of coils in the spiral and sum of coil diameters, and volume of water scooped into the pump at each turn of the wheel.

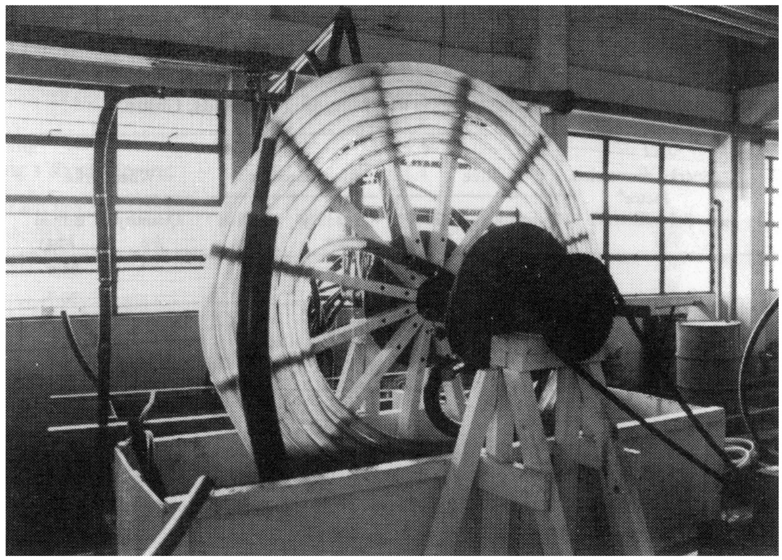
Influence of each parameter on performance was determined through multiple stepwise regression analysis. This showed that the lower the rotational speed of the pump and the higher the total head, the greater the efficiency (efficiency reached more than 50%) (Fig.2).

The maximum torque to rotate the pump without any impact on rotational speed is influenced mainly by the total head and tube diameter. The larger the tube diameter used, the higher the torque required to turn the wheel. Small tube diameters also proved to add to pump efficiency.

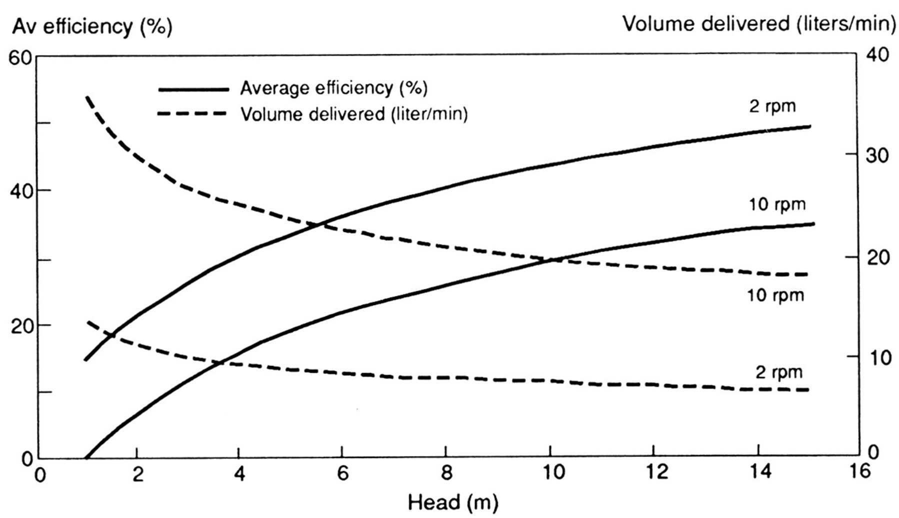
Regardless of the volume of water scooped in, it is not possible to fill the outer coil to more than 50%.

The most efficient combination of design paramaters for the spiral pump were found to be high head, slow rotational speed, scoop volume 100-120% of outer coil, and small tube diameters.

Knowing the kinetic energy of a given stream and the drag coefficient of the paddles of the pump, it is now possible to design pumps where all factors are well matched, allowing the most efficient kinetic energy utilization of a given stream flow for pumping purposes. ■



1. Overview of the spiral pump.



2. Predicted delivered water volume and average efficiency versus total head at different speeds of rotation.

Energy conversion of ratoon rice and its financial benefits

Zhang Hongsong and Gou Xiaohong, 326 Hua Xing Village, Chongqing Agrotechnique Extension Station, Chongqing, China

Double-cropped rice does not fit well in southeast Sichuan because of low temperatures. How to increase food production in the limited cultivated land of the municipality with the largest population in China is a problem.

Ratoon rice production is developing rapidly with wide adoption of Shanyou 63, a hybrid rice with good ratooning ability and medium duration. The area of ratoon rice cropping, 670 ha in 1986, reached 1.9 million ha in 1989. Production increase with ratoon rice was 5.8 million t in 4 yr. The main pattern for irrigated rice cropping systems in Chongqing is now rice - ratoon rice (or wheat, rape, and barley after ratoon rice harvest).

We evaluated energy conversion, grain yield, and financial benefits of several rice-based cropping systems 1987-89. Labor inputs were derived from a survey of 100 farmers. Financial analysis was based on the state purchasing price.

One season cropping of rice has the lowest energy input and output (Table 1). Energy output from rice - ratoon rice is 56.7 billion J/ha higher; energy input, 12.4 billion J/ha higher.

Because land use is prolonged with ratoon cropping, sunlight use efficiency/ year of a field also increased.

Ratoon rice costs less to grow than wheat or rape (Table 2). Total output value and net output value/$ invested are higher in the cropping systems with ratoon rice. Labor productivity of rice - ratoon rice is a little lower than that of one crop of rice.

We estimate the rice production from 2.0 million ha of ricefields could increase as much as 4.5 million t, if ratoon rice yields are a conservative 2.2 t/ha. ■

Table 1. Energy conversion for cropping systems in Chongqing ricefields, China.

	Energy conversion factor[a] (x1 million J)	Rice		Rice - ratoon rice		Wheat - rice		Wheat-rice-ratoon rice		Rape - rice		Rape - rice - ratoon rice	
		Quantity /ha	Billion J/ha	Quantity /ha	Billion J/ha	Quantity /ha	Billion J/ha	Quantity ha	Billion J/ha	Quantity /ha	Billion J/ha	Quantity /ha	Billion J/ha
Input			46.4		58.8		94.4		106.1		97.9		107.1
Organic [b]			34.1		40.2		70.7		75.1		76.5		77.1
Labor	0.75	2340 h	1.76	2940 h	2.21	5112 h	3.83	5712 h	4.28	6384 h	4.79	6984 h	5.24
Seeds [c]		112.5 kg	1.70	112.5 kg	1.70	240 kg	3.77	240 kg	3.77	122.3 kg	1.87	122.3 kg	1.87
Compost (dry matter)	13.5	2270 kg	30.64	2688 kg	36.29	4674 kg	63.1	4966 kg	67.05	5173 kg	69.84	5184 kg	69.99
Inorganic [d]			12.3		18.6		23.7		31.0		21.4		30.0
Nitrogen	90.0	105.4 kg	9.59	172 kg	15.65	189 kg	17.20	274.5 kg	24.98	169.8 kg	15.45	260 kg	23.66
Phosphorus	13.3	27.0 kg	0.36	31.5 kg	0.42	79.5 kg	1.06	84.0 kg	1.12	81.75 kg	1.09	86.25 kg	1.15
Potassium	9.0	30.15 kg	0.27	36 kg	0.32	60 kg	0.54	64.5 kg	0.58	63.0 kg	0.57	64.65 kg	0.58
Tools	210.0	7.43 kg	1.56	7.71 kg	1.62	12.43 kg	2.61	13.67 kg	2.87	13.0 kg	2.73	13.80 kg	2.90
Insecticides and herbicides	102.0	5.1 kg	0.52	5.78 kg	0.59	13.1 kg	1.34	14.2 kg	1.45	15.3 kg	1.56	16.76 kg	1.71
Output			233.7		290.4		314.9		353.9		326.0		365.0
Grain			122.1		151.8		159.8		180.2		148.8		170.5
Straw			111.6		138.6		155.1		113.7		177.2		194.5
Total energy output/input			5.04		4.94		3.34		3.34		3.33		3.41
Sunlight use efficiency			.73%		.97%		1.05%		1.18%		1.09%		1.22%

[a]Energy conversion factors are from Gou Xiaohong, Du Hongzuo (1989) A preliminary approach to energy flow in Chongqing agro-ecosystem. J. Southwest Agric. Univ. 11(3):319-324. [b]Organic energy does not include animal power in no-till ricefield. [c]Energy conversion factors of seeds of rice, wheat, and rape are 15.1 million J/kg, 16.3 million J/kg, 2.63 million J/kg. [d]Energy of film used to cover seedlings is too little to be counted.

Table 2. Grain yield and financial benefits from cropping systems in Chongqing ricefields, China.

Cropping system	Grain yield (t/ha)				Total value ($/ha)	Total cost ($/ha)	Net value ($/ha)	Net value/ $ infested	Labor productivity ($/d)
	Rice	Ratoon rice	Wheat	Rape					
Rice	8.1				920	398	522	1.31	3.15
Rice - ratoon rice	8.1	2.0			1144	468	676	1.44	3.11
Wheat - rice	7.6		2.7		1250	746	504	0.68	1.96
Wheat - rice - ratoon rice	7.6	1.4	2.7		1404	816	588	0.72	1.97
Rape - medium rice	8.1			1.6	1462	832	631	0.76	1.83
Rape - rice - ratoon rice	8.1	1.4		1.6	1626	902	724	0.80	1.86

Space limitations prevent IRRN from publishing solely yield data and yield component data from routine germplasm screening trials. Publication is limited to manuscripts that provide either a) data and analysis beyond yield and yield components (e.g., multiple or unique resistances and tolerances, broad adaptability), or b) novel ways of interpreting yield and yield component data across seasons and sites.

Emission of methane (CH_4) from Italian irrigated rice fields

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Methane is produced by anoxic degradation of organic matter, primarily in aquatic soil and sediment systems. Flooded ricefields occupy about 1.5 million km^2 of the world's total arable land, and are projected to be a dominant source of atmospheric methane.

First field measurements in California, Spain, and Italy indicated that reliable data on the importance of ricefields as a source of atmospheric methane can only be obtained by continuous measurements. We have developed a continuous CH_4 sampling and analyzing system (Fig. 1).

Air samples from 16 gas-collecting boxes are taken by means of pumps and flushed through a tubing system to a gas chromatograph for CH_4 analysis. The system is run by a programmed microcomputer that also stores the CH_4 concentration data reported by the integrator.

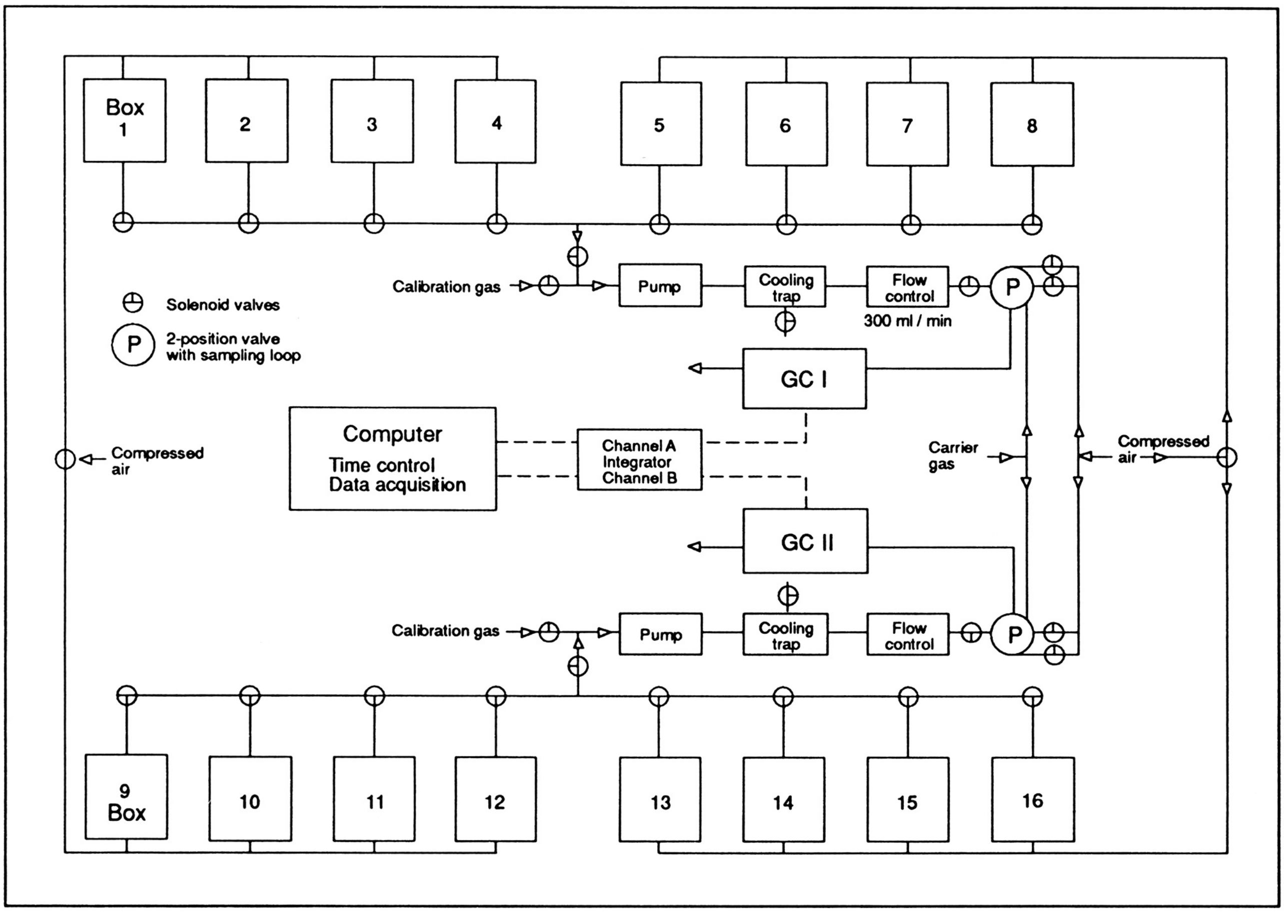
CH_4 emission rates are calculated from the increases across time in the CH_4 mixing ratios inside the closed boxes, as determined 8 times/d on each field plot. This results in a high resolution of the CH_4 flux.

We used this system in single-cropped, irrigated ricefields of the Italian Rice Research Institute near Vercelli, Italy. Soil is sandy loam with 2.5% organic C and 0.15% total N. The pH varies between 6.5 and 7.5. The field was wet seeded with pregerminated seeds of a japonica rice variety, for a plant density of 200/m^2.

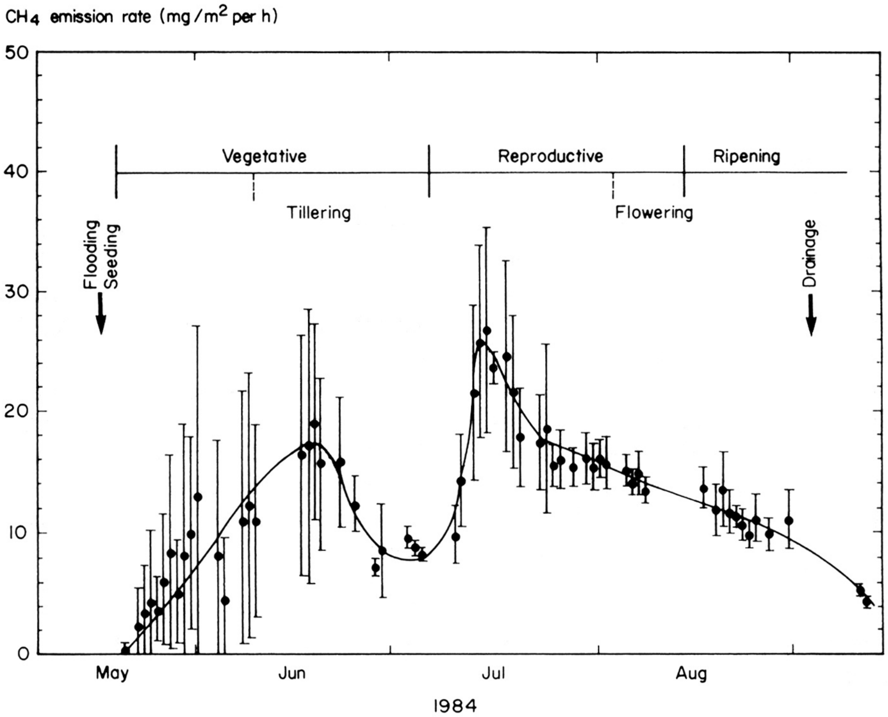
Figure 2 shows the seasonal variation of CH_4 emission rates from an unfertilized field plot. Two pronounced peaks occurred: one shortly after flooding in May/Jun and one during the reproductive stage of rice in Jul.

The first peak is caused by mineralization of rice straw stubbles and other organic material present in the soil at flooding. The second peak is due to stimulation of CH_4 production by organic root exudates in the anoxic soil.

During early vegetative phase (EVP), methane is emitted into the atmosphere



1. Continuous CH_4 sampling and analyzing system.



2. Seasonal variation in CH_4 emissions from an unfertilized irrigated ricefield in Vercelli, Italy.

primarily by gas bubbles. Plant-mediated transport is the dominant pathway during Jul and Aug.

High diurnal variations in rates were observed during EVP (values between R and 30 mg/m^2 per h). These changes correlated well with changes in soil temperature. On a seasonal average, 0.28 g CH_4 was emitted/m^2 per day, resulting in a total emission of about 33 g CH_4/m^2 during the vegetative phase.

On the basis of this value, we estimate the global annual CH_4 emission from ricefields to range between 50 and 150 million tons. Thus, flooded ricefields may be the most important individual source of atmospheric methane, contributing about 25% of the total annual CH_4 emission. Further field measurements in the major rice-growing areas of South and Southeast Asia are needed to better estimate global emission of CH_4 from ricefields. ■

Agroecological zoning of the Red River plain region, Vietnam

Cao Liem, Dao Chau Thu, and Tran Tu Nga, University of Agriculture N1, Hanoi, Vietnam

The Red River plain (about 15,000 km^2) is one of two main rice-producing regions of Vietnam. Altitude is less than 25 m above sea level, with relatively flat topography. Soil is primarily Red River alluvial. The climate is monsoon tropical with a cold winter. Current population density is the highest in Vietnam: more than 500 inhabitants/km^2.

The region has diversified cropping systems: rice, maize, peanut, tuber crops, and short-duration industrial crops. The rice crop is essential.

We have been working on agroecological zoning of the Red River plain region.

The objective is, first, to divide the Red River plain region into ecosystems that have

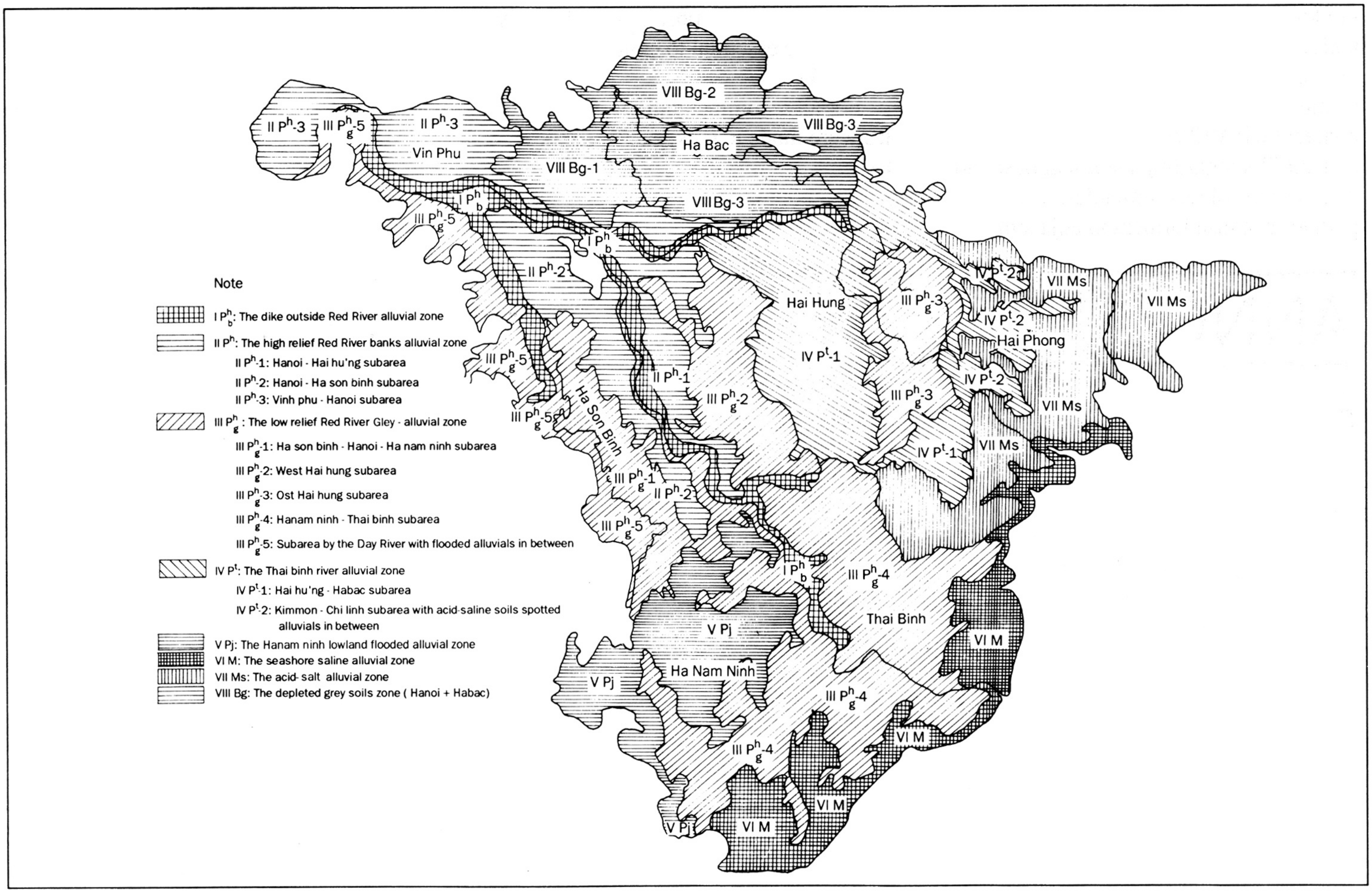
- the same main soil class, meso-macrorelief type, and water regime,
- the same main cropping systems,
- the same trends in land use, crop protection, and yield improvement.

Next is to divide the ecosystems into subecosystems with some interchange of ecological factors (by cropping system).

On the basis of these criteria, we have divided the Red River plain region into eight ecosystems (see table and figure). ■

Agrosystem zones in the Red River Delta, Vietnam.

Zone	Name of the zone	Area (km^2)	Topography	Water regime	Cropping pattem	Solution
I	The alluvial zone outside the Red River Dike	48,000	High	Seasonal flood	Legume - maize Vegetable - maize Sugarcane	Seasonal occupation
II	The high alluvial bank of the Red River	172,000	High to middle	Relatively suitable	Rice - rice - maize Rice - rice - potato Rice - rice - vegetables Sugarcane - jute	More effective cropping pattem
III	The low gley alluvial zone in the Red River Delta	499,000	Low	High ground water table	Rice - rice	Intersification of rice crop
IV	The Thaibinh River alluvial zone	183,600	Middle to low	Unsustainable	Rice - rice	Fertilizer and water management
V	The Hanamninh alluvial lowlands	103,200	Low	Flooded year-round	Rice - fallow Rice - rice	Drainage, liming, phosphorus fertilizer and flood-tolerant varieties
VI	The seashore saline alluvial zone	l04,500	Low	Seasonal	Mangrove:flooded Rush: mean saline Rice - food crops in less saline	Salt washing and salt-tolerant varieties of rice
VII	The acid salt alluvial zone	158,400	Middle to low	Seasonal Al^{3+} toxic	Rice - rice Rice - tobacco Rice - vegetable	Sulfate acid washing, liming and phosphorus fertilizer Variety improvement
VIII	The depleted grey soil zone	194,200	Terraced	Waterstress	Rice - rice - legume Rice - potato Rice - rice - vegetables Rice - mung - maize	Water management intensification



Agroecological zoning of the Red River plain.

EDUCATION AND COMMUNICATION

Information flow from farmers in extension training and visit system: a case of rice production recommendations

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

Main channels for backward flow of information in the T&V extension system in Sri Lanka.[a]

Extension recommendations	Main farmer-to-extension contacts (backward flow) (%)			No "backward" contact (%)
	VEWs	CFs	FFs	
Variety	41	14	12	33
Transplanting methods	48	11	14	27
Fertilizer use	34	14	12	40
Chemical pest control	30	10	24	36
Chemical disease control	28	08	20	44

[a]n = 100 farmers.

Extension organizations are concerned with the transfer of information from experiment stations to farmers. Diffusion and adoption of recommendations have been used to assess the effectiveness of extension methods used. But practical problems faced by farmers are often not conveyed to scientists.

The Training and Visit (T&V) system of agricultural extension attempts to address this drawback. In the T&V system, information is passed from village extension workers (VEWs) to contact farmers (CFs), then to follower farmers (FFs). Information also flows in the other direction, from farmers back to extension workers and to researchers.

In Sri Lanka, one VEW is assigned to 36 CFs, and one CF is responsible for 21 farmers. CFs are expected to perform a catalyzing role, so that agricultural information can be more widely disseminated to farmers. Ideally, CFs also convey farmer queries, problems, and needs back to the VEWs (in a process of "backward flow").

We investigated the backward flow of information about selected rice production recornmendations in Matara district, southern Sri Lanka, in a survey of 100 randomly selected rice farmers (see table).

For the five types of recommendations examined, more farmers tended to contact their VEWs. Some farmers also consult FFs regarding chemical pest and disease control recommendations, perhaps because farmers in adjacent fields have similar problems and timely actions are essential to control such outbreaks.

For all recommendations, few inquiries were made to CFs, and this link seems to be ineffective in the process of two-way communication. Overall, feedback to research was limited. ■

ANNOUNCEMENT

Direct-seeded rice technology

Direct-seeded rice, principles and practices, by K. N. Singh and H. C. Bhattacharyya, consolidates information on direct seeding, an alternative to transplanting. The chapters describe direct seeding practices in various parts of the world, discuss technologies for the practice, and point out future research areas. The book was published by Oxford & IBP Publishing Co., Pvt. Ltd., 66 Janpath, New Delhi 1 10001, India. That company should be contactcd for ordering information. ■

ERRATA

Decline of morphogenic in microspore-derived calli from indica/japonica and japonica/japonica F_1 hybrids, by E. Guiderdoni, J.Luistro, and G. Vergara. 15(2) (Apr 1990), 6-7.

On page 7, column 2, line 9, change Kelef/IRAT216 to IR64/IRAT216; in line 13, change 10% to 1%. ■

An IRI3240-108-4-2-3 line with leaf blast (B1) and brown planthopper (BPII) biotype 2 resistance in Angiang, Vietnam, by Le Hieu Huu, Nguyen Thuan Khiet, and Vo Van Mieng. 15 (1) (Feb 1990), 19.

In the title and in the first line of paragraph I, IRI3240-108-4-2-3 should read IRI3240-108-2-2-3. ■

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