

Fate of applied N in traditional, modern, and conservation farming systems.<sup>a</sup> Maha Illuppallama, Sri Lanka.

Farming system	Applied N (kg/ha)		Removal by crop harvest (kg N/ha)			Retained in stubble (kg N/ha)			Retained in soil (kg N/ha)		Losses <sup>b</sup> (kg N/ha)		Net removal of N from farming system (kg/ha)
	PI	Cf	PI	Cf	So	PI	Cf	So	PI	Cf	PI	Cf	
Traditional: natural fallow incorporation	63	-	7.6 (12.1 b)	-	28.7 b	1.1 (1.7 a)	-	4.4 b	23.6 (37.5 a)	-	30.7 (48.7 b)	-	5.1 c
Modern: full amount recommended chemical fertilizer	-	87	-	16.1 (18.8 a)	28.3 b	-	1.7 (2.0 b)	3.5 c	-	9.4 (10.8 a)	-	59.8 (68.7 a)	18.7 b
Conservation:													
a) <i>S. rostrata</i> + 1/2 recommended chemical fertilizer	40	44	4.5 (11.7 b)	9.4 (20.3 a)	36.4 a	0.6 (1.0 b)	1.1 (2.5 b)	4.9 ab	4.8 (12.0 c)	6.1 (13.9 a)	30.1 (75.3 a)	27.4 (62.3 a)	25.3 a
b) <i>S. speciosa</i> + 1/2 recommended chemical fertilizer	30	44	5.0 (16.6 a)	9.9 (21.9 a)	30.6 b	0.6 (2.0 a)	1.7 (3.9 a)	5.4 a	8.9 (29.7 b)	3.6 (8.2 a)	15.5 (51.7 b)	28.8 (65.5 a)	17.9 b
LSD (0.05)			4.2	7.5	2.9	0.6	0.6	0.6	7.6	6.7	9.3	7.4	2.3
CV (%)			19.3	23.0	4.71	17.2	10.4	7.03	14.2	30.5	7.94	5.67	7.34

<sup>a</sup>PI = plant (green manure/natural fallow), Cf = chemical fertilizer, So = soil. Values within parentheses indicate amounts as percentages of applied N. In the same column, values followed by the same letter are not significantly different at the 0.05 probability level. <sup>b</sup>Losses from soil through leaching to subsoil, denitrification, and NH<sub>3</sub> volatilization.

fertility is sustained because rice straw incorporation can fix 20 kg N/ha. Other sources do not replenish net N removed in the modern system because adding chemical N fertilizer brings negative N

balance in ricefields. This tends to decrease soil N fertility in the long run. It has, however, been reported that incorporating fresh leaves of *Sesbania* spp. into soil under flooded condition could

increase nonsymbiotic BNF. More data are needed to fully evaluate the sustainability of N fertility in conservation farming. ■

## Integrated pest management—diseases

### Occurrence of rice tungro disease in central Vietnam

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Symptoms similar to those of rice tungro disease (RTD) were first observed in Vietnam in 1982. The disease reached epidemic levels in 1990 on about 20,000 ha of summer-autumn rice grown in Khanh Hoa, Binh Dinh, Phu Yen, and

#### Retention period of the agent of yellow leaf symptoms in GLH.

Days after acquisition	No. of infective insects <sup>a</sup>
1	42
2	36
3	20
4	8
5	2
6	0

<sup>a</sup>70 GLH were tested.

Quang Nam-Da-Nang provinces in central Vietnam.

The usual symptoms were yellow leaves and stunting. Leaf discoloration started from the tip, and mottle symptoms were sometimes observed on young leaves. Plants infected early often had delayed flowering, small panicles, and a high percentage of sterile and unfilled or empty grains. Although late-infected plants did not show any symptoms, ratoons grown from their stubble did. Varieties IR17494, IR8, IR9823, Binh dinh, CN47, CN78, VL 12, and LD84 were severely affected; IR64, TH28, IR68, and KSB21 were considered resistant.

As RTD had never before been reported in the region, we conducted insect transmission tests and an enzyme-linked immunosorbent assay (ELISA). Preliminary tests using insects with 10-d acquisition periods and 24-h inoculation periods indicated that the green leafhopper (GLH) transmitted the

disease, but not the brown planthopper or whitebacked planthopper.

We examined the transmission manner by allowing 70 GLH to feed on infected IR17494 plants for 24 h. GLH were transferred serially onto 10-d-old seedlings in tubes for a 24-h inoculation access time. Forty-five GLH transmitted the disease. Maximum retention period of the agent in GLH was 5 d (see table).

These results indicate that GLH transmits the disease in a semipersistent manner. Using ELISA, we detected both rice tungro spherical virus and rice tungro bacilliform virus in infected plants. Therefore, RTD is the cause of the yellow leaf symptoms. ■