Table 1. Behavior of some CMS lines at 3 locations in the Philippines.

CMS line	Location	Pollen sterility [a]	Seed setting (%) of bagged panicles	Reaction to RTV [b]	Outcrossing potential [c]	Days to 50% flowering
V20 A	IRRI	CS	0	S	3	83
	Banaue	CS	0	R		102
	San Mateo	CS	0	I		81
IR46830 A	IRRI	CS	0	I	9	86
	Banaue	CS	0			108
	San Mateo	CS	0	I		89
IR54755 A	IRRI	CS	0	R	9	81
	Banaue	CS	0	R		108
	San Mateo	CS	0	R		88
IR58025 A	IRRI	CS	0	I	3	102
	Banaue	CS	0	R		116
	San Mateo	S	0.33	R		90
IR62829 A	IRRI	CS	0	I	1	85
	Banaue	PS	2.20	R		105
	San Mateo	S	0.05	R		84

[a] CS = completely sterile (0% fertility), S = sterile (1.10% fertility), PS = partially sterile (11.30% fertility), [b] RTV = rice tungro viruses. R = no infection, I = slight infection, S = severe infection. [c] Outcrossing potential on 1–9 scale: 1 = high and 9 = low.

were selected to develop heterotic rice hybrids.

We made 251 testcrosses using elite lines, IR62829 A, and IR58025 A to identify maintainers and restorers. Pollen sterility was 98–100% in testcross F_1s. This indicates that the male parent is a maintainer that can be converted into a CMS line by recurrent backcrossing.

Testcross F_1s showed normal seed setting (more than 75%), indicating that the elite line is a restorer and can be used as a male parent in developing heterotic rice hybrids. We identified 14 maintainer and 18 restorer lines (Table 2).

Maintainer lines have been backcrossed 1–3 times to convert them into CMS lines. Restorers are being purified by re-test crossing single plants before use in developing experimental rice hybrids for yield testing. □

Table 2. Maintainer and restorer lines identified at Philippine Rice Research Institute, 1990-91 dry seasons.

Cultivar	Tester CMS line	Backcrosses (no.)
Maintainers		
BPI 30-2	IR62829 A	3
MRC22387-859	V20 A	3
BPI 121-407	IR62829 A	2
IR5537-32-D	IR62829 A	1
IR55548-05	IR62829 A	1
IR57893-26	IR62829 A IR58025 A	1
IR60076-04	IR62829 A	1
IR60080-45	IR62829 A	1
IR57934-02	IR54755 A	1
IR60077-09	IR54755 A	1
IR60080-35	IR54755 A	1
IR60080-41	IR54755 A	1
IR55543-51-B	IR58025 A	1
Cavitena	IR58025 A	1
Restorers		
BPI Ri 10	IR62829 A	–
MRCl1055-432-23	IR62829 A	–
MRCl8186-611	IR62829 A	–
MRC18624-1466	IR62829 A	–
MRC22367-807	IR62829 A	–
Mantika Banguin	IR62829 A	–
PR21209-389-5	IR62829 A	–
RP1057-393-1	IR62829 A	–
OR141-99	IR62829 A	–
IR66	IR62829 A	–
IR3380-60-1-2-2	IR62829 A	–
IR31432-9-3-2	IR62829 A	–
BR11-461-1	IR62829 A	–
BR425-189-1-6-2-1-2	IR62829 A	–
BR316-15-4-4-1	IR62829 A	–
BR11	IR62829 A	–
IR60080-27	IR62829 A	–
PR23342-5	IR62829 A	–

Low light-tolerant restorers in hybrid rice breeding

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Low light during reproductive and ripening phases can critically constrain rice productivity during wet season.

We studied the low-light adaptability of 19 IRRI purified restorers during dry season. Wooden screens artificially shaded plants (50% normal light) from 35 d after planting to harvest. Controls were maintained under normal sunlight.

The experiment was laid out in a split-plot design with three replications. The

Effect of 50% shade from 35 d to harvest on total dry matter (TDM) and yield of restorers. 1990 dry season.

Restorer	TDM (g/m^2)		Reduction	Yield (g/m^2)		Reduction
	Light	Shade	(%)	Light	Shade	(%)
IR36	872	433	51.3	405	170	58.0
IR46	866	360	58.4	440	96	78.2
IR50	775	500	35.5	399	200	49.9
IR54	983	528	46.3	406	193	52.5
IR58	1190	350	70.6	450	118	73.8
IR64	896	479	46.5	446	204	54.3
Milyang 54	654	473	27.7	302	186	38.4
ARC1 1353	888	542	39.0	373	173	53.6
IR4422-480-2-3-3	974	599	38.5	338	209	38.2
IR9761-19-1	625	414	33.8	305	165	46.0
IR13419-113-1	993	414	58.3	483	147	69.6
IR13524-21-2-3-3-2-2	713	305	57.2	365	118	67.7
IR19058-107-1	930	577	38.0	413	232	43.8
IR19392-211-1	937	425	54.6	466	181	61.2
IR21916-128-2-2-3	1029	436	57.6	493	153	69.0
IR25912-63-2-2	856	466	45.6	435	137	68.5
IR27315-145-1-3	1013	460	54.6	318	133	58.2
IR28178-70-2-3	719	537	25.3	291	179	38.5
IR29723-143-3-2-1	854	436	48.9	424	127	70.0
Annapurna (check)	759	391	48.5	326	126	61.3
Jaya (check)	978	524	46.4	401	230	42.6
Mean	881	459	46.8	394	165	56.8
LSD (0.05)						
Treatments (T)	79			21		
Variety (V)	94			55		
V at same T	133			77		
T for same V	221			89		

two light treatments were in the main plots and the restorers in the subplots. Total dry matter (TDM) and yield were recorded at harvest.

Low light reduced mean TDM 47% and yield 57%. Reductions ranged between 25-71% for TDM and 38-78% for yield (see table). TDM and yield were higher in IR54, IR58, IR134 19- 1 13- 1, and IR21916-128-2-2-3 under light. IR19058-107-1, Milyang 54, IR4422-480-2-3-3, and IR28178-70-2-3 all showed little reduction in TDM and yield percentages under low light. This indicates their high yield capability under low-light stress.

Physiologically effective restorers, especially IR 19058-107-1, may be useful in developing superior rice hybrids for low-light monsoon areas. □

Physiological traits of certain restorers in hybrid rice breeding

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Restorers have been selected for cytoplasmic genetic male sterile lines based on fertility restoration and general combining ability for yield.

We tested the photosynthetic potential, growth, and yield efficiency of 20 purified IRRI restorers against controls Annapurna (early) and Jaya (medium) under field conditions during the 1989 wet season. We periodically drew samples to assess leaf area index (LAI) and dry matter (DM) production.

The photosynthetic rate (Pn) of the top three leaves at flowering was measured with the LI-6000 Portable Photosynthesis System at near saturated light (above 900 μ E/m^2 per s).

The high Pn entries IR58 and IR9761 - 19-1 had low LAI (see table), resulting in low canopy photosynthesis (Pn × LAI). IR25912-63-2-2, with moderate Pn and high LAI, recorded high canopy Pn, DM, and yield. IR19058-107-1 was especially efficient in LAI at flowering, DM production, and yield. To develop stable, superior F_1 hybrids with high yield potential, IR25912-63-2-2 and IR19058-107- 1 may be useful for heterotic combination of physiological traits. □

Physiological traits of selected restorers from IRRI. Cuttack, India, 1989 wet season.

Restorer	Pn (mg CO_2/ dm^2 per h)	LAI F	Pn × LAI (g/m^2 per h)	Total DM (g/m^2)			Yield (g/m^2)
				30 d	Flowering	Harvest	
IR36	36.3	2.48	8.9	99	619	887	339
IR46	28.9	3.78	10.9	86	617	901	262
IR50	34.3	2.46	8.4	88	394	537	207
IR54	30.4	3.80	11.5	109	691	789	289
IR58	40.4	2.05	8.3	121	420	569	234
IR64	35.5	2.88	10.2	123	600	758	256
Milyang 54	35.2	2.34	8.2	96	498	606	188
ARC11353	25.2	4.47	11.3	129	1124	1326	478
IR4422-480-2-3-3	26.2	4.15	11.1	140	886	1074	347
IR9761-19-1	39.3	2.28	9.0	105	550	714	198
IR13419-113-1	24.3	4.49	10.9	103	818	964	233
IR13524-21-2-3-3-2-2	35.5	2.60	9.2	118	534	707	228
IR19058-107-1	27.3	4.94	13.5	150	1213	1547	458
IR19392-211-1	33.3	2.47	8.2	130	564	751	238
IR21916-128-2-2-3	29.6	3.09	9.1	90	564	701	196
IR25912-63-2-2	35.3	6.39	22.5	110	1010	1365	456
IR27315-145-1-3	24.4	4.85	11.8	112	886	1161	389
IR28178-70-2-3	28.9	4.17	12.0	109	869	1192	482
IR29512-81-2-1	31.9	3.71	11.8	83	955	1227	476
IR29723-143-3-2-1	26.7	5.13	13.7	137	953	1194	490
Annapurna (check)	31.6	2.09	6.6	109	429	590	279
Jaya (check)	38.4	2.71	10.4	86	582	798	318
Mean	31.7	3.51	10.8	110	717	925	320
LSD (0.05)	3.4	0.95	3.5	ns	I62	179	85

Yield potential

Effect of nitrogen level on the relation between sink-source parameters and grain yield

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We studied correlation coefficients between sink-source parameters and grain yield in lowland rice. In a field experiment at IARI during the 1988 kharif (monsoon), seedlings of C-1907, Pusa 169, and Pusa 312 were transplanted at 20- × 10-cm spacing.

The experiment was laid out in a split-plot design with three replications. Various growth and biochemical parameters were recorded at different stages and then correlated with grain yield. Nitrogen levels were in the main plots and cultivars in the subplots.

Grain yield correlated better with source than sink parameters particularly LAI and total chlorophyll content at flowering stage (Table 1). An increased

Table 1. Correlation values between different sink and source parameters and grain yield. IARI, 1988 kharif.

	r value[a]
Sink components	
Panicles (no./m^2)	0.46*
1000-grain weight (g)	0.49 *
Spikelets (no./m^2)	0.46*
Sink size	0.42*
Source components	
LAI	0.70**
Total chlorophyll content at flowering stage	0.60**
Leaf N content at flowering stage	0.43*

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