Heterosis [a] in 38 combinations. Coimbatore, India, 1985 dry season.

Character studied[b]	26 combinations (ovule parent used: Zhen Shan 97A)				12 combinations (ovule parent used: Er-jiu-Nan 1A)			
	Range of standard heterosis (%)		Range of heterobeltiosis (%)		Range of standard heterosis (%)		Range of heterobeltiosis (%)	
	From	To	From	To	From	To	From	To
Plant ht (cm)	–42.53 (Kanchi)	–2.12 (K. Samba)	–49.72 (PTB10)	+17.81 (TNAU658)	–34.09 (IET5103)	11.12 (IR9698)	–41.32 (IET6208)	+7.12 (IR19053)
Tiller number per plant	+100.00 (IET1722)	+242.85 (TNAU4372)	+111.11 (Co 13)	+242.85 (TNAU4372)	+117.14 (IET3267)	+222.85 (IR2307)	+111.11 (IET3267)	+207.93 (IR9715)
Panicle length (cm)	–19.46 (Co 33)	+0.44 (ASD8)	–24.80 (BAS370)	+25.41 (ASD8)	–19.02 (IR9698)	–2.21 (IR19053)	–18.30 (IR9698)	+11.61 (IR19053)
Spikelets per panicle	–65.85 (TNAU658)	–9.15 (Co 37)	–54.10 (TNAU658)	+41.84 (IR50)	–48.17 (IR9698)	–12.80 (AS19789)	–67.81 (IET6208)	+53.32 (IR2307)
Grain yield per plant (g)	–81.77 (BAS370)	–8.33 (AD9246)	–87.27 (BAS370)	–3.82 (AD9246)	–65.26 (IR19053)	+7.89 (IET6208)	–69.01 (IET5103)	+11.11 (IR9698)
Grain number per panicle	–93.6 (ADT31)	–74.4 (K. Samba)	–93.10 (ADT31)	–43.01 (IR36)	–94.16 (IR2307)	–47.76 (IET6208)	–87.14 (IR2307)	–36.19 (IR19053)
Unfilled grains per panicle	–5.12 (TNAU658)	+238.46 (Co 37)	+77.94 (TNAU4372)	+728.57 (PY2)	–46.93 (IET5103)	+226.02 (IET3630)	+7.21 (IET5103)	+908.94 (IR2307)
Straw wt (g)	–42.50 (IR9752)	+91.25 (IR56)	–47.50 (TNAU4372)	+90.62 (Co 37)	–30.00 (IR19053)	+134.37 (IET6208)	–11.66 (IR18599)	+111.65 (BPHR5)

[a]Standard heterosis compared with Co 37, heterobeltiosis compared with pollen parent. Variety in brackets = pollen parent. [b]Av for 5 plants.

Variation in stigma exsertion in rice

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Stigma exsertion rate (SER) in 105 cultivars from Zhejiang and Taiwan, China, and from India was examined in late 1983 and 21 floral and panicle characteristics including stigma exsertion were examined in 330 cultivars from Taihu Valley and Yunnan Province in late 1984. Variation in SER in relation to other agronomic and morphological traits was examined by correlation, path, cluster, and principal component analyses.

SER ranged from 0 to 76% (mean 12.8%) among the cultivars observed in 1983 (see table). SER was 0-76% (mean 19.9%,) in indica rices and 0-40% (mean 5.9%) in japonicas. SER ranged from 0 to 69% (mean 8.5%) among the cultivars observed in 1984. The mean SER in indicas (19.3%) was higher than that in japonicas from Taihu Valley (3.2%), but lower than that in japonicas from Yunnan plateau (25.2%). Upland rices showed higher SER (18.8% in 1983 and 30.5% in 1984) than lowland rices (11.2% in 1983 and 5.3% in 1984).

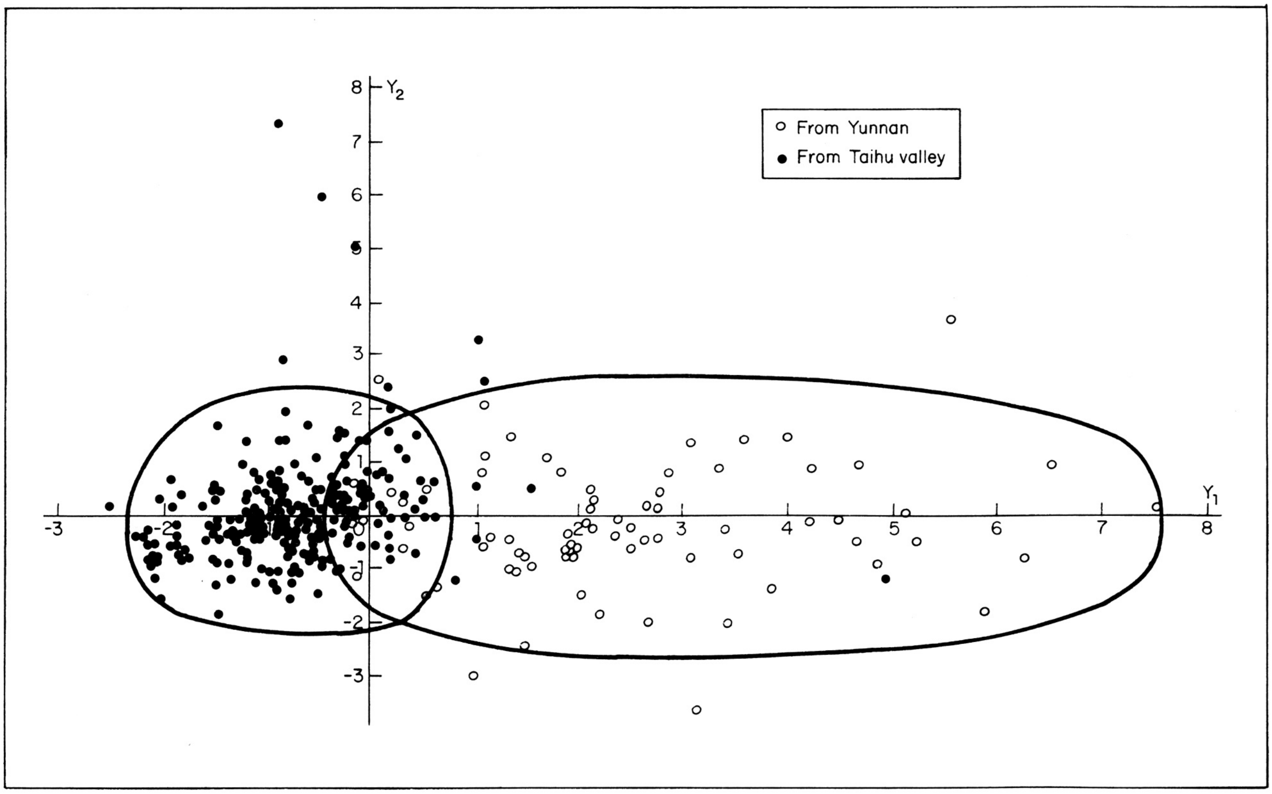
Variation in SER in cultivars. Hangzhou, China, 1983-84.

Cultivars		SER (%)				
Type	No.	Mean	Upland rice		Lowland rice	
			Mean	Range	Mean	Range
Observed in 1983	105	12.8	18.8	0 -54.3	11.2	0-75.9
Indicas	52	19.9	21.1	2.3-34.8	19.4	0-75.9
Japonicas	53	5.9	14.7	0 -54.3	2.3	0-39.7
Observed in 1984[a]	330	8.5	30.5	5.6-54.2	5.3	0-68.6
Indicas	19	19.3	30.7	10.5-52.6	16.3	0-63.2
Japonicas	306	7.6	30.5	5.6-54.2	5.6	0-68.6
From Yunnan	84	23.2	30.5	5.6-54.2	20.7	0-68.6
Indicas	18	16.9	30.7	10.5-52.6	12.9	0-46.3
Japonicas	61	25.2	30.5	5.6-54.2	22.9	0-68.6

[a]Some cultivars from Yunnan were medium type in indica-japonica differentiation.

Cultivars from Yunnan could be divided into two groups on the basis of differences in SER, which were in proportion to numbers of lowland and upland rices. Differences between cultivars from Yunnan and Taihu Valley on the scatter diagram were in concordance with differences in SER (see figure).

Major characteristics contributing to SER were classified as stigma characteristics (outwardly curved stigma, pistil length, number of stigma branches), spikelet characteristics (length, width, and 1ength:width ratio), and angle of floret opening. Glume pubescence and awn length also may be used as indirect indices of SER. □



Two-dimension ordinations of 330 cultivars observed in Hangzhou, China, 1983.

Possibility of transferring apomixis from sorghum to rice

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Apomixis can be exploited for the fixation of heterosis in hybrid rice. However, no cultivated or wild rice species with apomictic modes of reproduction are known. The only cereal in which a high frequency of facultative apomixis (80%) has been exploited is grain sorghum. We attempted intergeneric transfer of apomixis using protoplast fusion.

An embryogenic cell suspension culture LB-1 of rice variety T309 is available as a source of protoplasts at Nottingham University. Sorghum protoplasts can be isolated from leaves. Using standard procedures, protoplasts from the LB-1 suspension culture of T309 and mesophyll protoplasts from the apomictic sorghum line R473 were isolated. Rice protoplasts were vitally stained with fluorescein diacetate (FDA) to facilitate identification.

After washing in electrofusion solution, protoplasts were mixed in a ratio of 1:1. Fusion was accomplished using Watts and King electrofusion equipment. Alignment of protoplasts was obtained in an AC field of 500 KHz volts for 20 s. A high frequency (6-8%) protoplast fusion was obtained with a 400 V DC pulse for 2 µs. The mixture of unfused protoplasts and heterokaryons was plated in sea plaque agarose in petri plates, with the position of heterokaryons marked with ink dots.

Within 10-12 d, the heterokaryons had formed walls and undergone 3 divisions. There was no subsequent development.

Further manipulation of the cultural conditions (prior conditioning of the medium with T309 callus, change in the composition of the medium, nurse culture, etc.) could help realize regenerated somatic hybrids. In similar intergeneric somatic hybrids, the genome of one parent is eliminated. It should be easy to screen progeny of regenerated rice plants for apomixis. □

Receptivity of exserted stigmas

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Experimental evidence suggests that exserted stigma traits, in particular its receptivity (probability of fertilization and seed set on spikelets with exserted stigma by artificial pollination after flowering) in CMS lines would increase outcrossing rates. We analyzed cultivars Xie-qing-zao (completely male sterile) and selections 25154 and 97154 (both partially male sterile) with exserted stigma, and Er-jiu-qing with non-exserted stigma for stigma receptivity to alien pollen at Linshui, Hainan, China, in spring 1984.