Overview of Hybrid Rice Research and Development in Nepal

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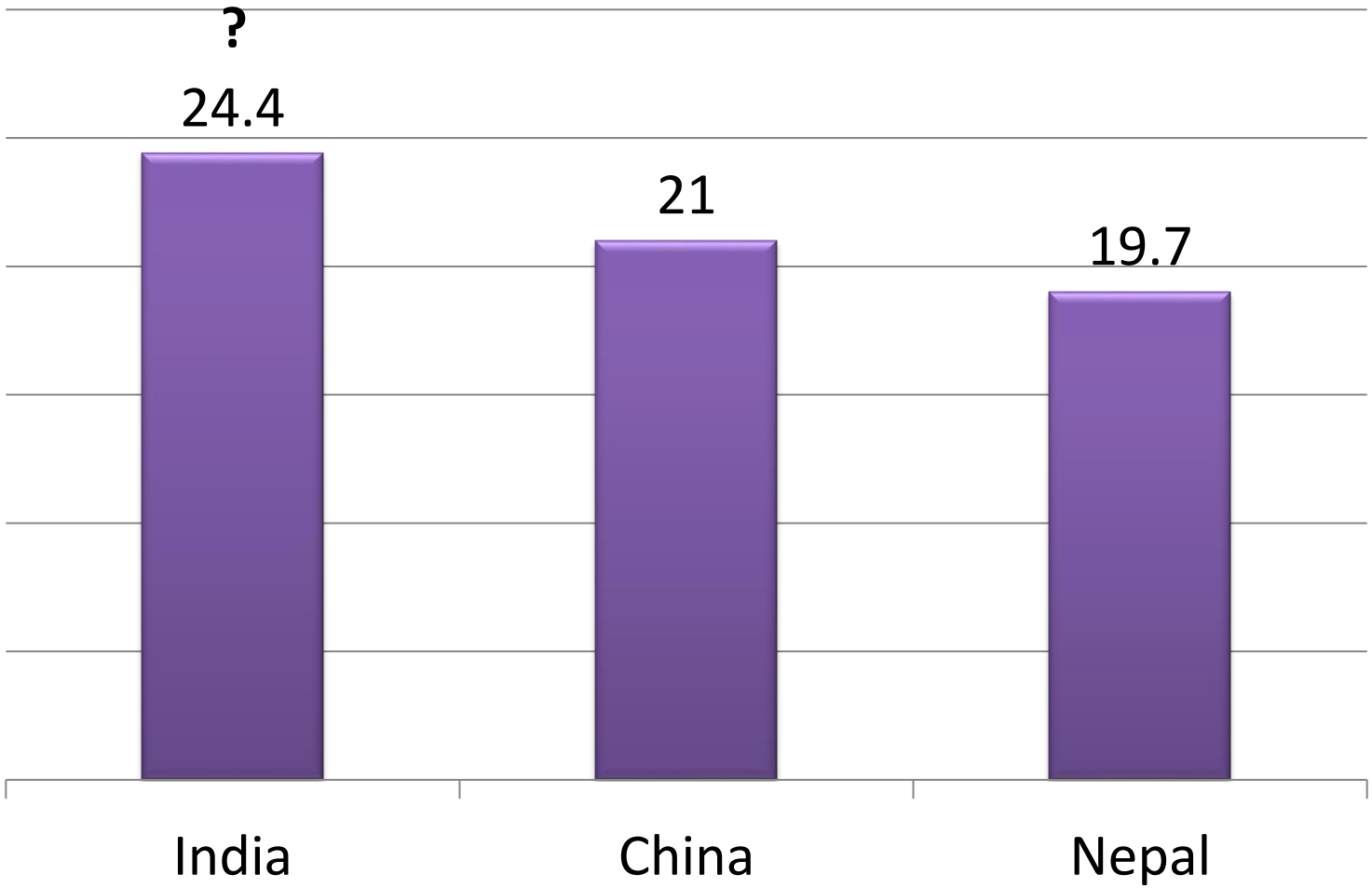
Plant Breeding Generations that we deal

- OPV
- Pure line/ Inbred
- Bulk/ Composite generations
- BC generations
- Segregating generations (F_2 onwards)
- Mutants
- NILs/ Multilines
- RILs
- Engineered generation
- DH
- Synthetic generation
- Polyploidy

F_1 Hybrid = The highest yield potential generation

? Additive, dominance and epistasis

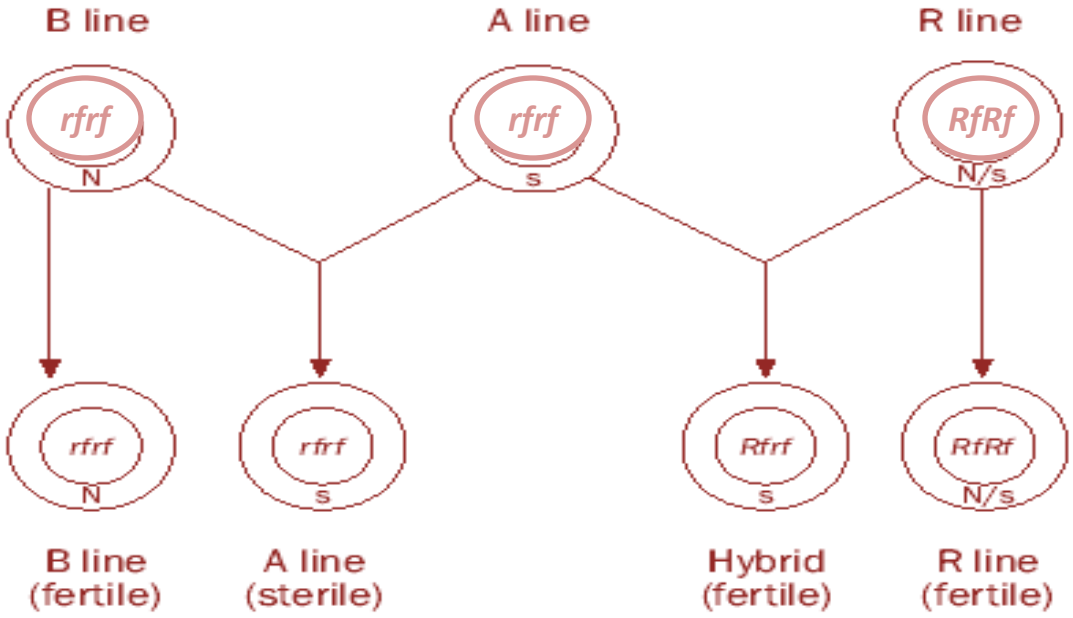
Experimental Yield (t/ha) of Hybrid Rice



Options for Hybrid Rice Development

A. Based on Breeding Methodology

- 3-Line Method (CMS System): 1st Generation Hybrid Rice-1974



- 2-Line Method (PGMS, TGMS & Chemically Induced MS System): 2nd Generation Hybrid Rice-1996
- 1-Line Method (Apomixis, Fixing Heterosis)

B. Based on the Degree of Heterosis

- Inter-varietal hybrids
- Inter-subspecific hybrids (*indica/ japonica*)
- Distant heterosis (using yield enhancing genes from other species/ genera, QTLs, C_4 gene)

Heterosis Level in Rice

indica/ japonica > *indica/ javanica* > *japonica/javanica* > *indica/ indica* > *japonica/japonica*

History of Hybrid Rice Cultivation and Research in Nepal

- Cultivation of Indian Hybrid Rice from 1995 by Farmers in Taulihawa, Kapilbastu
- Both in Tarai and Mid Hill areas (More in Western Nepal?)
- Chinese and Indian Hybrid Rice in Farmers' Fields
- IRRI Hybrid Rice in Research Station
- 3-line method of Hybrid Rice Research from 1999
- WA cytoplasm from weedy rice (*O. sativa f. spontanea*)

Organizations involved in Hybrid Rice Research

National Rice Research Program-NARC

- Next Presentation: SN Sah

Agriculture Botany Division-NARC

- 12 CMS lines (A and B lines) from IRRI in 2004
- Identified some Restorer (R) lines from 31 cross combinations

Agronomy Division-NARC

- One season trial of Indian Hybrid Rice in 2003

NARC Vision (2011-2030)

- Development of crop varieties/hybrids to address biotic and abiotic stress as well as quality

SQCC

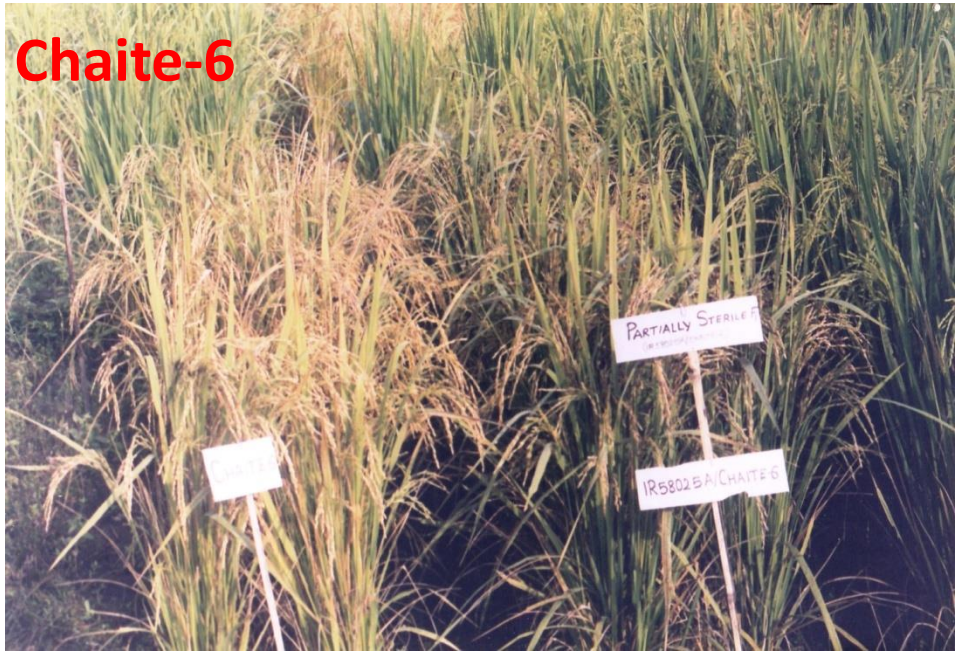
- Registered 3 Chinese Hybrid Rice in 2009 (Yield potential: 8-9 t/ha)
- Registered 14 Indian Hybrid Rice in 2011 (Yield potential: 7-9 t/ha)

Seed Vision-2025

- Hybrid Rice Research Unit
- 10 Hybrid Rice Varieties by NARC (Public sector)
- 4 Hybrid Rice Varieties by Private sector

IAAS, Rampur

- 3-line system from 1999



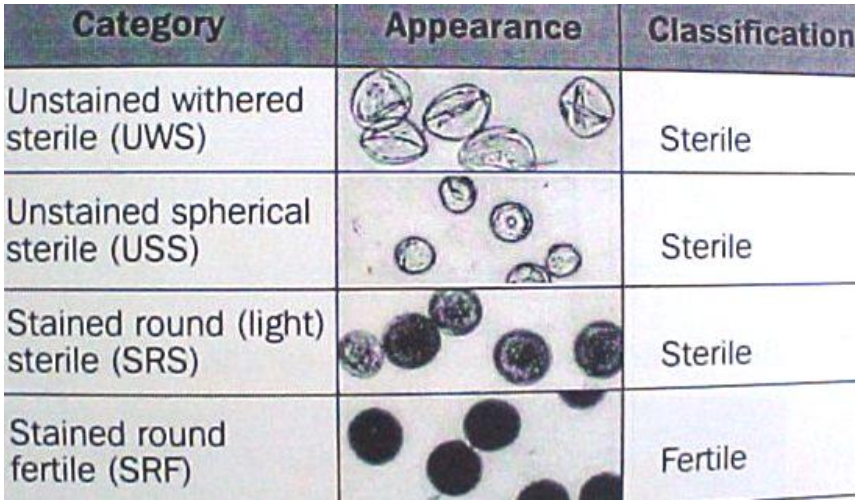
Heterosis Breeding in Rice:
Practical Experiences from Experiment in IAAS, Rampur

Steps in 3-Line System

- Development and evaluation of CMS lines (A)
- Development of maintainer lines (B)
- Identification/ development of restorer lines (R)
- Production and evaluation of F_1 hybrid seeds
- Maintenance of A, B and R Lines

Evaluation of CMS Lines (A)

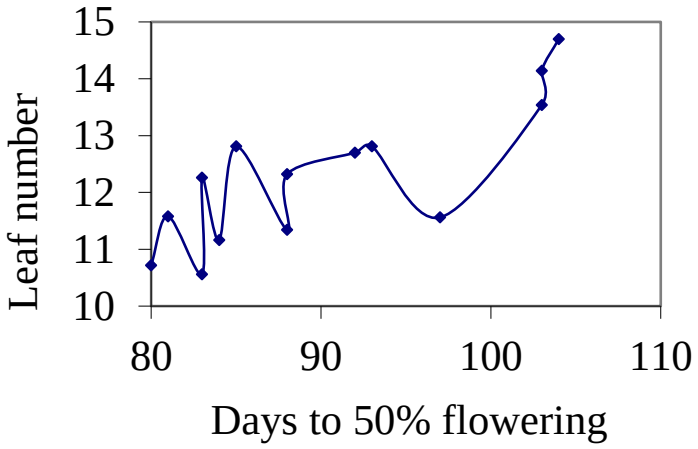
CMS line (A)	Pollen sterility (%)	Spikelet fertility (%)
IR58025A	98.62	0.00
IR62829A	88.30	0.00
IR68888A	100.00	0.00



Pollen sterility test using I-KI solution

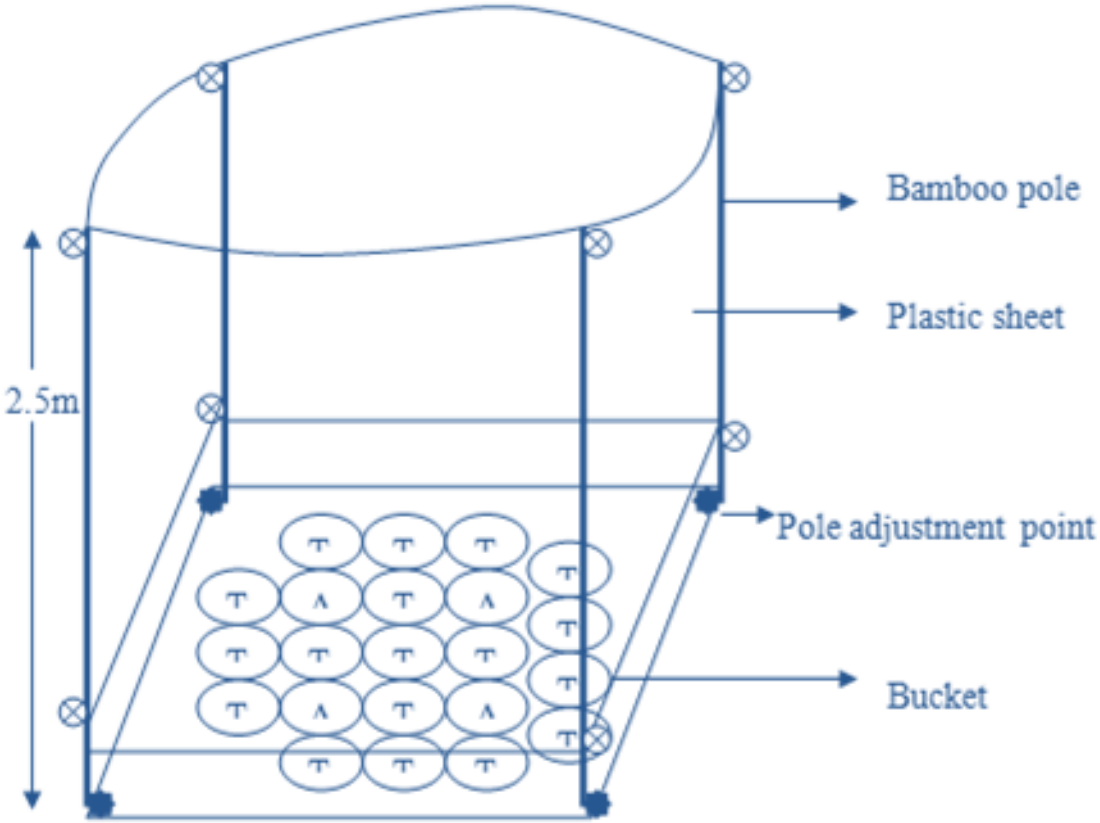
Synchronization Study

- Seeding interval (SI) for different hybrid combinations: Growth duration and leaf number methods
- Flowering period: 80 to 104 days
- Leaf number: 10.24 to 14.7
- Leaf number of a given cultivar: Stable over seasons/years
- Leaf number method more stable and accurate



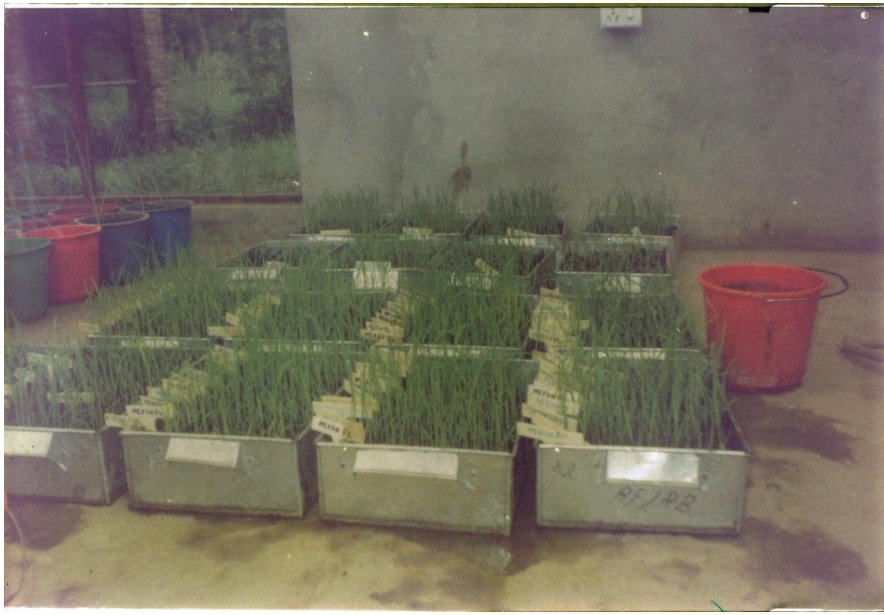
F_1 Seeds Production Using CMS Lines

Crossing chamber for F_1 seeds production



(A = Seed parent, T = Pollen parent

Test Cross Nursery + Heterosis Study



Identification of Restorer and Maintainer Lines

Pollen fertility (%)	Category	Spikelet fertility (%)
0-1	Maintainer	0
1.1-50	Partial maintainer	0.1-50
50.1-80	Partial restorer	50.1-75
>80	Restorer	>75

IAR-97-34

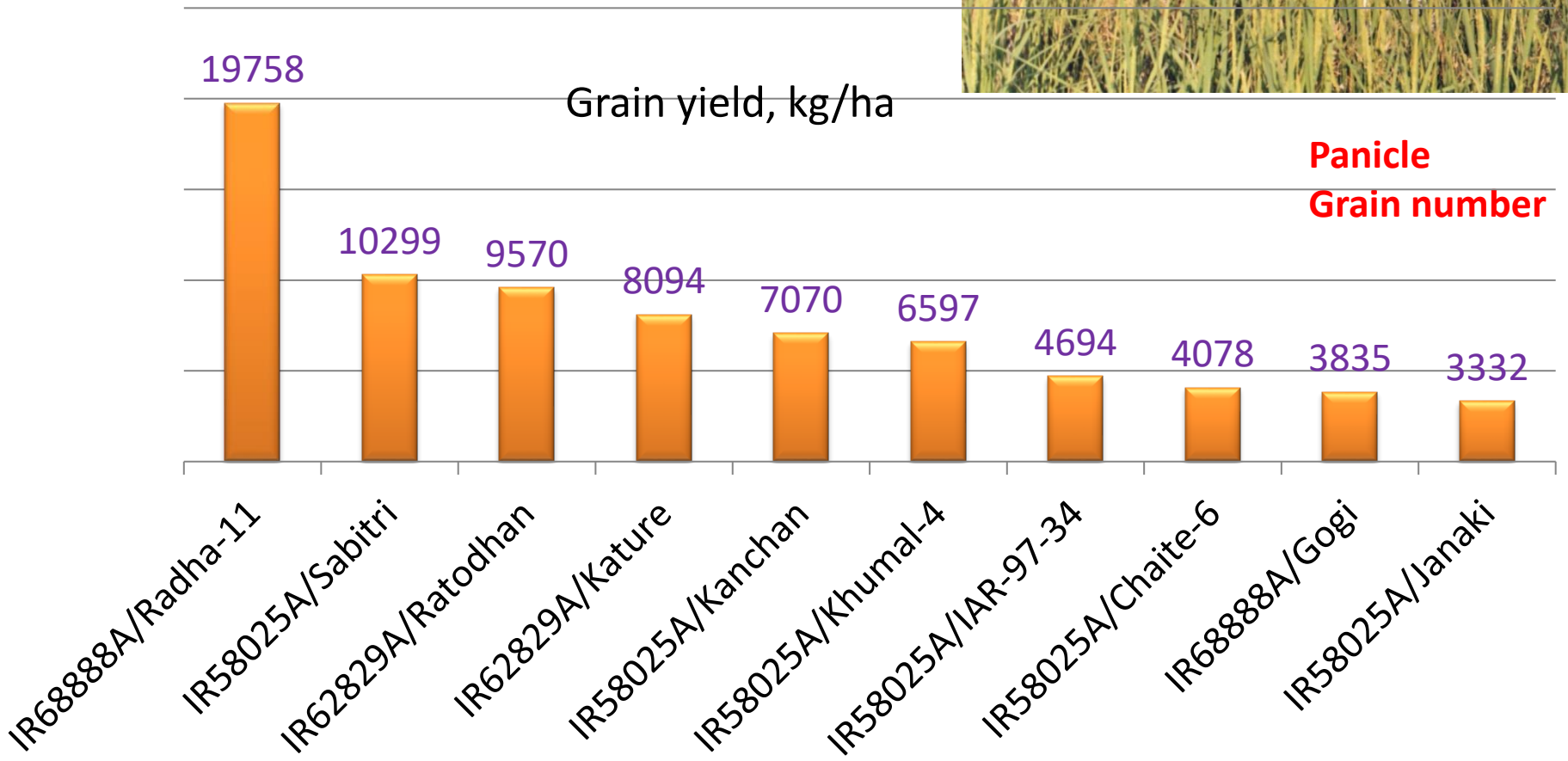
Restorers and Maintainers for 3 CMS Lines

CMS line (A)	Restorers (R)	Maintainers (B)
IR58025A	Kanchan, Sabitri	-
IR62829A	Kature, Ratodhan	Deharadhune
IR68888A	Radha-11	Bindeswori, Khumal-7, Chiunde
Frequency (%)	36	29

- TN-1 and CR94-13: Donors of maintainer and restorer genes (Sabitri, Bindeswari)
- R lines for hybrid seed production or to develop other R lines
- B lines to maintain A lines, or to develop CMS line (cybrid)

Heterosis on Grain Yield

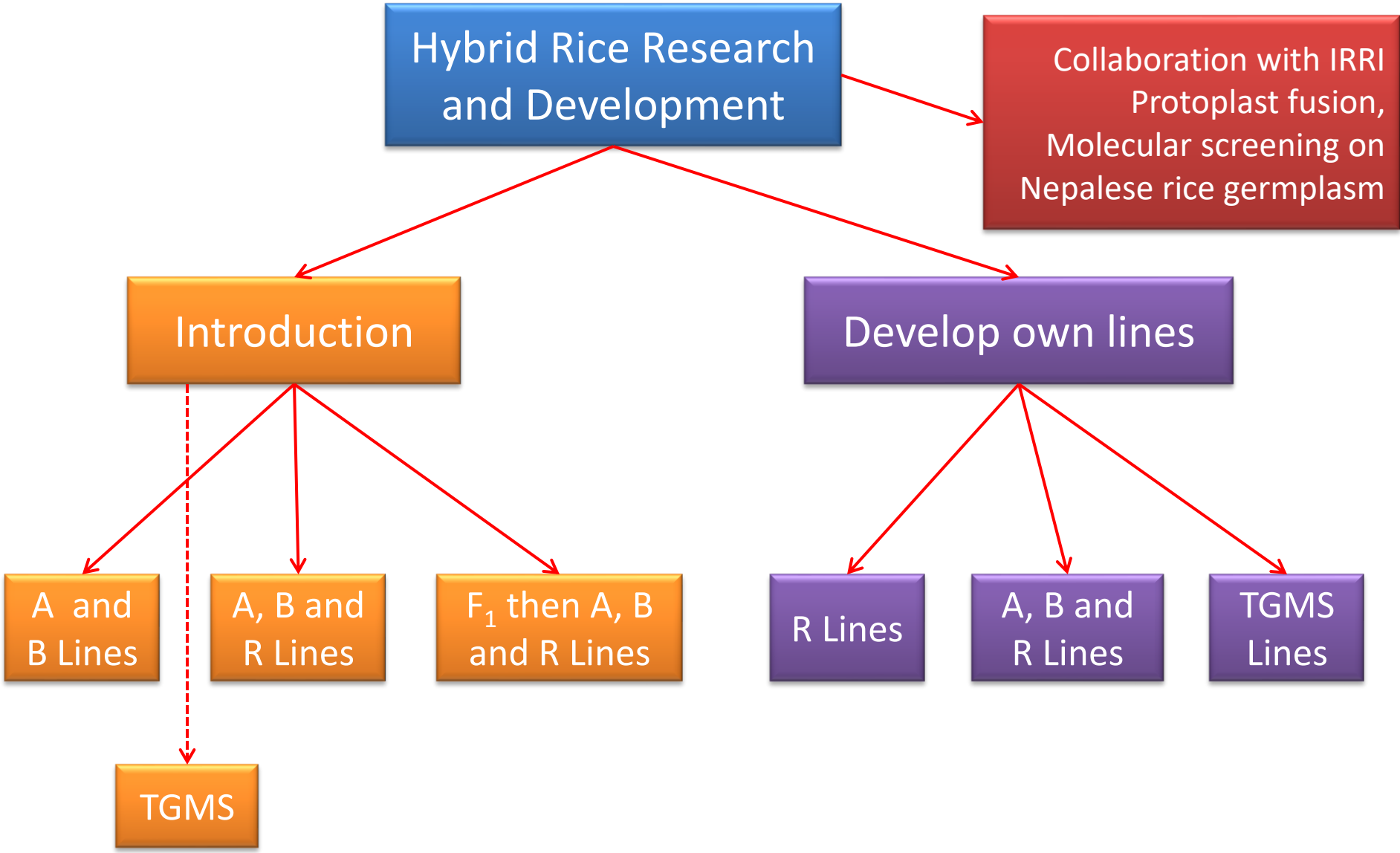
- Heterobeltiosis: –55 to 139%
- Standard heterosis: –11 to 369%



Molecular Markers for Accelerating Hybrid Rice Breeding

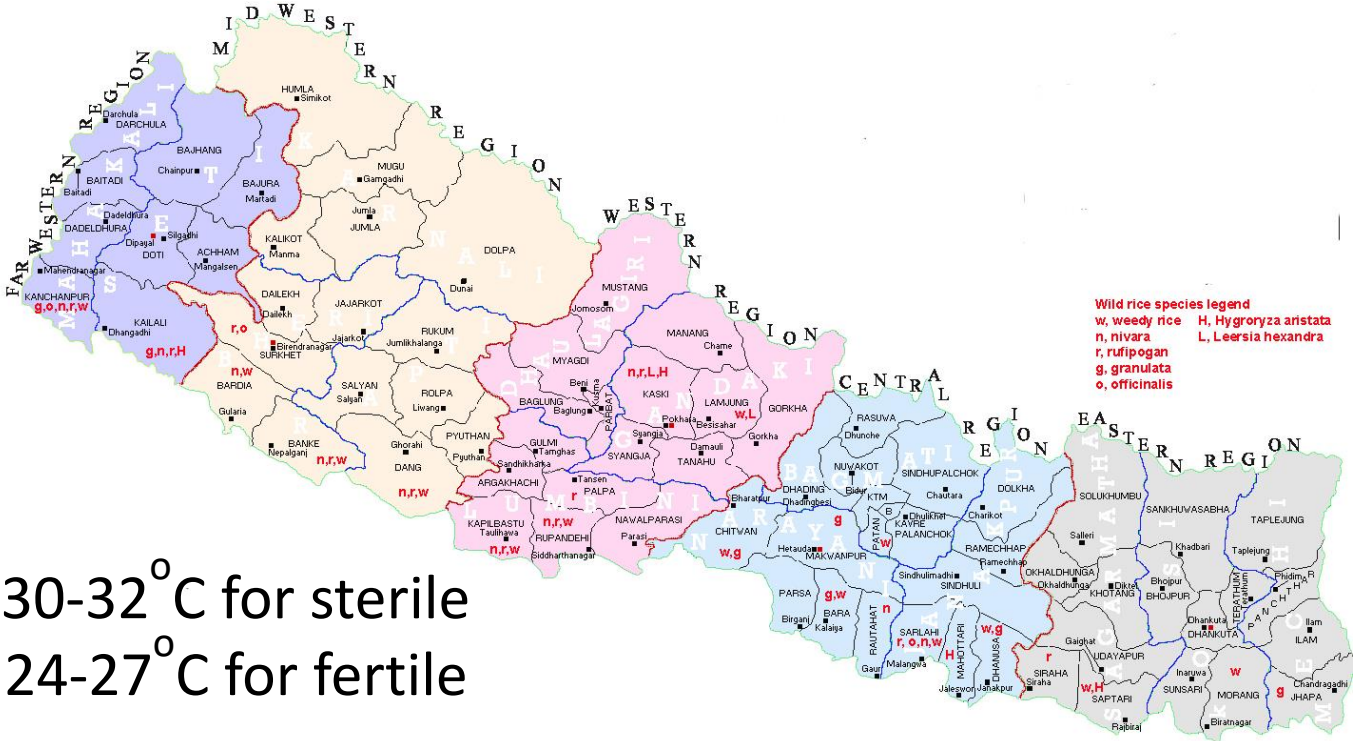
- Identification of restorer lines
- Marker assisted backcrossing (to develop A and B lines)
- Tagging genes for fertility restoration and TGMS
- Selection of parents to obtain highly heterotic combinations
- Identifying QTLs for heterosis
- Immediate transfer of S-cytoplasm into elite breeding lines through Protoplast Fusion (Cybrid)

Strategies for Hybrid Rice Research in Nepal



For Initiating Hybrid Rice Research

- Sabitri and Radha-11
- Deharadhune, Bindeswori, Khumal-7 and Chiunde
- IR58025A, IR62829A and IR68888A
- Weedy rice



- Temp (TGMS): 30-32^{o}C for sterile
  24-27^{o}C for fertile

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