

Varietal Diversity of Rice in India

B.N. Singh

Director Research

Birsa Agricultural University, Ranchi

Jharkhand, India

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Global Rice area: 2007 (FAO)

Continents	Area (Mha)	% of Total
Asia	140.0	90
Africa	9.3 +	6
South America	4.8 -	3
North & Central America	1.8 -	1
Europe	0.6	<1
Oceania	0.1-	<1
Total	156.6	100

Rice Area in Indian Subcontinent (FAO)

Countries	Area (Million ha)	Milled rice Production (Million tons)	Rice Yield (t /ha)
India	44.6	94.1	2.1
Bangladesh	11.2	29.0 +	2.6
Myanmar	8.2 +	21.7 +	2.8 +
Pakistan	2.6 +	5.5 +	2.1
Nepal	1.4 -	2.5-	1.7
Sri Lanka	0.8	2.1	2.6
Bhutan*	27,000 ha	46,000 tons	1.8
Total	68.8 (45%)	154.9 (37%)	2.2 (-)



Major rice ecologies

Rice Ecologies	Area (Mha)	% rice area	Production (M tons)	% of total production	Grain Yield (t /ha)
Irrigated	78	50	300	70	3.6
Rainfed lowland	54	35	93	20	2.0
Uplands	16	10	20	5	1.2
Deepwater & Flood prone	5	3	12	3	0.8
Coastal Wetlands	3	2	8	2	1.5
Total	156	100	433	100	2.6

Rice Ecologies	Intensity
Irrigated	4
Rainfed lowland	3
Uplands	2
Deepwater & Flood prone	1
Coastal Wetlands	1
Total	11

Rice Ecologies	India	Banglad esh	Myanmar	Pakistan	Nepal	Sri Lanka	Bhutan	Total
Irrigated	45	40	50	100 (48% basmati)	50	65	20	55
Rainfed lowland	35	44	32	-	45	30	65	33
Uplands	10	5	4	-	5	-	15	5
Deepwater & Flood prone	8	10	10	-	-	-	-	5
Coastal Wetlands	2	1	4	-	-	5	-	2
Total	100	100	100	100	100	100	100	100

History of Systematic Rice Research in the south Asia

Year	Establishment of Research Station
1907	Rice Research Station at Mandalay in upper region of Burma (Now Myanmar) was established
1911	Rice Research station was established at Dhaka (now in Bangladesh)
1912	Rice Research Station Was established at Coimbatore (Madras, now Tamil Nadu), India
1913	Rice research station was established at Karimganj , Assam India
1914	Rice research station at Hmawbi in lower region of Myanmar was established
1919	Rice research started at karjat in Kolaba in Maharastra State, India

History of Rice Research in the South Asia

Year	Establishment of Research Stations
1923	Rice research station was established at Titabar, Assam and Ratnagiri, Maharastra State, India
1924	Rice research station at kanpur was established in Uttar Pradesh, India
19296	Rice Research station was established at Kala Shah Kaku, (Now in Pakistan)
1929	Imperial (now India) Council of Agricultural Research was established at New Delhi as an apex body for Agricultural Research in India
1932	Rice research station at Nagina (Uttar Pradesh), Chinsurah(West Bengal), Sabour (Bihar), Raipur (Madhya Pradesh) were strengthened
1934	Rice research station for deep water rice research was established at Habiganj , Assam (now in Bangladesh)
1937	Rice research station at Dokri (now in Pakistan) was established

History of Rice Research in the South Asia

Year	Establishment of Research Stations
1943	Bengal Famine occurred due to poor rice garvest in which 2 million pepole died due to cyclone, flood and brown spot disease in rice
1945	FAO was established at Rome, Etaly as UN agency to reduce global hunger through Agricultural developmentin 90 countries of world
1946	Central Rice Research Station was established at Cuttack, Orissa, India
1947	Rice Research was established at Parwanipur in Nepal
1954	Rice Research station was established at Batalagoda in Sri Lanka
1960	International Rice Research Station was established at Los Banos Philippines
1965	Establishment of All India Coordinated Research Project (AICRP) at Hyderabad Andhra Pradesh India



AICRP

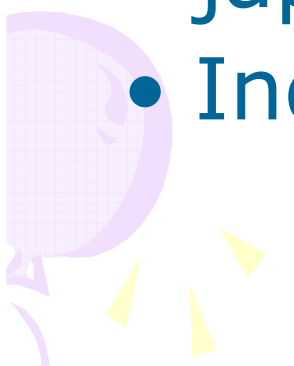
All India Coordinated Rice Improvement Project

- Estd. 1965
- Multilocal & Multidisciplinary evaluation of test entries, disease and insect trials and Agronomic evaluation
- Directorate of Rice Research , Hyderabad
- Holds Annual meeting in April each year
- Identifies varieties for release
- Monitor insects & Diseases and its management
- Has over 150 testing centers in India and 900 varieties released in different States in India.



Oryza and related species

Two cultivated spp.

- *Oryza sativa* (Globally)
 - *Oryza glaberrima* (Africa)
 - *O.sativa* : three subspp.
 - Indica (eotypes aus & aman)
 - Japonica (tropical & temperate japonica)
 - Indica-japonica
- 

Taxa in Genus *Oryza* in South Asia:5

O.sativa complex

Taxon	Genome	2n	Distribution
<i>O.sativa</i> L.	AA	24	Asia
<i>O.nivara</i>	AA	24	Annual wild rice: South Asia
<i>O.Spontanea</i> (<i>O.fatua</i>)	AA	24	India
<i>O.rufipogon</i>	AA	24	South asia

Taxa in Genus *Oryzain* South Asia:5 *O. officinalis* complex

Taxon	Genome	2n	Distribution
<i>O.officinallis</i>	CC	24	Tropical Asia
<i>O.rhizomatis</i>	CC	24	Sri Lanka
<i>O.malampuzh aensis</i>	BBCC	48	Kerala, India



Taxa in Genus *Oryzain* South Asia:5 *O. meyeriana* complex

Taxon	Genome	2n	Distribution
<i>O.granulata</i>	GG	24	South & South east Asia



Taxa in Genus *Oryza* in South Asia: Unknown

Taxon	Genome	2n	Distribution
<i>Porteresia</i> (<i>Oryza</i>) <i>coarctata</i>	?	48	Bangladesh & India (Tolerant to coastal salinity)



NBPGR National Bureau of Plant Genetic Resources

- New Delhi
- 87, 000 collections of traditional varieties of rice from India
- 1000 wild rices
- Long term conservation

Landmarks in Varietal selection from land races and traditional rice germplasm in South Asia

variety	Germplasm and land race and area of Adaptaion
Basmati 370	Punjab(India and Pakistan). Selection from Basmati collections at Kalashah kaku, Scented, long grain, and good kernel elongation of cooked rice, good eating quality
Type 3	Selection from Dehradun Basmati, at Nagina Western Uttar Pradesh, LS grains, scented and good eating qulity
Taraori Basmati	Selection from Basmati collections from Haryanaat village Taraori. Extra LS grains, scented good eating quality
N22	Selection from Rajbhog, drought and heat tolerant, early maturing upland rice variety
Safri 17	Rainfed lowland drought tolerant selection from safari land races collection from Madhya Pradesh and Chhattisgarh

Landmarks in Varietal selection from land races and traditional rice germplasm in South Asia

variety	Germplasm and land race and area of Adaptaion
PTB 33	Collections at Pattambi, Kerala. Multiple resistant Resistant donor for BPH, WBPH, BLB & Thrips. Parent of IR 56 and IR 62, ADT 37
TKM6	Donor for multiple resistance for BLB and Stem borers.Parent of IR 20, IR 26, Ratna, Vices etc
GEB24	Donor for good grain quality. Parent of ADT 27, Sona, Sambha Mahsuri
T 141	Donor for high photosynthetic efficiency. Parent of Jaya.
Kalakeri	Drought tolerant donor from Orissa, India. Parent of Vandana
H5	Donor for BPH from Sri Lanka

Landmarks in Varietal selection from land races and traditional rice germplasm in South Asia

variety	Germplasm and land race and area of Adaptaion
Vytilla 1	Selection from Pokkali, tolerance to Coastal salinity and water logging in Kerala, India
CSR 1	Selection from Damodar land races collection . Tolerance to coastal salinity
Nona Bokra	Selection from Land races, tolerance to coatal salinity in West Bengal, India
Br8	Selection from Kessore land races collection from Bihar, India
Sudha	Selection from Deep water rice collection from Bihar, India
Sugandha	Selection from photosensitive land races collection of scented rice in Bihar, India

Outstanding donor for resistance to biotic and abiotic resistance from rice germplasm in South Asia

variety	Germplasm and land race and area of Adaptaion
PTB 2	PLS from Ponnaryan. Resistance to RTD. Parent for Vikramarya
PTB 10	PLS from Thekkancheera. Resistant to gall midge. Parent of variety Jyothi, Annapurna, Abhaya, Triveni and Rohini
PTB 21	PLS from Thekkan. Resistance to gall midge, GLH, RTD, BPH, and Ragged stunt virus. Parent of CR 94-13, PR 108
Vellathucherra	Donor for resistance to gall midge from Kerala
ARC 10773	Assam Rice collections. Resistance to RTD and GLH
FR13A	Land race from Orissa. Donor for submergence tolerance.

Landmarks in utilization of wild genetic resources

Genetic resources	origin	Gene source	Utilization
<i>O.nivara</i> Acc 101508	Uttar Pradesh, India	Resistance to Grassy stunt virus	23 IR varieties released after IR 28 onwards, and almost all IR lines carry this gene
<i>O.officinallis</i> Acc. 100896	India	Resistant to BPH	Three varieties: MTL 98, MTL 103, and MTL 105 released in Vietnam
<i>O.rufipogon</i>	India	Resistance to BLB, blast, gall midge, tolerance to acid sulphat soils, salinity and yield QTL (Yld1& Yld2)	AS 1007 released in Vietnamas Acid sulphate tolerant variety. Dhanrasi relased in India with multiple disease resistance

Landmarks in Varietal Development in South Asia

Year	Cultivar	Origin	Major traits
1965	Mahsuri	CRRI(IxJ program) & Malaysia	Good grain quality, Widely grown in 10 mha in 1970's & 1980's
1968	Jaya	DRR Hyderabad	Widely grown variety (5 mha in 1970's & 1980's
1978	BG 90-2	Sri Lanka	Widely grown variety (5 mha in 1980's & 1990's
1982	Swarna	Maruteru, Andhra Pradesh	Widely grown variety (6.5 mha) in India, Nepal, & Bangladesh in 1990's & 2000's
1982	BR 11	Bangladesh	3 mha in 1980's& 1990's
1985	Samba Mahsuri	Baptala, Andhra Pradesh	3 mha, good grain quality in 1990's &2000's
1989	Pusa Basmati	IARI, New Delhi	1 mha, good grain, export quality in 1990's



Rice based Production System

- **Definition:** Production system is a method of cultivation, where varieties are cultivated based on rice ecologies, irrigation, seasons, altitude, seedling age, seeding methods, disease and insect pest complex, fertilizer use, grain quality, use of machinery and cropping system.

Rice Ecologies and Production Systems(REPS) in South Asia: 32

SN	REPS	Area Mha	varieties
1	Irrigated-Wet season	15	Swarna, IR 64,IR 36,Lalat, sarjoo 52, NDR 359
2	Irrigated – Hybrid rice	1.5	PA 6444, PHB 71, KRH 2, Pusa RH 10
3	Irrigated : Dry season/ T.Ahu	1.0	Tella Hamsa, IR 64, MTU 1010, Luit, Lachit,
4	Irrigated – Boro rice	4.0	Khitish, IR 64, Krishna Hamsa, satabdi,BRRI Dhan 28, BRRI 29
5	Irriagated- high altitude	0.2	CH 1039, CH 988, VLK 39, Jhelum, Shalimar rice 1, Kohsar, Barakat, Khumal 2, Khmal3, Khuamal4
6	Irrigated- Mid altitude Indica rice	0.5	Pant Dhan 6, Pant Dhan 10, Himali

Rice Ecologies and Production Systems(REPS) in South Asia

SN	REPS	Area Mha	varieties
7	Irrigated gall midge biotype 1	2.0	Phalguna, varalu, IR 36, Surekha, Danteswari, Uma, Pavithra
8	Irrigated gall midge biotype 2	1.0	Lalt, Shaktiman, Meher, Manika
9	Irrigated gall midge biotype 3	1.0	Srikakullam sannalu, vasubdhara, Vibhava, Abhaya
10	Irrigated gall midge biotype 4	1.0	Srikakullam sannalu, vasubdhara, Vibhava, Abhaya, ratnagiri 3
11	Irrigated gall midge biotype 5	0.5	Panchami, Pavitra, Uma
12	Irrigated gall midge biotype 6	0.5	Tempha phou, Sona phou, Priphou

Rice Ecologies and Production Systems(REPS) in South Asia

SN	REPS	Area	varieties
13	Irrigated : Inland saline and Sodic (WS)	2.0	CSR 13, CSR 27, CSR 30, narendra Usar 3
14	Irrigated: Coastal saline (DS)	0.5	Khandagiri, Parijat, BR 40, BR 41
15	Irrigated: Scented rice	1.0	Pusa Basmati 1, Pusa 1121, Kasturi, vasumati,
16	Rainfed uplands: favourable	2.5	Annada, Birsa Dhan 110, Anjali, vanaprabha, rasi, JR 75
17	Rainfed upland drought prone/ B.ahu/ Bhata	4.0	Kalinga 3, Vandana, Birsa Dhan 111, VLK Dhan 221, Dumai, Dr 92

Rice Ecologies and Production Systems(REPS) in South Asia

SN	REPS	Area	varieties
18	Rainfed upland: Hills (Jhum cultivation)	1.0	Garó malati, Jhum Maloti, Bhalum 1, Bhalum 2, RCM 9, RCM 10, Aghoni Bora
19	Rainfed lowlands:Shallow favorable	3.0	Swarna, BR 11,Ranjit, Mahsuri, Samba Mahsuri, Savitri, Intan, Rajshree,Mandya Vijaya
20	RL: Drought Prone	7.0	Sagri 17, Gurmatia, vaidehi, Swarna
21	RL: Scented	2.0	Sugandha, Keteki Joha, Kamini, Dubhraj, Kalanamak, BR 5(Dulha bhog), kala Joha
22	RL: Medium deep/ Chauri	3.0	Gayatri, Sarla, C 14-8, Savita, Basudeo, Panchanan

Rice Ecologies and Production Systems(REPS) in South Asia

SN	REPS	Area	varieties
23	RL- Flood prone During flood	2.0	Swarna-Sub, Janaki (64-117), FR 13A
24	RL: post flood	0.6	Manohar Sali, Andrewsali, CR 1014, Durga, Prafulla, janaki
25	Deepwater rice/ Asra/ Chaur	3.0	Chakia 59, Sudha, Durga, Savita, panindra, Rayada,
26	Very Deep water/ Floating/ Bao	1.0	Kartiksail, Shadapankaj, Varidhi, Jalnidhi, Dinesh , Panikekwa
27	Coastal salinity wet season	1.0	Lunishree, SR 26B, Pokalli, Vylitta 1, Vytilla 2, Panvel 2, Jarana

Rice Ecologies and Production Systems(REPS) in South Asia

SN	REPS	Area Mha	varieties
28	Medicinal rices	0.1	Navara rices (Kerala)
29	Iron toxicity	0.2	Mahsuri, Parijat
30	SRI method of Cultivation	0.5	Pro Agro 6444, Swarna, Samba Mahsuri
31	Use of machine	1.0	Pusa 44 (for combine harvesting & reapers),
32	Aged seedlings	4.0	Swarna, Manoharsali, Prafulla

Upland rice cultivation



Sowing by Oxen/ Buffalo



Puddling by Oxen for transplanted rice cultivation



Seedlings uprooting and Transplanting manually



Women for paddy transplanting



Drudgery for women: Need for innovative methods



Upland direct seeded rice

Yield Potential: 3 t/ha



Fertilizer Use in Upland rice

- 40:20:10 kg NPK + Lime 4 quintals / ha in acid upland soils and FYM/Organic manure @ 5 t ha⁻¹ Organic manure, P and K+ Lime as Basal

N as top dressing , 15 and 30 days after germination: 20 kg N each, after weeding

Growing Sun hemp with upland rice and incorporating in between rows increases yield and n availability



Insects : Gall Midge Tolerance

On-farm trial : Kolebera, Simdega

<i>Variety</i>	<i>SS</i>	<i>Hill infestation</i>	<i>Yield Q/ha</i>
• IR 64	44.5%	96.7%	16.7
• Lalat	6.4 %	30.0%	29.2
• PA 6444	19.5%	73.3 %	26.0
• KRH-2	13.4%	56.7 %	21.5
• Swarna	18.8%	63.3%	14.9



Gall Midge Resistant
variety (Lalat)

LALAT

Naveen : a new rice variety tolerant to gall midge for lowlands





Hybrid rice for house hold food security

- PA 6444
- Yield potential : 80q /ha
- Seed rate : 15 kg /ha
- SRI with hybrid rice; 5 kg /ha seed rate



Technology for Hybrid Rice

Yield Potential : 12 tons / ha

PA 6444 for Irrigated/ Rainfed Lowland - 140 days

Pusa RH 10 : Scented rice

- Fertilizer: 150 kg N: 75 Kg P_2O_5 :90 Kg K_2O / ha
- FYM/ Compost : 5 tons /ha; Vermicompost : 1.5 t/ha
Neem/Karanj cake (5 quintal/ha)

N in 4 splits:basal 30 kg: 40 kg each at 3,6 & 9 WAT

P Basal : Use SSP. If DAP Use Sulphur(25 Kg Gypsum) or
IFFCO:20:20:0:13

K : 60 kg basal : 30 kg topdressing at flowering stage




SRI (System of Rice Intensification)

- Both in Hybrid rice and conventional varieties
- 10 days old seedlings
- 25 x 25 cm transplanting of single seeding
- 10 tons organic manure
- Drainage channel, each after 2 meters
- Use of cono / rotary weeder : 5 times

15-20% yield advantage


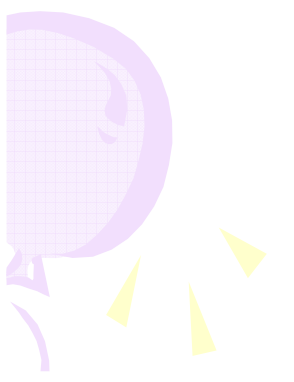


Seed Rate in Rice

- 100 Kg for Direct Seeding in upland as broadcast
 - 80 kg in line sowing behind plough
 - 70 Kg by seed drill
 - 50 Kg (Bold seed) for transplanting / ha
 - 40 Kg for medium/ slender rice
 - 15 for Hybrid rice
 - 5 kg for SRI
- 



Seedling age

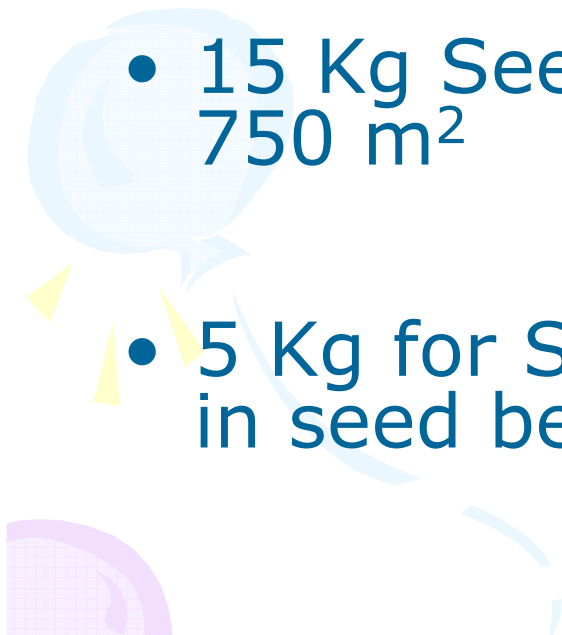
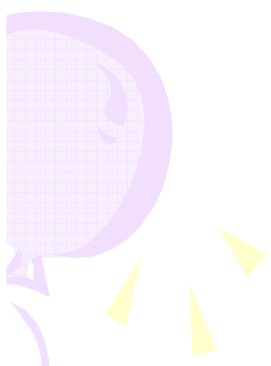
- Earlier 21 days old
 - Now reduced to 15 days
 - In SRI : 10-12 days
- 
- 

Wet Bed Nursery : Conventional 50 gm / m²





Seed rate and Seed Bed area

- 50 kg seed : 1000 @ 50 gm per m²
 - 15 Kg Seed Hybrid rice @ 20 gm per m² : 750 m²
 - 5 Kg for SRI : 15 gm per m²: 300 m² area in seed bed
- 
- 

**WET NURSERY: fertilizer
use & Seeding 20 gm / m²**



12 days old seedlings from SRI and traditional (right side) nursery





Seedlings uprooting





Drainage channel





Photo: Transplanting

Criss cross Weeder Use

02.08.2005



SRI technology in hybrid rice
(Use of rotary weeder)

**10 day old seedling: 30
days after transplanting**



06/09/2006





**variety, Yunnan, 2004 – 18 t
ha⁻¹**



Plastic Drum Seeder for direct seeding in wetland rice





Plastic Drum Seeder for seeding sprouted seeds



PLASTIC DRUM SEEDER



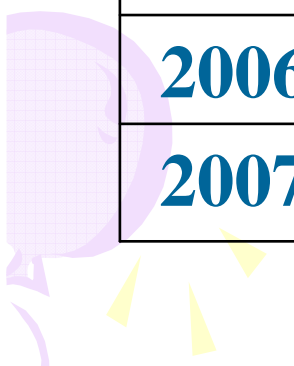
SUBABOOL : in Alley Cropping with Upland rice & other crops





Basmati Rice Export from India

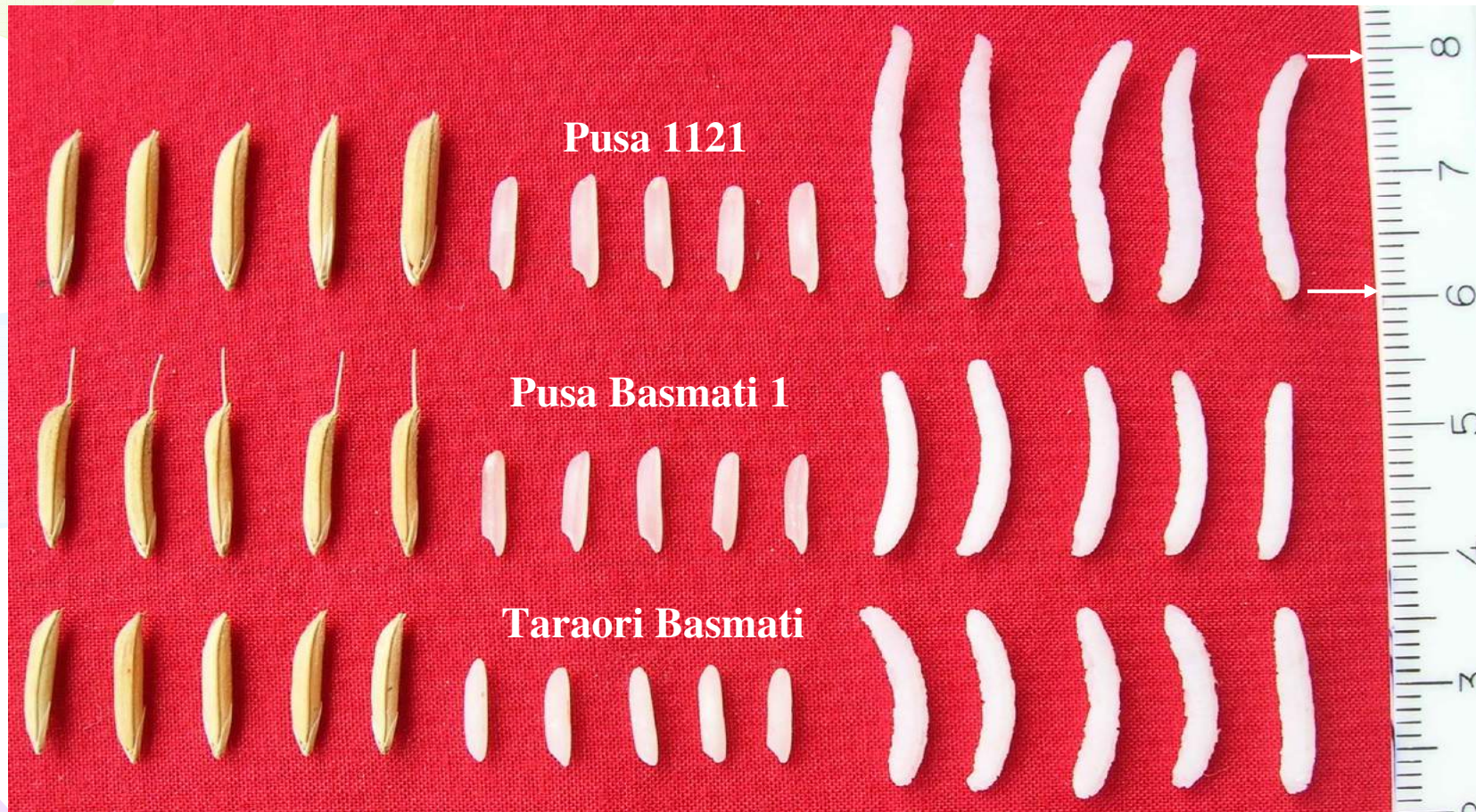
Year	Basmati	
	Quantity (Million tons)	Value (Rs. millions)
1990-91	0.23	2,940
1995-96	0.37	8,500
2000-01	0.84	21,480
2005-06	1.16	30,300
2006-07	1.04	27,920
2007-08	1.18	43,440



Pusa Suandh 4 (Pusa 1121)



Pusa 1121 covered >60% of Basmati rice area during *Kharif* 2007

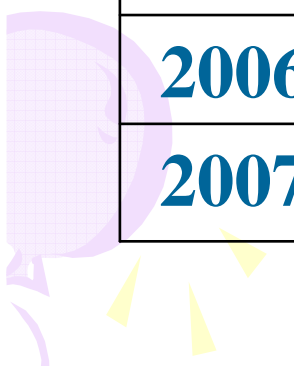


**Pusa 1121 sales \$ 100/ton more than Taraori Basmati in
the International market: Current price \$ 1800/ ton**

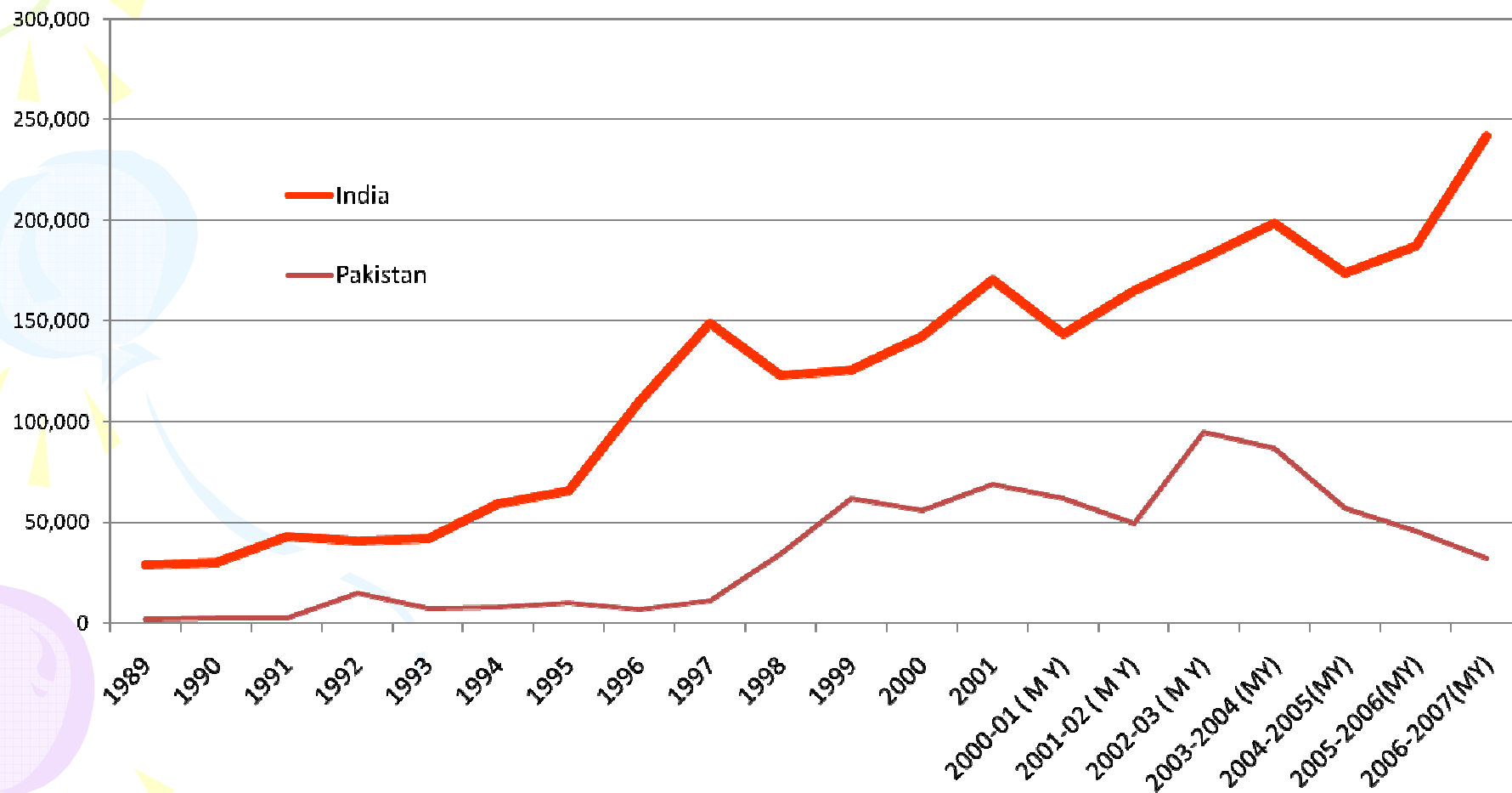


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Basmati Exports to the EU-India and Pakistan



Area and total production and quality traits of Aromatic Short grain Rices

No concrete information on the exact area cultivation under aromatic short grain rice. The aromatic short grain rices grown in small pockets practically in every state of India. It is estimated about 1 percent of total rice area.

Varieties/landraces		Adapted area			Estimated area (acre)		Average yield (q/acre)		Expected Total Production (ton)		Plant height (cm)		Durati(days)	
UTTAR PRADESH														
Kalanamk		Siddharthnagar, Basti, Maharajganj, Gonda, Balrampur, Gorakpur, Santkabir nagar, Mau			70,000		6.00		42,0000		155-160		160-165	
Quality traits														
Hulling	Milling	HRR	KL	KB	L/B	KLAC	KBAC	ER		Aroma				
76.40	65.32	62.0	4.47	2.00	2.24	10.0	2.87	2.42		3				





Tilakchand 3047



Bindli 3133-2





Govind Bhog

Badshah Bhog



Tulsi Panji

Randhuni Pagal

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Aanandi

Badsah Bhog



Kanak Choor

Dubraj

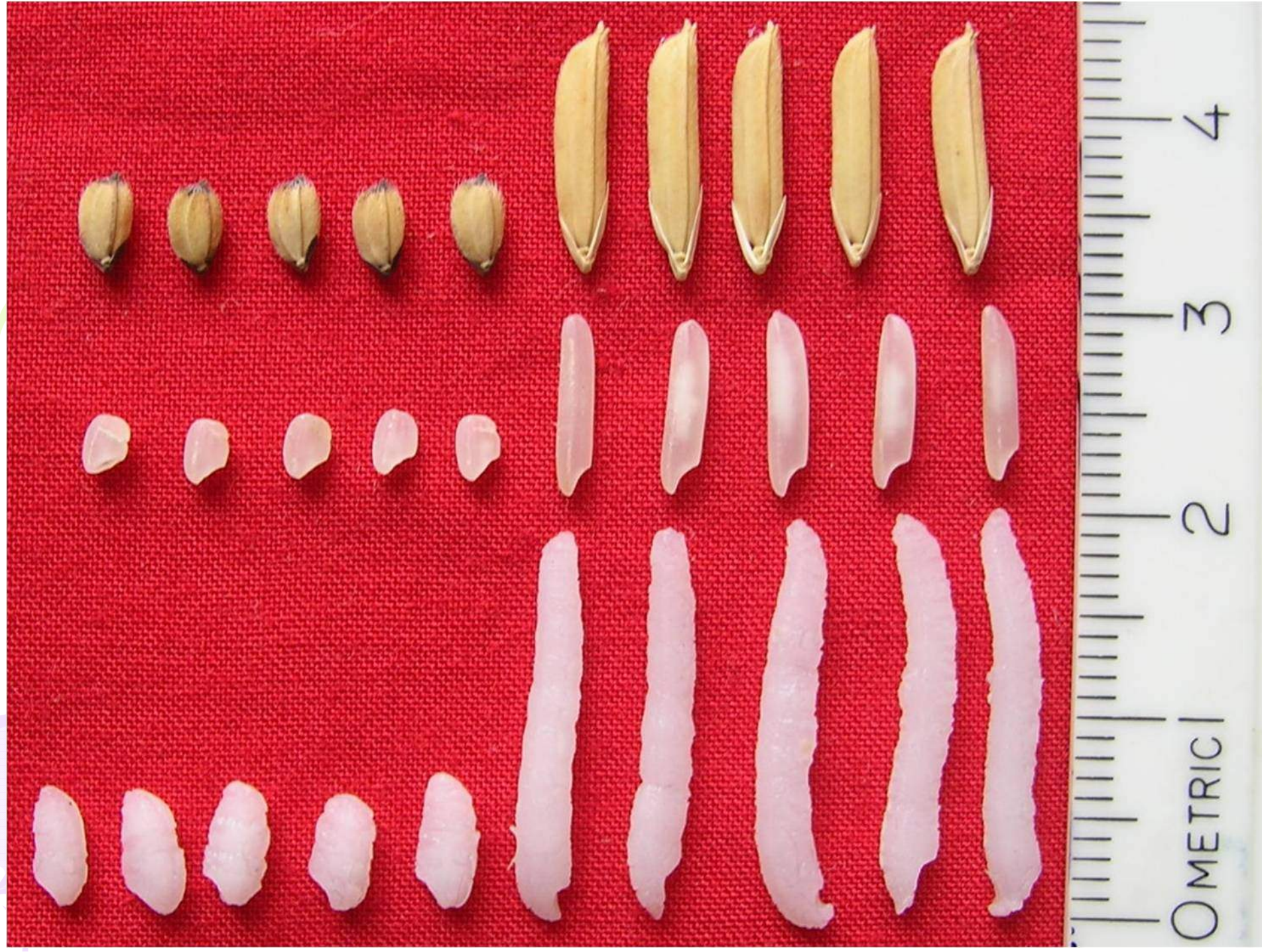
Champan Basmati

Katarni



Kala Jeera

Mircha



Comparative features of basmati and non-basmati scented rice

Characteristics features	Basmati type *	Non-basmati scented rice **
Kernel Length (L)	6.4-7.6	5.4-5.7
L/B ratio	3.5-4.2	3.3-3.35
Lc-Lu/Bc-Bu	8.8-10.6	2.8-4.6
Lc/Bc	4.9-5.6	2.95-3.8
Lc/Lu	1.70-1.83	1.40-1.57
Bc/Bu	1.26-1.33	1.31-1.61

• ***Basmati culture: Basmati /Basmati Punjab, Basmati (raw milled)***

*****Non-basmati Scented: Champaran basmati***

Lc : Length of kernel after cooking

Lu : Length of kernel before cooking

Bc : Breadth of kernel after cooking

Bu : Breadth of kernel before cooking

Birsamati: Semidwarf scented variety from Jharkhand





Birsa Vikas Sugandha 2

Scented lowland rice





Basmati: The Existing Definition

Basmati

**Traditional
Basmati**

Traditional Basmati shall mean land races or varieties of rice of uniform shape, size and colour traditionally recognized as Basmati

**Evolved
Basmati**

Evolved Basmati shall mean a variety whose one parent is a traditional variety and which has been recognized as a Basmati variety under the applicable law

Reaper for harvesting rice & Wheat



Paddy Harvesting by Reaper



Harvested Paddy Field



Water harvesting for rainfed rice cultivation





Coclusions

- Rich genetic diversity in terms of wild rice, land races, traditional varieties , and improved varieties exists in the South Asia region.
- Need to develop better cultivation practices for increased production and reduced human drudgery
- Pusa 1121 as best Basmati rice developed
- Sustainable rice production for future rice farmers and consumers.

Thank You





*Thanks to IRMM
for their Kind invitation*