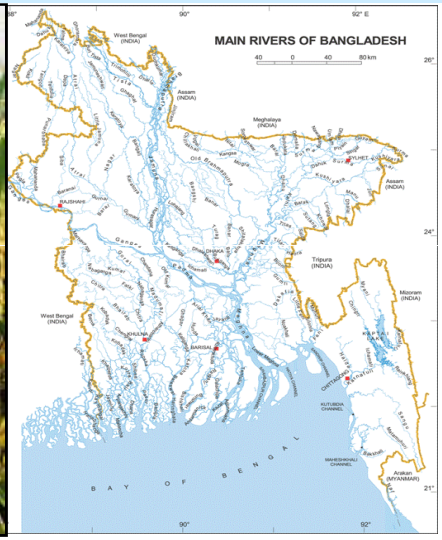
Welcome to Presentation on

"Bangladesh perspectives on high yielding rice variety production for food security and experience-sharing on adoption of hybrid rice"



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Regional Seminar on Rice Production and Mechanization
12-13 December 2011,Sanya, China

Rice Production

- **Bangladesh is almost self sufficient in its rice production.**
- **Increased rice production is vital to feed the growing population.**
- **Additional production on limited land resources in the face of increased biotic and abiotic stresses.**
- **Yield potential of a rice variety need to be increased.**

Irrigated rice (Boro) :

▲Boro rice gives highest yield compared to T. aman
▲ Low pest-disease incidence
▲ Cost of irrigation is high
▲ Salinity in coastal areas

Rainfed lowlands T. aman:

▲ Unstable rice yield
▲ Uncertain arrival of rainfall
▲ Delayed transplanting
▲ Flood, drought,
▲ More insect-diseases

Partially irrigated T. Aus:

▲ Lower rice yield
▲ Uncertain arrival of rainfall
▲ More insect-diseases

Major Constraints to rice production

- **No scope for expansion of area under rice**
- **Limited water resource**
- **N deficiency is wide spread**
- **Declining soil fertility**
- **Inability to provide good management by the farmers**
- **Declining or stagnated yields of modern varieties**

Major Problems in rice ecosystem

Abiotic stress

- Climate change
- High tide
- Submergence
- Salinity
- Drought
- High Temperature
- Cold injury
- Poor soil fertility

Biotic stress

- Disease
- Insect
- Weed

Socioeconomics

- Resource constraints
- Yield gap

BRRI MANDATE

- Engage in all aspects of R & D pertinent to increased productivity of rice.

PURPOSE

- Develop high-yielding Modern Varieties for diverse rice ecosystems.
- Generate improved rice production technologies to realize maximum of yield potential.
- Transfer technologies to the end users

Research Program and Management

1. Irrigated lowland	– Transplant Boro
2. Rainfed lowland	– Transplant Aman
3. Rainfed/upland	– Broadcast/Dib Aus
4. Tidal wetlands (saline /non-saline)	– RF Aus & T. Aman
5. Deep water (flood-prone)	– Broadcast Aman

Recommended Rice Varieties

Variety Name	Season	No.
BR17, BR18, BR19, BRRI dhan28, BRRI dhan29, BRRI dhan35, BRRI dhan36, BRRI dhan45, BRRI dhan47, BRRI dhan50, BRRI hybrid dhan1, BRRI hybrid dhan2, BRRI hybrid dhan3	Boro	13
BR20, BR21, BR24, BRRI dhan42, BRRI dhan43	B. Aus	5
BR26, BRRI dhan27, BRRI dhan48	T. Aus	3
BR4, BR5, BR10, BR11, BR22, BR23, BR25, BRRI dhan30, BRRI dhan31, BRRI dhan32, BRRI dhan33, BRRI dhan34, BRRI dhan37, BRRI dhan38, BRRI dhan39, BRRI dhan40, BRRI dhan41, BRRI dhan44, BRRI dhan46, BRRI dhan49. BRRI dhan51, BRRI dhan52, BRRI hybrid dhan4	T. Aman	23

Boro Season

Variety	Remarks
BR1, BR6, BRRI dhan28, BRRI dhan45	Irrigation scarcity area
BR14, BR16, BRRI dhan29, BRRI hybrid dhan1, BRRI hybrid dhan2	Fertile land and available irrigation
BR17, BR18, BR19	Fertile land, Haor area
BR35	BPH resistant variety
BR36	Cold tolerance at seedling stage
BR8, BR9	Hailstorm prone area
BRRI dhan47	Saline coastal belt

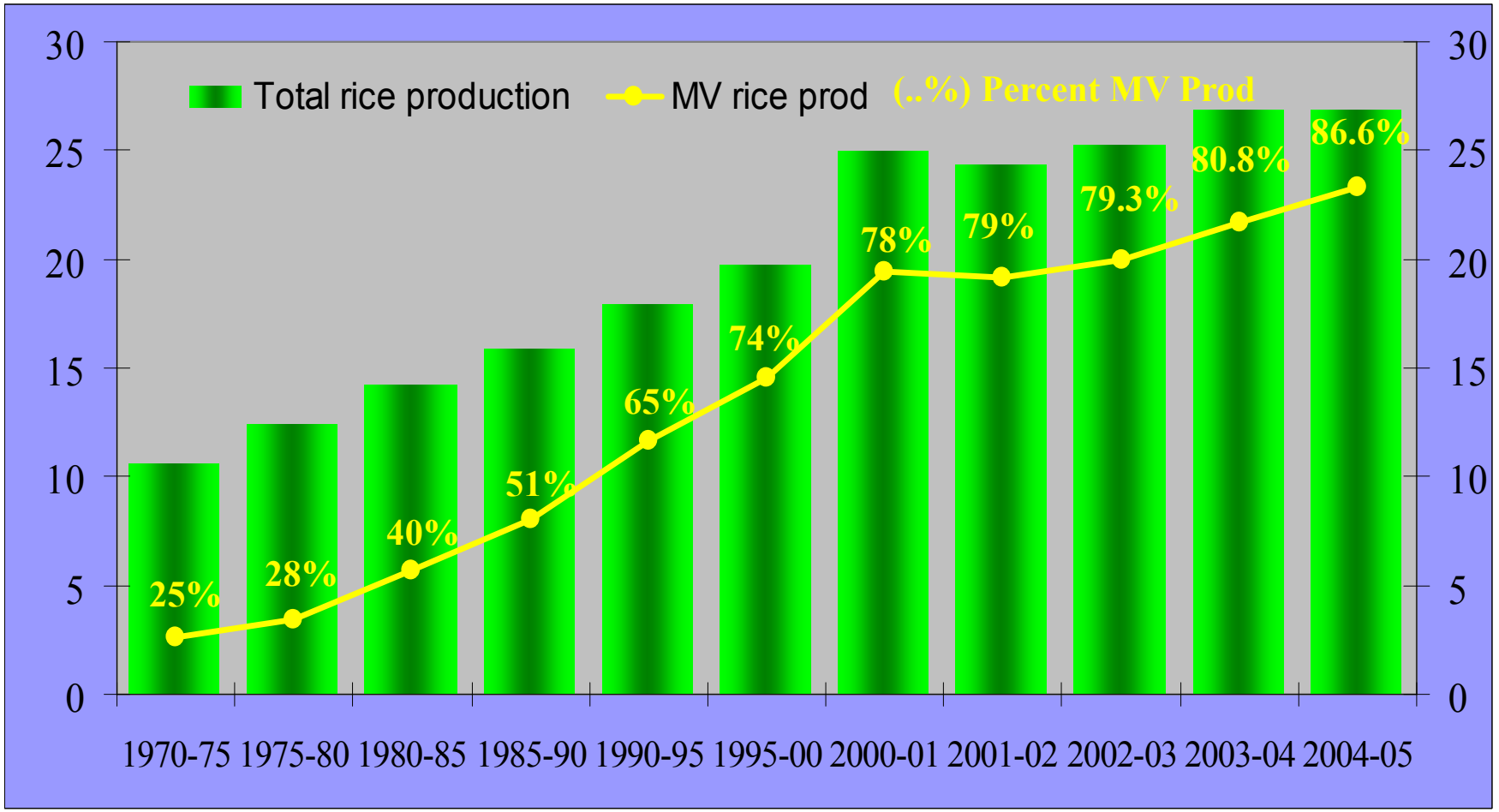
Great achievements

- Mega varieties in boro season: BRRI dhan28 &29.
- Irrigation facilities development and expansion of boro areas
- Mega varieties in T. aman season: BR11
- Intermediate plant height concept (more than 110 cm hight)

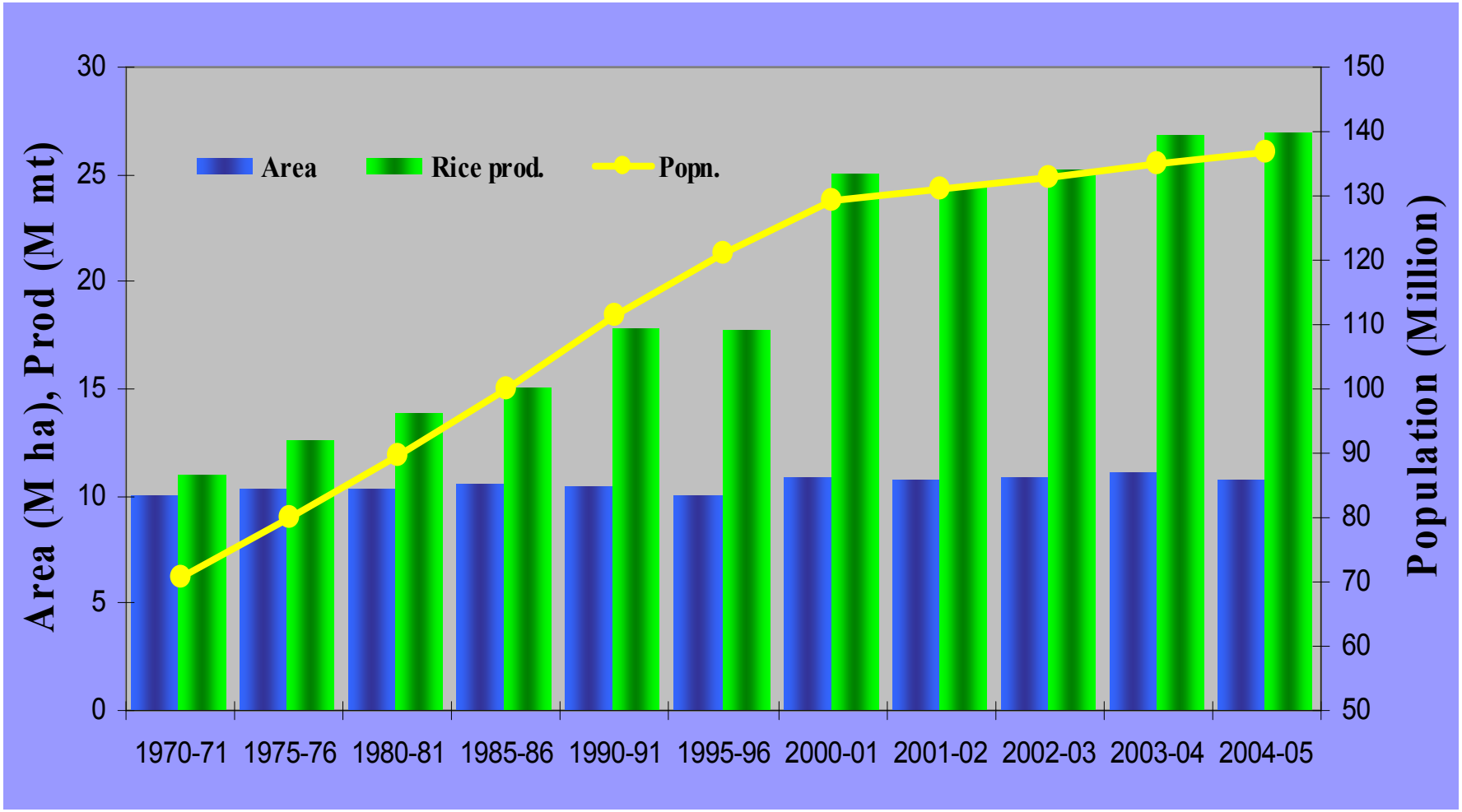
Adoption of MV rice (2004-05)

Season	Total Rice (M ha)	Total MV (M ha)	MV coverage
Aus	1.20	0.65	54.18%
T. Aman (WET)	5.24	3.20	61.08%
Boro (DRY)	4.29	4.09	95.34%
	10.73	7.94	74.00%

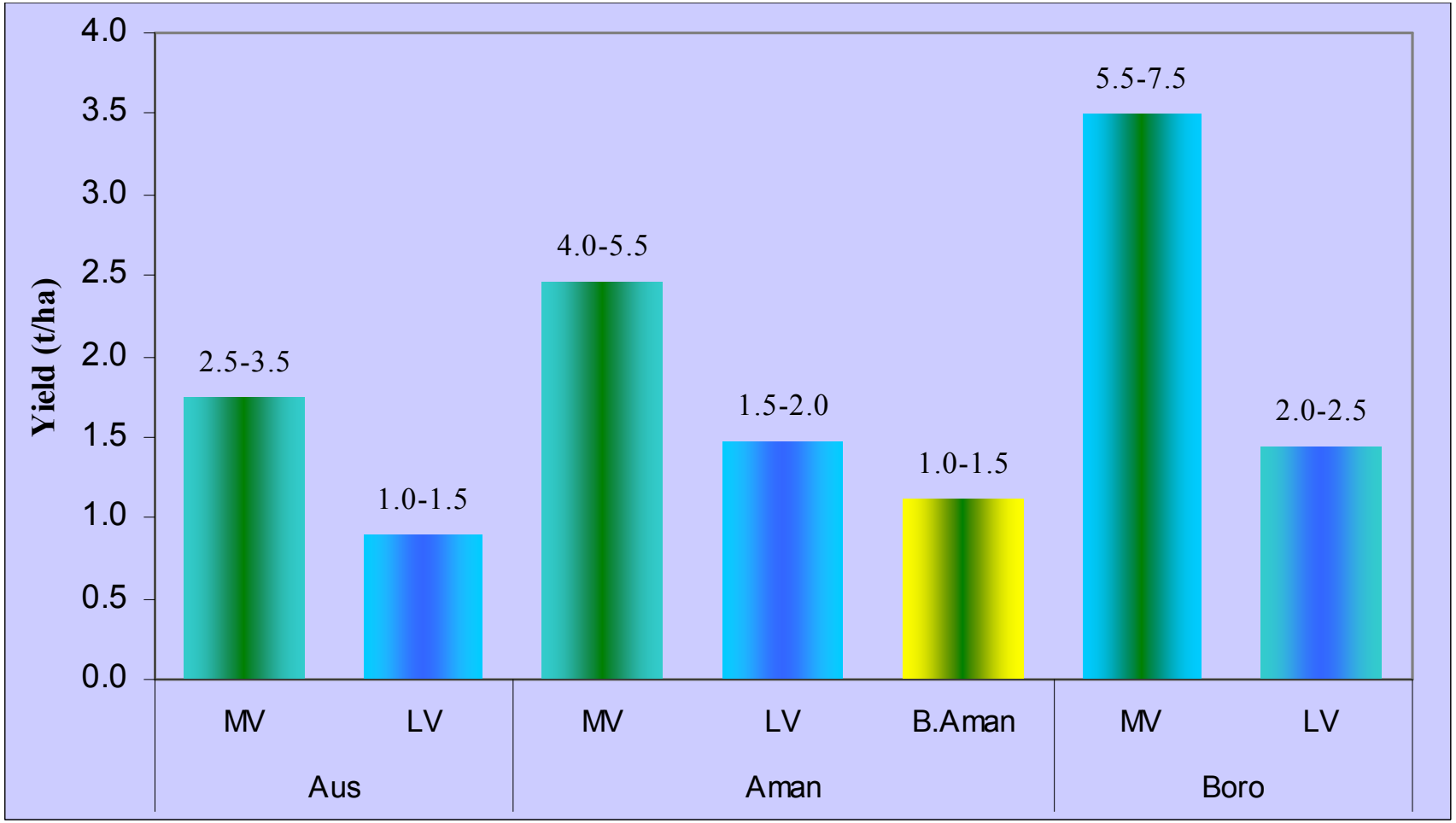
Contribution of MVs to Total Rice Production in Bangladesh 1970-2005



Changes in population, rice area and rice production in Bangladesh during the last 3 decades



Rice yield in 2004-05

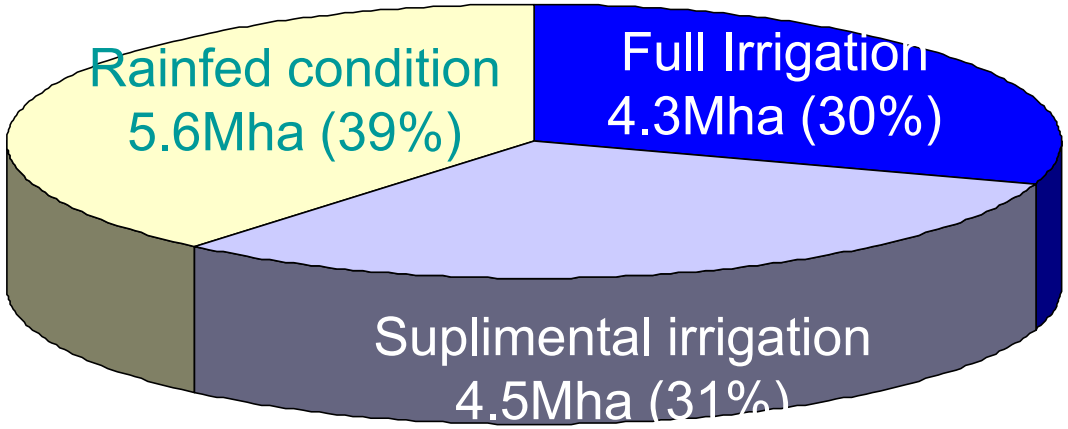


- **BRRI developed technologies account for 87% of the total rice production in Bangladesh**

- **Each Taka investment in rice R & D returns 38 Taka in the form of increased rice production.**

Crop Production System

- **Total cropped area is 14.27 M ha and crops are grown under both irrigated and rainfed condition**

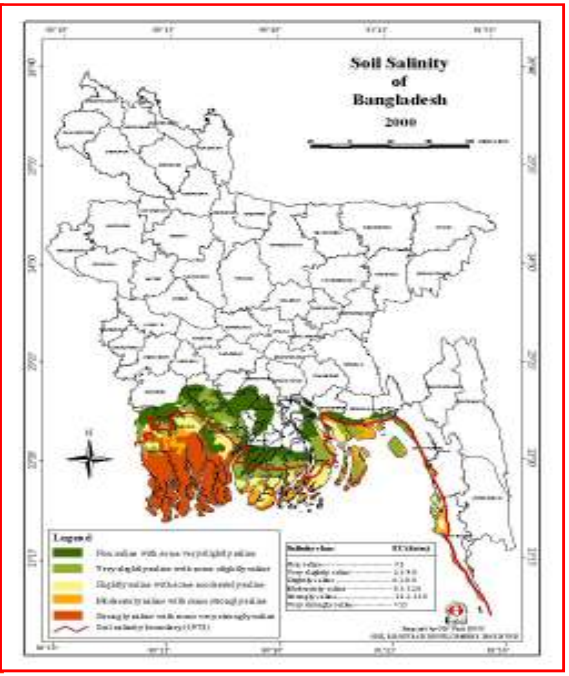


- **Major irrigated crops: Rice, Wheat, Potato and winter vegetables etc.**
- **Major rainfed crops: Rice, Wheat, Jute, Oilseed, Pulses, Sugarcane and summer vegetable etc.**

Effect of Climate change

Bangladesh is facing severe threat of climate change challenges specially in crop sector.

Salinity, drought, flood, cyclone, storm, surges etc. are causing harmful effect on crop production and rural livelihood.



General features of T. Aman Rice

- Rainfed
- Photoperiod sensitive / Photoperiod Insensitive early
- Drought tolerant - at seedling and at reproductive stage
- Tidal submergence tolerance
- Submergence tolerance
- Tolerant to pest-diseases

General Features of Aus Season Rice

- Photoperiod Insensitive
- Short Growth Duration (105-110)
- Rainfed/ partial irregated
- Drought Tolerance for Upland Aus
- Pre-harvest sprouting tolerance

General Features of Boro Season Rice

Highest Yield (5.0-8.0 t/ha)

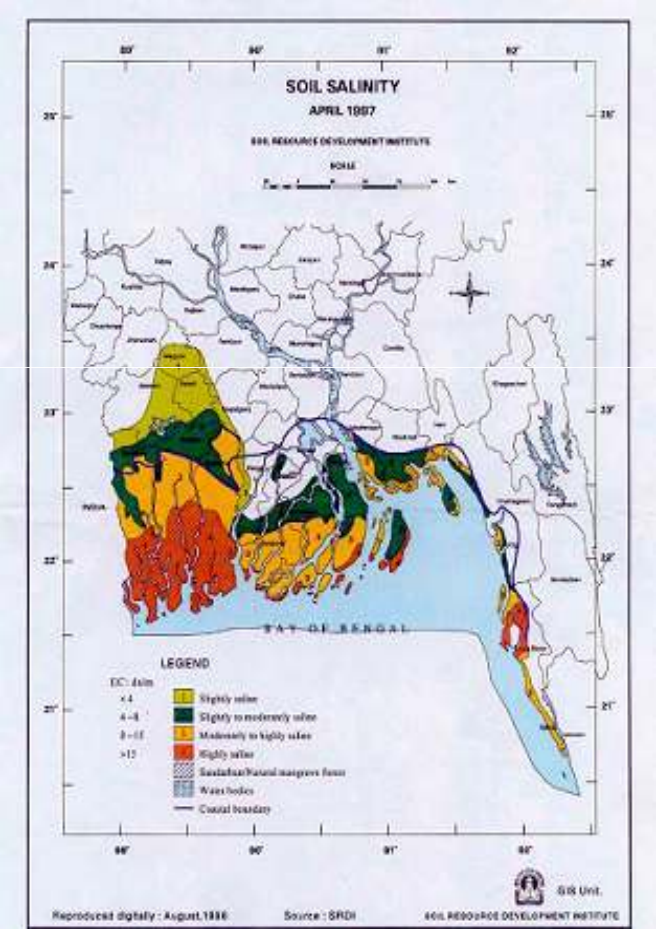
High Water Requirement (Irrigation)

High Input Requirement

Medium-long Duration (140 – 160 days)

Cold Tolerance (Seedling and Reproductive Stage)

SALINITY



Coastal zone

- About 1M ha fallow during winter
- EC 6-12 dS/m (soil and water)
- Improving the productivity


10 12:30

Release of BRRI dhan47 for Boro at saline prone areas

Breeding for salt tolerant rice varieties

Yield and other characteristics of modern varieties suitable for wet season (T. Aman)

Variety	Pl. Ht. (cm)	Duration (days)	Salt tol. score	Yield (t/ha)
BR23	110.0	150	5	4.0
BRRI dhan40	110.0	144	5	5.0
BRRI dhan41	115.0	144	5	5.0

These three varieties are photoperiod sensitive, lodging tolerant, early, high yielding and salinity tolerant up to 8 dS/m at reproductive stage

SHRIMP culture in rice field

Flash Flood Submergence

- Nearly 24% (2.6 million hectare) of total rice areas are affected by flash flood during T. Aman season.
- T. Aman rice often gets submerged during vegetative stages for 1-2 weeks incurring yield loss.

ACHIEVEMENTS: SUBMERGENCE

Two submergence tolerant varieties

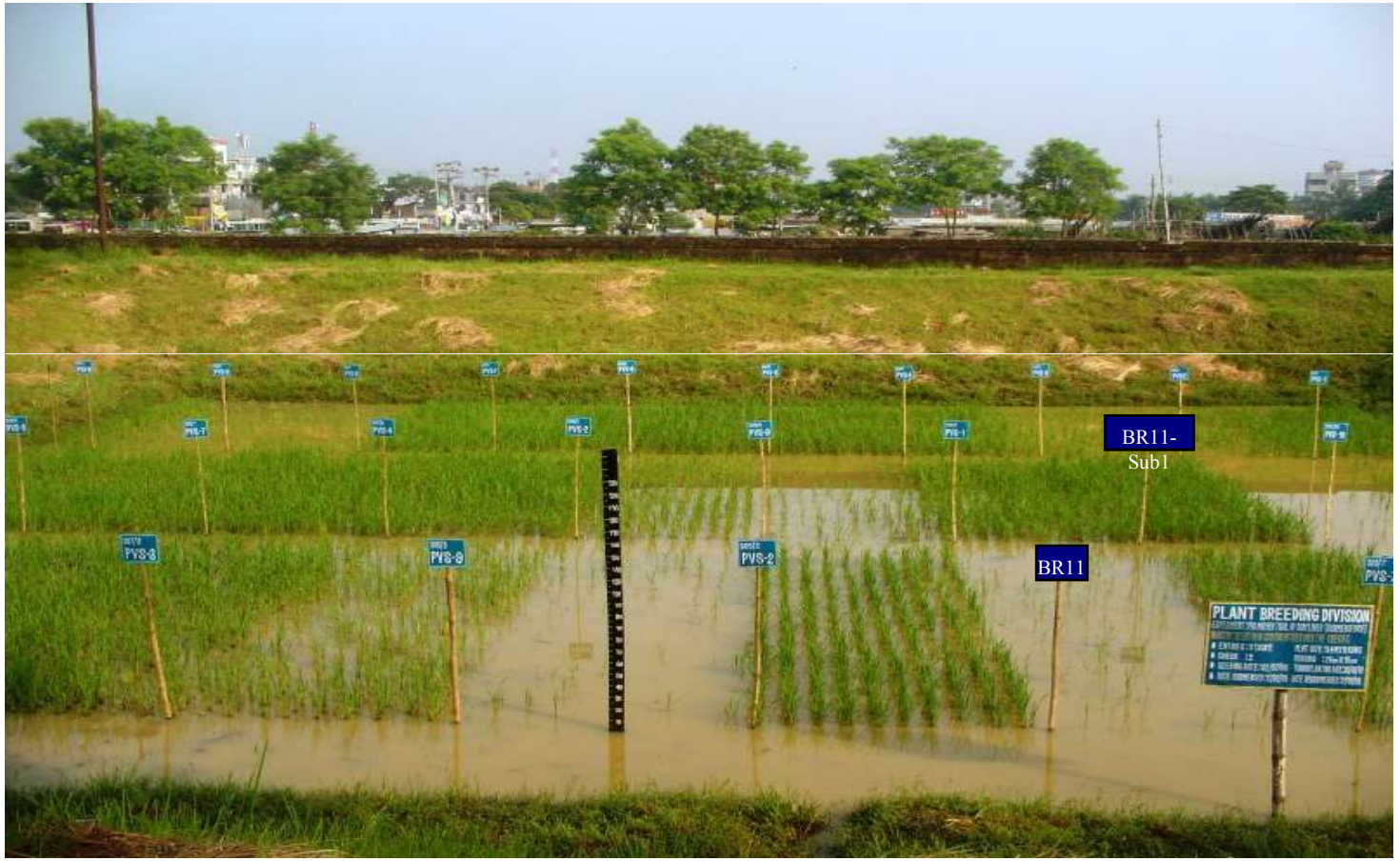
BRRI dhan51 (Swarna-Sub1:IR81213-246-237)

- Can tolerate 10-16 days of submergence with 4.0-4.5 t/ha yield potential

BRRI dhan52 (BR11-Sub1:IR85260-66-654-Gaz2)

- Can tolerate 10-14 days of submergence with 3.5-4.0 t/ha yield potential

Survival of BR11-Sub1 after 14 days of submergence



- **Drought tolerance and**
- **Drought escaping**

Early rice varieties for T. Aman to escape drought

Varieties	Plant Height (cm)	Duration (days)	Yield (t/ha)	Remarks
BR33	100	118	4.5	Early (escape drought), small bold grain, lodging tolerant
BR39	106	122	4.5	Early (escape drought), long slender grain, lodging tolerant
BR11 (ck)	120	130	5.0	Late, lodging susceptible
BRRI dhan32 (ck)	115	145	6.0	Late, bold grain, ShB susceptible

BRRI dhan33: An early drought escaping variety for T. Aman season

ACHIEVEMENTS: TIDAL SUBMERGENCE

Three T aman varieties released for tidal areas

Tallness is imp for tidal varieties

Field view of BRRI dhan41 in tidal areas

Two saline tolerant varieties for T aman season

Significant information:

Traits directly related high yield potential

- ▲ Growth duration
- ▲ Grain filling duration (days)
- ▲ No. of effective tiller per hill
- ▲ High nitrogen use efficiency
- ▲ Panicle length (cm)
- ▲ Filled grains per panicle
- ▲ % sterility
- ▲ Grain shape (length-breadth ratio)
- ▲ 1000-grain weight (gm)
- ▲ Greater sink size: High harvest index

Physiological traits indirectly related high yield

- ▲ Higher photosynthesis
- ▲ Lower respiration or higher starch storage in stems
- ▲ Short plant height
- ▲ Stiff stems-Lodging resistance
- ▲ Short and thick lower culm
- ▲ Dark green leaf color
- ▲ Long, broad and thick flag leaf
- ▲ Erect flag leaf angle
- ▲ Optimum leaf area
- ▲ Vigorous root systems
- ▲ Total biomass production
- ▲ Dry matter partitioning at pre anthesis period (total panicle weight- total biomass ratio)
- ▲ Late senescence of flag leaf

Identification of Physiological traits related high yield potential

Objective: To determine the correlation between physiological traits with yield

Materials : 34 promising lines/varieties including inbred and hybrids

Data to be collected:

- ▲ Seedling vigor
- ▲ Plant height: short to long
- ▲ Stiff stems-Lodging resistance , (1-9 scale)
- ▲ Short and thick lower culm
- ▲ Flag leaf color: Dark green to light (1-9 scale)
- ▲ Flag leaf length: broad and thickness
- ▲ Flag leaf angle: erect to droopy
- ▲ Optimum leaf area
- ▲ Biomass production
- ▲ Root systems: Normal to vigorous
- ▲ Total biomass production
- ▲ Dry matter partitioning at pre anthesis period (total panicle weight- total biomass ratio)
- ▲ Late senescence of flag leaf : 1-9 scale
- ▲ Greater sink size: High to low harvest index
- ▲ Yield and yield contributing traits

- **Correlation of traits influencing high-yield in rice**

- **Methodology:**
- Thirty-four advanced breeding lines and hybrids
- three replications during Boro 2009-10 seasons
- Physiological traits related to high yield potential were measured and
- data were analyzed to determine correlation of traits with high yield.

- **Progress and outputs:**
- Yield/plant showed positive correlation with
- no of spikelets/panicle (r=0.70),
- no of tillers/hill (r=0.74) and
- flag leaf area (r=0.59).
- BR7166-5B-1Ran1, BR7414-22-1 and BRRI hybrid 2 were selected as high yielding genotypes

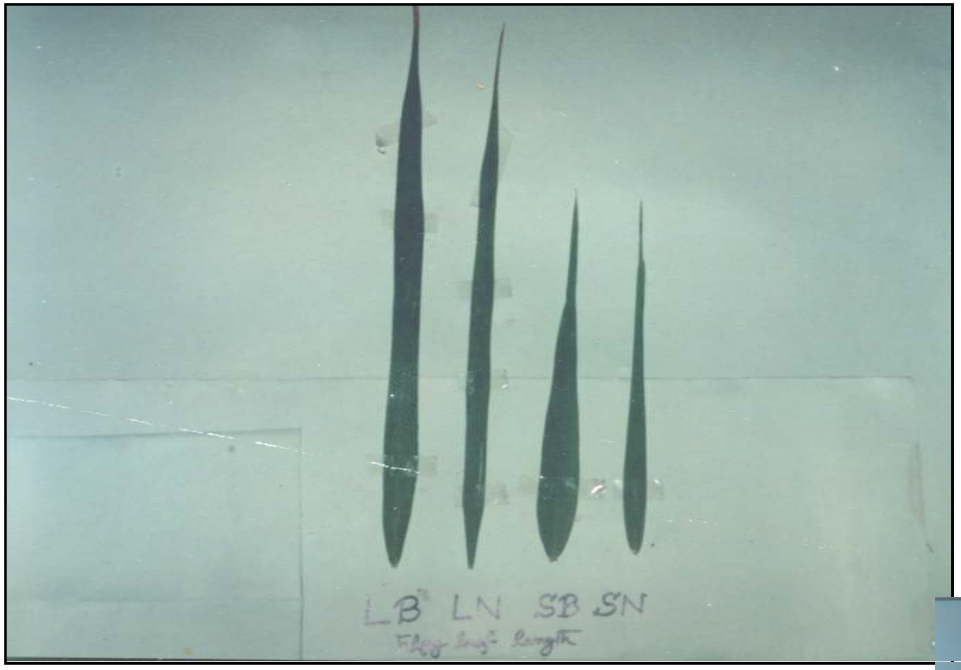


Fig 1: Different flag leaf size

Fig 2: Flag leaf angle

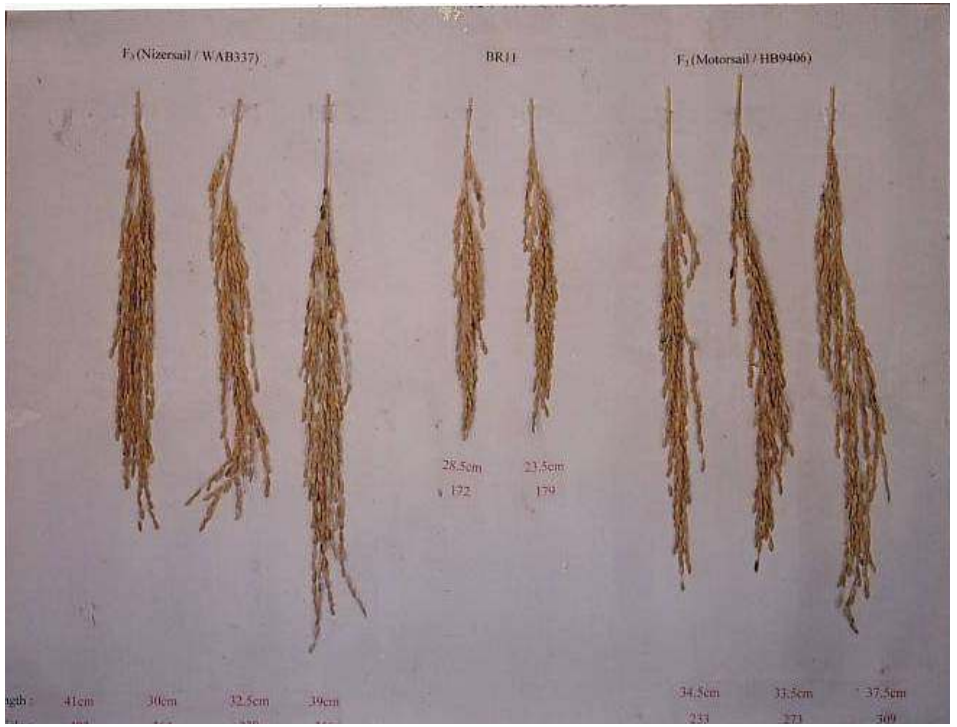


Fig 3: Effect of flag leaf length on panicle

Fig 3: Length of lower inter-node

Physiological traits related to heat tolerance

- High temperature favour pest-disease
- >33.5^{O}c
- Different sensitivity
- Time of anthesis and avidance
- Poor anther dehiscence
- Rate of spikelet opening
- Sterility is associated with low number of pollen germinated on stigma
- Reduced fertility

Increasing the heat tolerance of rice at flowering

- elements of escape, i.e.
- timing of panicle emergence and
- spikelet/floret opening relative to the occurrence of the stress, and

- Absolute tolerance
- such as anther dehiscence.

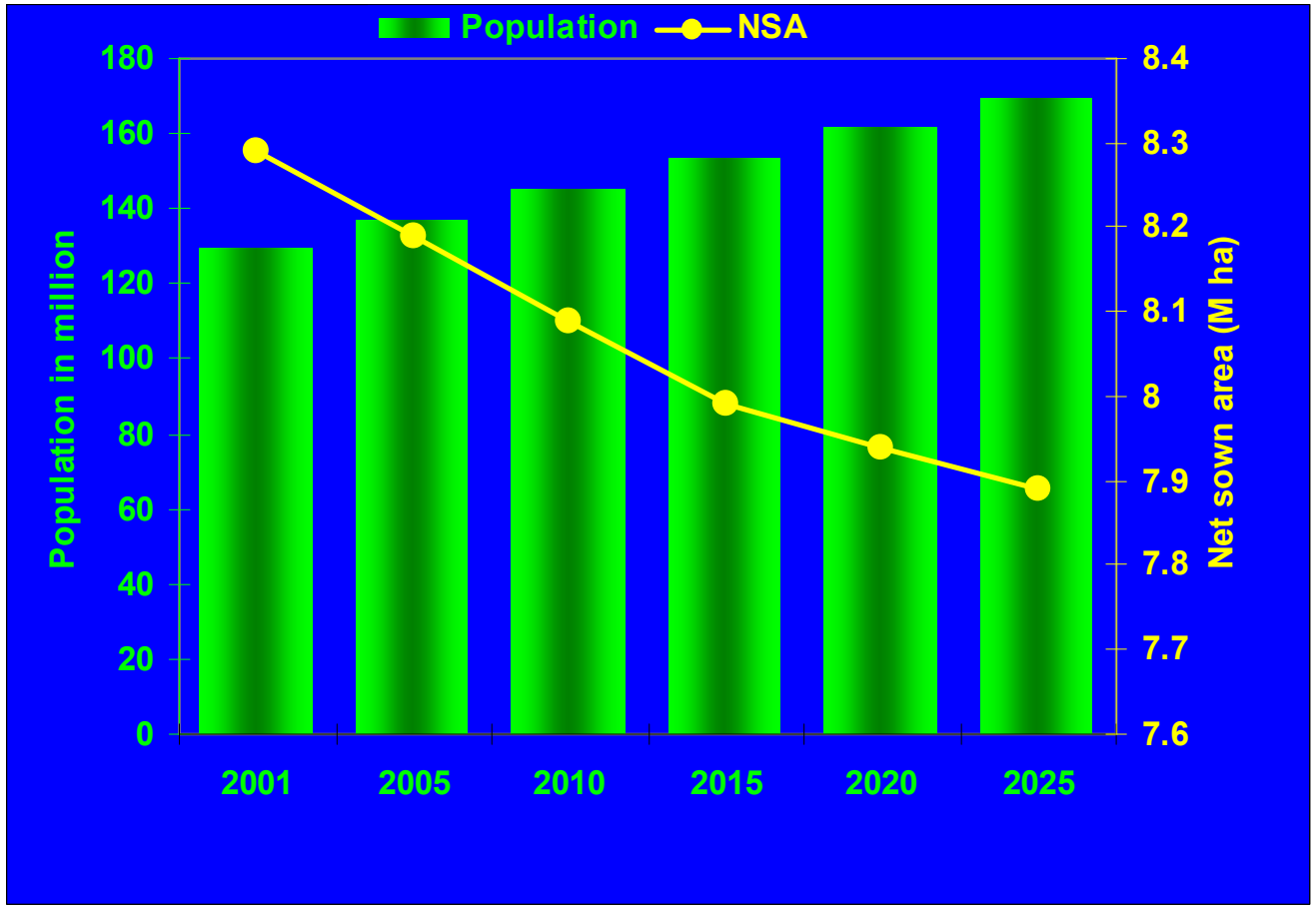
- 1217 entries from IRRI were evaluated during the March-August, 2010 tolerant to heat and high grain filling under high temperature

Yield and Ancillary Characters of Selected Entries, Aus 2010

SL No	Designation	PACP Veg.	Mat.	Days to Maturity	Plant height (cm)	Spiklet fertility	Yield/ Plant (gm)
1	IR 87606-109-2-2	2	1	131	95	73	19.35
2	IR 88268-12-2-1	2	2	125	105	83	16.73
3	IR 88269-114-1-3	2	2	126	100	61	12.53
4	IR 88270-119-2-2	2	2	120	100	73	16.98
5	IR 86970-45-1-3-3	1	1	120	86	72	17.46
6	IR 86977-87-1-2-3	2	2	138	123	63	14.08

Future direction

Projected population and net cultivable area for the year 2001-2025



- Population will increase to 169 millions in 2025
- Net cultivable land will shrink to only 7.89 M ha

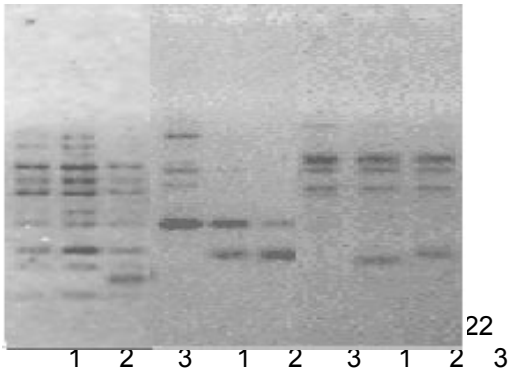
•BRRI varieties played significant role to the food security in Bangladesh

A Challenge for breaking the Yield Ceiling of Rice

- **Develop high yielding varieties for favourable ecosystems**
- **Introducing new plant type**
- **Varieties for less favorable like drought, cold, submergence and salinity prone areas**
- **Exploitation of hybrid vigour**
- **Super high yielding hybrids.**
- **Use of biotechnological tools**

- **Marker assisted breeding for manipulation of traits**

- **Developed biotechnological methods and protocols for culturing explants of Indica rice**



Utilization of preserved germplasms (about 8000) in BRRI Gene Bank

BRRI moves ahead with

- **Transgenic rice**

Establish greenhouse and containment facilities for testing of Golden and Bt rice

- **MVs with high-quality grain and with high Iron and Vitamin contents**

- **Improved crop management to exploit genetic potential**

To face the challenge, BRRI will need

- **Quality scientific manpower**
- **Modern labs. and GH facilities**
- **Adequate incentives to retain trained qualified manpower**

BRRI continues its journey along with the toiling farmers towards the ultimate goals

- **Wiping out hunger from the country**
- **Providing food security for all**

Adoption of hybrid rice

Superiorities of F1 hybrids

- Maximum performance under optimal conditions.
- Heterosis utilization is the best way compared to conventional breeding
- Stability of performance under stress.
- Proprietary control of parents.
- Often, reduced time to cultivar development.
- Joint improvement of traits.
- It has many technological, economical, social and environmental advantages

Added value > cost of hybrid seed production

Hybrid Rice Technology

STEP 1: Maintenance

Male sterile line 'A'

rfrf

S

Female parent

X

Maintainer line 'B'

rfrf

N

Male parent

rfrf

S

'A' line seed

8A:2B

STEP 2: Restoration

Male sterile line 'A'

rfrf

S

Female parent

X

Restorer line 'R'

RfRf

N

Male parent

Rfrf

S

'F1' seed for farmers-Fertile

10A:2R

16A:2R

STEP 3: Hybrid Rice cultivation by Farmer

BAHAR 1

Medium slender aromatic rice hybrid

Seed rate:20kg/ha

Single seedling /hill

25 x 25cm spacing

Blast resistant & moderate tolerance to Stem borer

Hybrid Rice in Bangladesh

- **Hybrid rice yields about 20% more than the best commercial varieties**
- **0.57 Million Ha. was hybrid in 2009**
- **Based on CMS system**

Government's role in hybrid rice research and development

- Involved public, private sector in 1998-99
- NGO and private companies commercialized Chinese rice hybrids
- Hybrid rice research project through IRRI-ADB and DFID financial support.

GOB project "Research and development of hybrid rice in Bangladesh"(July 25-June 2011) :

BRRI hybrid dhan2 at farmer's field

Yield recorded 11.80 t/ha

Salient features of BRRI hybrid dhan 3

BRRI hybrid dhan 3

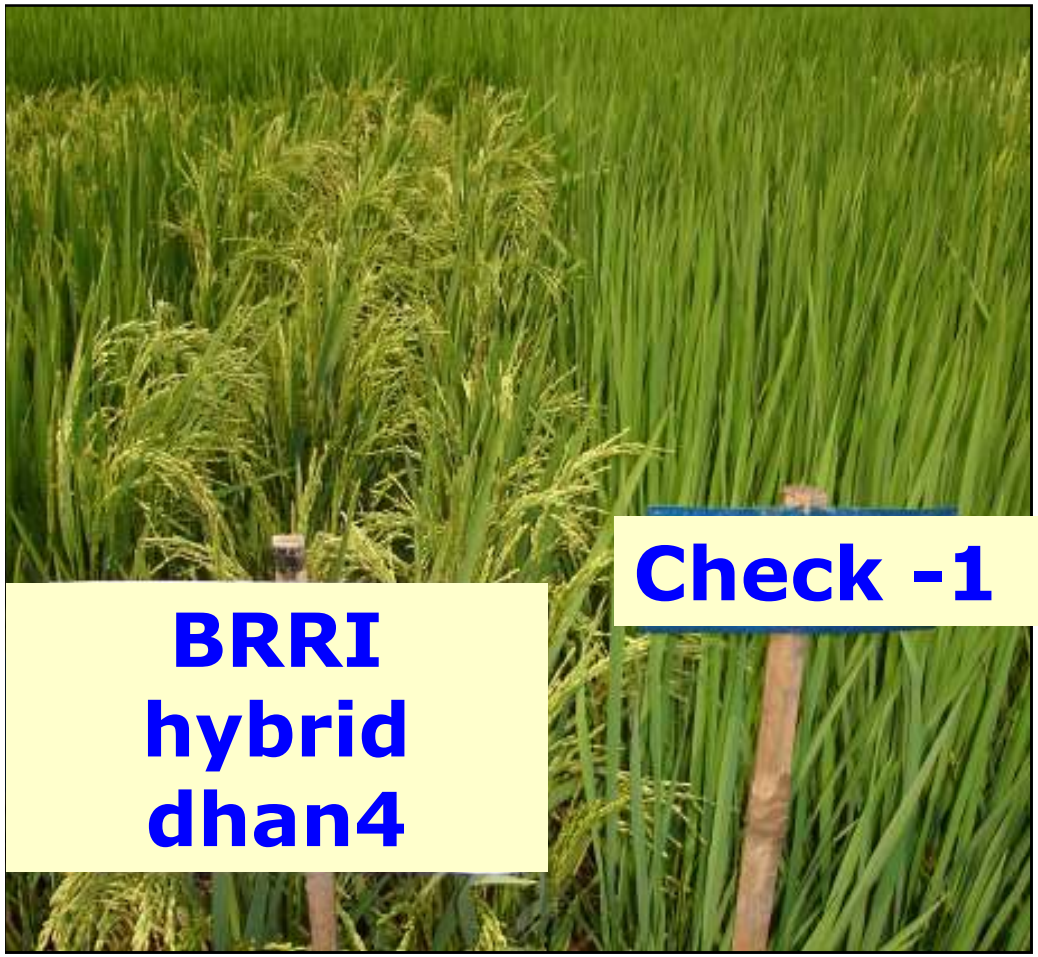
Plant height: 110-112 cm

Yield: 8.5-9.0 ton/ha

Duration: 142-147 days

Season: Boro

Salient features of BRRI hybrid dhan 4



Plant height: 112-115 cm
Yield: 6.0-6.5 ton/ha
Duration: 115-120 days
Season: Aman

Eighteen days earlier

than BRRI dhan31

Comparative growth durationa & yield of BRRI hybrid dhan-2 at different locations, Boro 2008-09				
Locations	BRRI hybrid dhan 2		BRRI dhan 29	
	Growth duration (days)	Yield (t/h)	Growth duration (days)	Yield (t/h)
Kapasia	144	9.88	158	6.90
Daudkhandi	142	9.90	157	7.20
Burichong	143	9.50	158	7.00
Bagharpara	145	8.98	159	6.17
Bhangha	140	9.70	159	7.50
Singra	146	9.80	158	7.05
Manikgonj	147	8.89	157	6.75

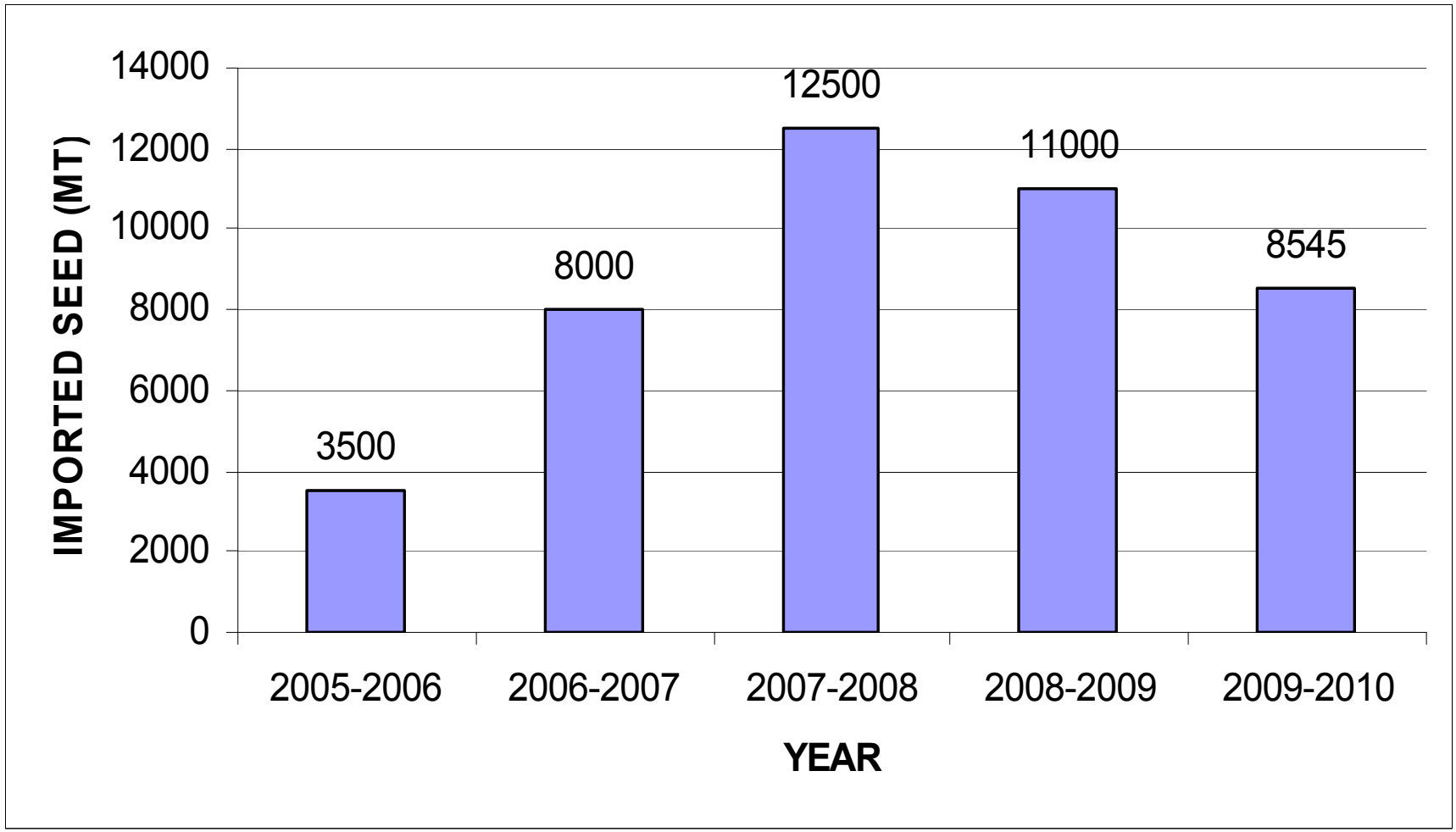
Constraints for adoption of hybrid rice

- Heterotic level of new combinations
- Crop management for expression of heterosis
- Yield level of hybrid seed production
- Crop management for increasing F_1 seed yield
- Seed requirement in crop establishment
- Disease susceptibility
- Grain quality

Hybrid varieties recommended by government of Bangladesh

Year of Recommend	No. of hybrids					
	India	China	Phillipines	BRRI	Private Co.	Total
1998	3	1	0	0	0	4
2000	1	0	0	0	0	1
2001	0	2	0	1	0	3
2002	0	1	0	0	0	1
2003	1	5	0	0	0	6
2006	0	17	0	0	0	17
2007	0	12	0	0	2	12
2008	0	12	1	2	2	13
2009	0	10	0	1	1	12
Total	5	60	1	4	5	75

Import scenario of Hybrid rice seed



IMPORT & LOCAL PRODUCTION OF HYBRID SEED

Year	Imported and local production (MT)			Area covered by hybrid ('000 ha)
	Private Sector	Public Sector	Total	
2005-2006	3500	-	3500	233
2006-2007	8000	49	8049	537
2007-2008	12500	-	12500	833
2008-2009	11000	-	11000	733
2009-2010	8545	69	8614	574

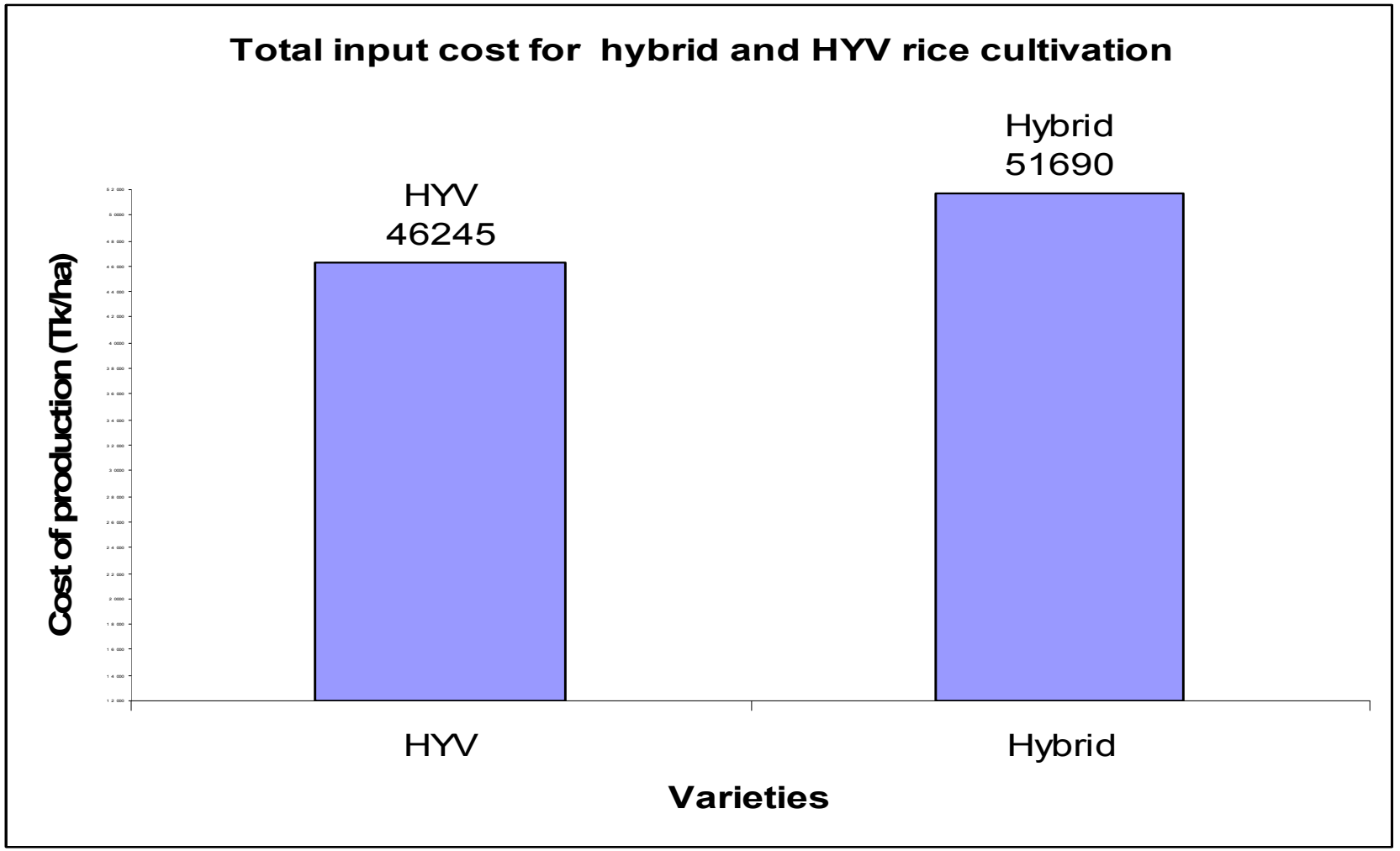
Source: BADC

Constraints in producing hybrid seeds in Bangladesh

- Have to be procured every year
- Lack of skill man power
- Seed production is expensive
- Maintaining quality seeds by companies
- Seed price is not economical at rice price

Difficulty of sustaining higher yields at farmer's field

- Poor farmers do’nt have enough resources for rice cultivation
- Majority of farmers can not use the proper doses of fertilizer
- Knowledge gap at farmers level
- High cost of hybrid seeds
- Not suitable for poor farmers
- **Lack of knowledge for raising healthy seedlings**


Total input cost for hybrid and HYV rice cultivation
Cost of production (Tk/ha)
HYV
46245
Hybrid
51690
HYV
Hybrid
Varieties

Direct seeded hybrid rice culture

Comparison of directed seeded with transplanting rice, Boro 2010-11

ariety	Direct seeded condition			Transplanted condition			Yld adv. over Transplant (%)
	Pan/ m^2	DTM	Yld	Pan/ m^2	DTM	Yld	
RRIdhan 28	191	138	5.86	244	143	5.35	9.53
RRIdhan 29	224	153	8.54	310	160	7.25	17.79
RRI hybrid dhan 1	231	149	7.44	277	155	8.17	-
RRI hybrid dhan 2	198	141	8.14	244	145	8.25	-
RRI hybrid dhan 3	211	144	9.28	251	147	8.75	6.06
eera-1 (hybrid)	226	148	7.96	271	152	7.76	2.58
L-8H (hybrid)	218	149	7.70	185	153	7.31	5.34
agoron (hybrid)	223	150	7.53	172	154	7.83	-

Development of suitable technologies for hybrid rice cultivation

- Cost effective production technologies.
- Crop management, direct seeding method, water saving technique etc.
- Technologies for unpredictable stress conditions (drought, floods and salinity etc).
- Higher N use efficiency.
- Standard agronomic and nutrient management of hybrid rice.

Progress of BRRI hybrid rice program

- 4 hybrids released from BRRI in Bangladesh

  Several promising hybrids are in pipe line

  About 70 hybrids introduced mainly from China

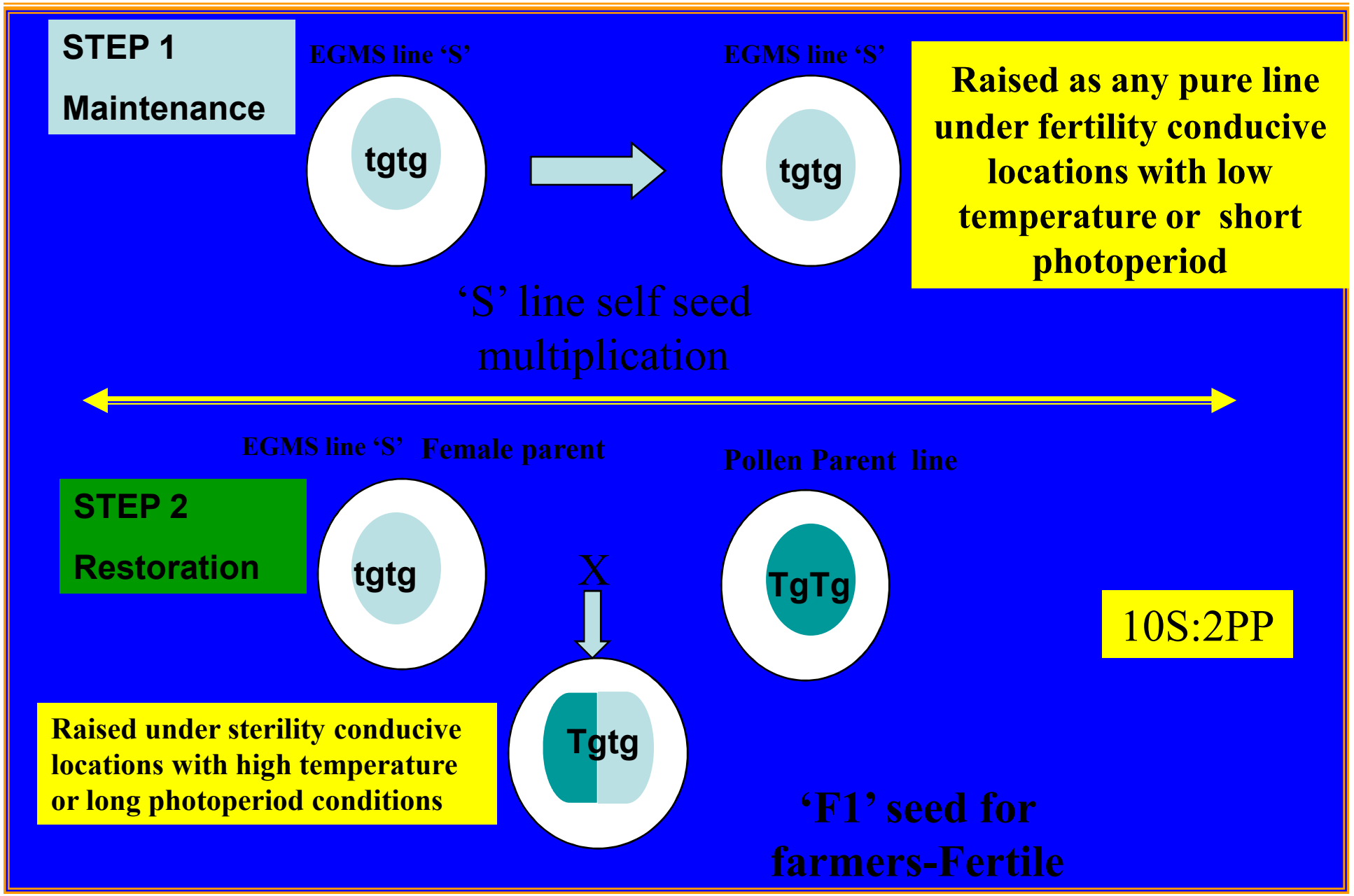
- China -bred CMS lines were used as hybrid parents

Strategies to enhance heterosis:

- Increase genetic diversity in hybrid germplasm– Molecular markers
  - – Traditional grouping methods
- Biotechnology application
  - – Parental selection
  - – Heterotic gene/gene block
- Exploiting intersubspecific heterosis
  - – Indica x New plant type
- Application of 2-line hybrids to expand germplasm pools

(Xie, 2009)

EGMS system for TWO LINE RICE HYBRIDS



IRRI

Top three leaves of "super" hybrid rice

- Flag leaf length of 50 cm and 55 cm for the –2nd and –3rd leaves. All three leaves are above panicle height.
- Should remain erect until maturity. Leaf angles of the flag, –2nd and –3rd leaves are around 5º, 10º, and 20º.
- Narrow and V-shaped leaves (2 cm leaf width when flattened).
- Thick leaves (specific leaf weight of top three leaves = 55 g/m^2).
- Leaf area index (LAI) of top three leaves is about 6.0.

(Yuan 2001)

Hybrid Rice Breeding Priorities

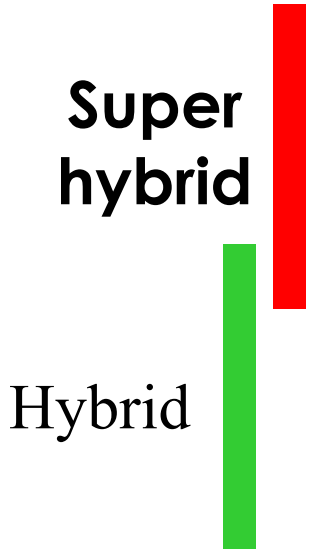
Agronomic Characteristics

1. Yield
2. Resistance to preharvest sprouting
3. Outcrossing rate (A line)
4. Pollen load and strong restoring ability (R line)
5. Stable sterility (CMS and TGMS line)
6. Good combining ability

Diseases/Pest

1. Bacterial Leaf Blight
2. Tungro
3. Blast
4. Brown planthopper
5. White-backed planthopper
6. Stemborer

Breeding for target environment



Increase yield potential under sufficient supply of nutrients and water

Maximize grain yield under limited supply of nutrients and water

Expt 1 Source Nursery: Crossing of materials for identifying salinity tolerance hybrids

Specific objective: To identify salinity tolerance maintainers and restorers.

Materials: Thirty five salinity tolerance parents were grown.

Results and discussion: In total of 107 crosses have been done (Table 2).

Expt 2. Source Nursery: Crossing of materials for identifying heat tolerance hybrids

Specific objective: To identify maintainers and restorers tolerance to heat stress.

Materials: Forty one heat tolerant parents were grown in three sets
Results and discussion: 154 crosses have been made (Table 2).

Stress Tolerance Hybrid Breeding

Performance of promising hybrids during Boro season 2009-10.

SL#	Designation	Maturity (Days)	Pl ht (cm)	SF%	Yield (t/ha)
1	BRRI 1 A /BRRI 12 R	148	94.7	82	8.50
2	BRRI 1 A /BRRI 14 R	147	97.4	84	8.45
3	Il 32 A /BRRI 16R	148	103.6	80	8.48
4	BRRI 10 A /BRRI 11R	148	102.0	83	8.47
	IR 58025 A/BRRI 13 R	148	100.4	78	8.45
Ck-1	BRRI dhan 28	141	101.3	79	5.47
Ck-2	BRRI dhan 29	162	100.0	77	6.62
Ck-3	BRRI hybrid dhan 2	148	103.7	82	7.02


11 3R A13.BR7166-5B-1
Saltol

Breeding CMS lines and maintainers

- Introducing by testing adaptation.
- Transferring the CMS source to develop new CMS lines by successive backcross.

- Characters of CMS line
- Good agronomic characters.
- High out crossing rate
- Stigma with long style and fatherly stigma
- Wide angle and long duration of glume opening.

CMS lines development in Backcross Nursery

SLNo	Parent	Pedigree	Cross combination	Designated as
1	BRRIB x II 32B	HR 051-10-8-5-3B	II32A/ HR 051-10-8-5-3B	BRRI 10A/B
2	BRRI 10B x You 1B	HR063-7-33-B-2B	BRRI10A/ HR 063-7-33-B-2B	BRRI 11A/B

Table 7: Sterile entries from (Heat & saltol) Testcross Nursery

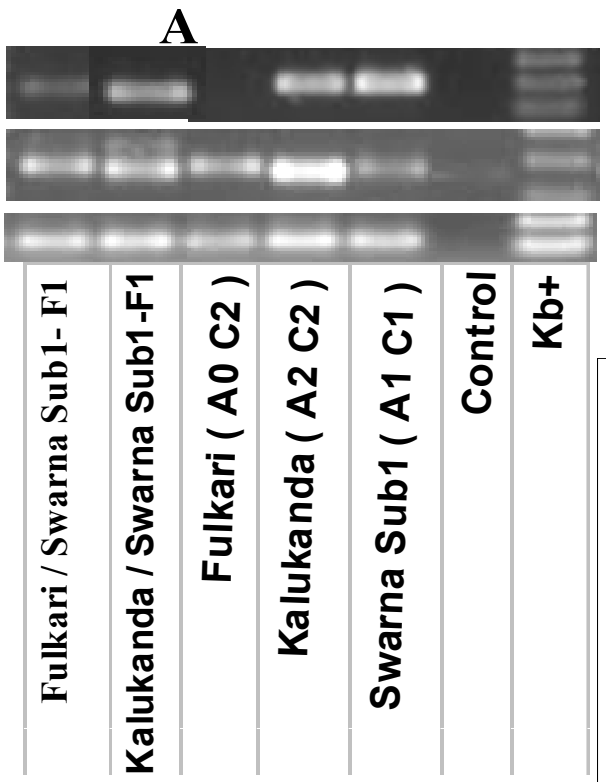
SL.No	Combination	Sterility	Remarks
01	BO59A A / 8. Pokkali (Sal tol)	CS	Evaluating as BC_1 in BCN
02	BRRI 1A/ 6.BRRI dhan29	CS	``
03	BRRI 1A/ 45. WAB 96-1-1(HT)	CS	``
04	BRRI 3A/ 9.BRRI dhan29 (HT)	S	``
05	BRRI 3A / 19.BR7414-25-1(HT)	CS	``
06	Jin 23 A/ 19.BR7414-25-1(HT)	CS	``
07	Jin 23A/ 45. WAB 96-1-1(HT)	CS	``
08	BO59A / 18.BR7414-22-1(HT)	CS	``
09	BO59A A / 45.WAB 96-1-1 (HT)	CS	``
10	BRRI 3A/ F6 (IR78362BxV20B)-1	CS	``
11	BRRI 3A/ F6 (IR78362BxV20B)-2	CS	``
12	BRRI 10A/ F6 (IR78362BxBRRI 9B)-2	CS	``
13	BRRI 11A/ F6 (IR73328BxIR77801B)-5	CS	``
14	II32A/ F6 (IR77801BxV20B)-2	CS	``
15	262A/ IR74963-262-5-1-3-3	CS	``
16	Jin23A/ F6 (IR78362BxBRRI 9B)-3	CS	``
17	BRRI 9A/ F6 (IR77801BxV20B)-1	CS	``
18	BRRI 9A/ F6 (IR77801BxV20B)-2	CS	``

Achievement

- Promising CMS: BR1A, BR3A, IR68888A, IR58025A, Jin23A
- A number of high yielding promising hybrids identified.
- The yield potentiality of the variety is >8 ton/ha
- Grain quality of the variety is medium slender.

Gene expression analysis for improving adaptive traits

- **Unequal expression in hybrids and their parents.**
- **Expression patterns, including maternal like, paternal like, high parent like, low parent like, and expression patterns outside the range of the parental inbreds.**
- **High levels of additive (equal to the average of two parents) expression with low levels of non-additive (different from the average of two parents).**



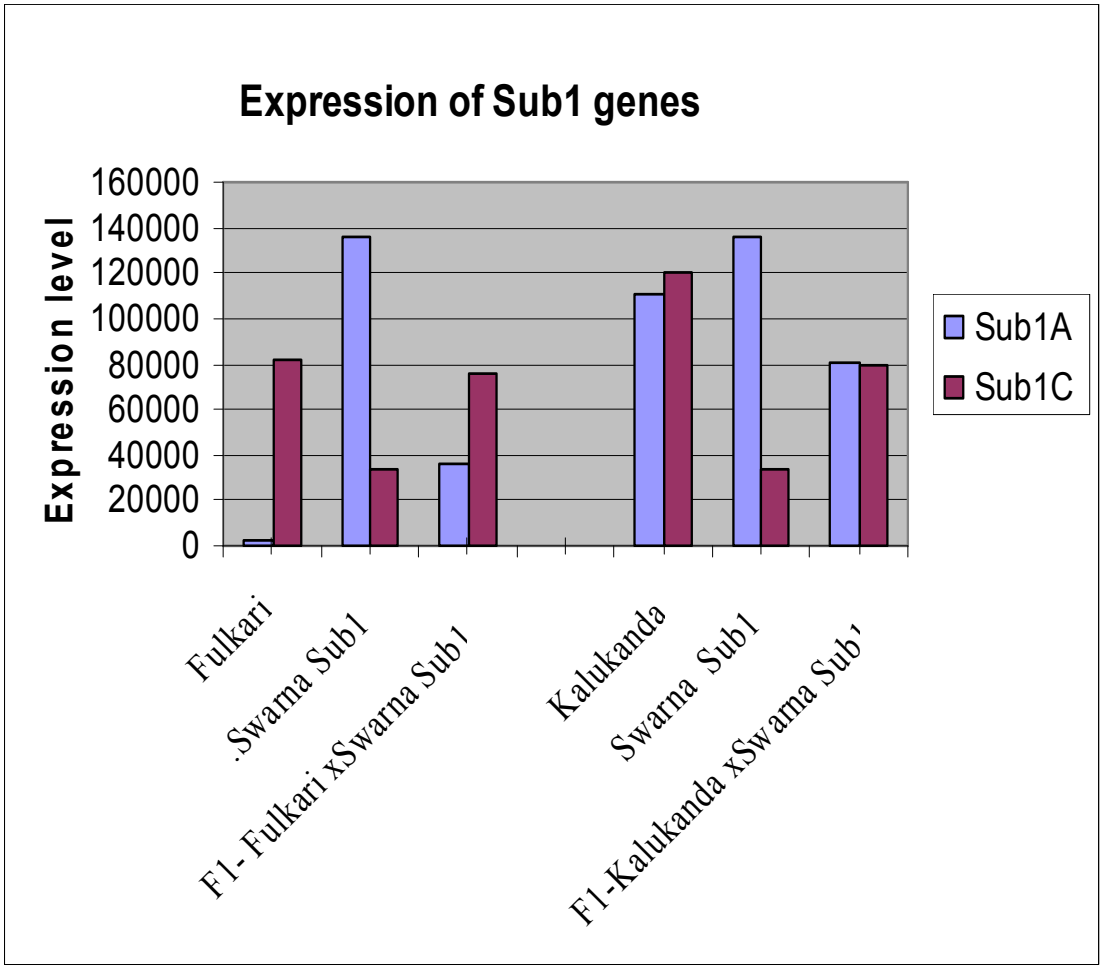


Fig. Detection of transcription at Sub1 locus in hybrids and their parents of rice

Heterosis% (MP) for allele-specific transcripts and different traits

Expression/ Phenotype	Fulkari	Swarna -Sub1	Hybrid-1	MpH%	Kalukanda	Swarna-Sub1	Hybrid-2	MpH %
Sub1A(E)	2	136	36	-47.8*	111	136	81	0.53
Sub1C(E)	60	38	64	30.6*	120	38	80	1.3
Elongatn%	156	42	137	38.4**	70	42	59	5.4
Survival%	5	90	41	-13.9*	67	90	73	-8.9*
Remarks	**S**	**T**	**S**		**MT**	**T**	**MT**	

MpH%= Mid parent heterosis %, E= Expression value

- Effects at two loci was not additive i.e. non-additive interaction of alleles.
- *Sub1A* and *Sub1C* expression values in hybrids were not equal to the average of both parents
- Involvement of interactions under heterozygous combination

Reasons stated by respondents for non-suitability of hybrid rice grain consumption

Reasons	% farms opined	
	Alok-6201 (n=43)	Sonar Bangla (n=53)
Stickiness of cooked rice	96.3	75.0
Taste not so good	48.1	62.5
Left over rice is not suitable for consumption	59.3	25.0
Inferior quality	29.6	12.5
Inconvenience in cooking	18.5	37.5
Unfavorable odour	7.4	12.5

Source:Hussain *et al*, 2000

High yield could be combined with good grain quality

Grain Quality Characteristics

1. Chalkiness
2. Amylose content
3. Milling yield
4. Eating quality
5. Grain length/diameter

Physio-chemical properties of some promising parental lines of hybrid rice

Designation	Milled rice (%)	Head rice (%)	Cooking time (min)	Size	Elongation ratio	Imbibition ratio	Amylose (%)	Protein (%)
BR827R (R line BHD-1)	70	70	22	Long	1.2	3.5	24	7.9
BRRI11B (BHD-2 B line)	63	81	21	Medium	1.4	3.3	25	7.4
BRRI11A (BHD-3 A line)	68	93	23	Medium	1.4	3.5	23	9.0
BRRI11B (BHD-3 B line)	67	83	23	Medium	1.3	3.5	25	8.0
BRRI 9A/BRRI 15R (Promising hybrid)	68	67	17	Long	1.4	3.0	23	6.8
BRRI 24R	69	62	20	Long	1.3	4.7	27	6.7
BRRI 25R	69	83	13	Medium	1.4	3.5	27	6.7
BRRI 26R	69	54	16	Long	1.3	4.7	26	6.4
IR 73328B	72	83	18	Long	1.3	3.3	26	7.5
BRRI 3B	72	87	15	Long	1.4	5.0	25	8.3
BRRI 9B	70	88	15	Long	1.3	3.7	25	9.9
II 32B	70	88	19	Medium	1.3	4.3	25	8.4
Gan 46B	62	80	20	Short	1.4	3.3	23	7.7
Jin 23B	69	78	15	Medium	1.6	3.8	27	5.9

Source: GQN division, BRRI

- **Developing hybrids resistant to major diseases**

Developing hybrids resistant to major insects

Hybrid variety development

- ▲Variety with fine grain and high amylose content
- ▲ Short duration varieties needed to intensify cropping
- ▲ Highly fertilizer use efficient rice hybrid
- ▲ Indica /Japonica hybrid for high heterosis
- ▲ Introducing super rice hybrid varieties from China
- ▲ Varieties tolerance to biotic and abiotic stresses
- ▲ Best adaptable variety for our climatic condition

Quality hybrid Seeds

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- **Quality hybrid seeds available to farmer's through public and private agencies.**
- **Frequent field visit by researchers/SCA people in the seed plots of private companies.**
- **Control of seed quality during storage and marketing.**

Actors

Producer	Classes of seed	Actor(s) for quality control
BRRI	BS	Breeders & SCA
BADC, PS and NGOs	FS	Producer, BRRI Scientists & SCA
BADC/DAE, PS and NGOs	CS/TLS	Producer (optional SCA and BRRI)

Constraints
for Rice Seed Network

- Lack of poverty oriented rice seed supply systems
- Farmers do not have timely access to quality seed
- Lack of farmers awareness about benefits of quality seed
- Low replacement rate of MV and quality seed
- Less development of seed supply system in private sector
- Less investment of private sector in rice seed business
- Low and imbalanced development of institutional facilities.
- Lack of trained technical manpower and infrastructure facilities in private sector and NGOs
- Lack of subsidy on public seed sector
- Inadequate quality control system of truthfully labeled seed

Strengths and weaknesses in Rice Seed Systems

System variables	Strengths	Weaknesses
Distribution/ marketing	Positive effect of selling less foundation seed to seed farmers; production and distribution networks close to the client, seed farmers participate in marketing; rice seed network is framework for assessing seed markets	Limited business and organisational skills of many organisations; limited market analyses and coordination within and among organizations
Outlet markets	Potential for linking seed networks to grain markets	Not addressed in rice seed network. Currently beyond its scope

Public-Private Partnerships (PPPs)

- There are limits to the ability of governments to foster development
- There are also limits to what the private sector can achieve by itself.
- Neither public not the private sector can ensure economic development
- Led to increased interest in public-private partnership
- PPPs deals to develop projects.
- Any collaboration between public bodies, such as local authorities or government
- Allow corporations such as government/donor agencies to finance
- Public-public agencies collaboration

A “mutual partnership” will develop in the space of common benefits

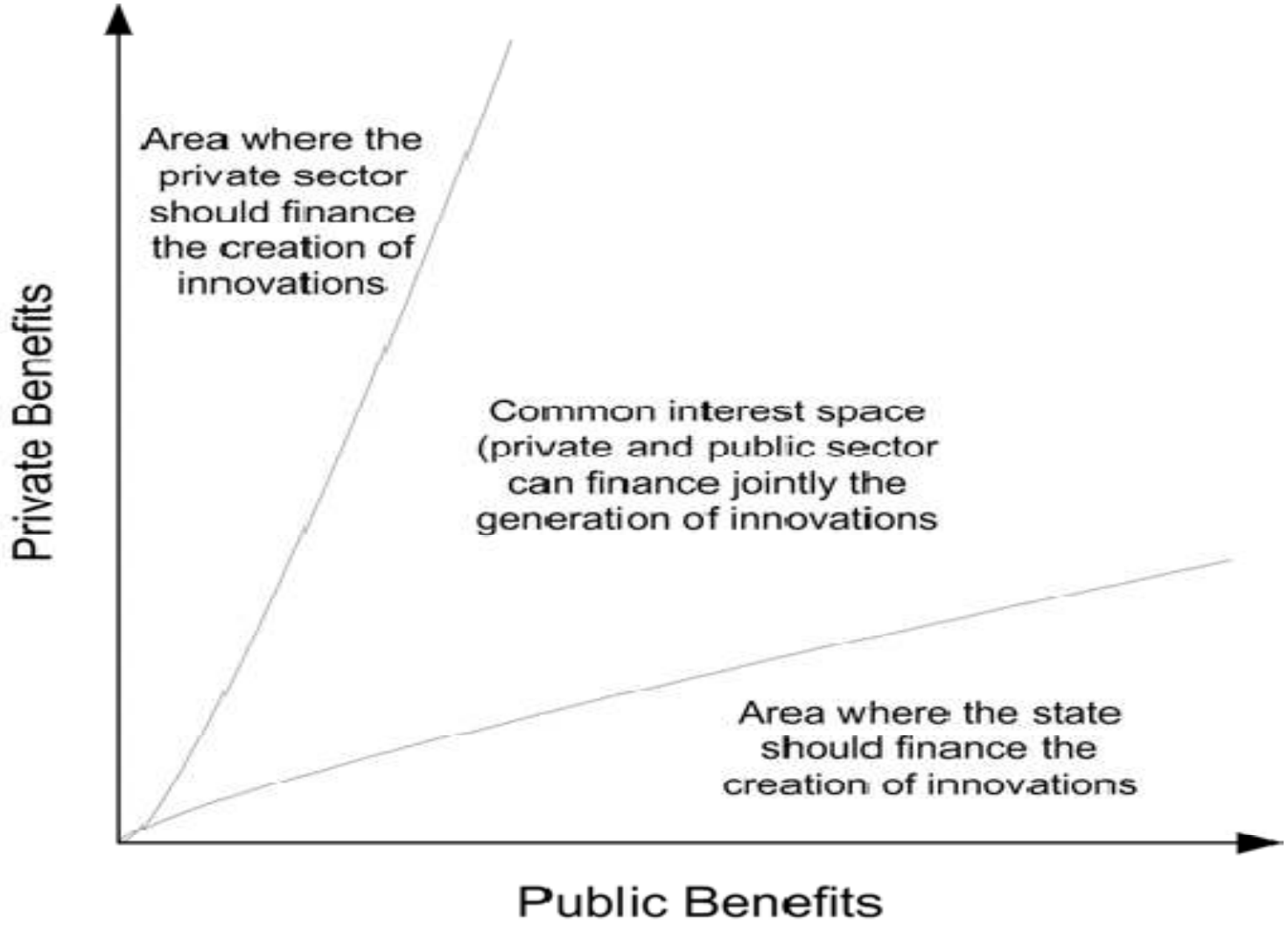

Figure 1: Space of Public and Private Benefits(Frank Hartwich; 2009)

Funds Supporting Public-Private Research

- Funds of the Government: promote basic research
- Funds of development aid donors: raise the quality of products.
- Researchers at public institutes may see partnership agreements with the private sector as sources of funds

Supply of parental seeds from BRRI to seed companies

Sl. No.	Recipient	Nos.	F_1 (kg)	A line (kg)	B line (kg)	R line (kg)
01	BADC	1	0.00	150.00	-	30.00
02	Seed Companies	21	75.00	706.00	-	150.00
02	Farmers	65	130.00	1.00	-	0.50
03	BRRI R/S	4	-	102.00	9.00	34.00
Total		91	205.00	959.00	9.00	214.5
Grand Total			1387.5			

200 tons of hybrid seeds produced in Bangladesh during boro 10-11

Projected domestic CMS seed, hybrid seed and hybrid rice production

BRRI		BRRI/ BADC/comp.		BADC/Comp.		Farmers			
CMS multiplication		CMS multiplication		Hybrid seed production (F1)		Hybrid rice production		Area covered in Boro	Inc. HR prodn. in Boro
Area (ha)	Prodn. (MT)	Area (ha)	Prodn. (MT)	Area (ha)	Prodn. (MT)	Area (Mha)	Prodn. (MMT)		
1.00	2.00	100.00	200.00	10000.00	25000.00	1.60	8.75	27 %	52 %

Targeted Hybrid seed= 25000 MT

Large quantity of hybrid rice seed production

- **Building up linkages with BRRI and BADC and seed companies for seed up-scaling.**
- **Net work for seed production through public and private agencies.**
- **Institutional and government support for public private partnership for seed production.**
- **Need seed production infrastructure.**
- **Hybrid Seed production of BADC strengthened.**
- **Involving many seed companies in hybrid seed production and marketing.**
- **Involving promising seed companies in multiplication of parental lines (A, B and R).**
- **Production of breeders seed of parental lines in BRRI regional stations.**
- **Supply of breeders seeds of parental lines (A, B and R) to seed companies.**
- **Training of people from NGO/seed companies on "hybrid rice seed production technology"**

More investments in agricultural research

Increase in yield potential:
inbreds (~10%); hybrids (~20%)

R&D Investments in: Water, nutrients, weeds, insects, diseases, rats, other abiotic stresses

PUBLIC-PRIVATE PARTNERSHIP

Good pro-active leadership, good planning and programming technical briefings and other activities in close collaboration with the seed supply, technology and support from the private sector make-up the ingredients for success in these endeavors

Steps for hybrid seed production

- B-line multiplication
- R-line multiplication
- A-line multiplication (Ax B cross)
- F1 seed production (Ax R cross)

- Row ratio
- Isolation distance/Barrier
- Flowering synchronization- time of sowing, GA3 application, water and fertilizer management
- Supplementary pollination.
- Roughing

- **Technological cooperation for attaining high F1 seed yield**

CMS multiplication of released hybrids, T Aman-2010

Combinations	Plant height (cm)		50% flowering (days)		PER (%)	OCR (%)	Yield	
							(kg/ plot)	(t/ha)
	A line	B line	A line	B line	A line	A line		
BR10A/B	84	86	73	72	74	34	65	1.4
BR11A/B	82	85	75	73	77	36	50	1.5
IR58025A/B	88	90	90	79	71	31	25	1.2

Not suitable for seed production

CMS multiplication of released hybrids. Boro, 2010-11.

Combinations	Plant height (cm)		50% flowering (days)		PER (%)	OCR (%)	Yield	
							(kg / plot)	(kg /ha)
	A line	B line	A line	B line	A line	A line	A line	
BR10A/B	80	83	121	120	87	45	550	2200
BR11A/B	82	84	123	121	88	49	1500	2500
IR58025A/B	79	78	120	120	82	43	276	1800

Suitable for seed production

Natural Barrier Isolation

Seed yield of BRRI hybrid2

Seed production field of private company

Genetic Purity

- **Genetic purity of the hybrid seeds is extremely important to exploit maximum heterosis.**
- **Genetic purity starts from the high quality parental line seeds.**

Technological cooperation for maintaining purity of F1 seed

List of Company taken parental line of BRRI hybrids during boro 2011-12

ACI Seed ACI centre # 245 Tejgaon C/A Dhaka.	**KRISHIBID FARM LIMITED** 301 (2nd floor), Rokeya Sarani, Kazipara, Mirpur, Dhaka-1216.
Asha Agro Limited Kamal Pukur,Syedpur, Nilphamari	**G. M. Foundation** Vill+P.O: Guabaria (Miabari), P.S: Hizla, Dist: Barishal.
Index Seeds Limited, Lake plaza (APP # 202, House # 12, Road # 30 Gulshan-1, Dhaka-1212.	**Shaw Unnayan Seeds** Pat Hatar Moor (Cenema hall Road) Chachkore bazar, Gurudaspur, Natore.
Ispahani Seeds Limited Ispahani Building, S K. Mujib road.14-15 Agrabad, Motijheel C/A, GPO. Box. No.80 Dhaka-1000.	**USHI Seeds** College road, Patkel ghata, Tala, Satkhira.
Metal Seed Metal Agro Limited, PBL Tower (14th floor), 17 North C/A. Gulshan Circle-2, Dhaka-1212.	**Phenix Feed Mill Limited.** Nurzahan Sharif Plaza (3rdfloor) 34, Purana Paltan, Dhaka-1000.
MEE BEEJ 9/9 Iqbal road, Mohammodpur, Dhaka-1217.	**M/S: Star Agro Farm** Sazanpur, Gopalpur, Tangail.

Borendra Multiple Development Authority (BMDA) Barendra Bhavan, Upa shahore, Rajshahi 6000.	**Petro-Chem (Bangladesh Limited)** ABC. Hetage(3rd floor), Plot 2 & 4, JAsimuddin Avenue, Sector 3, Uttara, Dhaka.
Lal Teer Seed Limited Anchor Tower # 108 Bir-Uttam C R Datta road, Dhaka.	**Bangladesh Agricultural Development** Corporation (BADC) 49-51 Dilcusha-C/A, Dhaka.
HI-TECH AGRO (HITC) Borogola, Bogra.	**M/S: Islam Agro Seed** Baganbari, Bhairob, Kishoregonj.
SOPAN Seeds 145, Siddique bazar, Dhaka-1000, Bangladesh.	**A Haque & Seed Store,** PS+PO: Saghata, Gaibandha.
SIDDIQUIS Seeds **Plot** # 7, Main road # 3, Block # A, Section # 11, Dhaka-1216	**M/S: Zahangir Bohumukhi Seed Bitan**, Khoira pukur bazar, Shibgonj, Bpogra.

Rupantor Agro Farm Limited (RAFL) Vill+P.O: Matifata, P.S: Srebordi, Dist: Sherpur**.**	**NAICOL** Awal Centre (9th floor), 34 Kamal Atattar Avenue, Bonani, Dhaka.
Gramini Bangladesh Ltd. Joydebpur, Gazipur-1700.	**BRAC** BRAC Centre 75 Mohakhali, Dhaka-1212.
Syngentra Bangladesh Limited House 2/6, Block E Lalmatia, Mohammodpur, Dhaka.	**New Zea Bangla Food Products (Pvt). Ltd.** 49 Naya Poltan (1st floor), Dhaka-1000.
SUPREME SEED COMPANY LTD. House # 13, Road # 15, Rabindra Sarani, Sector # 3, Uttara, Dhaka-1230. Banggladesh	**Golden Valley Agro Source Ltd.** Road 31, House 455 (4th floor), New DOHS, Mohakhali, Dhaka-1206.

Program for dissemination BRRI released hybrids and seed production technologies

- **Demonstration trials in farmers field.**
- **Distribution of hybrid seeds to farmers.**
- **Training extension people/ NGO personnel /farmers on " hybrid rice cultivation".**
- **Large quantity of breeder seed of A, B and R lines are needed.**
- **Large quantity of hybrid seed production by companies.**
- **Govt. and private sector investment to strengthen seed production.**
- **Research - extension service linkage.**

Demonstration trials of BRRI hybrid dhan2/3.

Year	Variety	Locations	Number	Total
2009-10	BRRI hybrid dhan 2 & 3	200	200	200

Training program conducted during

Year	Subject matter	Farmers	SA/SSA /SAAO	Agril. Extn. Officer	Scientists	Seed Companies	Total
2009	Hybrid Rice Cultivation	87	63	10	59	-	219
2010	Seed Production Technology	-	-		14	82	96
						Grand total	315


TRAINING CUM PLANNING WORKSHOP


TRAINING ON


Training on
"Hybrid Rice Seed Production Technology"
Date : 25-26 April, 2010
Venue : Training Division
Organized by : Hybrid Rice Project
and Training Division, BRRI, Gazipur

International training on hybrid rice

Activitiy: Demonstration trials of BRRI hybrid dhan2 and BRRI hybrid dhan3.

Table 28: Demonstration trials of BRRI hybrid dhan2 and BRRI hybrid dhan3

Sl.No.	Name of the Districts	No. of trials	Variety name	Sl.No	Name of the Districts	No. of trials	Variety name
1	Dhaka	8	BHD2	14	Bagerhat	8	BHD2
2	Gazipur	8	BHD2	15	Jamalpur	8	BHD2
3	Comilla	8	BHD2	16	Tangail	8	BHD2 and BHD3
4	Noakhali	8	BHD2 and BHD3	17	Nogao	8	BHD2
5	Chandapur	8	BHD2	18	Natore	8	BHD2
6	Chattagram	8	BHD2 and BHD3	19	Rangpur	8	BHD2
7	Habigonj	8	BHD2	20	Kurigram	8	BHD2
8	Kishorgonj	8	BHD2 and BHD3	21	Dinajpur	8	BHD2
9	Barisal	8	BHD2	22	Thakurgaon	8	BHD2
10	Chuadunga	8	BHD2	23	Panchagur	8	BHD2
11	Jessore	8	BHD2 and BHD3	24	Rajshahi	8	BHD2
12	Khulna	8	BHD2	25	Pabna	8	BHD2
13	Satkhira	8	BHD2 and BHD3	Total = 200 trials			

weª nvBweªW Gi Ggwb aiY

Kg Rwg‡Z AwaK djb|

weª nvBweªW av‡bi c¨v‡i›Uvj jvBb e¨envi K‡i

†`‡k nvBweªW av‡bi exR Drcv`b Ki“b Ges

Avg`vbx wbf©iZv Kwg‡q %oe‡`wkK gy`ªv mvkªq Ki“b|

nvBweªW ivBm cÖKí

evsjv‡`k avb M‡elYv Bbw÷wUDU, MvRxcyi|

‡Uwj‡dvb- 9257401-5 (340), 9293572

‡gvevBj- 01721964002, 01716937130

Demonstration trial of hybrid

Demonstration trial of hybrid

•Collaboration with China

• For materials and technical support

Collaboration with NGOs/seed companies

Marker assisted backcrossing (MAB)

- **Introgression of target gene into background of B and R lines**
- **Tightly linked marker with a trait useful in MAS.**
- **Increase efficiency of breeding program.**
- **Markers linked with useful traits used to transfer QTL into high yielding hybrids**

Past cooperation from China

- About 60 hybrid varieties introduced from China
- BRRI received CMS lines from China
- Scientific knowledge from CNHRRC on hybrid rice breeding and seed production

Cooperation from China for training

- BRRI scientists trained in hybrid rice breeding and seed production courses in China since 1998
- BRRI scientists participated in seminar/workshop in China since 1998.
- Two Chinese hybrid rice experts came at BRRI and trained scientists/ Extension people in hybrid rice courses during January- April 2001.
- Under China-Bangladesh government cooperation- Chinese hybrid rice two experts came at BRRI and trained 63 scientists/ Extension people/ Seed company personnel in 3 training courses (breeding, seed production and cultivation) during April- May 2011
-

Future need of cooperation

- More workshop programme in China
- More long and short term training programme in China
- More visit of Chinese hybrid rice experts in Bangladesh for training Bangladeshi scientists.
- Exchange of Super rice breeding materials, CMS lines and Indica breeding lines
- Exchange of stress tolerance hybrid rice breeding materials

Expanding the Hybrid Rice Breeding Program

Strategies:

1. Enhance collaboration with other institutes
2. Explore collaboration with private sector and international organizations
3. Funding
4. Pedigree generation and data input

SUMMARY AND RECOMMENDATIONS

1. Production, Technology Development, Extension and Information Support;

2. Infrastructure Development and Maintenance

3. Project fund and international cooperation

Thank You