THE PROGRESS OF HYBRID RICE RESEARCH AND DEVELOPMENT IN INDONESIA

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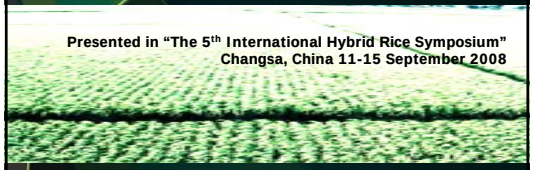

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HYBRID RICE RESEARCH IN INDONESIA IN THE PAST

- HR research → started in 1983.
- Until 1990s, HR research has not been successfull as expected → difficulties in obtaining stable CMS lines with high outcrossing rates (> 20%), and adapted to Indonesian environment.
- RYT → showed that the highest yield was always obtained by hybrid rice combinations.
- Finally resulted in several hybrid combinations showing consistently higher yield than check varieties → IR58025A/IR53942 and IR58025A/BR827-35 which were then released in 2002 as Maro and Rokan.

- Since 2001, HR research was intensified → collaboration between IAARD with IRRI and FAO.
- ICRR had come out with several promising hybrid combinations and new CMS, maintainer, and restorer lines.
- In 2004 → HiPa3, HiPa4,
- In 2006 →HiPa5 Ceva and HiPa6 Jete.
- The superiority of those new hybrids compared to Maro and Rokan were their degree of resistance to major pest and diseases, and one of them was aromatic.

CURRENT STATUS OF HYBRID RICE COMMERCIALIZATION

Table 1. Hybrid Rice Varieties Released in Indonesia

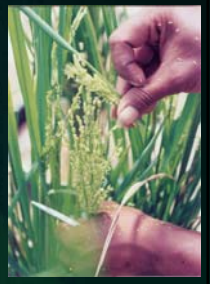
No.	Breeding Inst	No	Hybrid Varieties
1	ICRR	6	Maro, Rokan, Hipa 3, Hipa 4, Hipa 5 Ceva, Hipa 6 Jete
2	BISI	2	Intani 1, Intani 2
3	Bangun Pusaka	2	LP Pusaka 1, LP Pusaka 2
4	Kondo	5	Miki 1,2,3; Manis 4 & 5
5	Bayer Crop Sci	2	Hibrindo R1, Hibrindo R2
6	KNB Mandiri	2	Batang Kampar, Batang Samo
7	Dupont	2	PP-1, PP-2
8	Makmur SNT	2	Brang Biji, Segara Anak
9	TU Saritani	2	Adirasa-1, Adirasa-64
10	SL Agritech	2	SL-8-SHS, SL-11-SHS
11	Primasid	2	Mapan-P.02, Mapan-P.05
12	SAS	2	Bernas Super, Bernas Prima
13	Biogene Plantation	4	Sembada B3, SB-5, SB-8, SB-9
	Total	35	6 public + 29 private

Major challenges on the large scale adoption of hybrid rice technology in Indonesia are :

- very high expectations of farmers
- inadequate understanding of agronomic management of hybrids,
- poor grain quality of some hybrids compared to premium quality rice varieties (milling recovery, percent of broken rice, etc)
- inadequate level of disease/insect resistance in the most released hybrids,

Some programs to encounter the constraints are in progress :

- Improving the hybrid and parental lines resistance to major pest and diseases
- enhancing the level of heterosis through *indica x tropical japonica* hybrids
- Improving grain quality of hybrids by appropriate breeding and selection of parental lines
- Improving cultivation and pest management strategies for consistent performance of hybrids



Badan Litbang 7

Key Ingredients for Commercialization Already Present

- Food security challenge
- Large irrigated areas, low cost of labor
- Government policy support to hybrid rice technology development and promotion
- 35 hybrids released
- Seed production yields of up to 3 t/ha with 1 t/ha being regularly attained
- Integrated crop management for hybrid rice
- Increased national technical capacity in different sectors
- Vibrant private sector participation
- Plan for 2005-2009

Badan Litbang 8

PERFORMANCE OF RELEASED RICE HYBRID VARIETIES

Badan Litbang 9

Table 2 (Summarized). Average grain yield of Maro & Rokan in demonstration plots conducted in 10 district, DS 2002.

District	Maro		Rokan		Best check *
	(t/ha)	(%) **	(t/ha)	(%) **	(t/ha)
Subang	7.20	-	7.9	-	-
Sragen	7.83	92.7	9.57	113.3	8.45
Blitar	8.94	93.5	11.06	115.7	9.56
Bojonegoro	6.10	87.0	7.52	107.3	7.01
Palas	7.30	146.0	7.40	148.0	5.00
Musirawas	6.34	108.9	7.30	125.4	5.82
Tnh Datar	5.60	116.7	5.32	110.8	4.80
Maros	8.38	113.9	7.84	106.5	7.36
Goa	7.09	-	7.53	-	-
Pontianak	5.32	118.2	5.60	124.4	4.30
Average	7.01	106.9	7.70	117.4	6.56

- * Inbred variety IR64, Ciherang, Way Apo Buru, or Memberamo
- ** Percentage to the best check

DATA TAKEN FROM FRONT LINE DEM – ICFORD 2003

No. of Locations	:	14 district
Average yield Maro	:	7.3 t/ha
Average yield Rokan	:	7.5 t/ha
Standard Heterosis	:	-11% to 46% (14%)
Attainable yield Rokan	:	11.06 t/ha
Attainable yield Ciherang (inbred)	:	9.60 t/ha
Hybrid productivity	:	5.52 to 11.06 t/ha

Tabel 3. Average grain yield of hybrid varieties in Sukamandi DS 2007 & 2008, and Kuningan DS 2007.

No	Hybrid	Grain Yield (t/ha) at 14% MC		
		Ski DS 2007	Kng DS 2007	Ski DS 2008
1	Maro	7,40	6.90	7.47*
2	Rokan	6,81	6.40	7.19
3	Hipa3	7.74 ns	8,11 **	7.42*
4	Hipa4	7.23	6,66	7.00
5	Hipa5 Ceva	7.87 ns	6,74	7.55*
6	Hipa6 Jete	6.47	7,35*	6.17
7	Arize R1	6.99	6,91	6.98
8	Arize R2	6.94	6,05	5.89
9	Intani-2	7.25	7,64*	7.56*
10	PP1	7.12	5,56	6.72
11	PP2	6.98	7,36*	7.10

Tabel 3. Average grain yield of hybrid varieties in Sukamandi DS 2007 & 2008, and Kuningan DS 2007.

No	Hybrid Rice Varieties	Grain Yield (t/ha) at 14% MC		
		Sukamandi DS 2007	Kuningan DS 2007	Sukamandi DS 2008
12	Bernas Prima	6.37	7,13*	-
13	Bernas Super	7.18	7.92*	6.94
14	Batang Kampar	5.89	7.82*	-
15	Batang Samo	7.55	8.10 **	7.13
16	Brang Biji	6.78	6.50	-
17.	Segara Anak	-	-	7.24
18	Adirasa-64	6,04	6.90	7.04
19	SL-8-SHS	6.59	6,10	7.80*
20	Mapan P-02	8.89 *	6.97	7.16
21	Ciherang (inbred)	8.06	6.06	6.39

BREEDING PROGRAM

- **Approach/Technology : Three Lines Method (Introduced Lines → Mixed → Parental from National GP)**
  - **Selection & Testing of Introduced /mixed A-B-R**
  - **Simultaneously**
  - **Whole Breeding Process >> A-B-R : National**

- Program & Activities

Short term

- Identify and select Indonesian R lines
- Evaluate & test yield potential of promising hybrid & release hybrid rice derived from IRRI CMS X ICRR Restorer with standard heterosis of 15-20% > the best inbred

Long term

- Improvement of CMS & restorer (R) adapted under Indonesia condition
- Evaluate & test yield potential & release 'local' hybrids (deriving from Indonesia CMS & R lines) with standard heterosis 20-25% & resistant to major pest and disease
- Develop **NPT hybrid** with standard heterosis 25-30% > the best inbred

Table 4.Indonesian Restorer Lines and their reaction to Bph3, BLB IV, BLB VIII, and RTV

No.	Restorer	Reaction score to			
		Bph3	BLB IV	BLB VIII	RTV
1	S4124F	3	4	5	5
2	B9645E	7	3	4	4
3	B4070D	9	4	4	5
4	B10373E	3	4	4	3
5	B9775B	5	4	4	3
6	B2791B	9	4	4	4
7	B8239G	9	4	4	4
8	S4325D	3	3	4	3
9	S4424F	3	4	5	5
10	B8049F	5	4	4	6
11	BIO9	3	3	4	2
12	B5960	9	4	4	3
13	BP51	9	3	4	2
14	BIO12-2	3	3	4	4
15	B10214F-2	5	5	4	4
16	B10214F-1	5	4	4	3

Table 5.Restorer line candidates and their reaction to Bph3, BLB IV, BLB VIII, and RTV

No.	Restorer lines	Reaction score to			
		Bph3	BLB IV	BLB VIII	RTV
1	S4850-9F-6	3	4	4	6
2	S4653-164	3	5	5	7
3	B8974B	3	5	5	5
4	B10277D-1	3	5	5	6
5	BP1368-1D	3	5	5	6
6	BP1088-2E	3	5	5	7

Table 6 Reaction of some hybrid rice combinations to Bph3, BLB IV, BLB VIII, and RTV.

No.	Hybrid	Reaction to				Status
		Bph3	BLB IV	BLB VIII	RTV	
1	Hipa3	7	4	4	6	Released
2	Hipa4	5	3	4	5	Released
3	H13	3	4	4	5	AYT
4	H14	3	3	4	5	AYT
5	H17	3	4	4	5	MLT
6	H27	3	3	3	7	MLT
7	H29	5	4	4	8	MLT
8	H30	5	3	4	7	MLT
9	H33	3	3	4	5	MLT
10	Hipa5 Ceva	3	4	4	5	Released
11	Hipa6 Jete	9	4	4	7	Released
12	H39	3	5	5	2	AYT
13	H42	5	5	4	2	MLT
14	H48	3	5	5	4	AYT

Table 6 Reaction of some hybrid rice combinations to Bph3, BLB IV, BLB VIII, and RTV (continued).

No.	Hybrid	Reaction to				Status
		Bph3	BLB IV	BLB VIII	RTV	
15	H51	9	3	4	7	MLT
16	H54	5	4	4	5	AYT
17	H55	7	4	4	3	AYT
18	H57	5	4	5	2	MLT
19	H58	7	5	4	2	AYT
20	H59	5	5	5	3	AYT
21	H60	5	5	5	3	AYT
22	H63	5	4	4	3	MLT
23	H50	9	5	5	3	AYT
24	H64	5	5	5	2	AYT
25	H67	5	5	5	3	AYT
26	H68	3	5	5	5	MLT
27	H70	3	5	5	4	MLT
28	H71	3	5	5	5	MLT

Table 7. Grain yield and st. het. of promising hybrids tested in AYT in Muara, Sukamandi, and Cianjur, WS 2003-2004.

Hybrid/ Check	Muara		Sukamandi		Cianjur		Average	
	Yield (t/ha)	IR64* (%)	Yield (t/ha)	IR64* (%)	Yield (t/ha)	IR64* (%)	Yield (t/ha)	IR64* (%)
H30	5.14	21.88	6.11	7.19	7.61	18.72	6.28	15.5
H35	4.94	17.06	6.16	8.07	9.61	49.92	6.90	26.8
H42	5.79	37.24	7.05	23.68	9.62	50.07	7.48	37.5
H50	4.83	14.38	5.80	1.75	8.02	25.12	6.21	14.2
H55	5.08	20.36	5.80	1.75	9.21	43.68	6.69	23.0
H56	5.50	30.28	6.25	9.65	8.02	25.11	6.58	21.0
H58	5.61	32.98	6.16	8.07	8.42	31.25	6.72	23.6
H59	5.12	21.36	6.10	7.02	7.63	18.75	6.27	15.3
H65	5.08	20.48	5.97	4.74	8.40	31.25	6.48	19.2
H68	4.72	11.74	7.06	23.86	8.02	25.12	6.59	21.2
H70	4.71	11.68	6.74	18.25	8.03	25.27	6.48	19.2
Maro	5.77	36.72	5.12	-10.18	10.01	56.16	6.96	27.6
IR64	4.22	-	5.70	-	6.41	-	5.44	-

Table 8. Performance of some selected hybrids from OYT conducted in the WS 2003/2004

Hybrids/check variety	Flowering (days)	Plant height (cm)	No. tillers	BLB (skor) *	Yield (t/ha)	St. het (%)
IR68897A/BP165	90	99	13	5	7.34	50.12
IR68885A/BP154E	95	95	11	5	7.44	48.85
IR68885A/BIO-12	98	72	18	3	6.51	34.91
IR68885A/IR68077	89	88	13	5	6.56	34.32
IR62829A/IR59544	90	93	15	5	6.68	33.55
IR68888A/BIO-12	92	97	12	3	6.49	32.14
IR68886A/BIO-12	89	94	15	3	6.35	31.83
IR62829A/BP1028F	96	97	14	5	6.58	31.53
IR68888A/IR68078	95	85	15	5	6.54	30.69
IR68885A/IR25912	99	73	16	3	6.41	28.12
IR64 (Check)	97	89	11	7	4.89	-
Maro (Check)	104	70	12	7	5.60	14.48

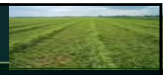
Table 9.Grain yield (t/ha) of some promising hybrids during the DS of 2007

Hybrid	Location			
	Bantul	Cianjur	Klaten	Salatiga
H17	9.92*	7.18*	8.28	7.15
H22	3.73*	7.25*	10.60	7.36
H25	10.23*	6.77	9.73	6.41
H27	8.59*	7.56*	10.07	8.23
H51	7.64	7.27*	11.11	7.32
H53	8.49*	6.83	10.30	5.10
H72	10.59*	6.90	11.28	7.34
H73	8.06	6.52	9.73	7.26
H88	9.89*	7.61*	10.44	6.60
H90	9.97*	7.95*	10.92	6.33
Maro	8.03	7.37*	10.32	7.21
Ciherang	7.64	5.00	9.79	6.88
LSD (5%)	0.69	1.98	2.73	2.05
CV (%)	7.02	15.80	18.60	18.40

Table 10. Regression coefficient and st. deviation of yield

Hybrids	Yield (t/ha)	St. Het on IR64 (%)	bi[1]	Sd[2]
IR58025A/MTU9992	8.63	19.7	1.20^{ns}	1.96^{ns}
IR58025A/C20R	7.59	5.3	0.83^{ns}	1.37^{ns}
IR58025A/IR65515	7.99	10.8	1.22*	1.83^{ns}
IR62829A/MTU9992	8.01	11.1	1.09^{ns}	1.91^{ns}
IR58025A/RHS-412	7.65	6.1	0.96^{ns}	1.57^{ns}
IR58025A/B10277	7.68	6.5	0.95^{ns}	1.39^{ns}
IR58025A/Maros	7.39	2.5	0.99^{ns}	1.62^{ns}
IR58025A/Cisokan	7.46	3.5	1.01^{ns}	1.51^{ns}
IR58025A/IR68	7.16	-0.7	0.78*	1.44^{ns}
IR58025A/B10373	6.92	-4.0	0.88^{ns}	1.30^{ns}
IR64	7.21	-	1.05^{ns}	1.60^{ns}

Seed Production Model for Public Hybrid Rice



1. Nucleus Seed Production of Parental lines
   - The SP phase aimed at producing genetically pure seeds of parental lines
   - Undertaken by breeders and specialized institutions
2. Breeder Seed Production of Parental lines
3. Foundation Seed Production of Parental lines
   - The SP phase aimed at producing more seeds of parental lines for use in hybrid seed production
   - Undertaken by seed companies/specialized growers
4. Certified Hybrid SP (A x R seed production)
   - The SP phase aimed at producing hybrid seeds
   - Undertaken by trained seed growers/private companies
5. Hybrid Rice or F1 Cultivation
   - Commercial cultivation by farmers

Table 11. F1 hybrid seed yield achieved in some locations from DS 2002 to DS 2008

Location	Hybrid	Season	Area (ha)	Total yiled (kg)	Yield (kg/ha)	
Pusakanegara	Maro	DS 2002	4,0	5050	1488	
Pusakanegara	Rokan	DS 2002	3,0	1382	466	
Pusakanegara	Rokan	DS 2003	1,0	550	550	750
Pusakanegara	Maro	WS 03/04	1,0	520	520	
Pusakanegara	Rokan	WS 03/04	1,0	730	730	
Sukamandi	Maro	DS 2002	0,90	250	278	
Sukamandi	Rokan	DS 2002	0,60	90	150	
Sukamandi	Hipa5 Ceva	DS 2006	0,25	150	600	762
Sukamandi	Hipa6 Jete	DS 2006	0,25	150	600	
Sukamandi	Maro	MK 02	3,0	660	220	834
Sukamandi	Hipa3	DS 2007	1,0	1200	1200	
Sukamandi	Hipa5 Ceva	DS 2008	1,0	1340	1340	
Sukamandi	Hipa6 Jete	DS 2008	2,0	4580	2290	
Muara	Maro	MK 02	1,0	4640	464	
Muara	Maro	MK 06	0,25	275	1100	808
Muara	Rokan	MK 06	0,25	215	860	
Tegalgondo	Maro	MH 03/04	1,0	320	320	
Tegalgondo	Rokan	MH 03/04	1,0	710	710	543
Tegalgondo	Hipa6 Jete	MK06	0,25	150	600	

ISSUES IDENTIFIED FOR FUTURE RESEARCH AND TECHNOLOGY DEVELOPMENT

- **Instability expression of heterosis → Increasing no of testing for early hybrid evaluation as OYT might identify hybrids > stable expression of heterosis.**
- **Resistant to major pests and diseases : HR var released in Ind are mostly S to BPH, BLB, and RTV → could contribute to the instability of het expression and constrain to rapid adoption of hybrid rice technology**
- **Grain and rice quality → e.g. milling recovery, broken rice, chalky, grain shape**
- **Hybrid of NPT rice → Inbred variety of NPT rice with higher yielding capacity has been released in Ind. Further increase in yield capacity could be obtained by developing hybrid of the NPT rice.**

FUTURE PLAN

- HR research still high priority in the next five year program.
- The major objectives are to dev better HR with high and stable het, res to BPH, BLB, & RTV, & good grain quality; to improve seed prod tech; & to dev ICM technology.
- NPT breeding material → used in HR breeding to improve the yield potential.
- Testing of promising hybrids will be conducted in more locations to identify hybrids with more stable heterosis.
- A network for testing HR has been developed between ICRR, some private companies, and AIAT present in all prov
- Research on HR seed prod will flowering synchronization between parental lines in different potential locations.
- Research on hybrid rice cultivation to develop appropriate ICM suitable for hybrid rice will be continued.
- Strengthening capacity of public seed farms will be continued by conducting training followed with training by doing on hybrid rice seed production technology.

CONCLUSION

- **35 HR released in Ind however, the dev of HR rice cultivation area slow due to the constraints of hybrid seed shortage, inconsistence of het expression, susceptibility of the some released hybrids to major pest and disease.**
- **Public-private sector partnership developed on hybrid seed production to accelerate the adoption of HR tech and some companies initiated to produce seed of public hybrids.**
- **Breeding to develop hybrid rice resistant to BPH, BLB, and RTV has high priority in the national rice research program and some promising hybrids were obtained.**
- **Breed mat including new developed parental lines & genetic source for desirable characters from IRRI are still needed.**
- **The gov of Ind supports not only the research & dev but also the dissemination and adoption of hybrid rice technology.**

Xie Xie

Thank You