

# INTERNATIONAL COLLABORATIVE RESEARCH NETWORKS FOR RICE BLAST

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**Yoshimichi Fukuta** is a senior researcher at JIRCAS and an invited professor at the Graduate School of Agricultural Sciences, Tottori University. He started his career in rice breeding at Hokuriku National Agricultural Experiment Station in 1986 and received his doctoral degree in 1993. From 1999 to 2004, he was dispatched to the International Rice Research Institute (IRRI) from the Ministry of Agriculture, Forestry and Fisheries (MAFF) as a seconded scientist. After returning to JIRCAS, he worked as project leader of the “Blast Research Network for Stable Rice production” and “Rice Innovation for Environmentally Sustainable Production Systems”



## ABSTRACT

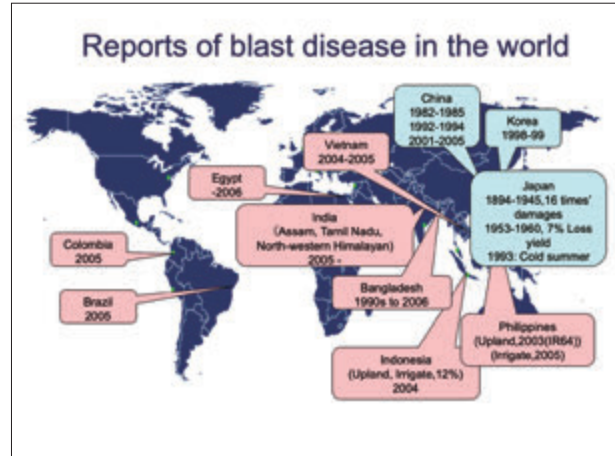
Blast is one of the most serious diseases of rice plants in temperate regions, and it has been found to occur frequently in the rainfed lowlands and uplands in the tropics. Japan International Research Center for Agricultural Sciences (JIRCAS) has been conducting the research project, titled “Blast Research Network for Stable Rice Production,” to solve this problem since 2006. Under the research network, an international differential variety set (DVs: monogenic lines) for 23 blast resistance genes; *Pish*, *Pib*, *Pit*, *Pia*, *Pii*, *Pi3*, *Pi5(t)*, *Pik-s*, *Pik-m*, *Pi1*, *Pik-h*, *Pik*, *Pik-p*, *Pi7(t)*, *Pi9(t)*, *Piz*, *Piz-5*, *Piz-t*, *Pita-2*, *Pita*, *Pi12(t)*, *Pi19(t)*, and *Pi20(t)*, and the methods of evaluation for reaction patterns of DVs against blast isolates and designation of blast races, are commonly used among participating nations (Korea, China, Vietnam, Philippines, Indonesia, Lao PDR, Cambodia, Bangladesh, Kenya, and Japan), international agricultural institutes (IRRI and AfricaRice), and university (Yunnan Agricultural U., China). The genetic variations of blast races and of resistance in rice cultivars have been clarified in each country and at the global level. These genetic variations of blast races and of resistance in rice cultivars differ dramatically among the countries, with Japan showing the lowest diversities and south Asia showing the highest. Additionally, highly virulent blast races were found to be distributed at high frequencies in West Africa and northeast China. Additionally, the differential system consisting of DVs and standard differential blast isolates was also developed in each institute, becoming one of many achievements from pathological studies. The differential system is a basic tool for the characterization of resistance genes in rice cultivars and the pathogenicity of blast isolates. Using the differential system developed in each institute, genetic improvement of leading rice cultivars is being conducted through introduction of partial resistance genes, such as *pi21*, *PBI*, *Pi34*, *Pi35*, and *Pi38*. Multiline varieties with genetic backgrounds of Indica Group rice cultivars, IR 64 and IR 49830-7-1-2-2, are also being developed. These differential systems, leading rice cultivars introduced with partial resistance genes, and multiline varieties, will be the key materials toward development of a durable protection system, which will be implemented in harmony with environmental conditions and contributing to sustainability in rice cultivation.

**JIRCAS**

## International Collaboration Research networks for Stable Rice Production



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JIRCAS project  
**Blast Research Network for Stable Rice Production**

China, DRC, GRAB, Egypt, India, Indonesia (IR6), Japan, JIRCAS, Korea, Philippines, Thailand, Vietnam, USA, West-Africa, Laos

"Differential System for Blast Resistance for a Stable Rice Production Environment" (29 August 2006)  
and Work Plan Meeting for JIRCAS research project -  
"Blast Research Network for Stable Rice Production" (30 August 2006)

1<sup>st</sup> Phase: 2006-2010, 2<sup>nd</sup> Phase: 2011-2015, 3<sup>rd</sup> Phase: 2016-2020

### Blast research network by JIRCAS since 2006

**JIRCAS**

1. Development of differential variety (DV)
2. Distribution of them with CG center

**Pathological study**

1. Pathogenicity analysis for blast isolate
2. Monitoring of blast races in field

**Differential system**

**Collaborative Institute**

1. Diversity study for blast races using DVs
2. Selection of standard differential blast isolates

**Breeding work**

1. Diversity study for resistance in rice germplasm and leading variety
2. Genetic characterization for resistance gene in rice variety
3. Genetic improvement using new gene  
Ex. (1) Multiple variety (2) Gene pyramiding (including partial resistance gene)

Development of durable protection system against blast disease using differential system

- Differential system consist of differential varieties and standard differential blast isolates.
- Differential system is the basic tool for breeding and pathological study, and JIRCAS network have developed and distributed it.

### Development of differential system and its application

**Evaluation method using MLs**

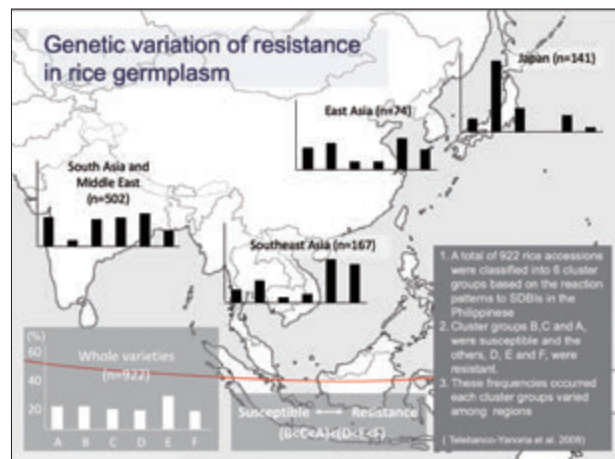
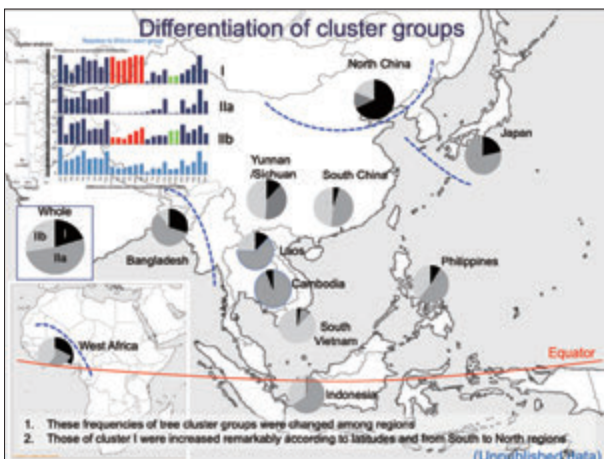
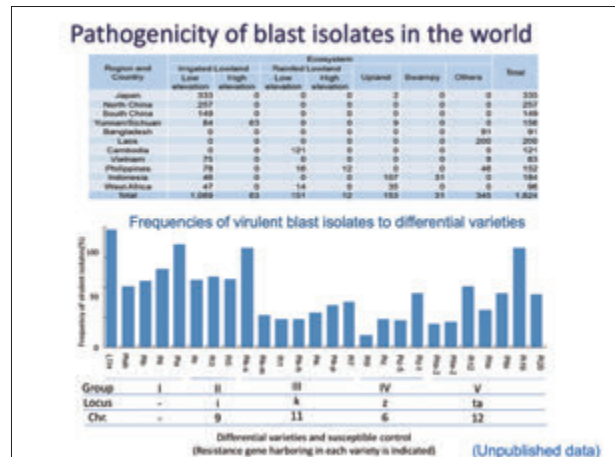
**Designation system using MLs**

**Differential variety (Monogenic lines: MLs)**

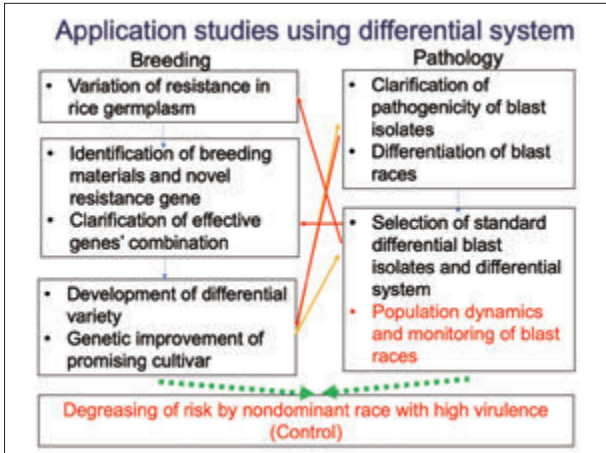
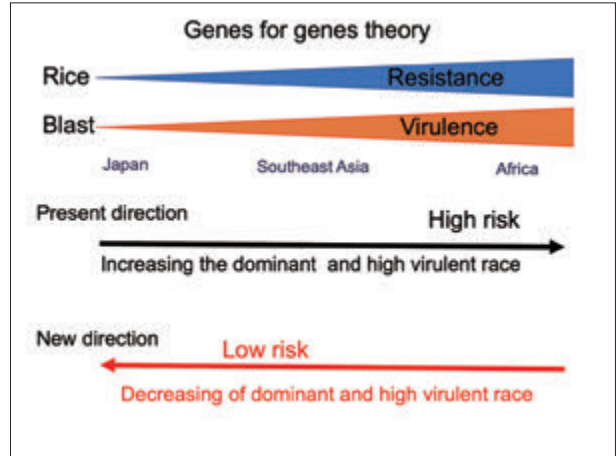
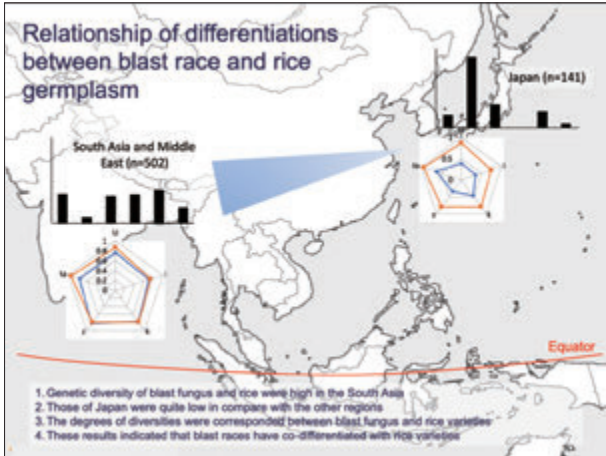
Gene	ML1	ML2	ML3	ML4	ML5	ML6	ML7	ML8	ML9	ML10	ML11	ML12	ML13	ML14	ML15	ML16	ML17	ML18	ML19	ML20	
Wg1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg3	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg4	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg5	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg6	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg7	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg8	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg9	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg11	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg12	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg13	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg14	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg16	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg17	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg18	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg19	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Wg20	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

How to create differential variety for and evaluation methods.

1. Development of differential system
2. Classification of presentations of blast races
3. Classification of genetic variety of resistance in rice cultivars
4. Selection of international standard differential case

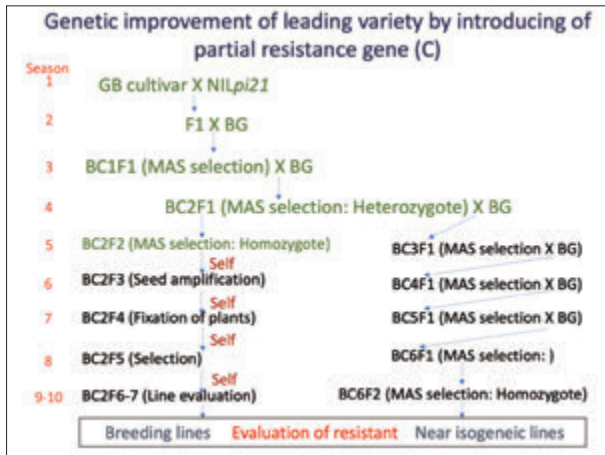






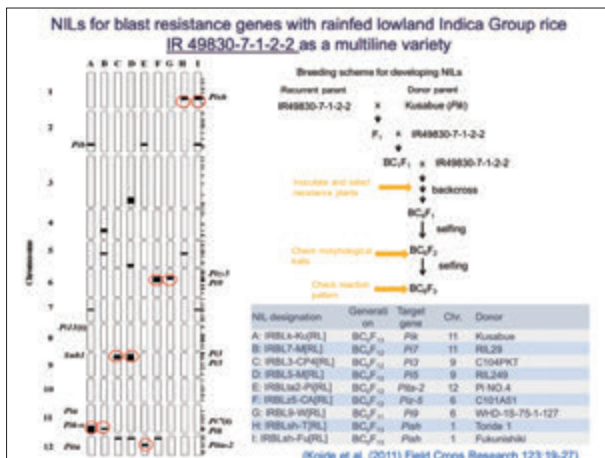
### New differential variety's set for true resistance gene with US-2 genetic background

Target gene	Chr.	Reference variety of true resistance gene			
		Monogenic line (Tsurumoto et al. 2002)	L-In NILs (Teshima-Yasuno et al. 2010)	CO88 NILs (Teshima-Yasuno et al. 2010)	US-2 NILs (Unpublished)
		Japanese Group	Japanese Group	India Group (backing Pta)	India Group
Pish	1	2	-	4	1
Pib	2	1	1	1	-
Pit	1	1	-	-	-
Pit1	11	2	5	-	2
Pit2	9	1	-	-	1
Pit3	9	1	-	-	1
Pit4	9	1	-	-	1
Pit5	11	2	3	1	2
Pit6	11	1	-	1	1
Pit7	11	1	1	2	1
Pit8	11	1	-	1	1
Pit9	11	1	-	-	1
Pit10	11	1	-	-	1
Pit11	11	1	-	-	1
Pit12	12	2	1	3	1
Pit13	12	1	-	-	1
Pit14	12	1	-	-	1
Pit15	12	1	-	-	1
Pit16	12	1	-	-	1
Pit17	12	1	-	-	1
Pit18	12	1	-	-	1
Pit19	12	1	-	-	1
Pit20	12	1	-	-	1
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Pit22	12	1	-	-	1
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Pit24	12	1	-	-	1
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Pit266	12	1	-	-	1</



### Genetic improvement of rice cultivars using partial resistance genes

Target country and area	Genetic background (Character)	Target country and area	Genetic background (Character)
Asia and Africa	IR 64	Africa and South Asia	Basmati 217 (Aroma)
	YTH183 (High yield)		Basmati 370 (Aroma)
	IR64NILDRO1	Thailand	Pusa Basmati (Aroma)
	IR64NILSPIKE		KDLM105 (Aroma)
	IR64NILqRL6.1-Kasaleth		BRRI dhan 28
IR64NILEMS3	BRRI dhan 29		
Indonesia	NERICA-L-19 (High yield)	Bangladesh	BRRI dhan 34 (Aroma)
	Ciherang (High yield)		BRRI dhan 63
	Situ Banerdi		BRRI dhan 64
Philippines	Situ Patenggang (Aroma)	Vietnam	BR 11
	NSIC Rc 152		Thien Un
	NSIC Rc 160 (Eating quality)		BT7
	NSIC Rc 240 (High yield)		BC15
Laos	NSIC Rc 402	Malaysia	OM576
	TDKS (High yield)		Mashuri
	Xebang Fai (High yield)		X-Jagna
	Hom Xebang Fai (Aroma)	Ethiopia	



- ### Key materials and tools for new direction of durable protection system
1. International standard differential blast isolates
  2. Partial resistance gene(s)
  3. Multiline variety
  4. Differential system
  5. Collaboration among pathologist, breeder, agronomist and so on
  6. International collaboration

