Development of rice genotypes suitable for growing in abiotic stress conditions caused by climate change

-Activities and achievement in Laos-

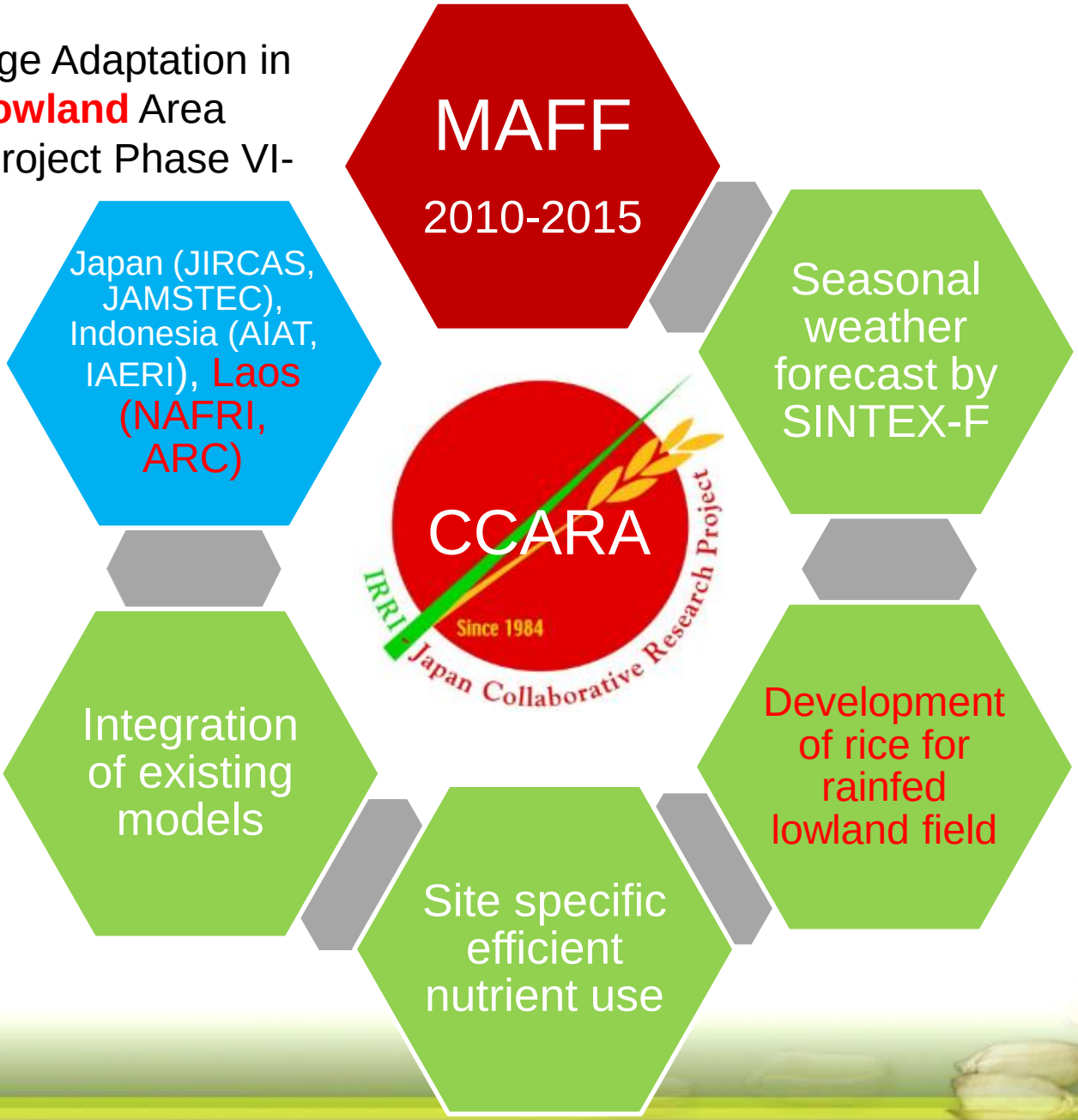
Tom Ishimaru

International Rice Research Institute (IRRI)

Japan International Research Center for Agricultural Sciences (JIRCAS)

IRRI-Japan collaborative research project

Climate Change Adaptation in
Rainfed lowland Area
-IRRI-Japan project Phase VI-



Since 1984

What's the 'rainfed field'?

Low rice productivity

Small-scale field and poor farmers

Improvement of rice productivity in rainfed field is beneficial to increase poor farmers' income

- Farming practices that rely on rainfall for water.
- More subject to flooding and drought than irrigated production areas.
- One-third of total paddy areas in the world

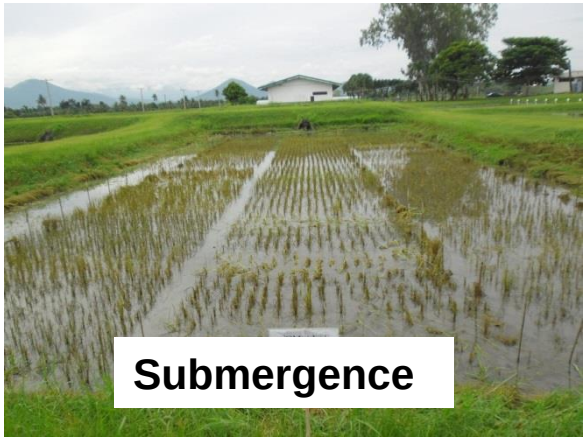
My breeding programs for rainfed lowland

Breeding challenges for

- Short heading date (drought escape)
- Yield potential (enhancing grain yield)

Improvement of these agronomic traits by introgressing useful genes from donor variety through DNA marker selection

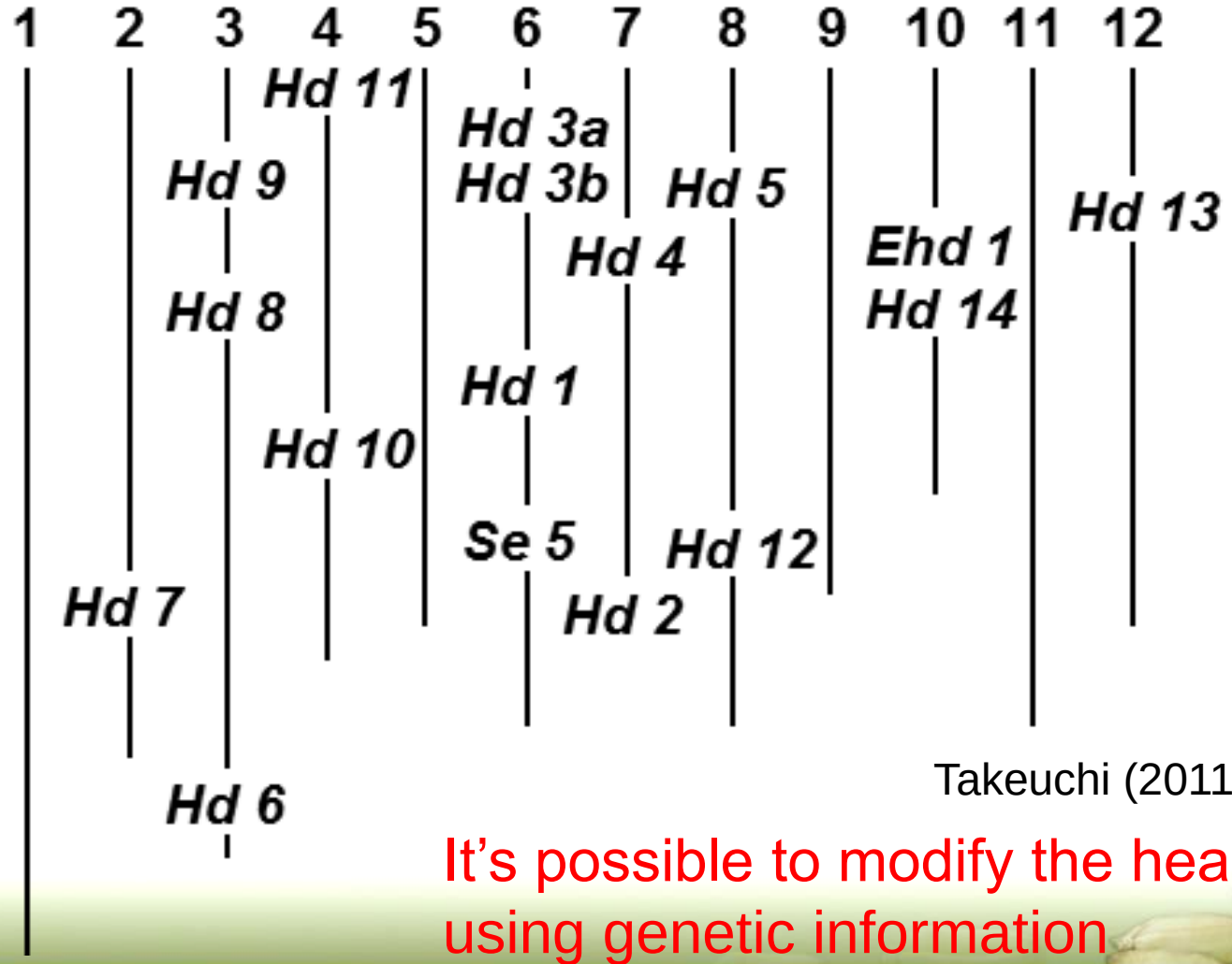
Merits of short heading date



Drought (Early stage)	If the start of wet season delays, transplanting must delay. The shortened crop season is beneficial.
Submergence	To avoid the long-term submergence stress at the late stage of wet-season crop, the shortened crop season is beneficial.
Drought (Late stage)	To avoid the high risk of drought stress at the late stage of dry-season crop, the shortened crop season is beneficial.

The genetic resources for short growth period is necessary to cope with climate change

Many quantitative trait loci (QTLs) for heading date (*Hd*) have been identified



Takeuchi (2011) JARQ

It's possible to modify the heading date using genetic information

Development of Heading date rices

Fujita et al (2011) Plant Breeding

-7 days **-5 days** **-5 days** **IR64*** **+5 days** **+10 days**

- *Hd* rices from -7 days to +10 days were developed.
- Japonica and tropical Japonica varieties are used to change the heading date of IR64

Demerit of short *Hd* rice

Smaller biomass and panicles

Yield penalty

Breeding program to increase yield potential of *Indica* varieties

Tropical Japonica

Popular Indica variety

Tropical Japonica

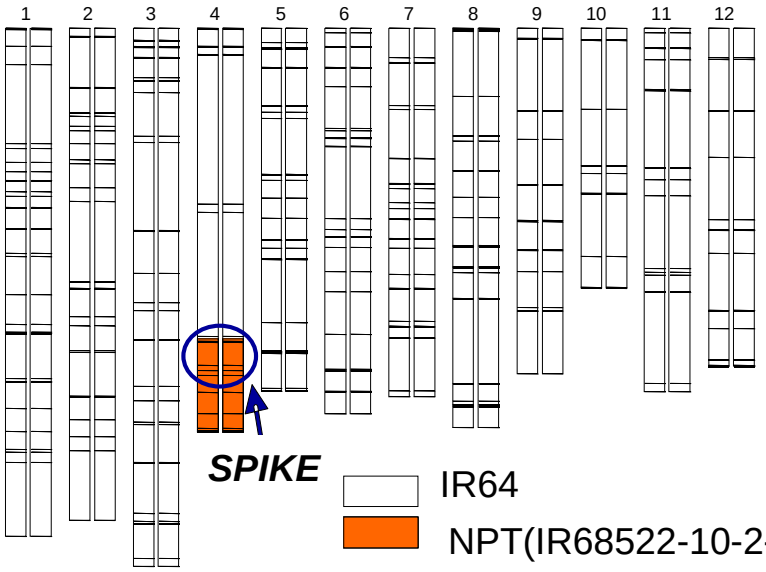
- Large panicles
- Less unproductive tillers
- Large leaves
- Greater roots

Tropical Japonica × Indica variety

Introgession of elite agronomic traits of Tropical Japonica to increase yield potential of Indica variety

Spikelet number becomes larger by replacing segment of chromosome 4 into Tropical Japonica

Graphical genotype of *SPIKE*-IR64



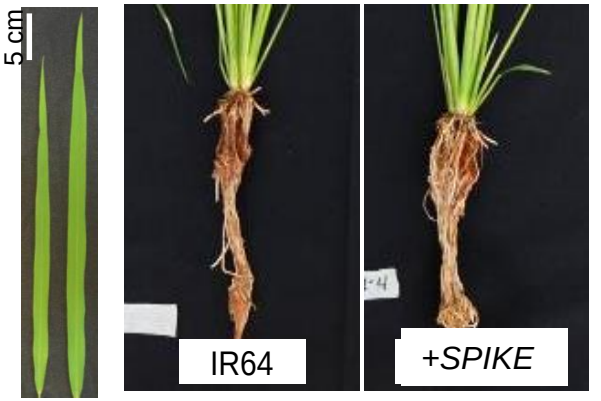
Fujita et al. 2012, Breeding Science

Pleiotropic effects of *SPIKE* on plant architectures

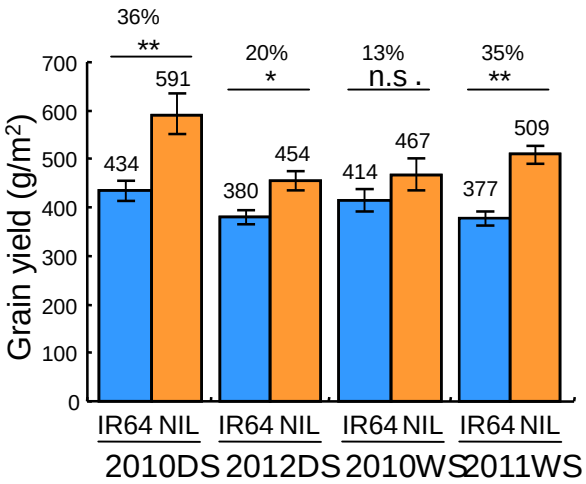
Fujita et al. 2013. PNAS. *Trial at IRRI fields under irrigated condition.

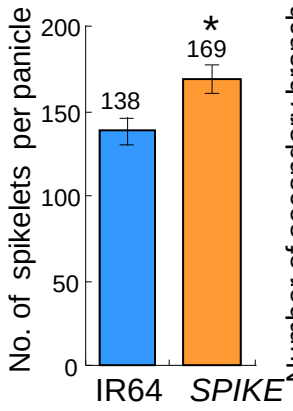
IR64 +*SPIKE*

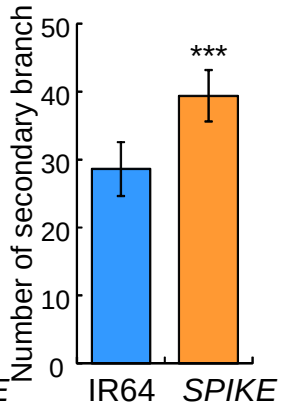
IR64 +*SPIKE*

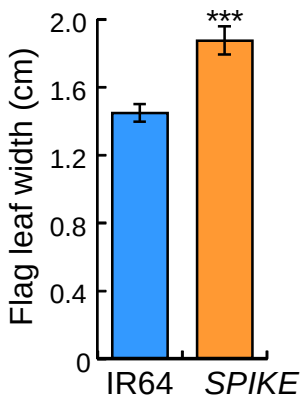


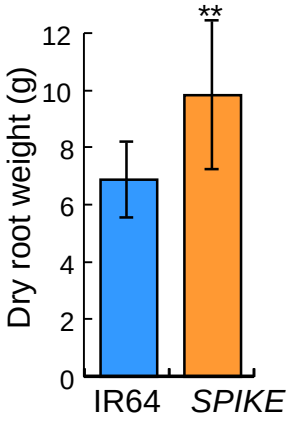
IR64 *SPIKE*











Higher grain yield

Larger panicle

Larger leaf

Larger root

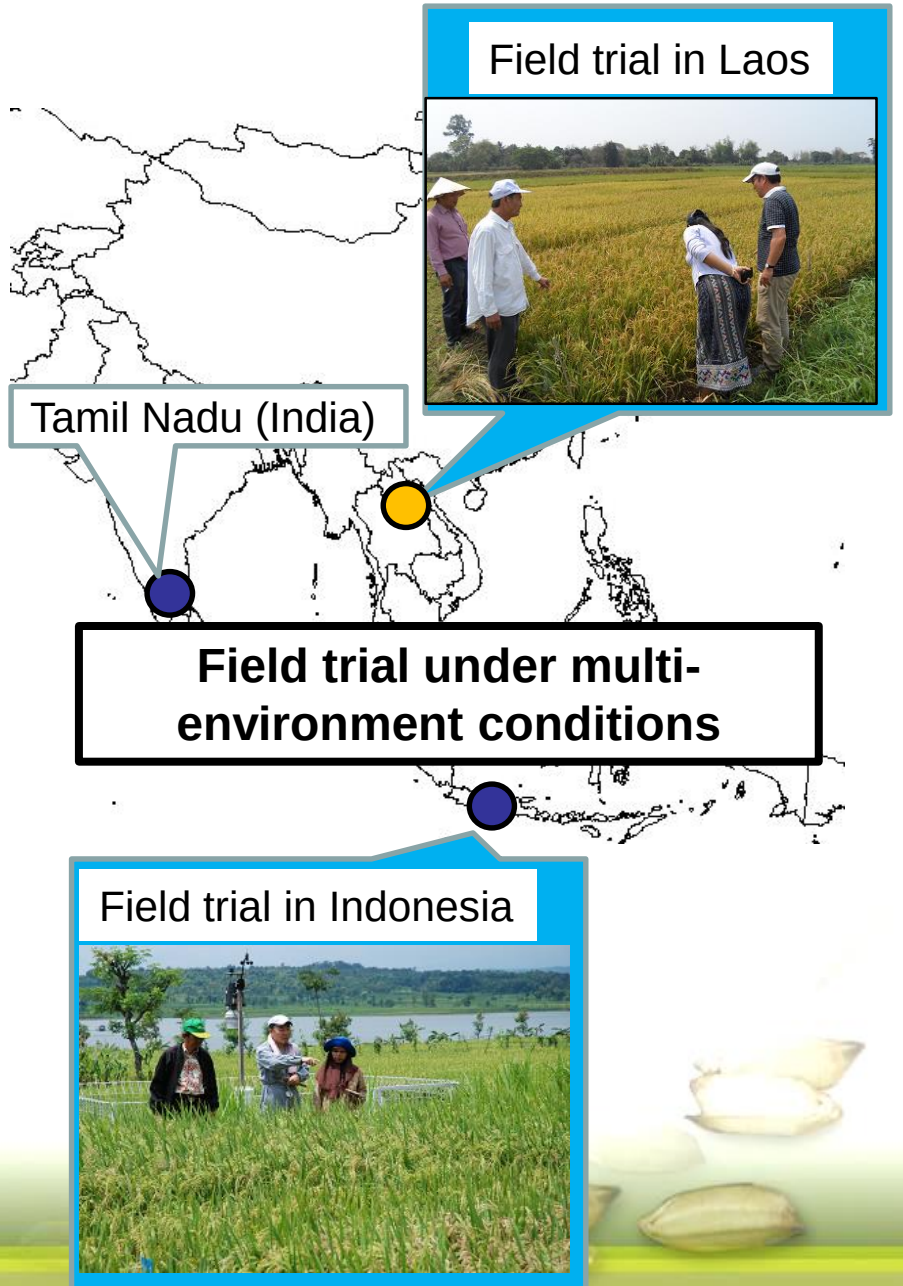
13-36%

Multi-Environment testing with *SPIKE*

Developing IR64 with high spikelet number

Gene discovery of *SPIKE*

- **Multi-Environmental Testing**
  ✓Field trial in ARC
- **Transfer of *SPIKE* gene to other popular varieties**
  ✓Capacity building to ARC researcher
- **International patent application**
  ✓Protection of Intellectual property

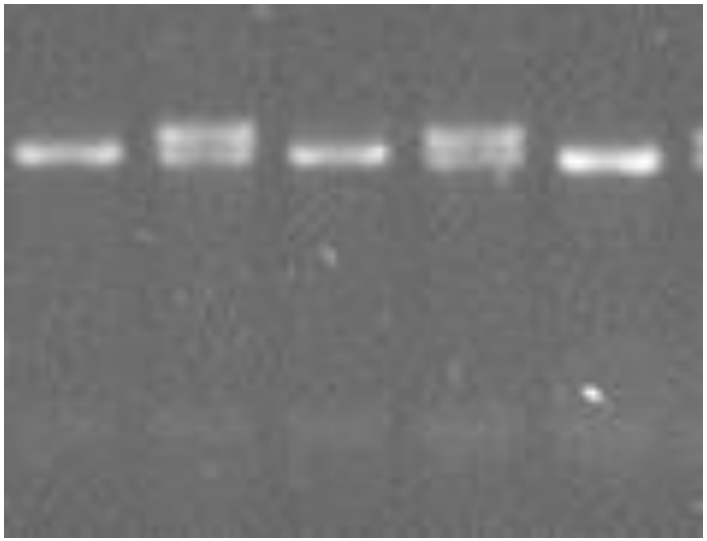


Transfer of *Hd* and *SPIKE* genes to Lao varieties Capacity building to ARC researcher

Training at IRRI

Ms. Soukphathay SIMEUANG(ARC)

DNA marker selection



Now the breeding facility for DNA marker selection is available at ARC.

Summary

- Breeding challenges for short heading date and yield potential are being made under CCARA project.
- Heading date rices from -7 days to +10 days were developed by using Japonica and tropical Japonica varieties a genetic resources
- SPIKE gene from Tropical Japonica increases grain yield of Indica variety through enhancement of plant architectures.
- Combining the Hd and SPIKE gene would produce the elite rice to increase rice productivity under rainfed lowland.
- DNA marker selection can be conducted in ARC as a consequence of capacity building at IRRI.

Thank you for attention!!

CCARA funded by MAFF, Japan, since 2010

IRRI
Dr. Inez H. Salamat-Loedin
Dr. Kazuhiro Sasaki
Dr. Daisuke Fujita

Dr. Yoshimichi Fukuta (JIRCAS)
Dr. Nobuya Kobayashi (NICS)

Collaborators in ARC
Dr. Chay Bounphanousay
Dr. Chanthakhone Boualaphanh
Ms. Souksamai Simeuang
Mr. Singty Voradeth
Dr. Phoumi Inthapanya