

# **G20 MACS Initiated 2019 Project**

## **Prevention of Wheat Blast Disease Pandemic**

### **(2019- March 2024)**

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Japan International Research Center for Agricultural Sciences



Masahiro Kishii

**International Consortium for  
Wheat Blast Control**

2024-5-15

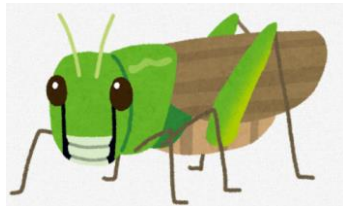
# One of Major Topics in G20 MACS, 2019

II

## International collaboration research on transboundary plant pests and diseases

No border exists for diseases and insects

Once it appears, it can affect the entire world



**Global efforts are necessary**

# Enough Wheat = World Stability



**2.5 billion people**  
in **89 countries**

WHEAT PROVIDES **19%** OF OUR  
TOTAL AVAILABLE CALORIES  
and **20%** of all PROTEIN



## World trade

## 211 million tons

(27% of global production)



## Six countries export about 80%

of global trade

# Importance of Disease Resistance Genes



~~Resistance gene #1~~

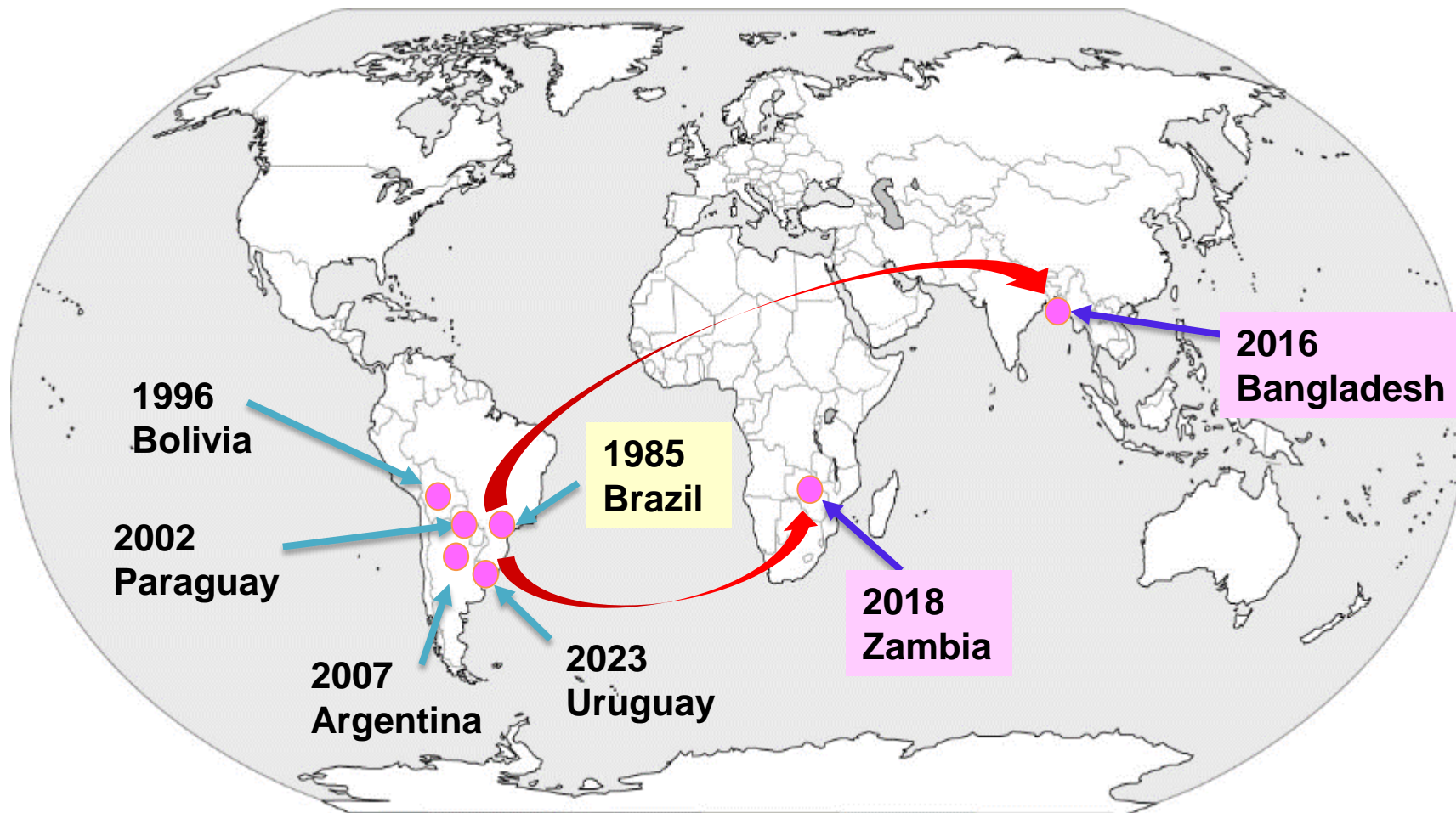


**New race**  
**New disease**

**Susceptible**  
**Yield loss**



# Wheat Blast (A New Emerging Disease)



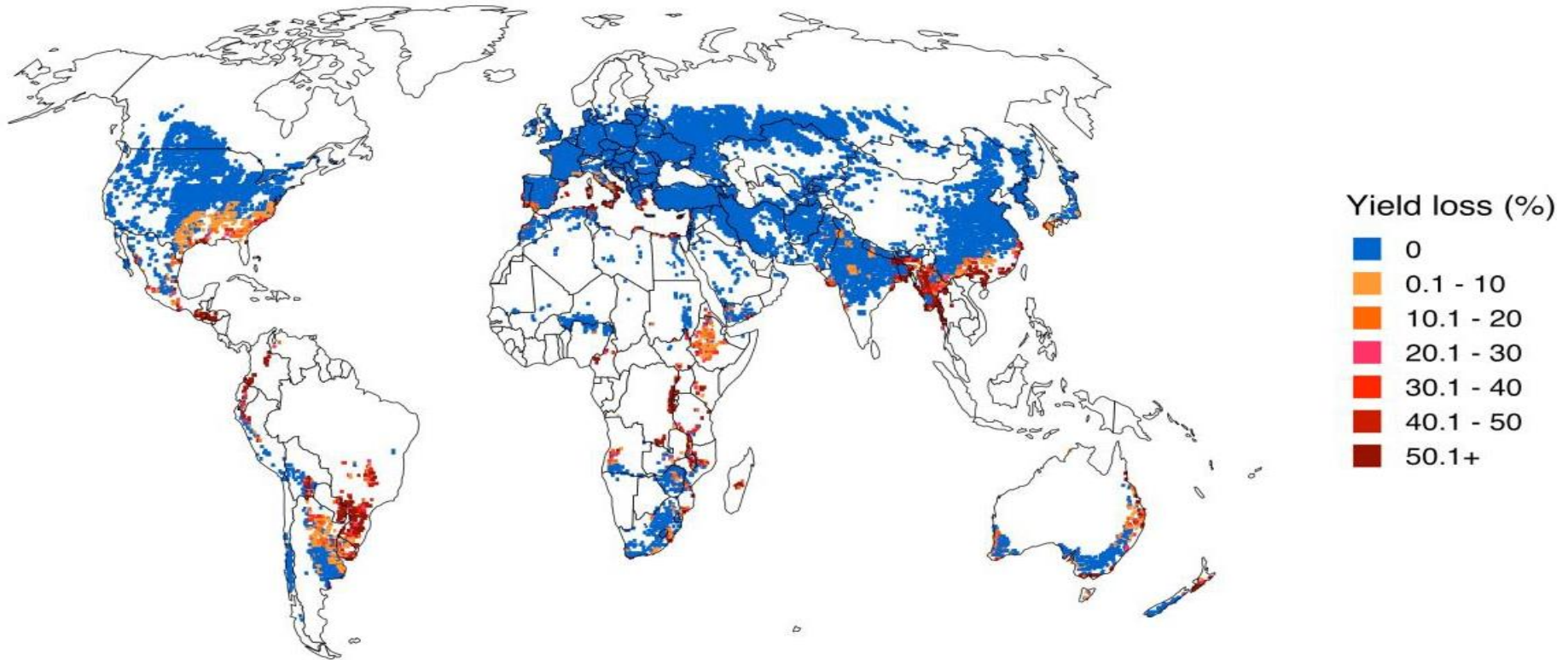
# Characters and Problem of Wheat Blast

- Up to 100% yield loss
- Cross-infect different hosts and break host resistance
- Fungicide: partially effective under low to medium WB pressure
- Ability to develop fungicide resistance
- Areas of rains & warm temperatures

Bleached spikes, no grain sets



# Losses from Wheat Blast Simulated for Climate Change for 2040-



WB threatens **6.4 million ha** currently → **13 million ha** by mid-century.

WB alone could reduce global wheat production by **13%**.

**South America** most, then **East Africa**, **South Asia** and **East Oceania**

# **Ministry of Agriculture, Forest and Fishery (MAFF) Japan Funded Project**

## **Project title:**

Development of technology to prevent wheat blast pandemic  
(2019 – March 2024)

## **Project leader:**

Dr. Yukio TOSA  
Kobe University, JAPAN

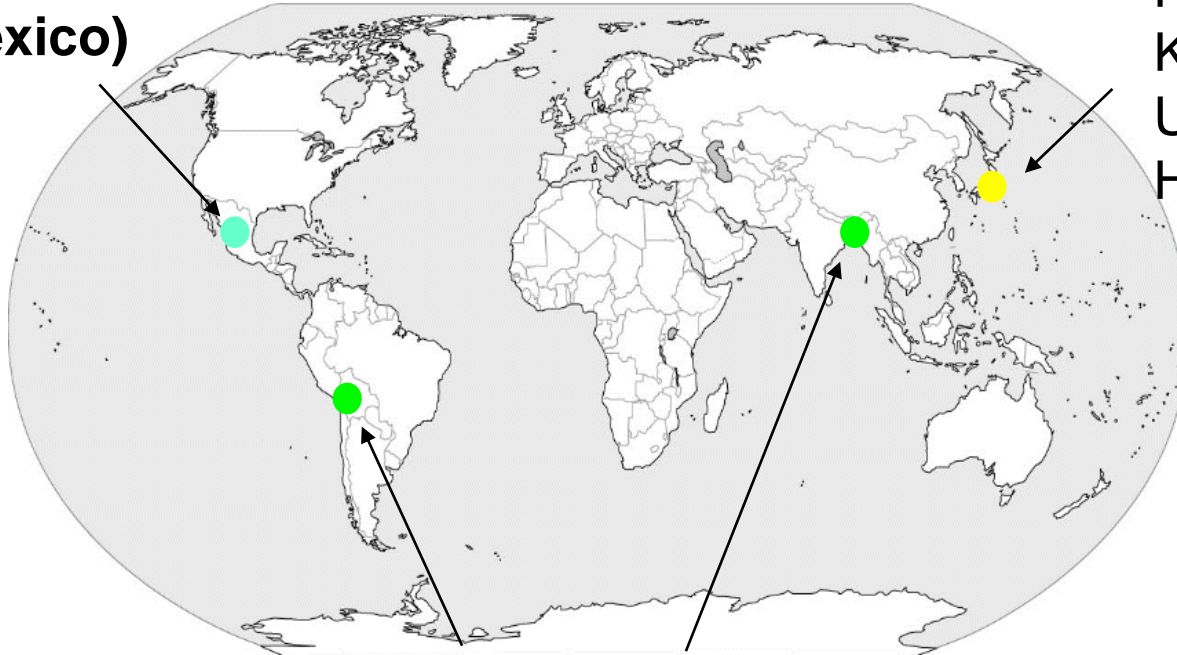


# International Consortium for Wheat Blast Control

**Basic science:**  
identify resistance  
genes and tools

**Wheat breeding**  
CIMMYT (Mexico)

**Japanese group**  
Kobe University  
Kyoto University  
Kyoto Prefectural  
University  
Hyogo Prefecture



**Field evaluation**

Bangladesh (BWMRI), Bolivia (INIAF) with CIMMYT

# Only One Resistance Gene Available in Elite Wheat Varieties against Wheat Blast in 2019

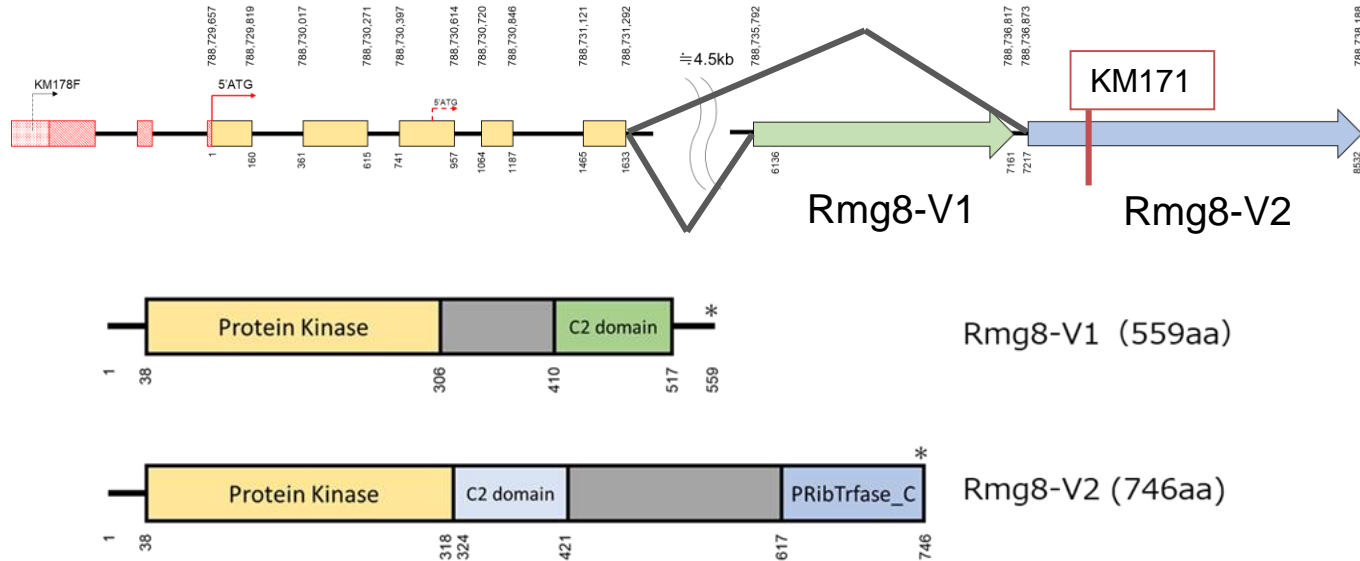
- 2NS

Currently, all resistance in almost all 'elite wheat varieties' relies on this resistance gene.

- *Rmg8* (from landrace=old wheat)

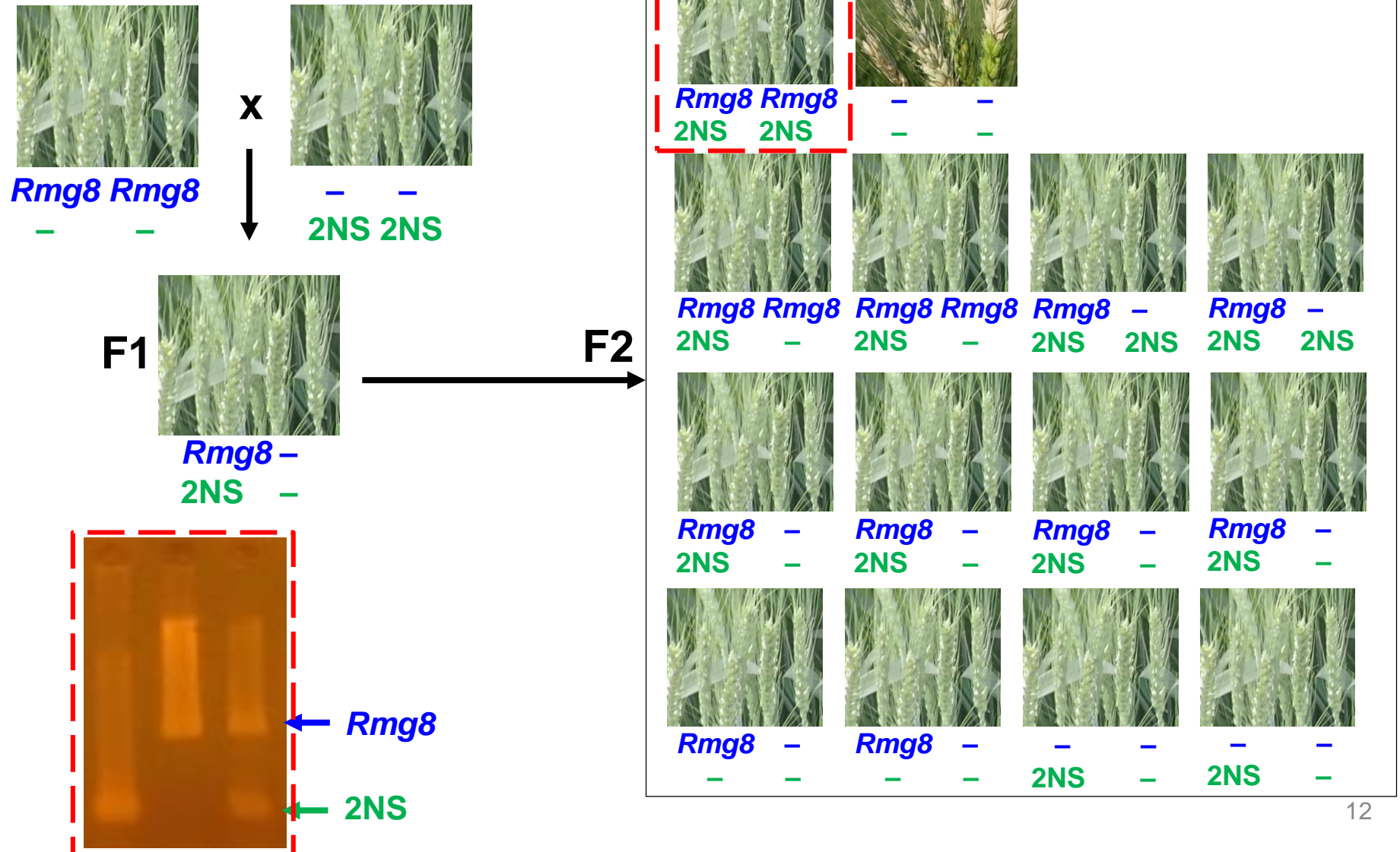
'Old wheat lines' have this resistance gene, but not utilized in current elite wheat varieties.

# Cloning of *Rmg8*



- Scientific insight of wheat blast resistance
- Molecular markers for wheat breeding

# Combine Two Resistance Genes by Markers in CIMMYT, Mexico





# Field Evaluation in Bangladesh and Bolivia



To check **resistance** and **enough grain yield** in actual wheat field

# Advantage of Multiple Resistance Genes



**Resistant**



**Damaged**

~~Resistance gene #1~~(2NS)



**New race  
New disease**

**Susceptible  
Yield loss  
Risks for world  
stability**



# Advantage of Multiple Resistance Genes



**Resistant**



**Damaged**

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~~Resistance gene #1 (2NS)~~  
Resistance gene #2 (*Rmg8*)

**Still resistance**

**New race**

**New disease**

# Advantage of Multiple Resistance Genes



**Resistant**



**Damaged**

~~Resistance gene #1 (2NS)~~  
~~Resistance gene #2 (*Rmg8*)~~

**Rare, but it can happen**



**New race**  
**New disease**

**Susceptible**  
**Yield loss**  
**Risks for world stability**



# Advantage of Multiple Resistance Genes



**Resistant**



**Damaged**

~~Resistance gene #1 (2NS)~~

~~Resistance gene #2 (*Rmg8*)~~

Resistance gene #3 (New 1)

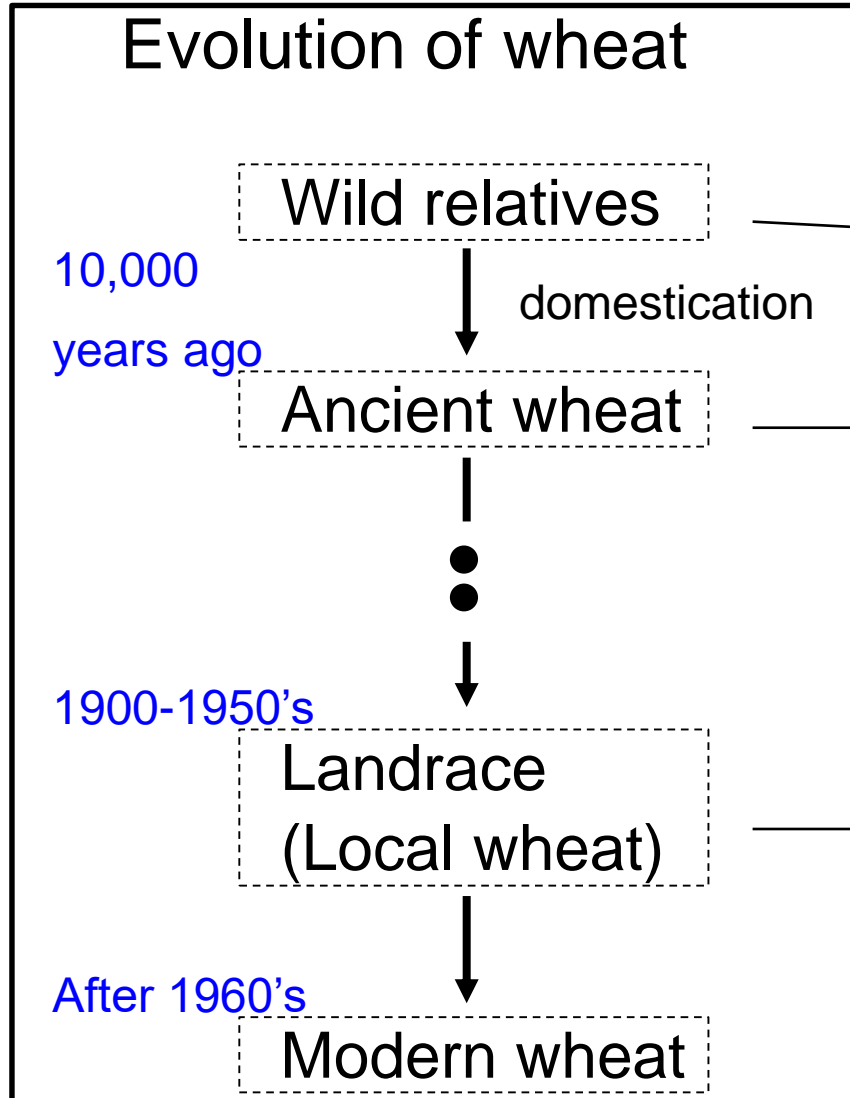
Resistance gene #4 (New 2)

**Durable resistance**

**New race**

**New disease**

# Search of Additional Resistance Gene from Wild Relatives, Ancient Wheat & Local Wheat



Screening for Japan's genebank collection (NBRP and NARO)

**From more than 3,000 lines**

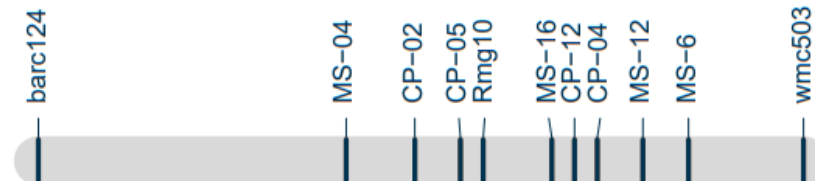
**63 resistant lines**

**18 resistant lines**

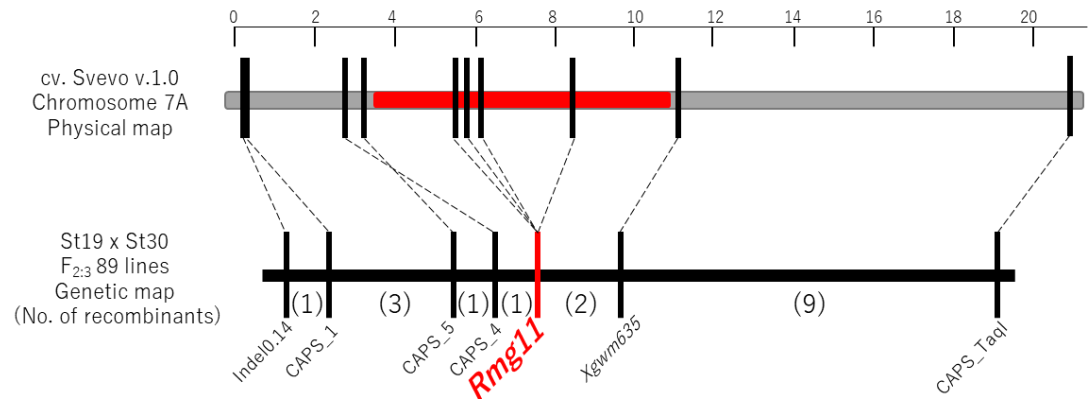
**4 resistant lines**

# Identified New Resistance Genes

***Rmg10***  
from ancient wheat



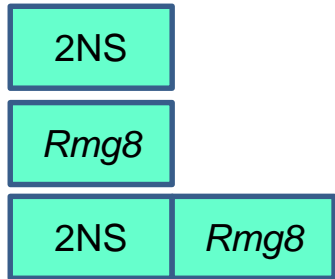
***Rmg11***  
from wild relatives



**Molecular markers developed, ready for use**

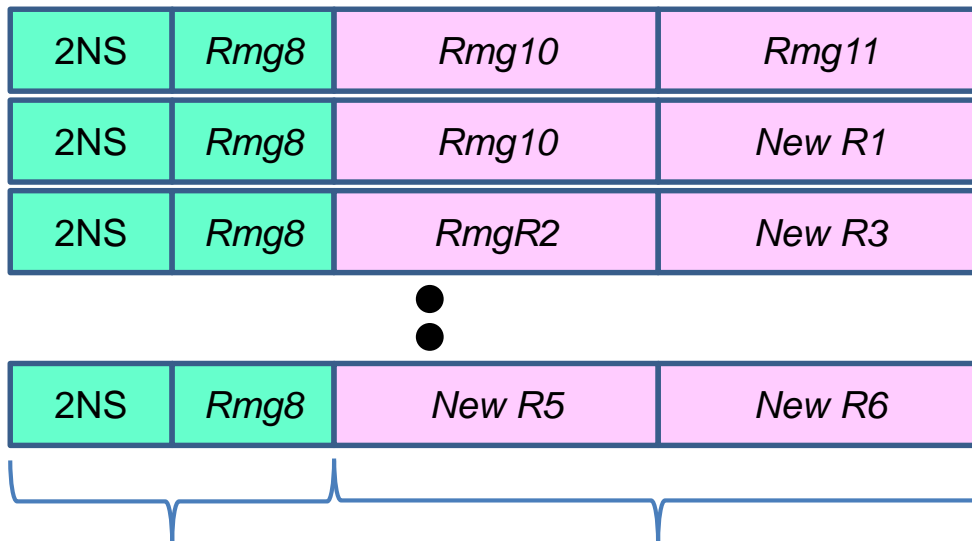
**Six additional candidate genes are under analysis**

# Future Perspective



Sequential deployment of each resistance gene should be avoided.  
Pathogens defeat each resistance gene.  
(happened many times in human history)

Accumulation of **four resistance genes** for **durable resistance** against wheat blast.



→ **Overcome wheat blast disease**





**Thank you very much**

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