National Report(2011)

Progresses on rice breeding and production in China

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Progresses on rice breeding and production in China

- Rice production situation
- Progresses on rice functional genomics research
- Rice breeding and production
- Prospects

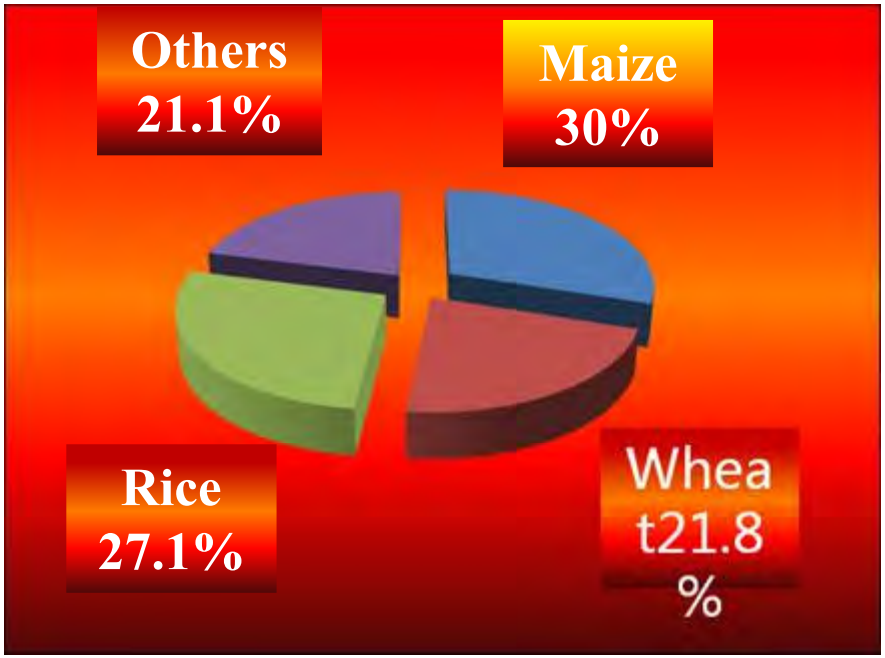
Rice to us Chinese…

- **Staple food for over 60% of the population**
- **Less than 30 % of grain crop area and near 40% of grain production**

Brief summary of country and rice situation

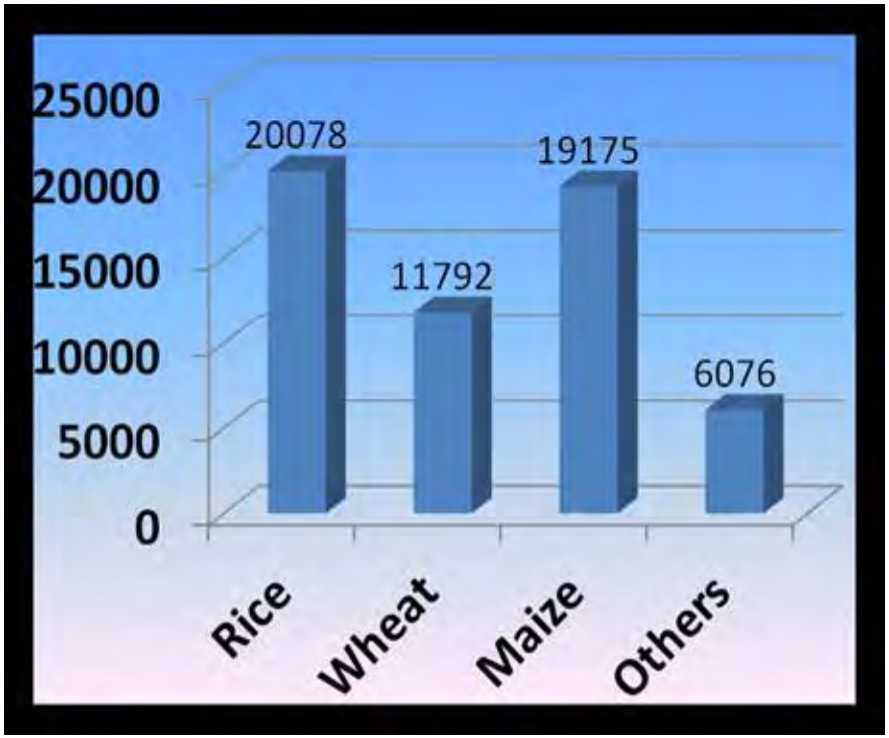
Year	2011
Country population (m)	1370.5
Population growth rate (%)	0.64
Rural population (%)	50.32
Number of rice farmers	N.A.
Total crop area ('000ha)	110570
Total rice area ('000ha)	30000
Average rice yield (t/ha)	6.69
Rice Production (mt)	200.78
Rice Imports ('000 t)	578
Rice Exports ('000 t)	490
Number of government researchers working on rice	N.A.
Number of government extension workers	N.A.

Rice production situation



30.0 mha sowing area in 2011

The second planting area with the largest yield in grain crops



The main crop grain production in 2011(Mt)

Progresses on rice functional genomics research

China National Rice Research Institute

Progresses on rice functional genomics research

Gene cloning and transformation are priority research areas of rice biotechnology in China. Many functional genes controlling important agronomic traits such as yield, resistance, quality and plant type had been cloned by scientists.

Those genes will be very helpful to battle with bio-stress and abio-stress in rice cultivation, quality improvement, as well as increase of yield.

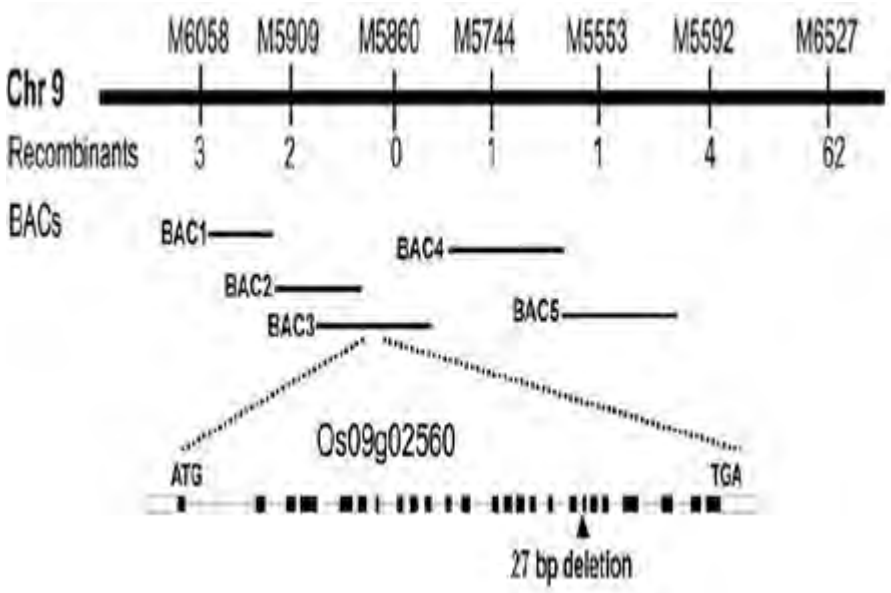
The cloned genes related plant type from 2011

Gene	Chr	Traits	Reference
OsPH1	1	Dwarf	Kovi et al 2011
DEP3	6	Grain number of panicle, panicle shape	Qiao et al 2011
OsPIN2	6	Plant height, tillering number, tillering angle	Chen et al 2011
BC12/GDD1	9	Dwarf	Li et al 2011
LB4D	11	Plant height, tillering number	Liang et al 2011
OsCD1	12	Short panicle, narrow leaf	Luan et al 2011
HTD3	12	Plant height, tillering number	Zhang et al 2011

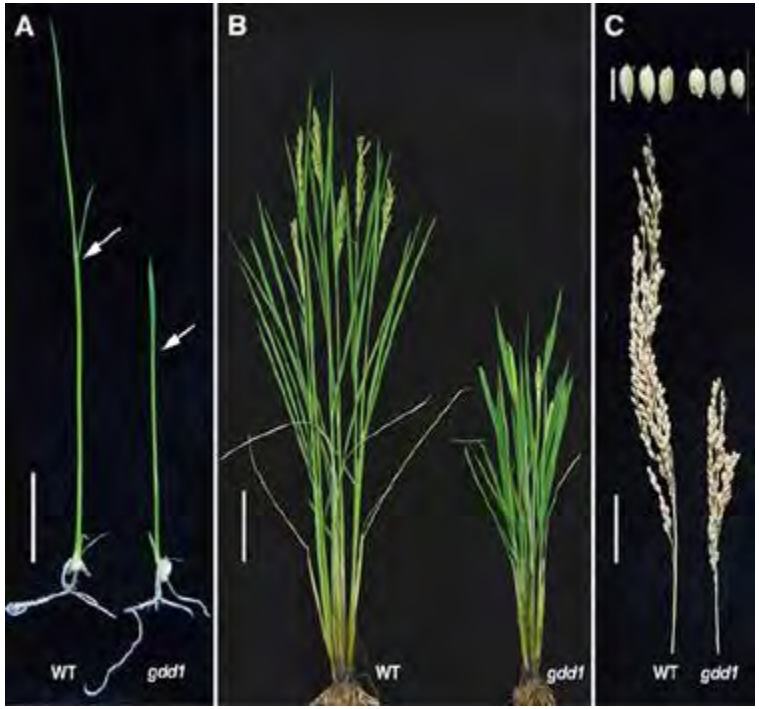
Plant type

The cloned genes related plant type:

- **Li et al. (2011) cloned the gene *BC12/GDD1* on Chr9, which encodes a Kinesin-Like protein that binds to a GA biosynthesis gene promoter, leads to dwarfism with impaired cell elongation.**



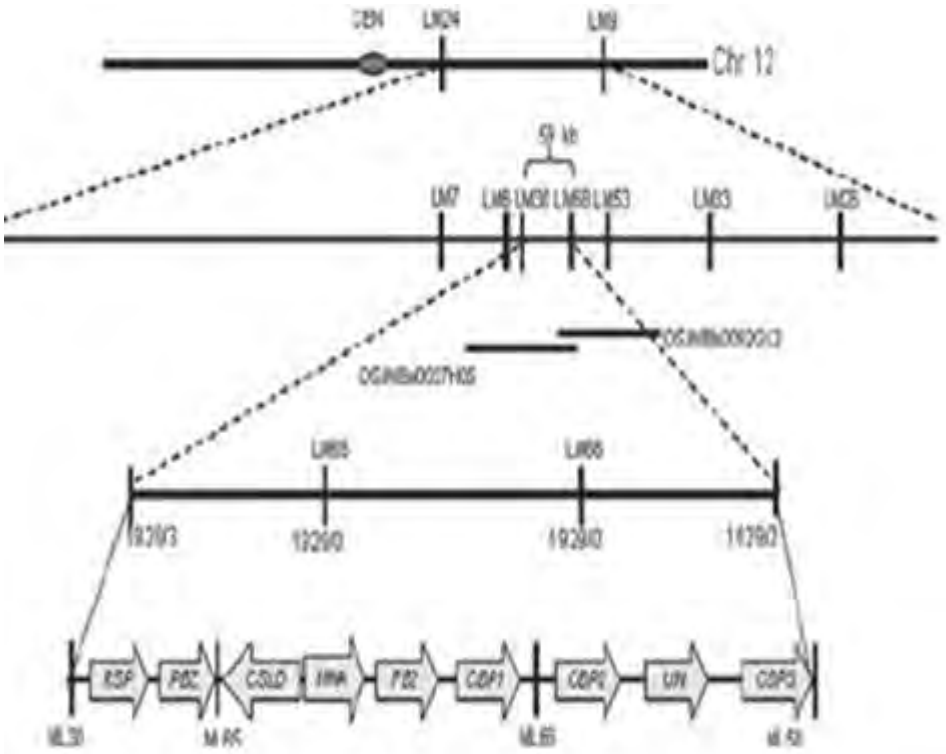
Positional cloning of *GDD1*.



Phenotypic Characterization of the *gdd1* Mutant.

• **Luan et al. (2011) cloned the gene *OsCD1* on Chr12, which encodes a putative member of the cellulose synthase-like D sub-family and is essential for rice plant architecture and growth.**

The phenotype of *cd1* mutant and wild-type.



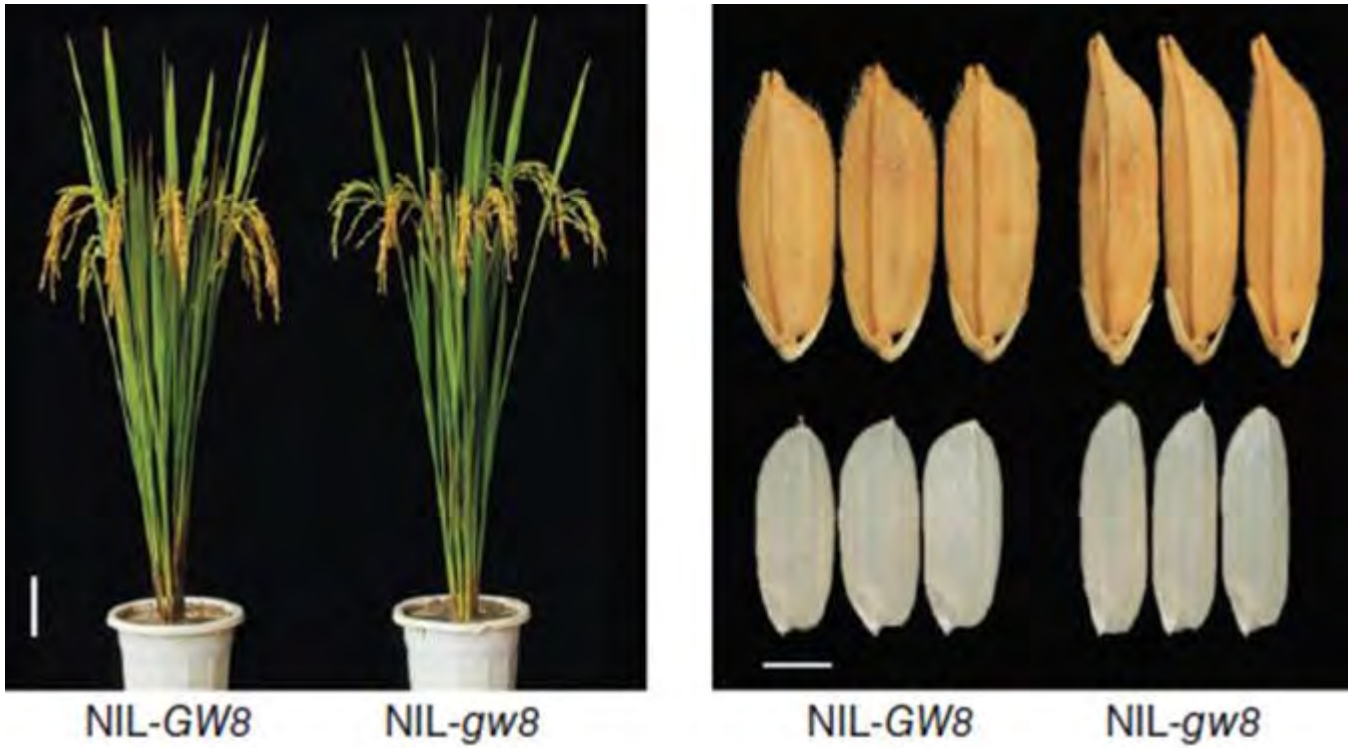
Positional cloning of *OsCD1*.

The cloned genes associated with yield traits from 2011

Gene	Chr	Traits	Reference
PGL1	5	Thousand-grain weight, grain length	Heang et al. 2012
GS5	5	Thousand-grain weight, grain size, fruiting rate	Li et al. 2011
SRS5	11	Grain shape	Segami et al. 2012
GW8	8	Grain size, grain shape	Wang et al. 2012
LP	2	Panicle length, panicle shape	Li et al., 2011
Ghd8	8	Heading date, grain yield	Yan et al., 2011

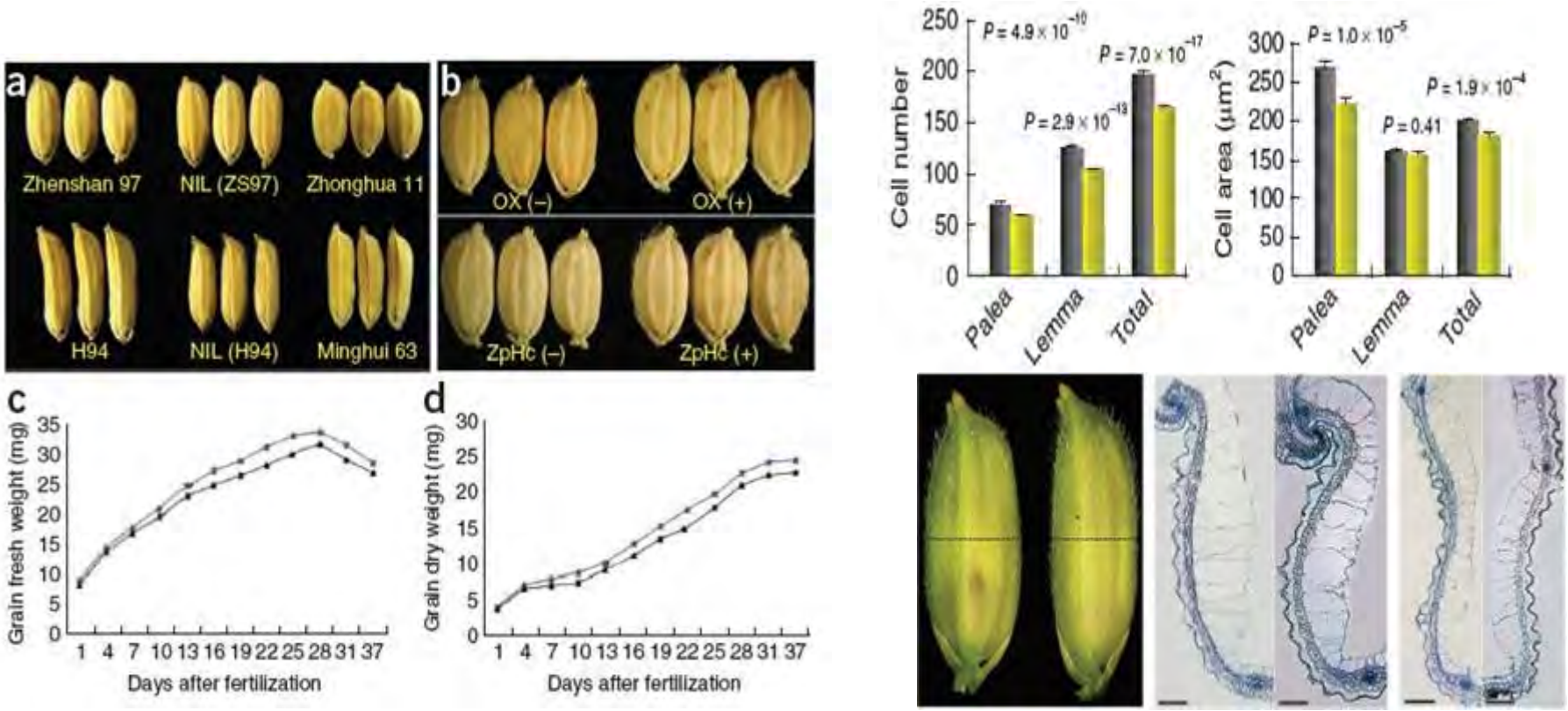
Yield related traits

- **Wang et al. cloned a quantitative trait locus *GW8*, which encodes a protein that is a positive regulator of cell proliferation. Higher expression of this gene promotes cell division and grain filling, with positive consequences for grain width and yield in rice.**



Contrasting phenotype and grain yield of NIL-*GW8* and NIL-*gw8* plants.

- **A QTL named *GS5* controls grain size by regulating grain width, filling and weight was cloned in rice , it revealed that natural variation in *GS5* contributed to grain size diversity in rice and may be useful in improving yield in rice and, potentially, other crops(Li et al.) .**



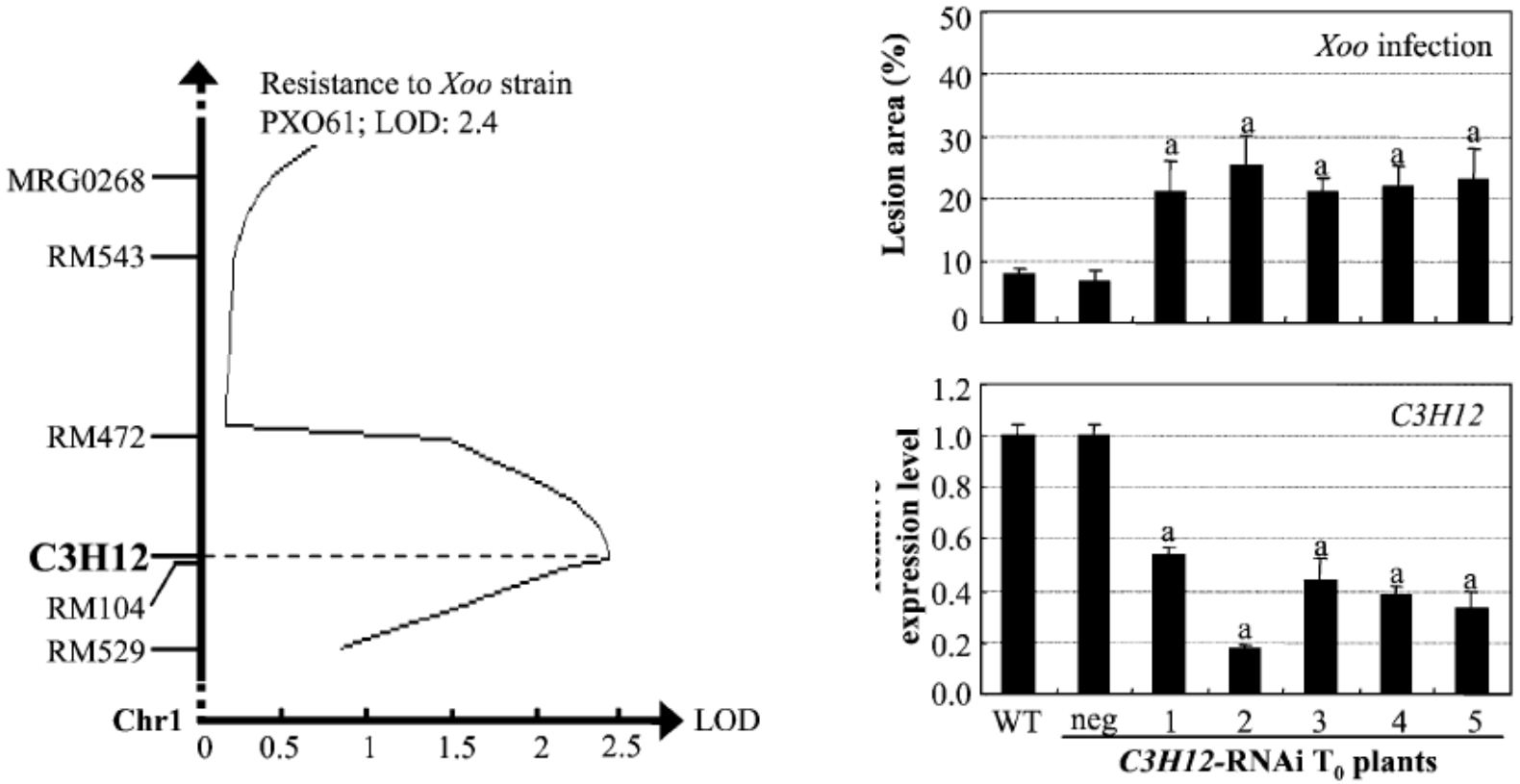
The effect of *GS5* on cell number and size in lemma/palea.

Cloned/mapped genes associated resistance from 2011

Gene	Chr	Traits	Reference
C3H12	1	Bacterial blight resistance	Deng et al. 2012
OsCOI1	1	Cnaphalocrocis medinalis resistance	Ye et al. 2012
pi55(t)	8	Blast resistance	He et al. 2012
RAI1	3	Blast resistance	Kim et al. 2012
OsbZIP16	2	Drought resistance	Chen et al. 2012
xa34(t)	1	Bacterial blight resistance	Chen et al. 2011
NLS1	11	Bacterial diseases resistance	Tang et al. 2011
Pi-47	11	Blast resistance	Huang et al. 2011
Bphi008a	6	Brown plant hopper resistance	Hu et al. 2011

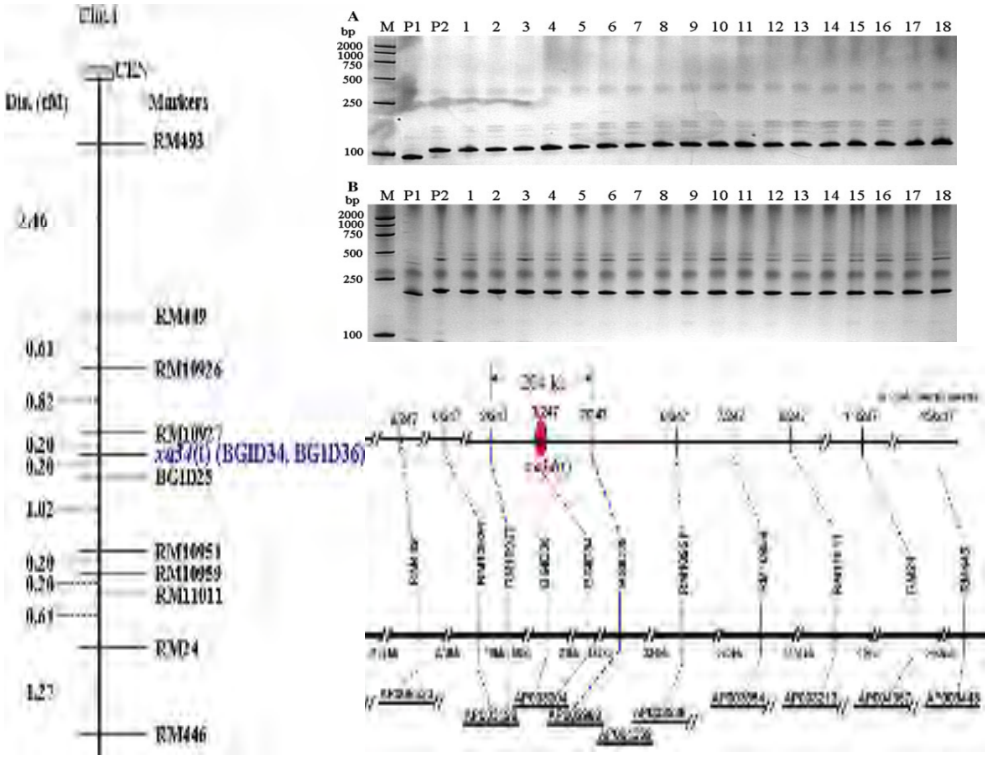
Research on biological/abiotic resistance

Deng et al. reported that one of the rice CCCH-type zinc finger proteins C3H12 involved in the rice-*Xoo* interaction. Activation of *C3H12* partially enhanced resistance to *Xoo*, accompanied by the accumulation of jasmonic acid (JA) and induced expression of JA signaling genes in rice.

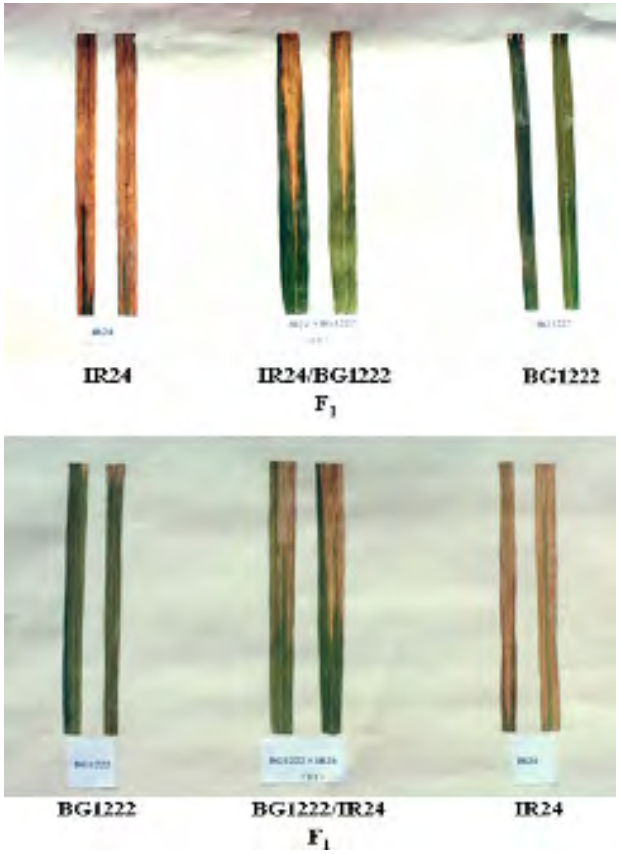


Association of *C3H12* with a bacterial resistance QTL.

Another research group identified a new bacterial blight recessive resistance gene *xa34*(t) from the descendant of somatic hybridization between an aus rice cultivar (cv.) BG1222 and susceptible cv. IR24, which was defined to a 204 kb interval flanked by markers RM10929 and BGID25 on Chr 1(Chen et al.).



High resolution genetic map and physical map of the *xa34*(t) gene.



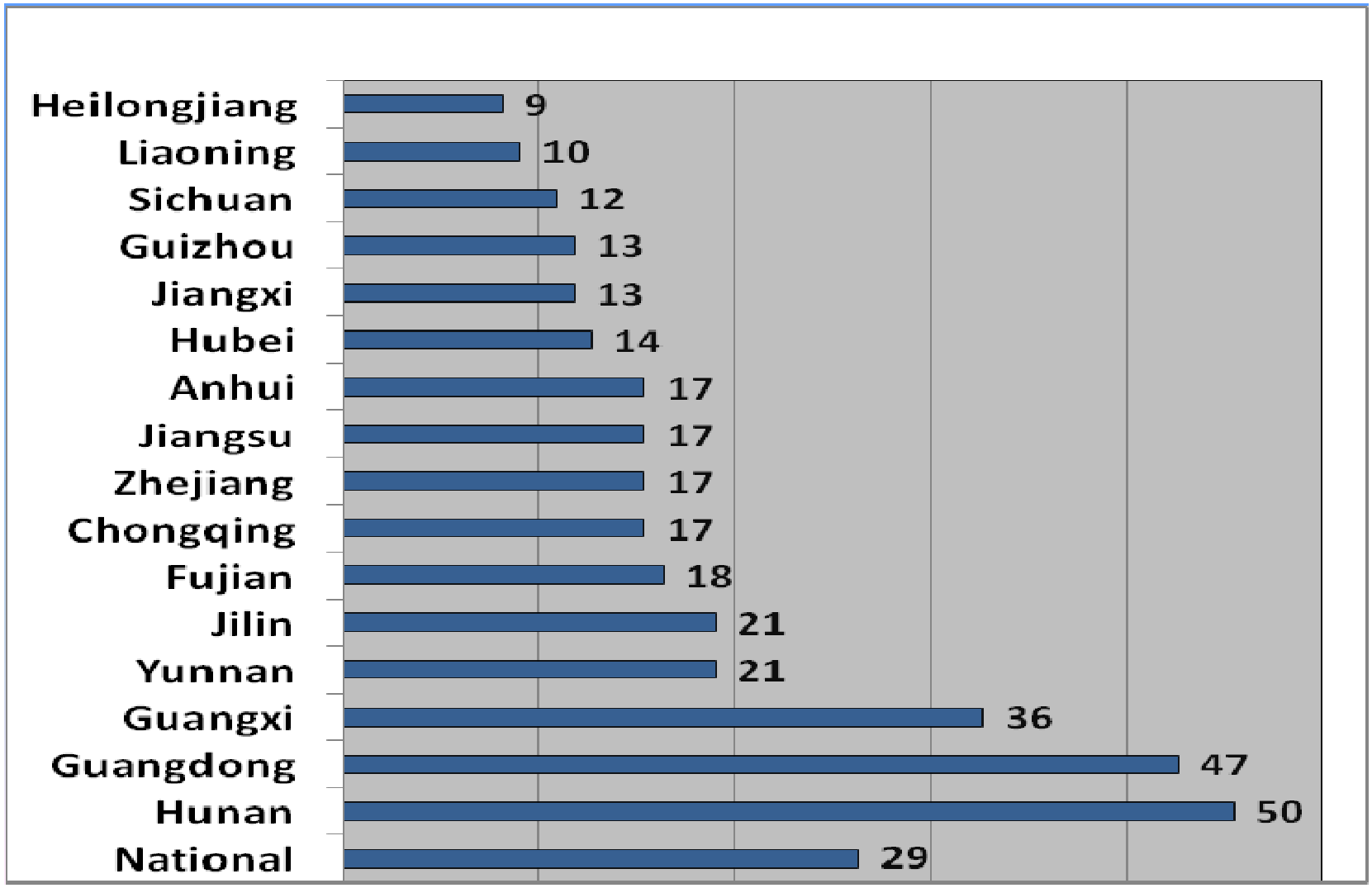
Reactions of BG1222, IR24 and the crosses F1 progenies to *Xoo* race V.

Rice breeding and production

Release of new rice varieties

- More than 353 rice varieties were released at provincial level and 29 varieties released at national level in 2011.

  Among the 29 new national varieties, there were 3 inbred japonica, 18 three-line indica, 1 japonica hybrid, 6 two-line indica hybrid, and 1 indica inbred.



No. of rice varieties released at national and provincial level in 2011

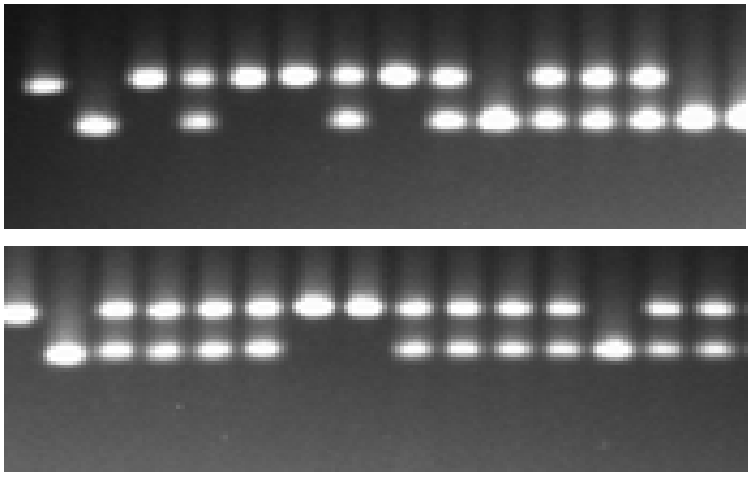
Breeding Methods Utilized

Conventional breeding

- Hybridization and selection
- Elite x elite
- Wide hybridization
- Inter-specific/sub –specific crosses

Molecular breeding

- Marker-assisted recurrent selection for yield
- Marker-assisted pyramiding of disease resistance genes
- Marker-assisted backcrossing



Mutation breeding

Anther culture

Rice breeding and production

- More and more seed companies invest in rice breeding

In 2011, there were 15 national released varieties developed by public institutes, 8 by seed companies. It indicated that the private sections will invest more in rice breeding in future.

- Production

Rice-growing area was about 30 mha, the average yields reached 6.69t/ha and total output attained 200.78 mt;

Both the average yield and total output reached a record high and achieved eight years continuous increasing in crop production.

Super Rice Breeding

- **Initiated in China in 1996, mainly focuses on super hybrid rice breeding.**
- **Strategy:**
  To integrate utilization of heterosis and construction of ideal plant type.
- **Core:**
  Increase the genetic diversity of parents Pyramid yield QTLs with biological and abiotic stress genes.
- **Achievement:**
  Up to 2011, there were 83 varieties identified by the Ministry of Agriculture as Super Rice, planted in 6.6 mha with average yield reached 9.0 ton /ha, among them 52 varieties are hybrid.

In 2011, the yield of super hybrid rice Y liang you 2 reached 13.9t/ha in 6.6ha demonstration area in Hunan province, it achieved the yield target of the third phase super rice for the first time.

Super hybrid rice Y Liangyou 2

Two-line hybrid rice breeding

- Planting areas accounting for 18.6% of the total hybrid rice planting areas in 2011;
- In 2002, a two-line hybrid Liangyou Peijiu, taking up the first place of planting areas instead of Shanyou 63, a more than ten year's leading three lines hybrid.

Two-line Hybird Rice Breeding

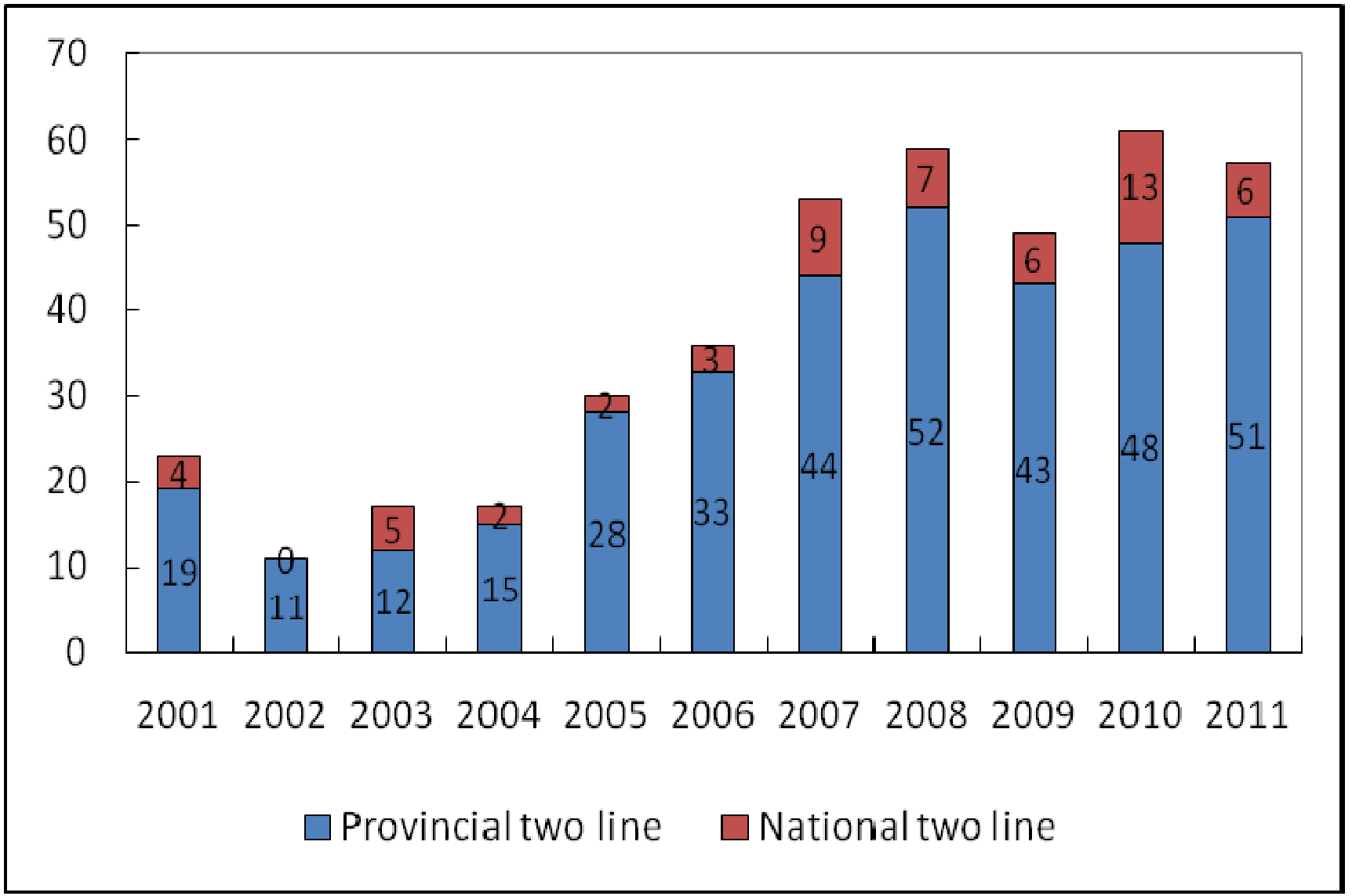
- More and more two-line hybrid rice varieties are released

  In 2011, there were 6 and 61 two-line hybrid combinations released at national and provincial level, respectively.

- The planting area of two-line hybrid rice is increasing

  The planting area of two-line hybrid rice reached 2.7 mha, The top three hybrid varieties with the highest extension area were all two-line combinations. The cultivation area of two-line hybrid rice will expend with the progress of research on seed production.

Liangyou peijiu



Two-line hybrid rice varieties released in China (2001-2011)

Japonica hybrid rice breeding

- Planting area accounting for 0.3 mha, about 3% of the total Japonica rice area;

- There were 1 and 8 Japonica hybrid varieties released at national and provincial level, respectively.

Japonica hybrid Yong you 9

Outstanding progress

- Extension area of Yongyou series varieties reached 154.7 thousand ha, accounted for more than half of the total area of Japonica Hybrid Rice.
- The extension area of single variety(Yongyou 9) break through 66.7 thousand ha for the first time.

Variety name	Area(000' ha)
Yongyou 4	1.2
Yongyou 5	2.5
Yongyou 6	18.4
Yongyou 8	22.4
yongyou 9	76.1
Yongyou 10	6.6
Yongyou 12	25.1
Yongyou 13	1.1
Yongyou 15	1.3

Extension area of Yongyou series varieties in 2010

◆A record high yield in Zhejiang province was created by Yongyou 12

In 2011, the average yield of japonica hybrid Yongyou 12 was over 13.65t/ha in 6.6ha demonstration area, the highest yield reached 14.15t/ha, and created a record high yield in Zhejiang

Super high yield combination Yongyou 12

Prospects

Main problems in rice production

Farmer's level:

- Lack the high yield varieties with good quality and multiple resistance
- Lack market information and low marketing capacity
- Small cultivation scale with low efficiency
- Low profit from rice cultivation

National level:

- Water shortage and environment pollution
- How to increase productivity of rice to ensure national food security under the decreasing field area situation.

Prospects

Development priorities in future

Targets:

- ✓Safe national food security
- ✓Increasing the farmers' income
- ✓Environment protection

How to do?

1.Breeding of rice varieties with high yield, good quality and multiple resistance

2.Technology transfer to narrow the gap between actual and potential yield

3.Low-cost and labor-saving rice cultivation technology

4.Management of nature resource and use chemicals efficiently

Challenges

- **Great achievement has been made, but challenge continues.**
- **Sustainable improvement of yield potential, grain quality, and tolerance to biotic and abiotic stresses?**
- **Many important genes had been cloned in rice, how to utilize?**
- **How to combine the national food security and farmers' demands?**

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