Improving wheat research capacity through international collaboration, China-CIMMYT example

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Outlines

- Background information
- Develop new technology
- Transfer CIMMYT technology and germplasm
- Future perspectives

Background information

Major cereals production in China, 2016

Crop	Area Mha	Yield T/ha	Production Mt	% World
Rice	30	6.9	207	28
Maize	37	6.0	219	21
Wheat	24	5.3	128	17

Production constrains

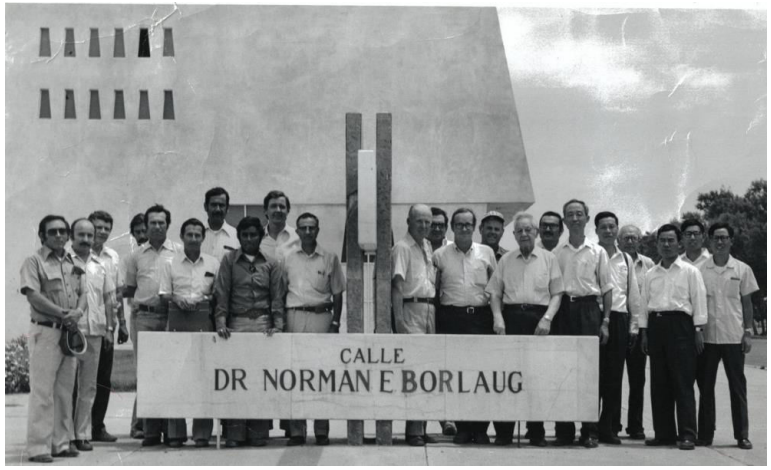
- Climate change, water shortage in northern China and unexpected temperature fluctuations
- Serve diseases, head scab is the most serious disease
- Consumers care both processing and nutritional qualities
- Small farmer size, strong competition between grain and cash crops

Why work with CIMMYT

- Research and training center focused on maize and wheat improvement, serves developing countries
- Improved germplasm and technology, freely available
- Multidiscipline team, great impact in farmer's field
- International network
- **Long term strategic and win-win partners**

40 years collaboration

- 1970-1985, purchase of commercial seeds from Mexico, and introduction of new varieties
- 1986-1996, wheat shuttle breeding and training
- 1997-present, opening CIMMYT China Office, and joint research programs with Chinese institutes



Approaches in China

- Development and application of new technology
- Transfer CIMMYT technology and germplasm to China
- Joint research program, new model with great impact
- Training and workshop, international network

CAAS-CIMMYT wheat team

- 10 scientists, 10 support staff, 20 postgraduate students
- Quality and molecular labs, four breeding stations

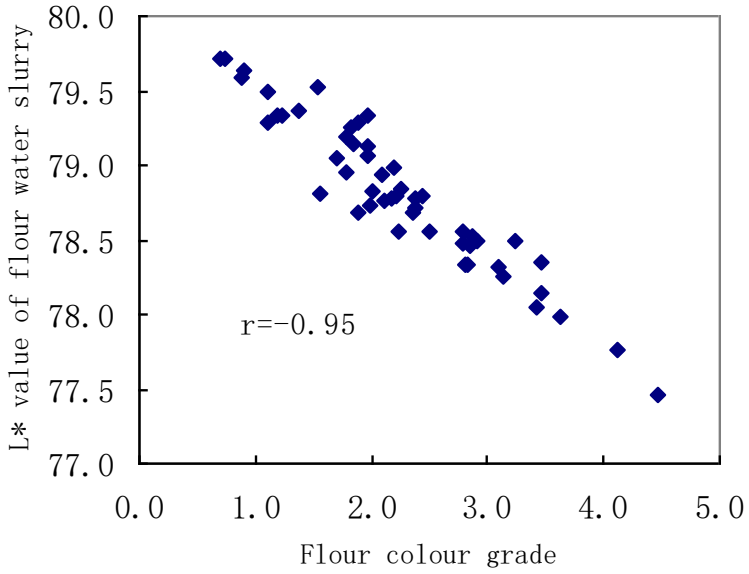
Develop new technologies

Quality improvement

- Standardize testing protocols for noodle and steamed bread
- Develop and validate functional markers by comparative genomic method
- Application of MAS in breeding programs

Three factors for noodle quality

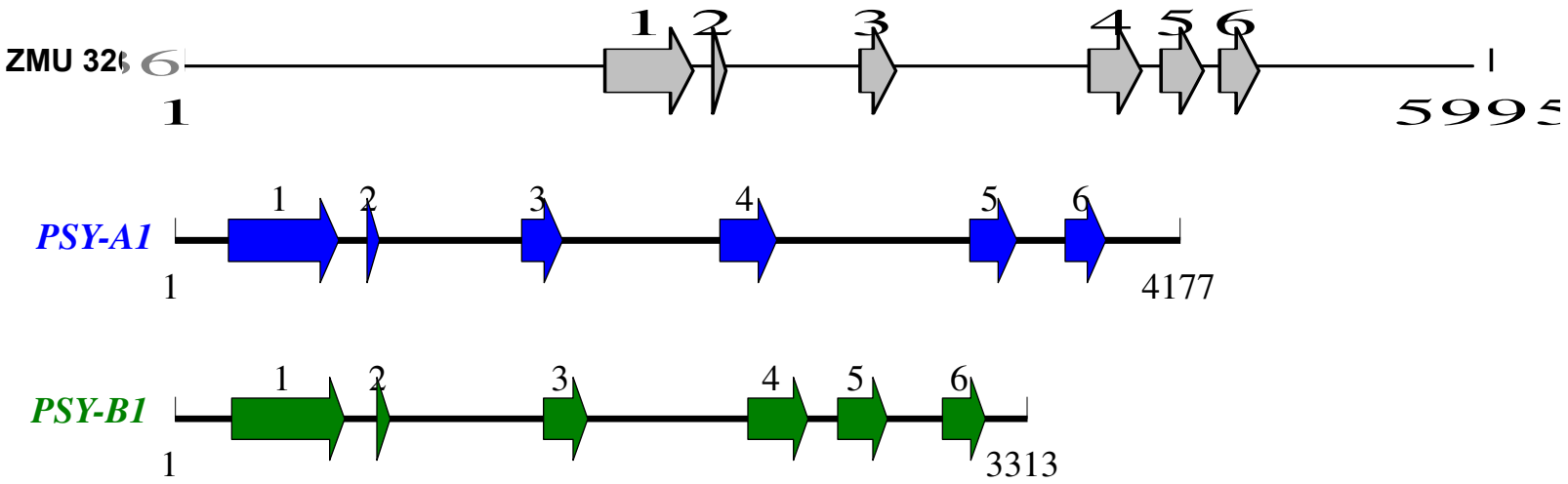
- Gluten quality
- Starch parameters
- Color



He et al, 2005, Cereal Chemistry, 82: 345-350
Zhang et al, 2005, Cereal Chemistry, 82: 633-638

Cloned *Psy* genes on wheat chr 7A and 7B

Allele	Coding seq (bp)	Intron	cDNA (bp)			Deduced amino acids	
			5’ UTR	ORF	3’ UTR	Residues	Mass (kD)
PSY-A1	4177 bp	5	221	1284	303	428	47.8
PSY-B1	3313 bp	5	222	1263	156	421	47.0



He et al., 2008, TAG, 116: 213-221

Markers for quality traits

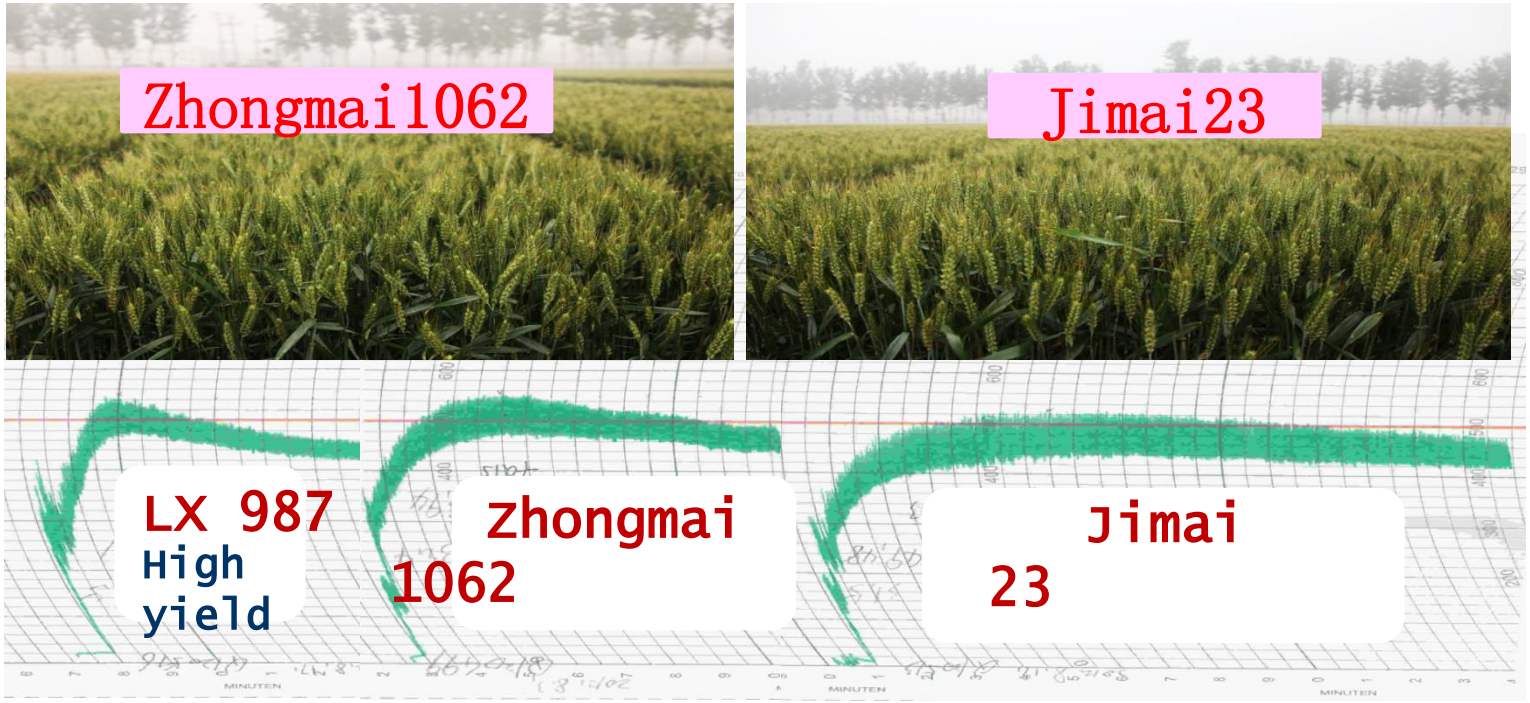
- **HMW-GS: *Ax2**, *Bx7*, *Bx 7OE*, *Bx17+By18*, *Bx14+By15*, *By8*, *By9*, *By16*, *Dx5*, and *Dy10***
- **LMW-GS: 20 markers for *Glu-A3* and *Glu-B3***
- **Polyphenol oxidase: *PPO16*, *PPO18*, *PPO29*, *PPO33***
- **Yellow pigment: *Psy-A*, *Psy-B*, and *Psy-D***
- **Grain hardness: *Pina-D1b*, *Pinb-D1b*, and *Pinb-D1p***
- **Sprouting tolerance: *Vp1B3***
- **Starch: *Wx-A1*, *Wx-B1*, *Wx-D1***

KASP (Kompetitive Allele Specific PCR)

- 150 KASP markers, 70 from CIMMYT-China and 60 from Mexico, validated and used
- Speed: genotype 1536 varieties with 150 markers in 72 hrs
- Cost: 9 cents/data point, or 13.5 US $ per genotype
- Highly consistent with traditional method

Varieties released from MAS

- Jimai 23 with high yield and quality released in Shandong
- Zhongmai 1062 with high yield and quality released in Northern China Plain

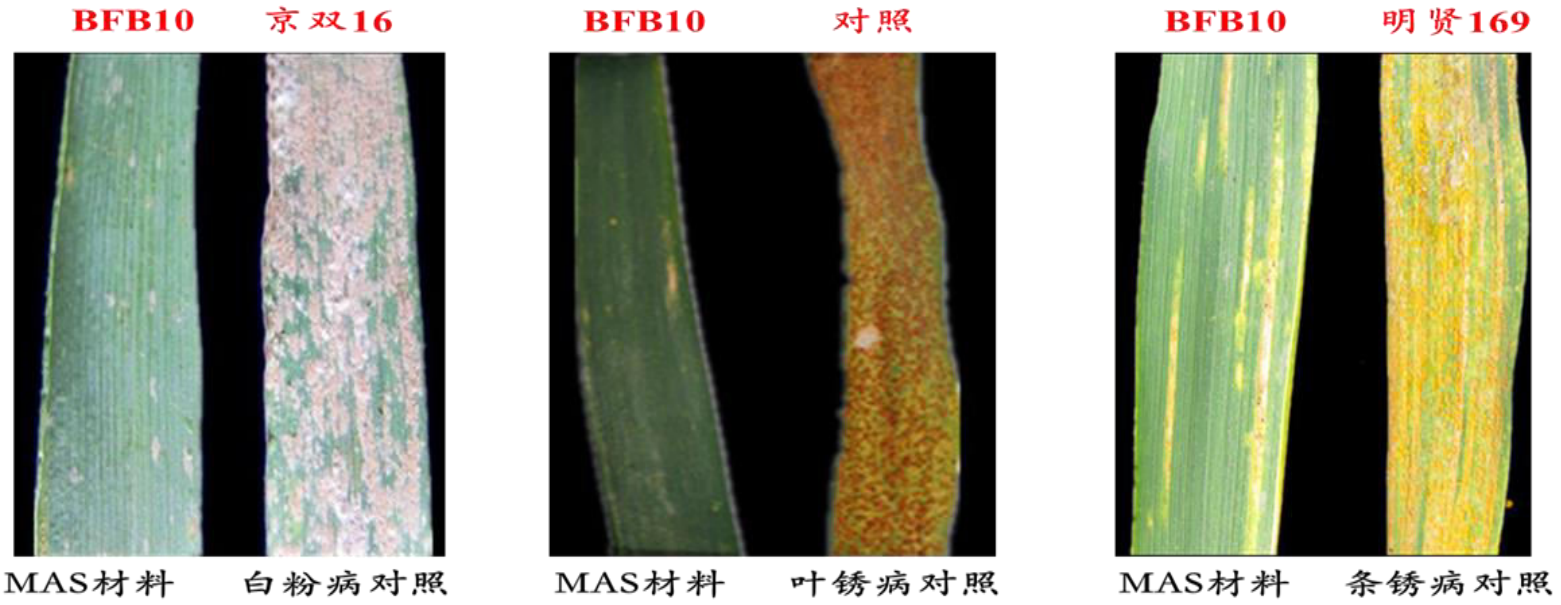


Impact

- International leader in Chinese wheat quality and gene specific marker development and application
- Molecular markers used in 20 Chinese institutes and 16 countries including international companies
- Ranked as the most cited Chinese wheat program

Transfer technology and germplasm to China

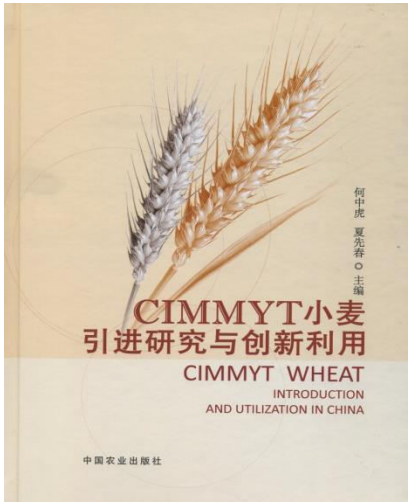
Development of varieties with adult plant resistance to powdery mildew and rusts based on minor genes, durable resistance

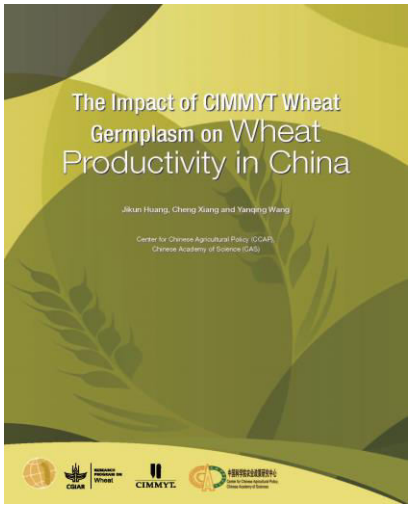


Journal of Chinese Agricultural Science, 2011, 44: 2193-2215
TAG, 2013, 126: 2427-2449
Crop Science, 2014, 54: 1907-1925

CIMMYT wheat in China

- 18,000 accessions were stored in Chinese gene bank
- Over 290 varieties were developed from CIMMYT wheat, covering 10% area, worth US $ 3.4 billion
- Introduced traits such as rust resistance and quality
- Received eight awards from State Council since 1998






Han 6172 containing KAUZ from CIMMYT is a major variety in Yellow and Huai Valley, total acreage of 7 million ha
甘6172=甘4032/KAUZ

Physiology and crop management

- GreenSeeker and Drone are used in phenotyping and genetic study
- Bed-planting technology is transferred to Gansu, Shandong, and Sichuan, inputs reduction by 30%


International Wheat Quality Conference
May 29-31, 2004, Beijing, China


第六届全国小麦遗传育种学术研讨会代表合影
2010年3月29日 江苏·扬州

Seven scientists received Friendship Award

- **Tom Lumpkin, Sanjaya Rajaram, Hans Braun, Ravi Singh**
- **S. Vasal, Carlos Leon, Jose Luis Araus**

Award from State Council

CIMMYT received the International Collaboration Award from State Council in 2016


中华人民共和国
国际科学技术合作奖
THE INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL COOPERATION AWARD OF THE PEOPLE'S REPUBLIC OF CHINA

证 书
CERTIFICATE

International Maize and Wheat Improvement Center (CIMMYT) 荣获中华人民共和国国际科学技术合作奖，特颁发此证书。

THE AWARD CERTIFICATE IS ISSUED TO THOSE WHO HAVE WON THE INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL COOPERATION AWARD OF THE PEOPLE'S REPUBLIC OF CHINA.

2016 年 12 月 21 日

证书号:2016-HZ-02

Expanding collaborations

Collaborations from Australia, USA, France, and UK, have also played a significant roles in Chinese wheat research

Future perspectives

Experiences

- CAAS serves as coordinator from China side, with over 20 participant Chinese institutes from provincial level
- Target both technology/science innovation and impact in farmer field
- Continuous postdoctoral and postgraduate training is the best approach to develop collaboration
- Expanding donors and partners

Challenges of China agriculture research

- More and better quality grains with less land and less inputs, 20% products from international market
- Significant effect of climate change
- Rapid development in new technology, however limited application
- Active involvements in international agriculture and Belt and Road Initiative
- China can not deal it alone

New business model

- China has a significant investment in agricultural research, international donors have less interest to support activities in China
- China faces imbalance development in science and technology, still needs to learn from other institutes, also has the capacity to help developing countries
- All CG Centers are operated based on project funding
- China needs to buy collaborator working time from project funding, win-win partnership

Collaborative subjects

- Use of new tools in wheat breeding
- Improving scab resistance in Yellow and Huai Valleys
- Phenotyping platform
- Crop management
- Support wheat research in Ethiopia/Pakistan

Opportunities

- CIMMYT-MOA agreement for joint lab
- CIMMYT-SCS agreement for 10 VS/students per year
- This workshop

Take home message

- **Develop new technology: quality testing and gene specific markers development and application**
- **CIMMYT germplasm, methodology, and training play a significant role in China**
- **Future: we still need to learn, new business model**

Acknowledgement

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- CAAS and many Chinese collaborators
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- Australia: Wujun Ma, Rudi Apples, Richard Trethowan, Bob McIntoish
- USA: Craig Morris, Guihua Bai