

Evaluating the impact of adopting CIMMYT wheat germplasm in China

— — Implications for wheat productivity

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June. 22, 2017

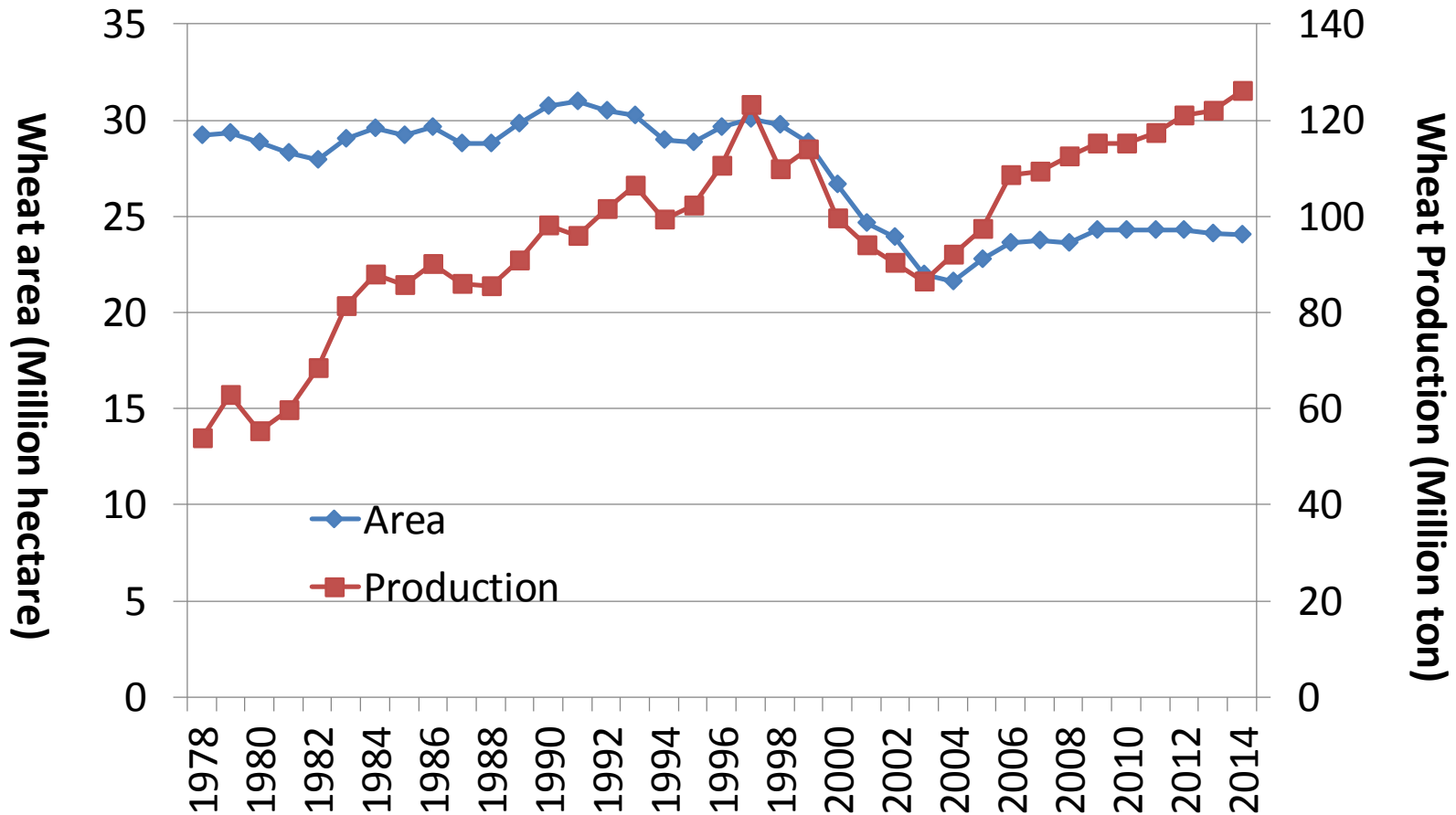
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Motivations

The impressive increase in wheat yields in China

- Area ↓ 17%
- Production ↑ 134%
- Yield ↑ 184%



Motivations

- **Given current land and water constraints and high cropping intensity, with the excessive use of agrochemicals, future wheat food security in China will depend largely on sustainably raising productivity**
- **Our question:**
What are the trends and sources for China's wheat productivity growth in recent decades?

Motivations

- **Previous studies:**

- Technology has contributed the most to rice yield growth during the period 1975-90, and hybrid rice adoption is responsible for most of the technical change component (Huang & Rozelle, 1996)

- The genetic material from CGIAR had contributed to China's wheat productivity prior to the mid-1990s (Jin et al., 2002)

- **Our questions:**

What are the trends and sources for China's wheat productivity growth in recent decades?

Is CGIAR germplasm contributing to China's wheat productivity growth since the mid-1990s?

Data

- **I** : **Wheat varieties**
- **II** : **Wheat production inputs & outputs**

Data I :Wheat varieties

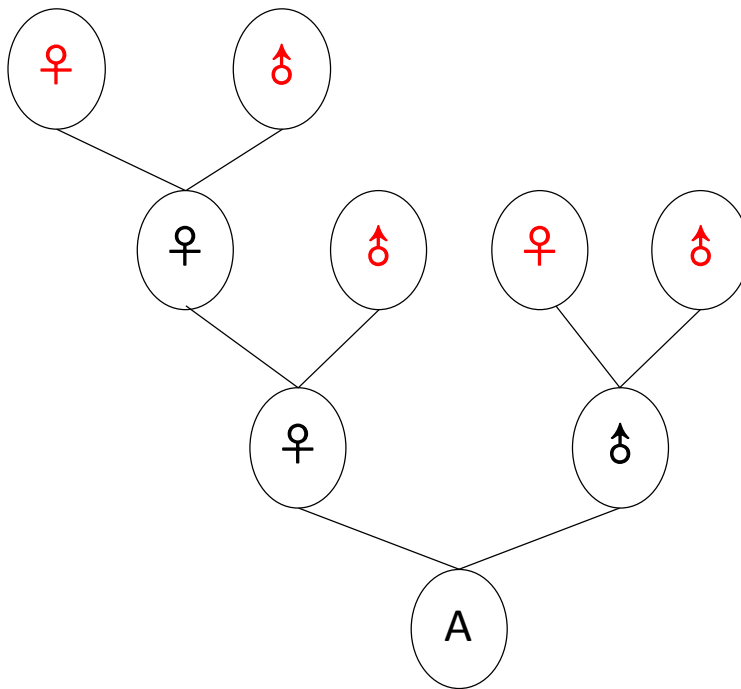
Major varieties

- Varieties grown on at least 6,667 hectares (100,000 mu) in China in a given year is considered “**major**”
- Area sown to **major** wheat varieties by province for each year during 1982-2014 (MOA, 1982-2014)
- Totaling **2146 major** wheat varieties from the top 17 wheat production provinces

Data II : Wheat varieties

Pedigree information

- Traced detailed **pedigree information** for each of the 2146 varieties
- Traced to the point where a **non-Chinese parent** appeared
- Traced **6 generations** averagely



For each variety, the top
germplasm of the family tree from:

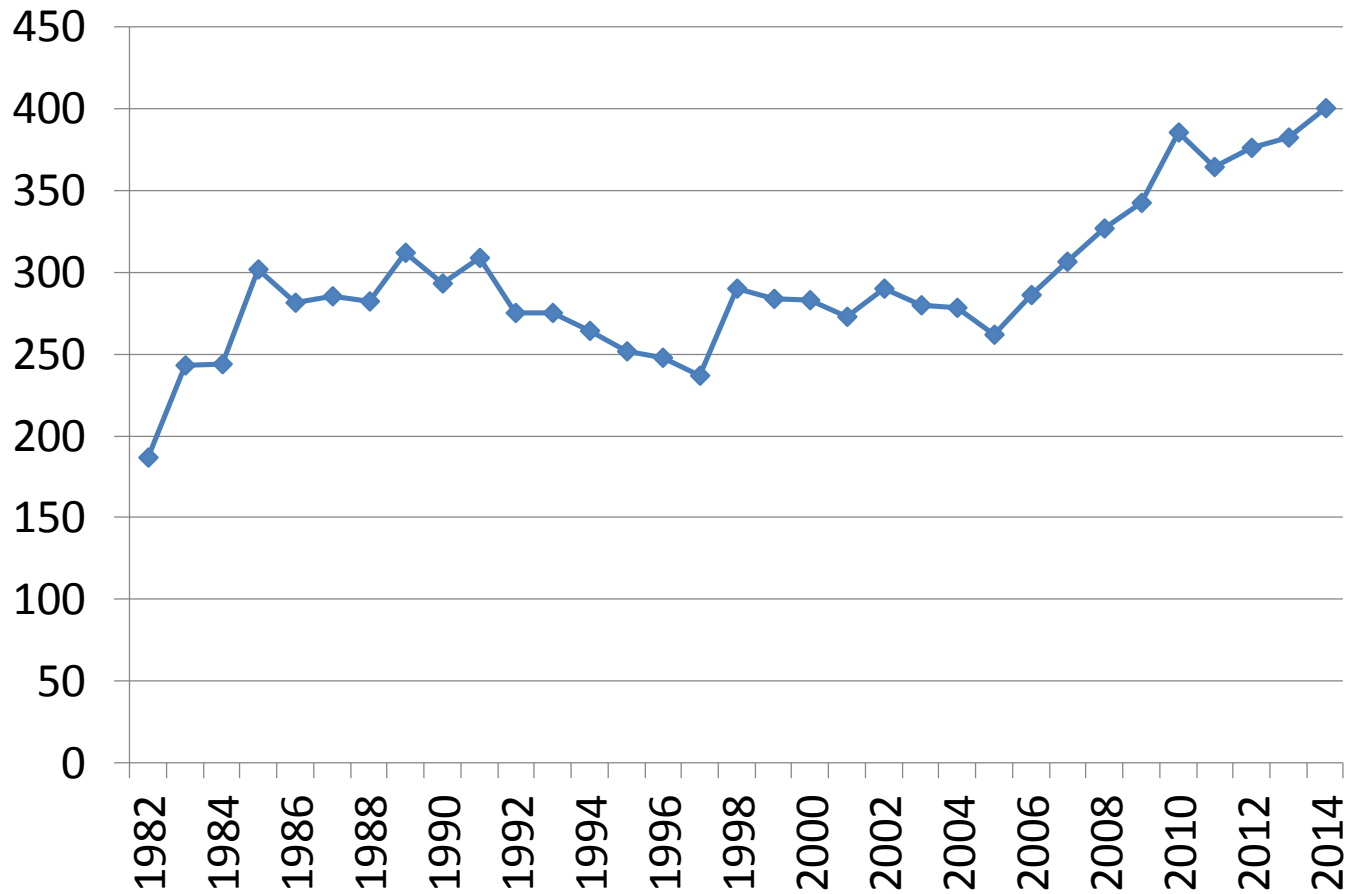
- China (Traditional landrace)
- CIMMYT
- Other countries

Data II :

Wheat production inputs & outputs

- **Wheat production inputs and outputs by province (NDRC, 1980-2015)**
- **Irrigation and abiotic constraints (e.g., drought and cold damage)**

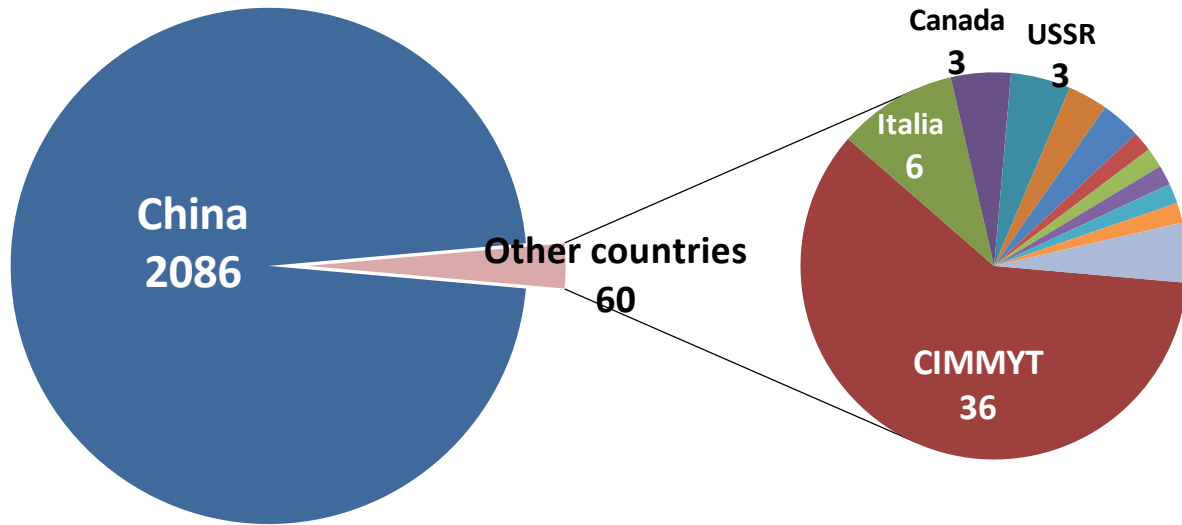
Number of wheat varieties



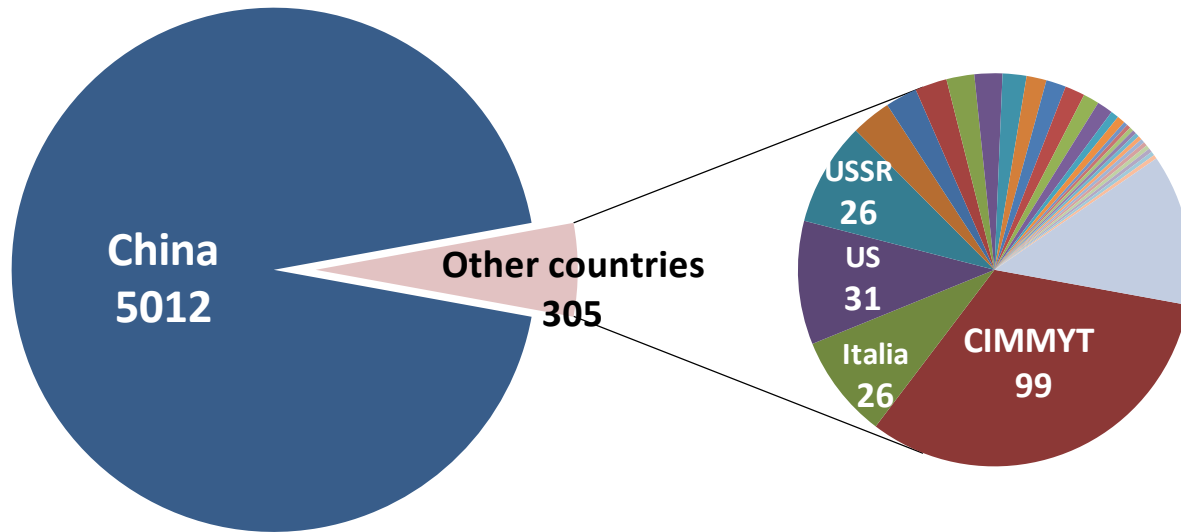
A slight **rising** trend in the number of wheat varieties

Number of wheat varieties & germplasm used

Number of wheat varieties
(2146 totally)

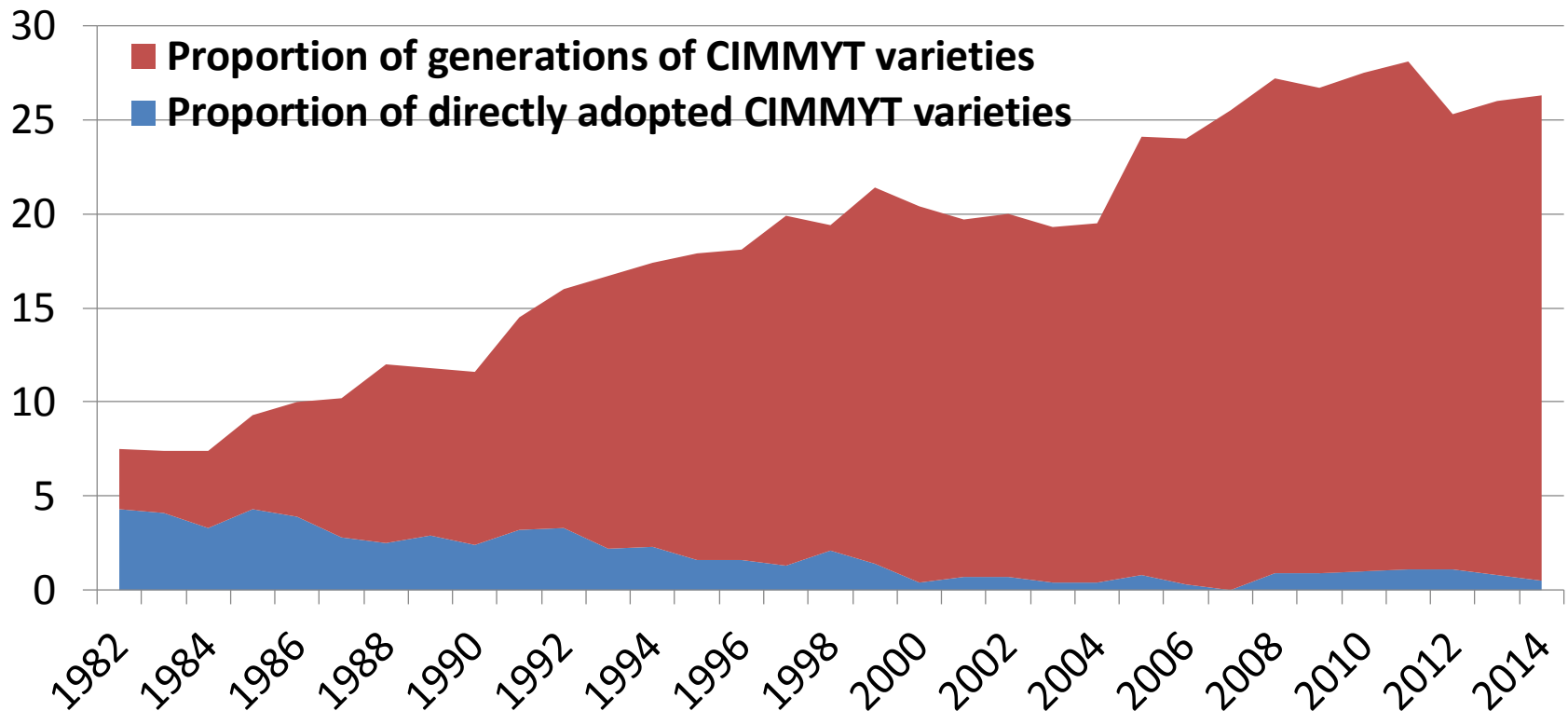


Number of germplasm
(5317 totally)



The contribution of CIMMYT Germplasm to wheat varieties in China

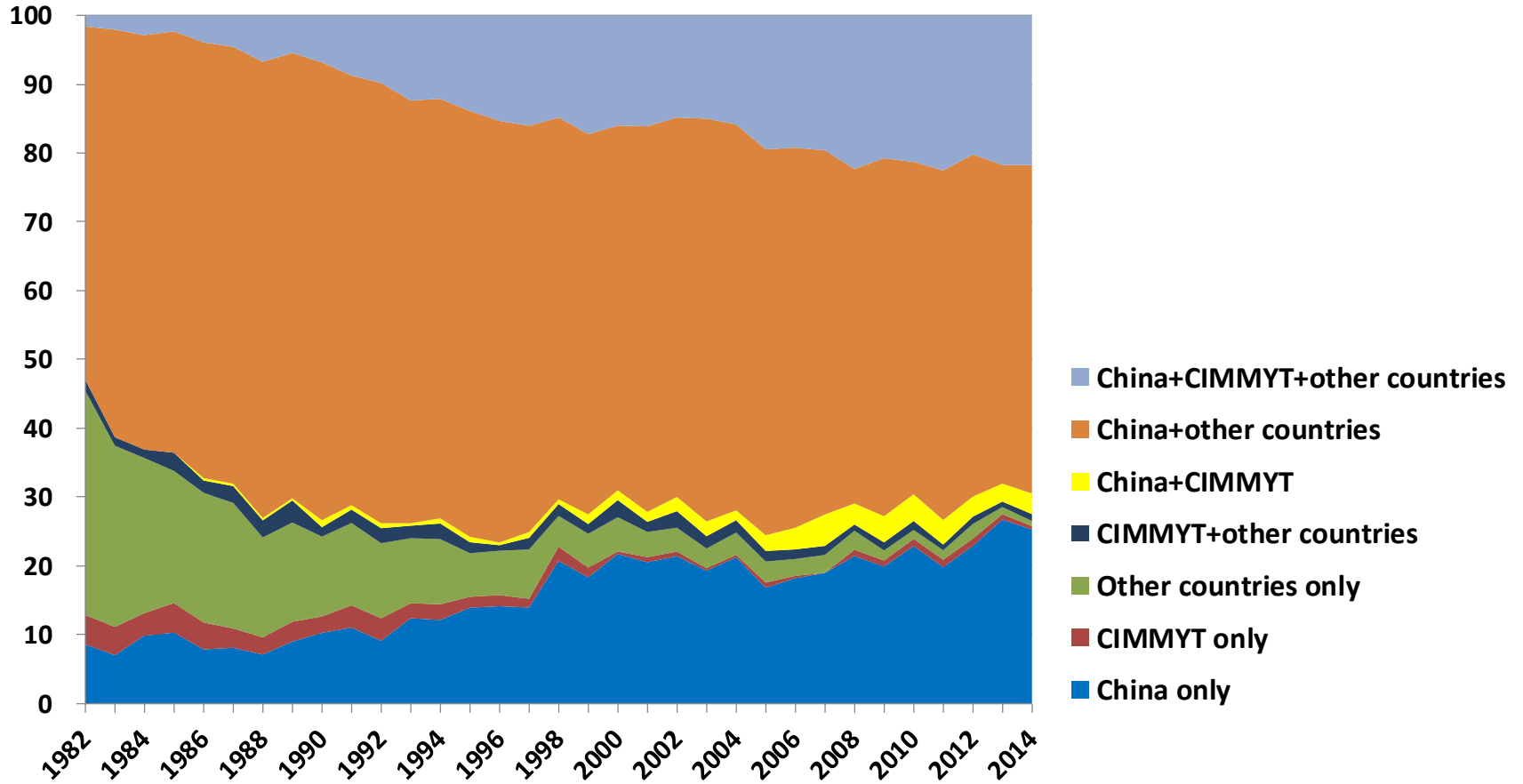
Proportion of varieties with CIMMYT germplasm (%)



- Chinese breeders used CIMMYT germplasm **increasingly** to generate new wheat varieties
- The contribution of CIMMYT's germplasm to China's wheat varieties is significant and has **grown** over time

The contribution of CIMMYT Germplasm to wheat varieties in China

Source of germplasm (%)



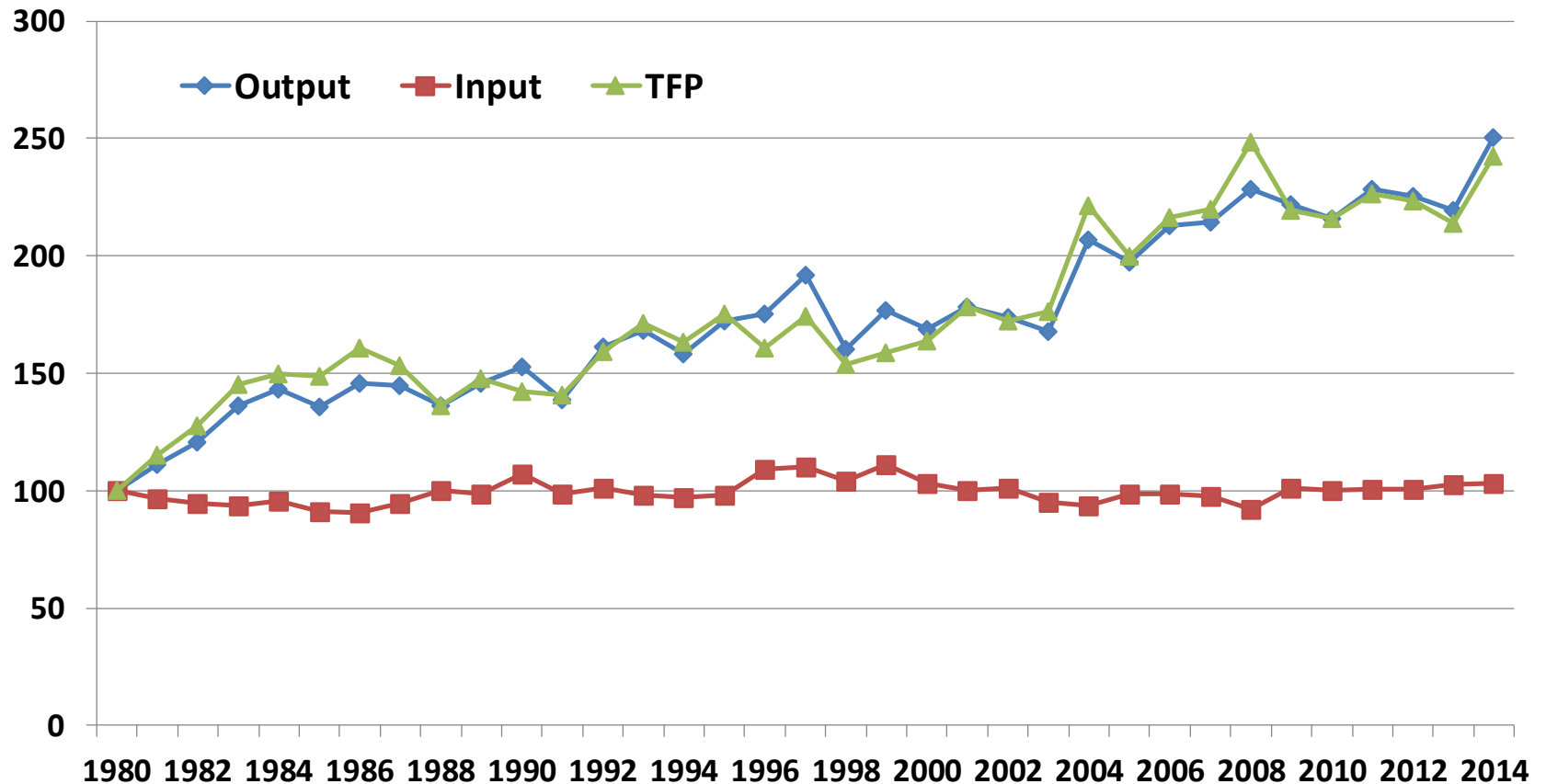
Wheat Total Factor Productivity

Tornquist-Theil TFP index :

$$\ln(TFP_t/TFP_{t-1}) = \ln(Q_t/Q_{t-1}) - 0.5 \cdot \sum_i (S_{it} + S_{it-1}) \cdot \ln(X_{it}/X_{it-1})$$

- Q_t : the wheat output (yield in kg/ha) in the t^{th} year
- S_{it} : the share of the i^{th} input in total cost
- X_{it} : the i^{th} input, including labor, seed, fertilizer, pesticide, machinery, equipment, and other material inputs

Wheat Total Factor Productivity



In general, China has experienced rapid and dramatic **growth** in wheat TFP during 1980-2014

Impact of CIMMYT Wheat Germplasm on wheat productivity in China

$$TFP_{jt} = \alpha + \beta \cdot CG_{jt} + \gamma \cdot Z_{jt} + \varepsilon_{jt}$$

- **CG_{it}**: the proportion of varieties with difference sources of germplasm
- **Z_{it}**: including
 - the proportion of crop area affected by drought and by frost
 - time trend

Impact of CIMMYT Wheat Germplasm on wheat productivity in China (Fixed-effect results)

	(1)	(2)	(3)
Proportion of varieties with CIMMYT germplasm	0.54*** (3.34)		0.54*** (3.37)
Proportion of varieties with germplasm from other countries		-0.00 (0.02)	-0.05 (0.43)
Proportion of crop area affected by drought (%)	-0.50*** (4.90)	-0.51*** (4.85)	-0.49*** (4.83)
Proportion of crop area affected by frozen (%)	-0.82 (1.64)	-0.78 (1.52)	-0.82 (1.64)
hrs	16.64 (0.60)	15.32 (0.53)	17.27 (0.62)
t	1.97*** (11.19)	2.51*** (15.53)	1.93*** (10.34)
Constant	71.74*** (2.65)	73.09** (2.50)	76.16*** (2.71)

The contribution of CIMMYT germplasm to China's wheat TFP:

$$0.54 * (26.3\% - 7.5\%) = 10\%$$

Impact of CIMMYT Wheat Germplasm on wheat productivity in China (Fixed-effect results)

	TFP
Proportion of varieties with China & CIMMYT germplasm	1.92*** (3.51)
Proportion of varieties with germplasm from China & other countries	0.09 (0.62)
Proportion of varieties with germplasm from China & CIMMYT & other countries	0.56*** (2.68)
Proportion of varieties with CIMMYT germplasm only	0.48* (1.76)
Proportion of varieties with germplasm from other countries only	-0.29 (1.34)
Proportion of varieties with germplasm from CIMMYT & other countries	0.00 (0.01)
Proportion of crop area affected by drought (%)	-0.50*** (4.76)
Proportion of crop area affected by frozen (%)	-0.84* (3.08)
The contribution of CIMMYT germplasm to China's wheat TFP: $1.92*(3\%-0\%)+0.56*(21.8\%-1.6\%)+0.48*(0.5\%-4.3\%)=15\%$	
hr	
t	1.58*** (6.00)
_cons	93.63*** (3.08)

Conclusions

- The wheat TFP has **grown steadily** in the past three decades
- Chinese breeders used CIMMYT germplasm **increasingly** to generate new wheat varieties
- Compared with the non-CIMMYT germplasm, CIMMYT germplasm brought an **increase** in China's wheat TFP in the range of **10-15%** in the past three decades

Thanks