FOTC 2014 Fertilizer Outlook & Technology Conference

MAKING THE RIGHT MOVES

OUR CHALLENGES. OUR IMAGE. OUR FUTURE

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Fertilizer Situation in China

The Fertilizer Institute
Nourish, Replenish, Grow

Fertilizer Industry Round Table

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Fertilizer situation in China

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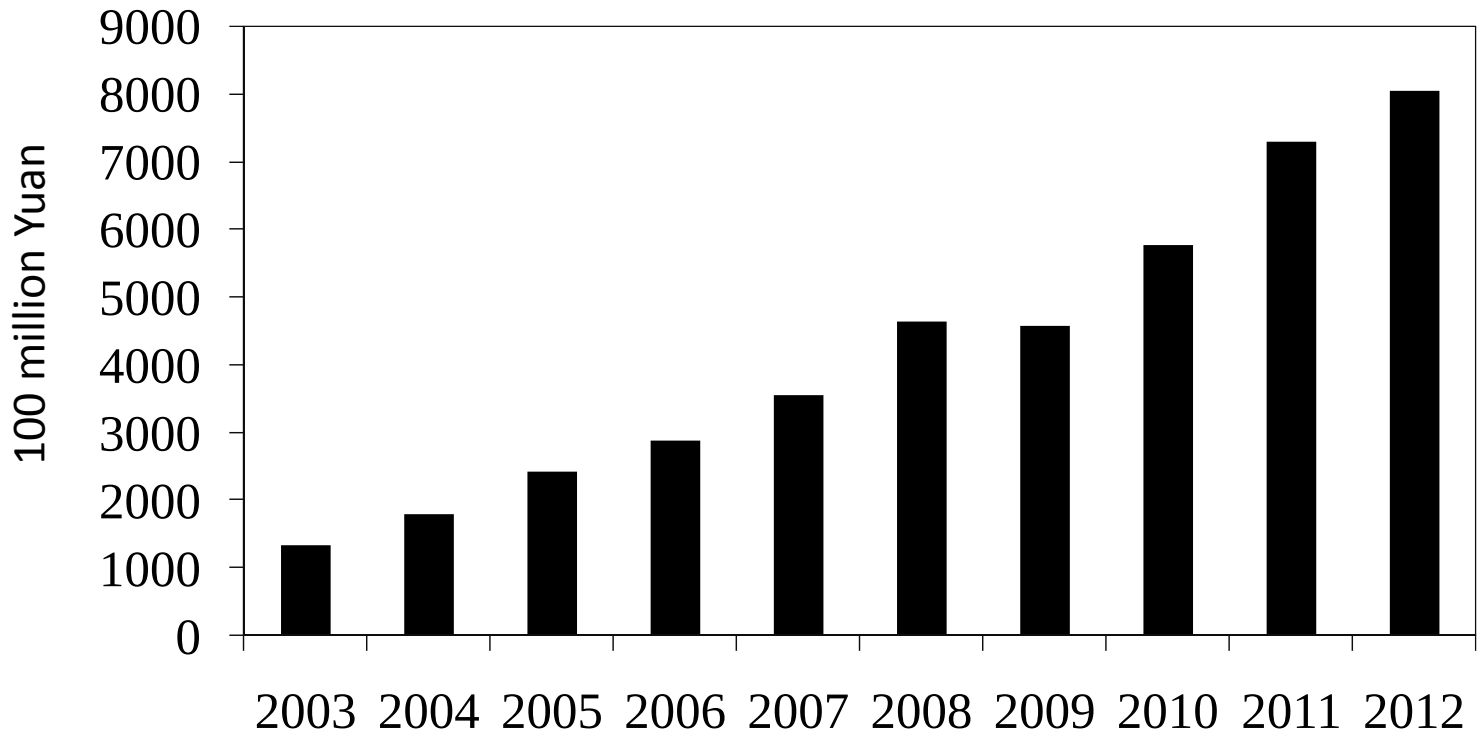
Outline

- **Fertilizer production and use in China**
- **Improvement in technologies and policies**
- **Challenges and perspective**

1. Fertilizer production and use in China

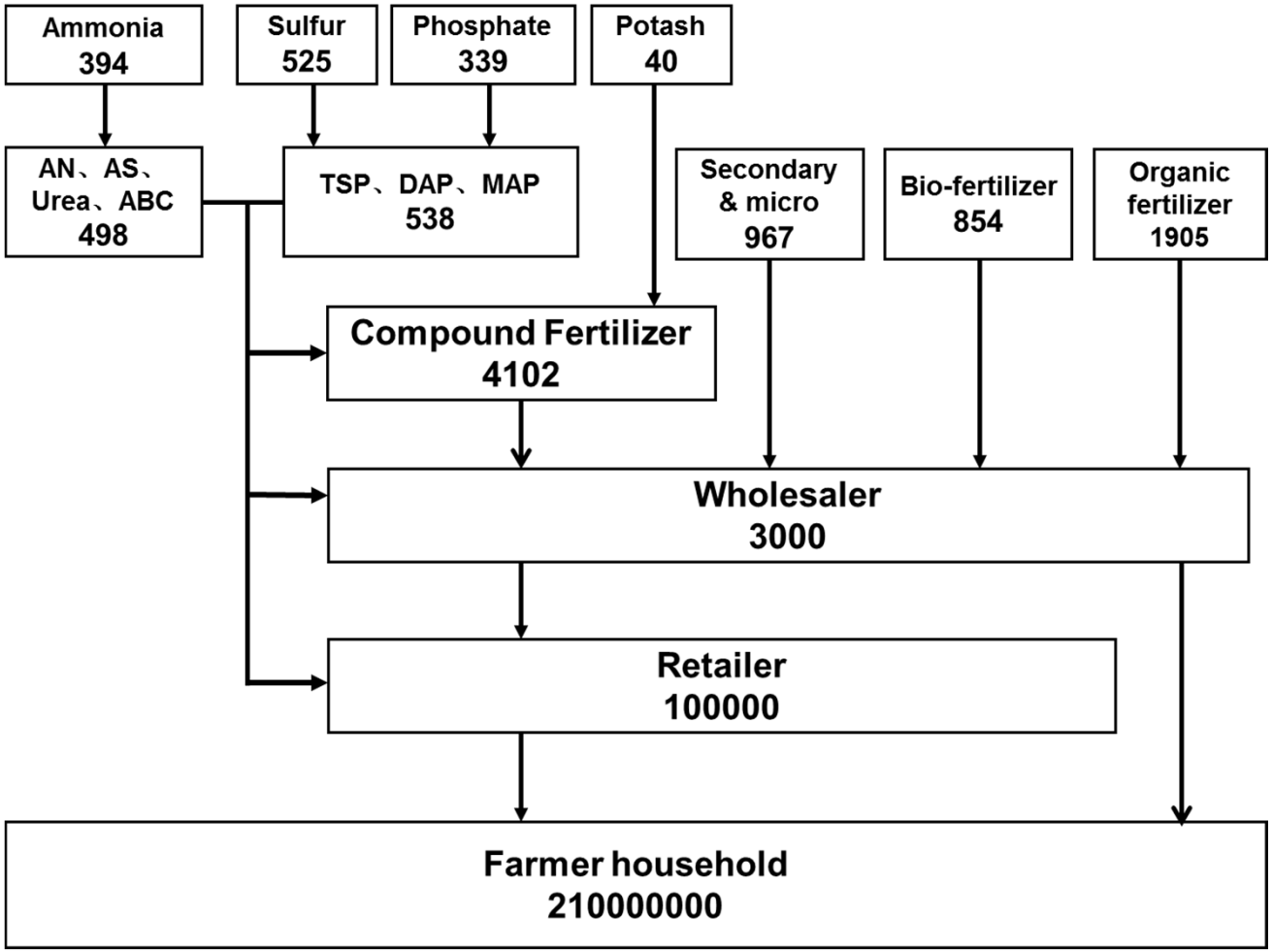
Chinese chemical fertilizer industry experienced a rapid development during last ten years. The value of gross output of fertilizer industry increased by 8 fold.



Value of gross output of fertilizer industry of China

1. Fertilizer production and use in China

Large number of fertilizer producers and distributers



Li et al.,2013,JEQ

Data in bracket is number of enterprise

1. Fertilizer production and use in China

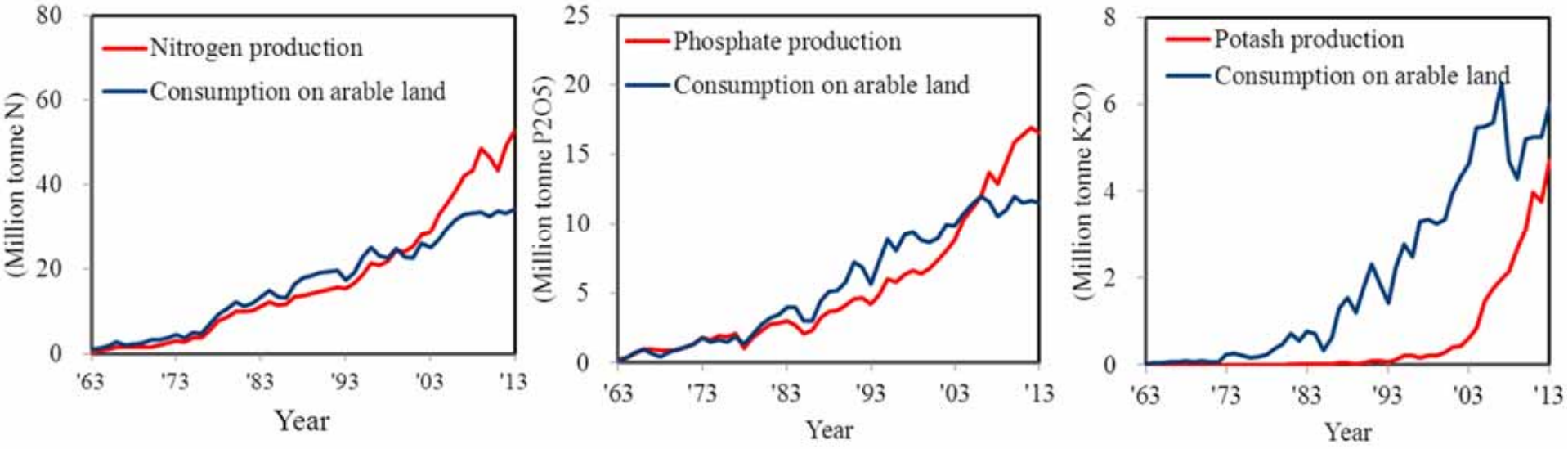
High increase in production compare to low increase in consumption

In last ten years, the growth rate of fertilizer production was much higher than before.

Nitrogen fertilizer production was 52 million tonne in 2013, with an increase of 6.9%

Phosphate fertilizer production was 16.5 million tonne in 2013, with a decrease of 2.4%

Potash fertilizer production was 4.7 million tonne in 2013, with an increase of 25%



The domestic agricultural consumption show a relative slow increase

Nitrogen fertilizer consumption was 34 million tonne in 2013, with an increase of 2%

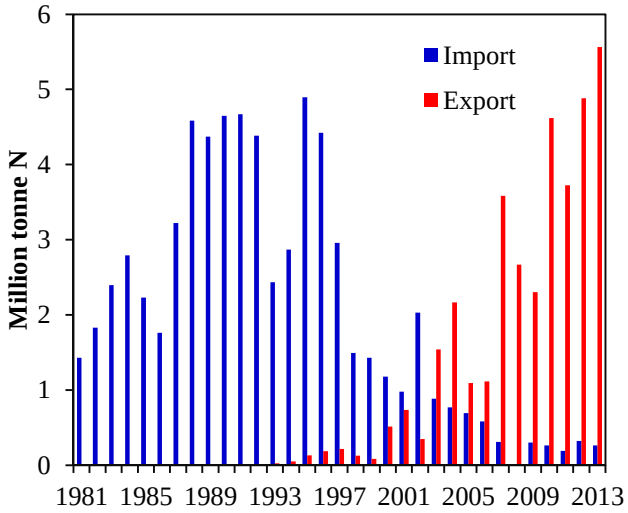
Phosphate fertilizer consumption was 11.5 million tonne in 2013, with a decrease of 2%

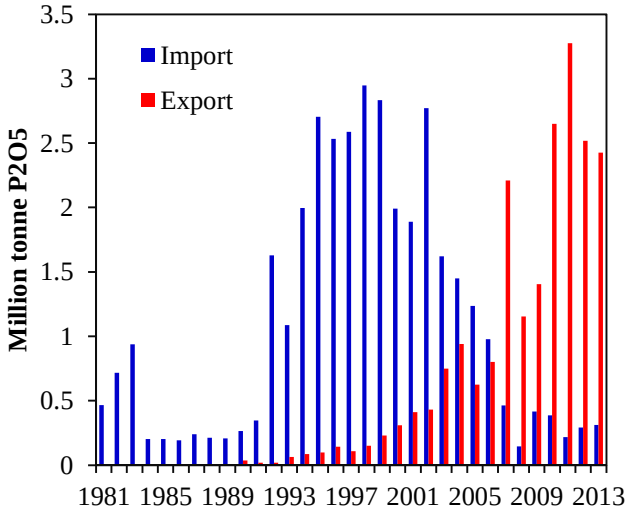
Potash fertilizer consumption was 6.0 million tonne in 2013, with an increase of 14%

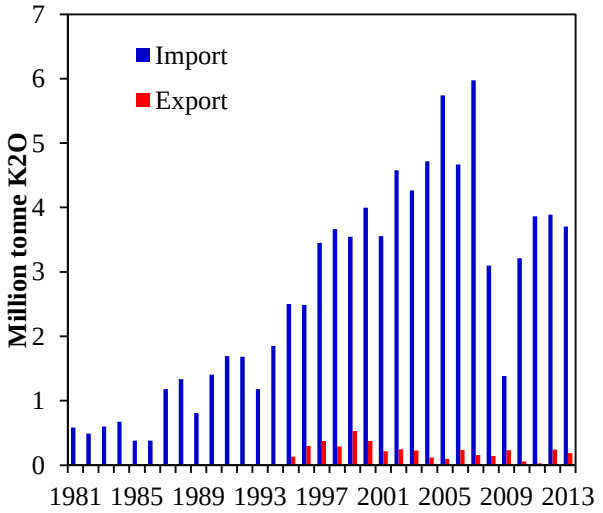
1. Fertilizer production and use in China

Big changes in fertilizer trade

Nitrogen export continually increasing and reached 5.57 MT in 2013
Phosphate export continually decline and reached 2.43 MT P2O5 in 2013
Potash import stabilized in last three years and reached 3.7 MT K2O in 2013



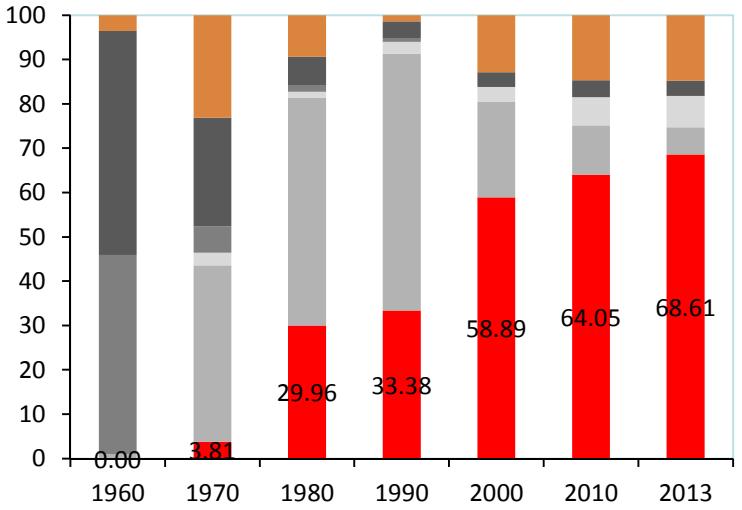


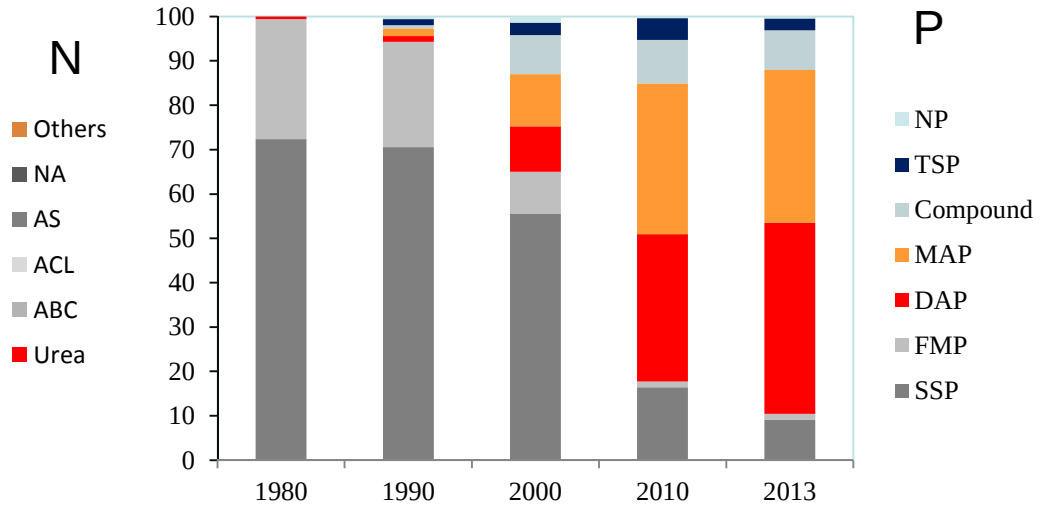


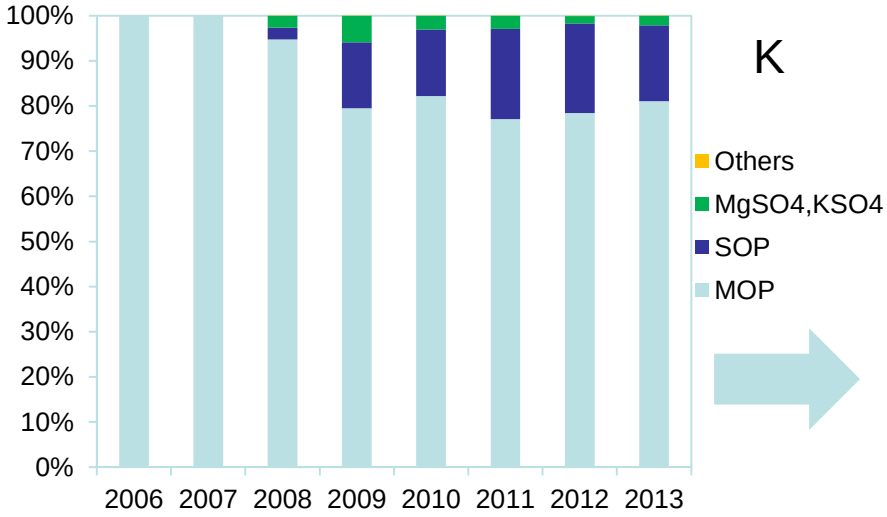
Government controls fertilizer trade with seasonal tariffs, but the rate and period have been changed every year. Recourses cost, environmental cost and subsidy are also important for export.

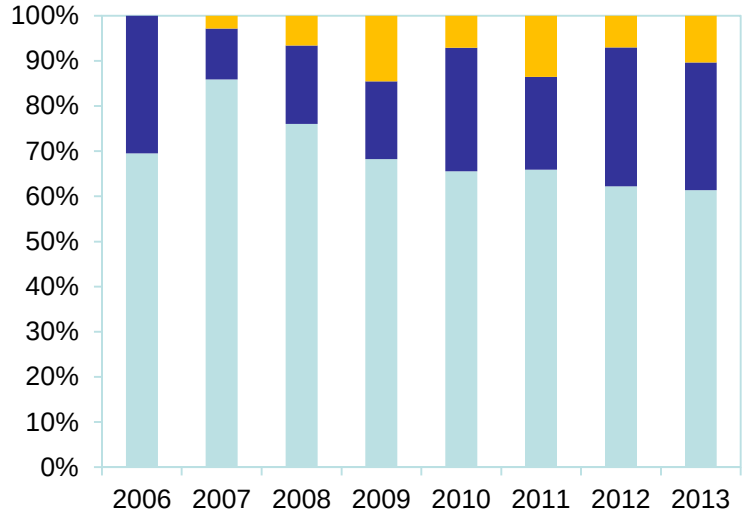
1. Fertilizer production and use in China

Products composition changed drastically









1. Fertilizer production and use in China

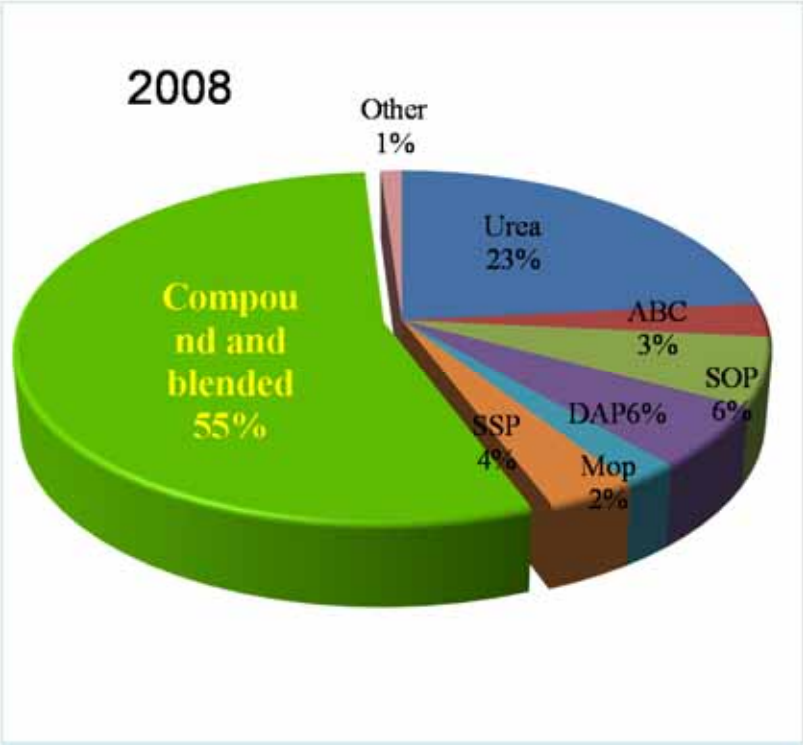
Upsurge of other products

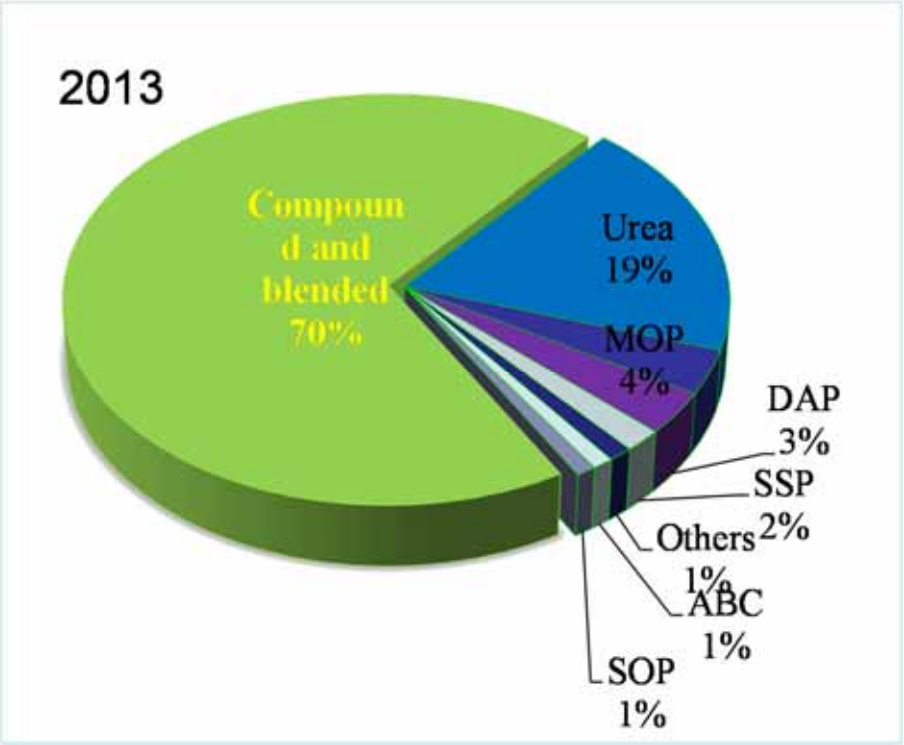
In last five years, number of registered fertilizer products increased by 83%.

Changes of fertilizer products registered between 2008-2013			
	Products in 2008	Products in 2013	Changes （%）
Total	35,132	64,340	83
Compound	24,222	32,942	36
Blended	4,511	20,346	351
Organic	3,137	5,890	88
Mix of organic and inorganic	1632	3,225	98
Micro soluble	1242	1357	9
Slow release	676	1133	68
Bio fertilizer	349	376	8
Soil amendment	278	352	27
Secondary soluble	51	78	53
Macro soluble	11	48	336
Micro	42	16	-62
Secondary	4	13	225
$MgSO_4$	7	8	14
$Ca(NO_3)_2$	6	2	-67

1. Fertilizer production and use in China

Compound and blended products are dominate the end usage





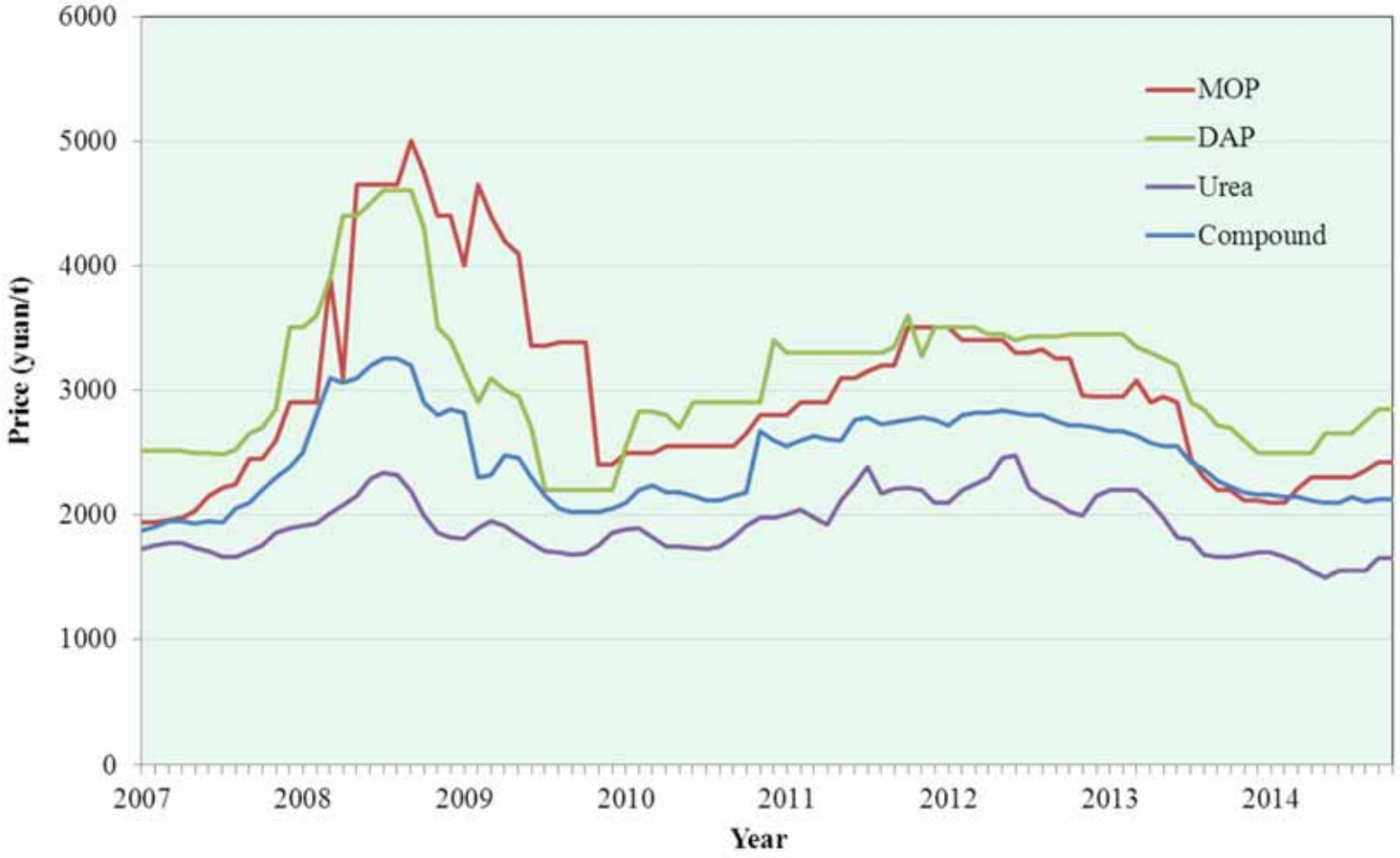
Fertilizer cost for grain crops

Farmer survey in 6 province (n=1152)

Farmer survey in 11 province (n=2112)

1. Fertilizer production and use in China

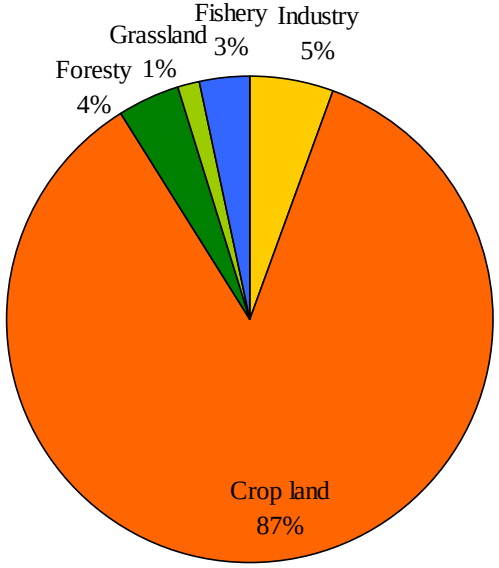
Intensively fluctuated price resulted from the changes of energy, policies and international market

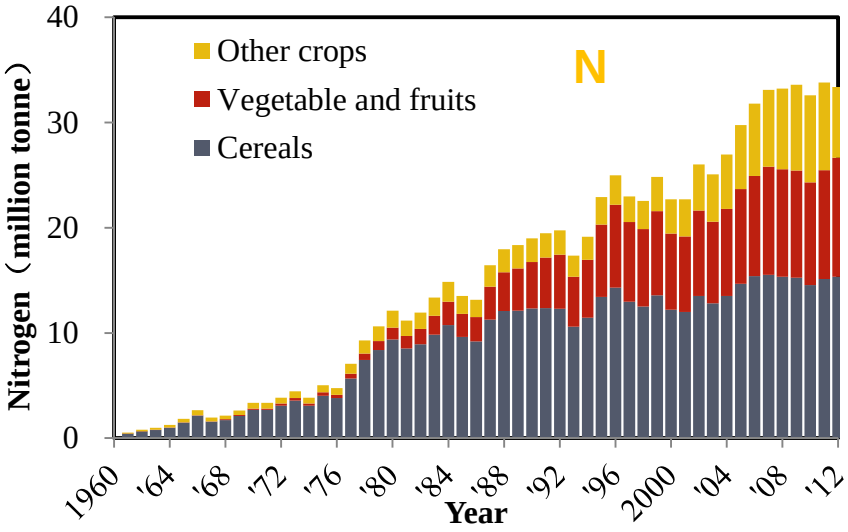


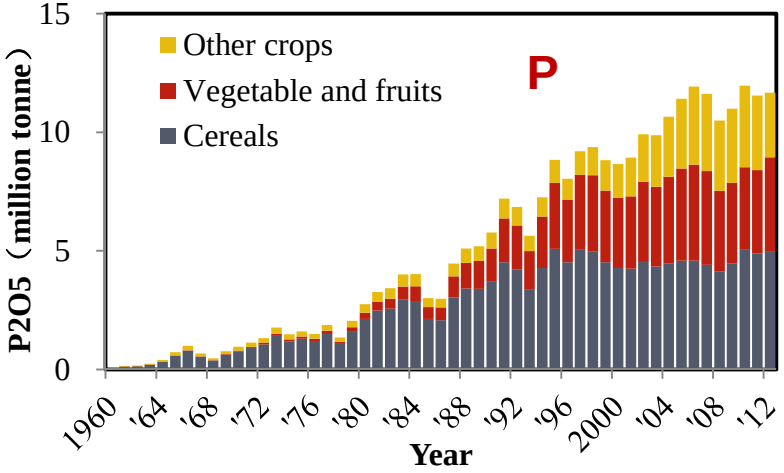
1. Fertilizer production and use in China

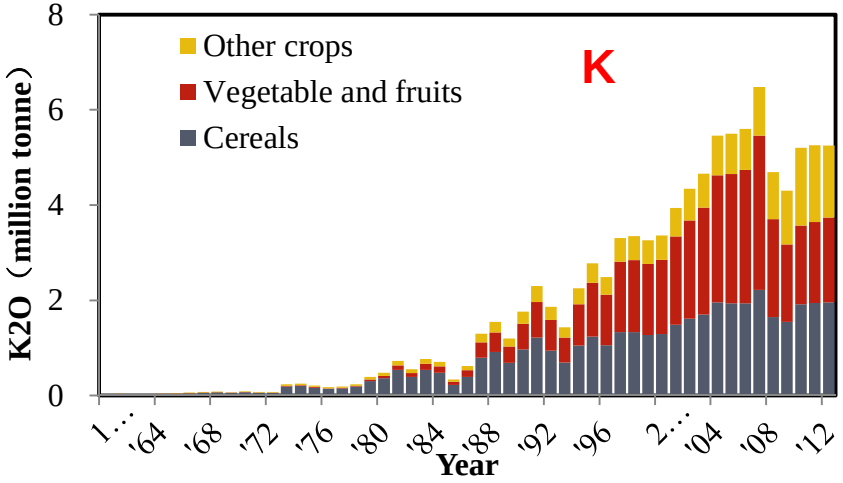
Fertilizer allocation changed greatly

Vegetable, fruits and other cash crops dominated the increase of fertilizer consumption









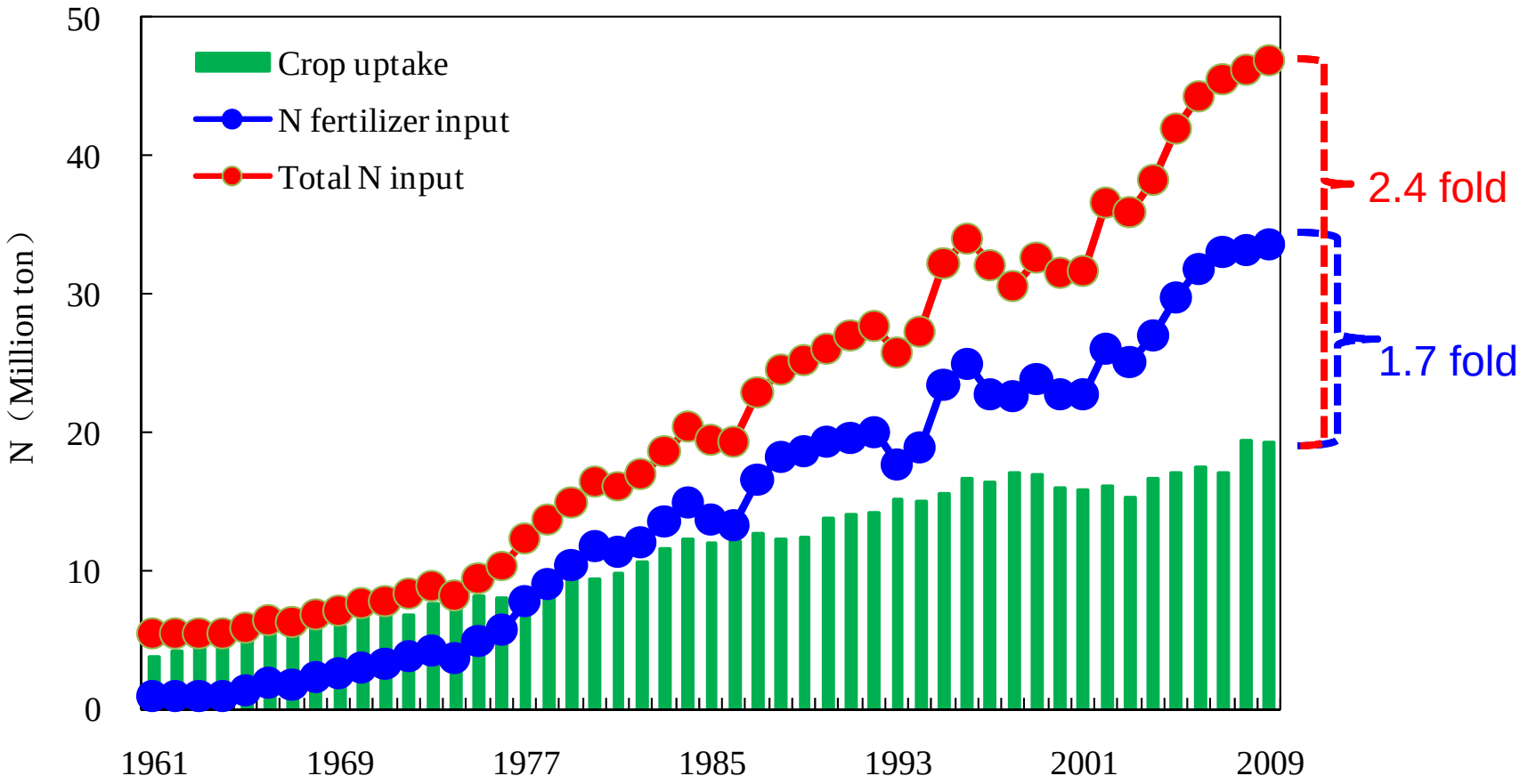
Weifeng Zhang, unpublished

1. Fertilizer production and use in China

Chemical fertilizer application rate is relatively higher in China.

1. Fertilizer production and use in China

N fertilizer input is 1.7 fold higher than crop uptake
Total N input is 2.4 fold higher than crop uptake



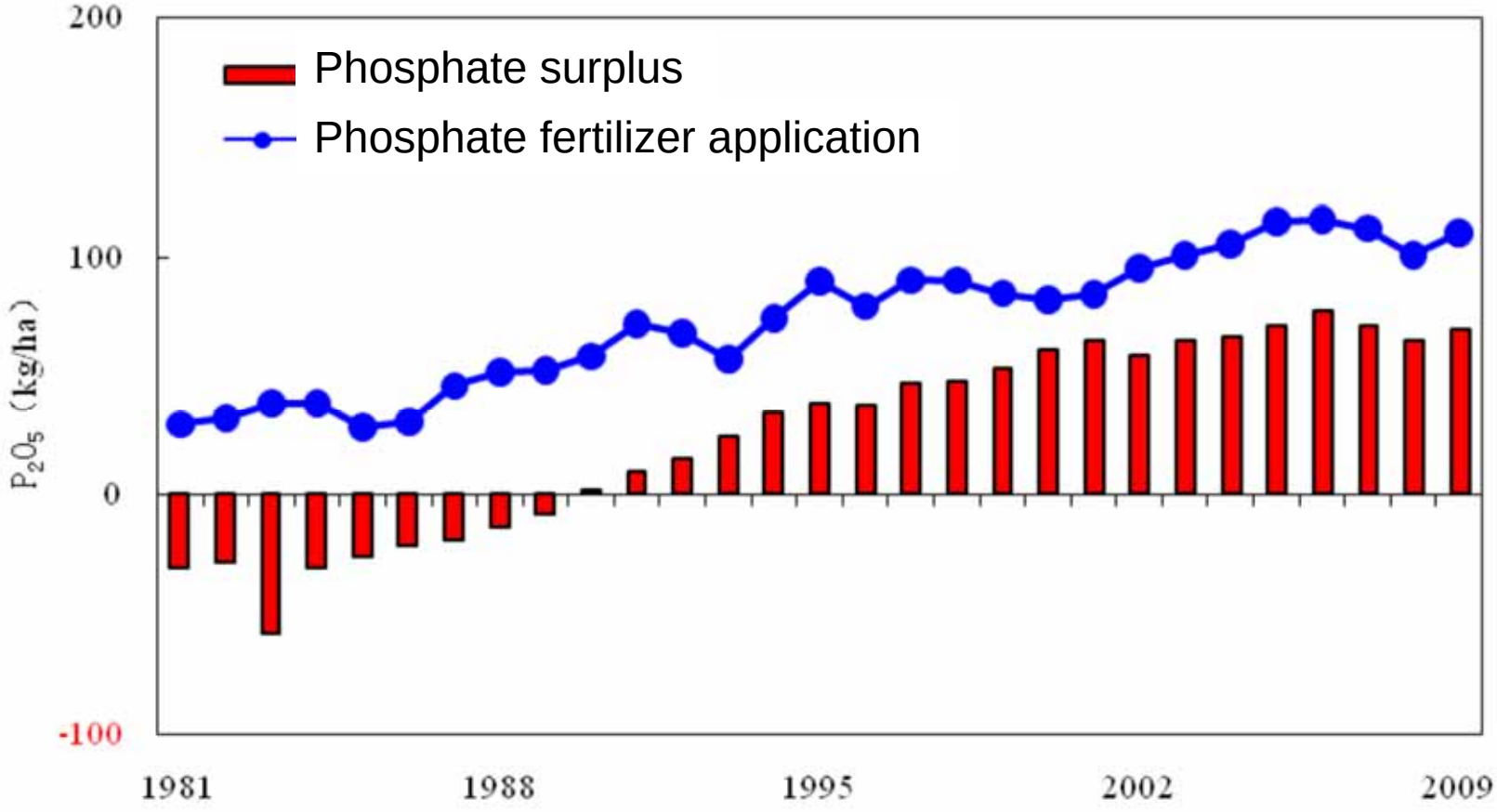
N input and crop uptake in Chinese crop land in 1961-2009

（Zhang et al., 2013, China Agriculture science）

1. Fertilizer production and use in China

Phosphate surplus is increasing since 1980s, and 65 million tonne P_2O_5 accumulated in arable land

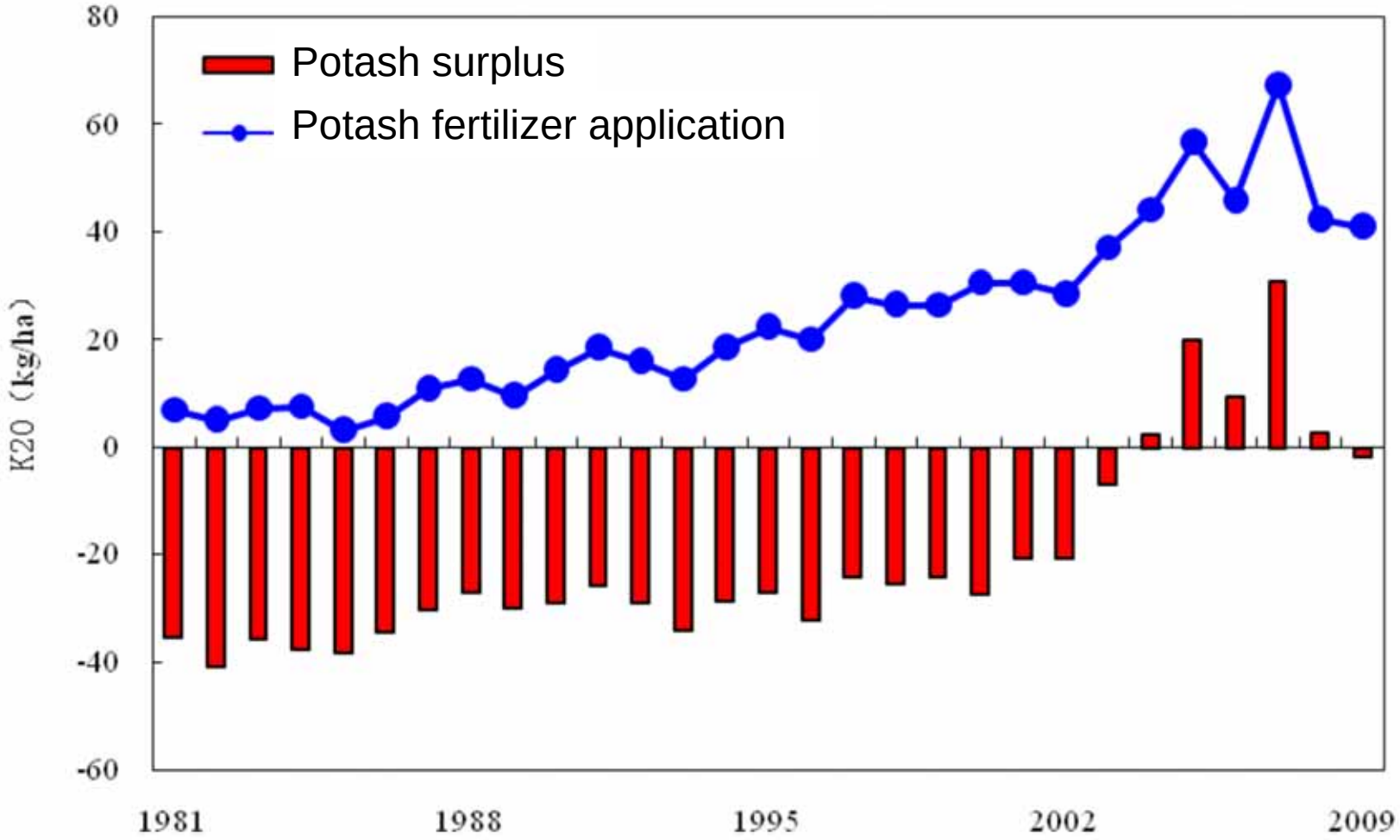
Soil Olsen-P increased from 8.4mg/kg in 1980s to 23.7mg/kg in 2006



Li et al., JEQ, 2011

1. Fertilizer production and use in China

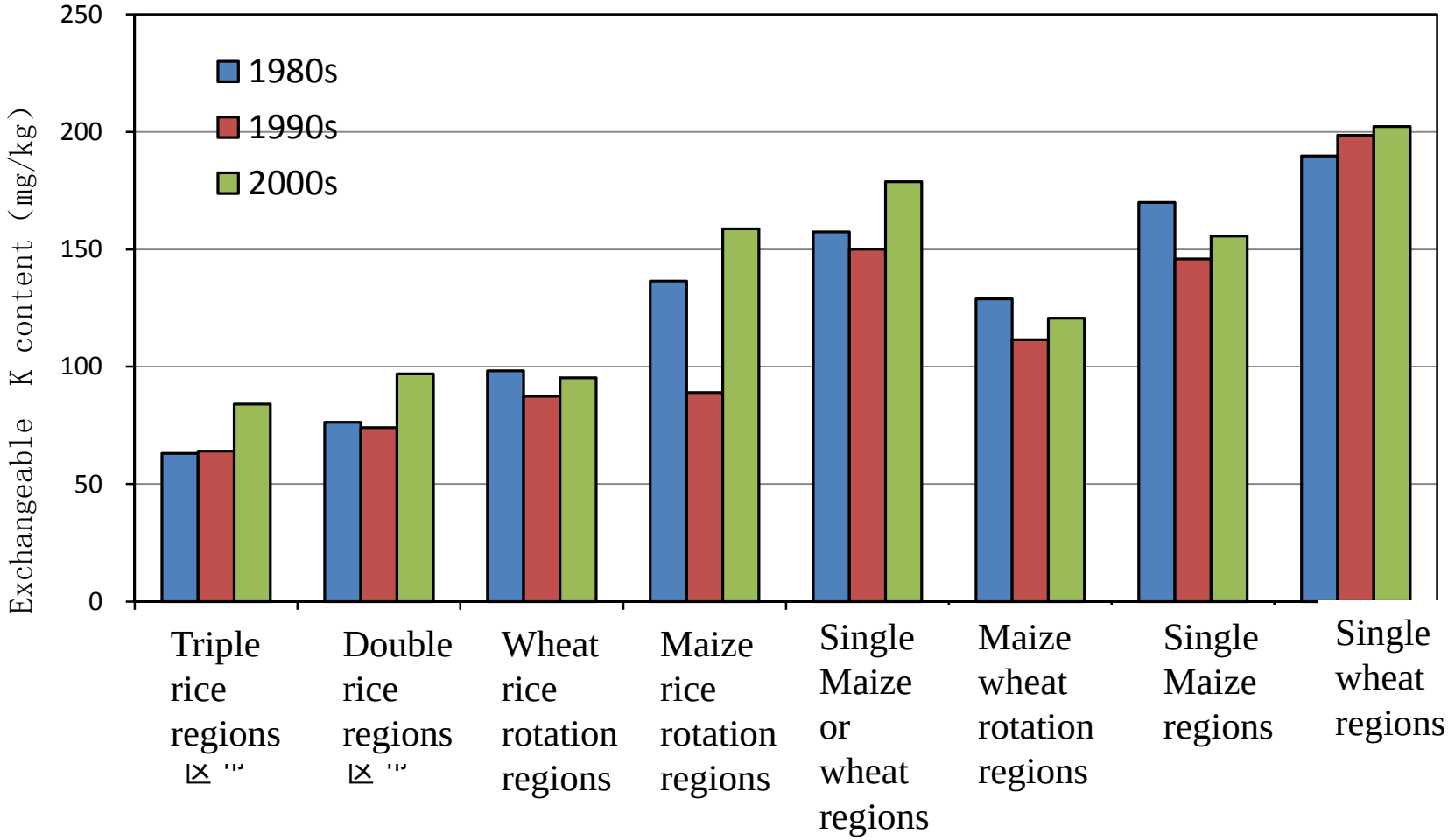
Potash balance transformed from negative to positive in recently years



Gao et al., in preparation

1. Fertilizer production and use in China

Soil exchangeable K content has also reversed from depletion to enrichment since 1990s



Data source：data of 1980s came from soil survey in 1979—1982(n=2990)
data of 1990s came from published soil testing results (covered 75.31 million ha)
data of 20s came from national soil testing and fertilizer recommendation project during 2007-2010 (n=10176)

1. Fertilizer production and use in China

Current production capacity is enough to support future demand in terms of high recourse use efficiency, food and environment safety

Baseline and forecast for fertilizer development in China

（Million Tonne）	Situation in 2013				Forecast for 2030	
Fertilizer	Production capacity	Real production in 2013	Total consumption in agriculture and industry	Consumption in agriculture	Demand for agriculture to keep balance	Theory demand for agriculture, industry and export
Nitrogen	59.49	52.87	45.41	34.20	21	30
phosphate	23.50	16.53	12.61	11.48	6.79	10
Potash	5.91	4.72	7.38	6.0	4.74	6

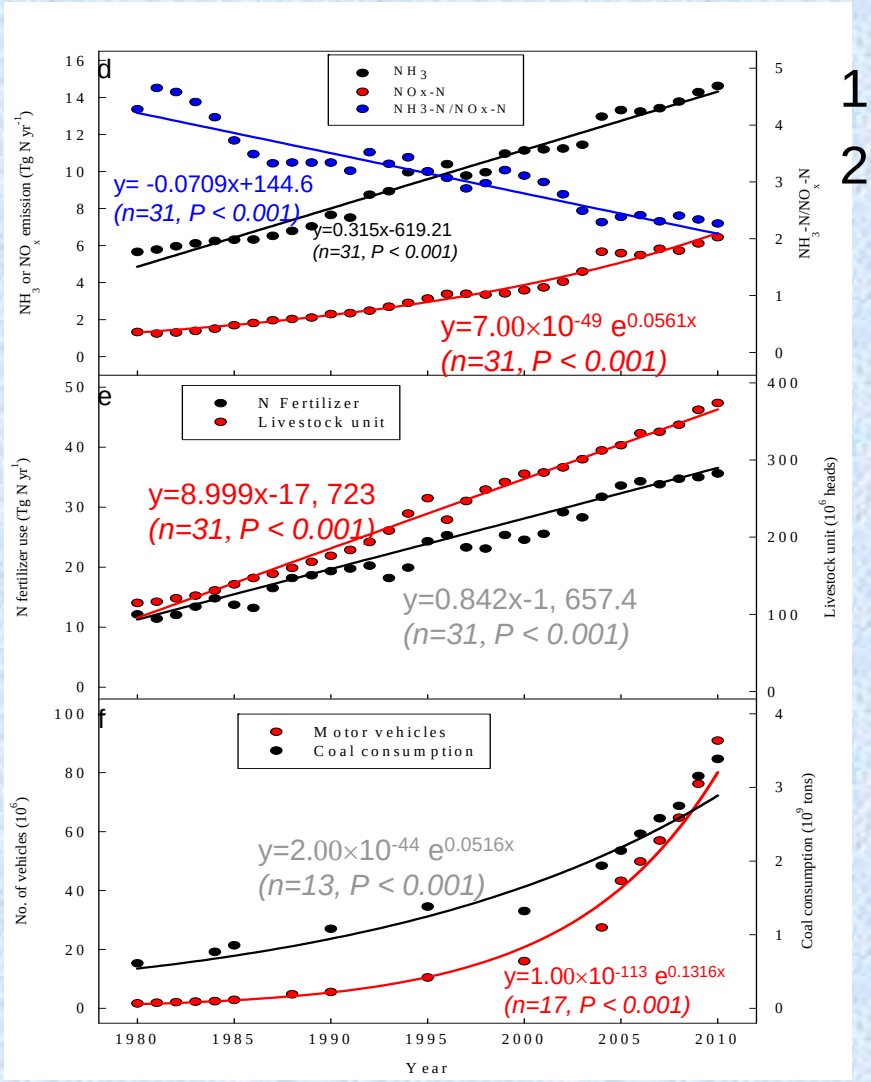
eutrophication

LETTER NATURE *(Liu et al.,2013)*

doi:10.1038/nature11917

Enhanced nitrogen deposition over China

Xuejun Liu[1]*, Ying Zhang[1]*, Wenxuan Han[1], Aohan Tang[1], Jianlin Shen[1], Zhenling Cui[1], Peter Vitousek[2], Jan Willem Erisman[3,4], Keith Goulding[5], Peter Christie[1,6], Andreas Fangmeier[7] & Fusuo Zhang[1]



1980: 13.2 kg N/ha

2000: 21.1 kg N/ha

+60%

Smog in beijing

Nature China20100304 - ACDSee v3.1

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Science

AAAS

Significant Acidification in Major Chinese Croplands

J. H. Guo, *et al.*

Science **327**, 1008 (2010);

DOI: 10.1126/science.1182570

therapy cancer biology

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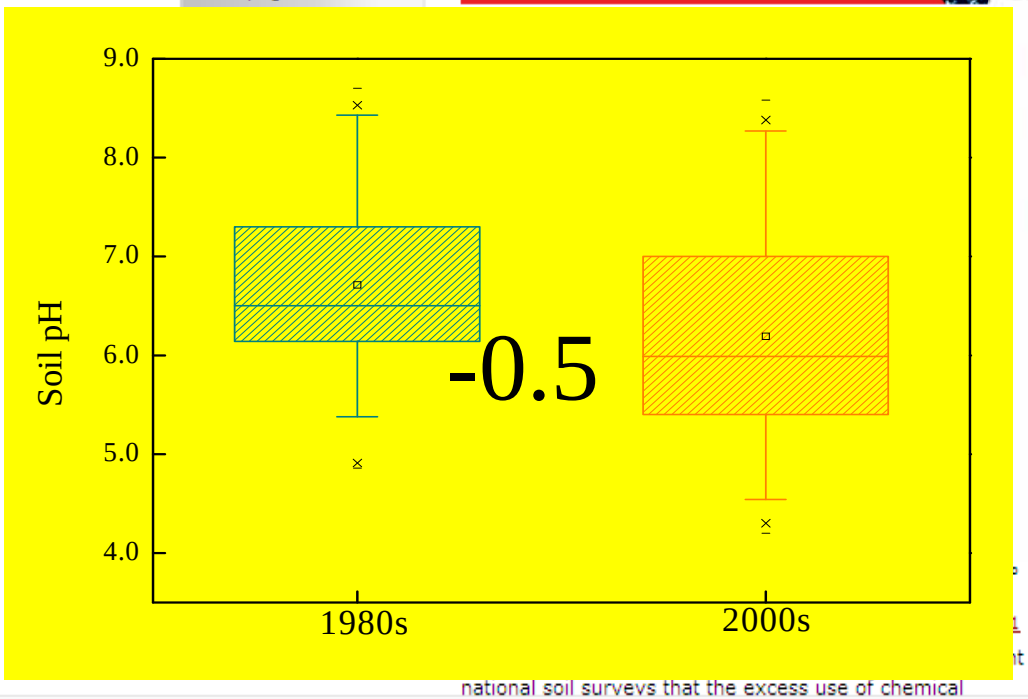
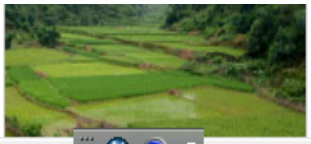


national soil surveys that the excess use of chemical

Significant Acidification in Major Chinese Croplands

J. H. Guo,[1]* X. J. Liu,[1]* Y. Zhang,[1] J. L. Shen,[1] W. X. Han,[1] W. F. Zhang,[1] P. Christie,[1,2] K. W. T. Goulding,[3] P. M. Vitousek,[4] F. S. Zhang[1]†

Soil acidification is a major problem in soils of intensive Chinese agricultural systems. We used two nationwide surveys, paired comparisons in numerous individual sites, and several long-term monitoring-field data sets to evaluate changes in soil acidity. Soil pH declined significantly ($P < 0.001$) from the 1980s to the 2000s in the major Chinese crop-production areas. Processes related to nitrogen cycling released 20 to 221 kilomoles of hydrogen ion (H^+) per hectare per year, and base cations uptake contributed a further 15 to 20 kilomoles of H^+ per hectare per year to soil acidification in four widespread cropping systems. In comparison, acid deposition (0.4 to 2.0 kilomoles of H^+ per hectare per year) made a small contribution to the acidification of agricultural soils across China.



3/10 Nature China20100304 487.0 KB 1263x1386x32b png 100%


Nematode !


Fruit rough bark disease

Controlling fertilizer use will reduce national GHG emission by 2-6%

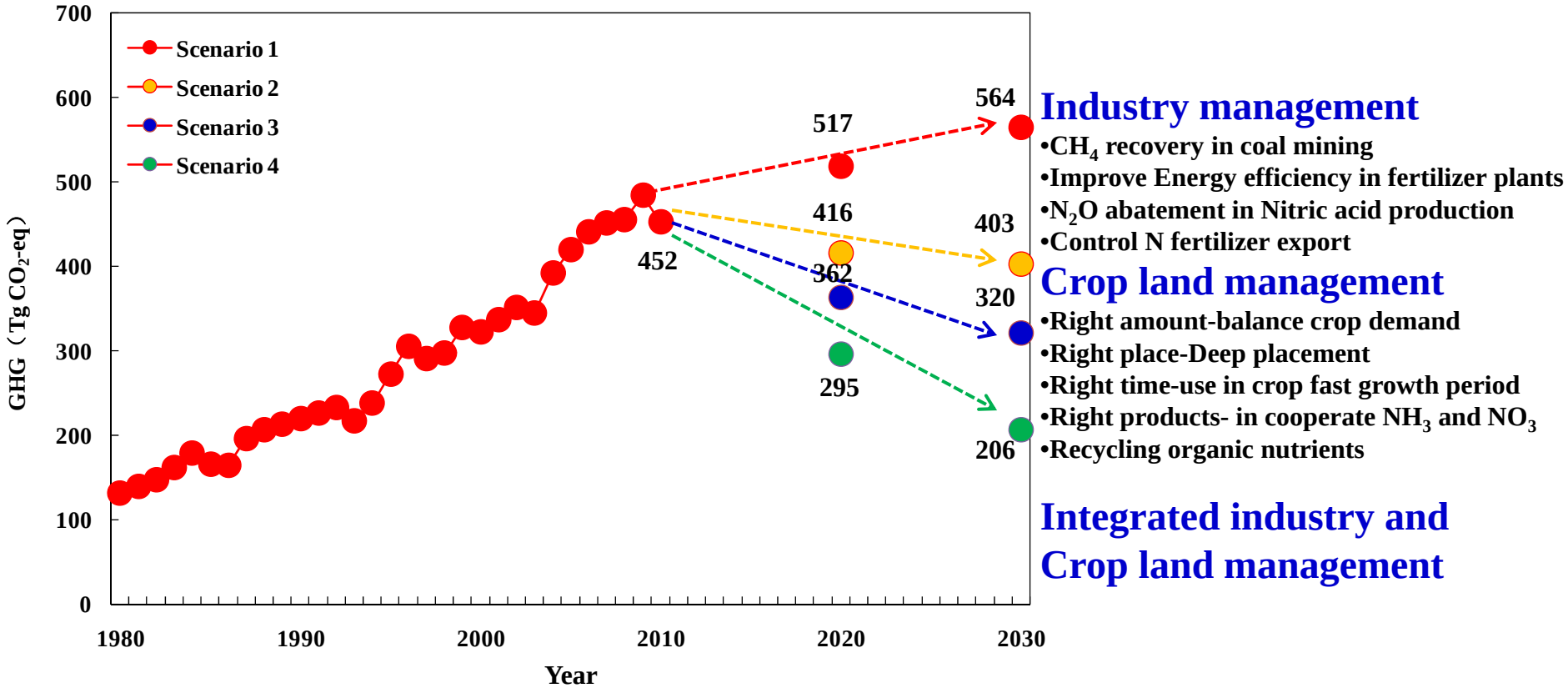
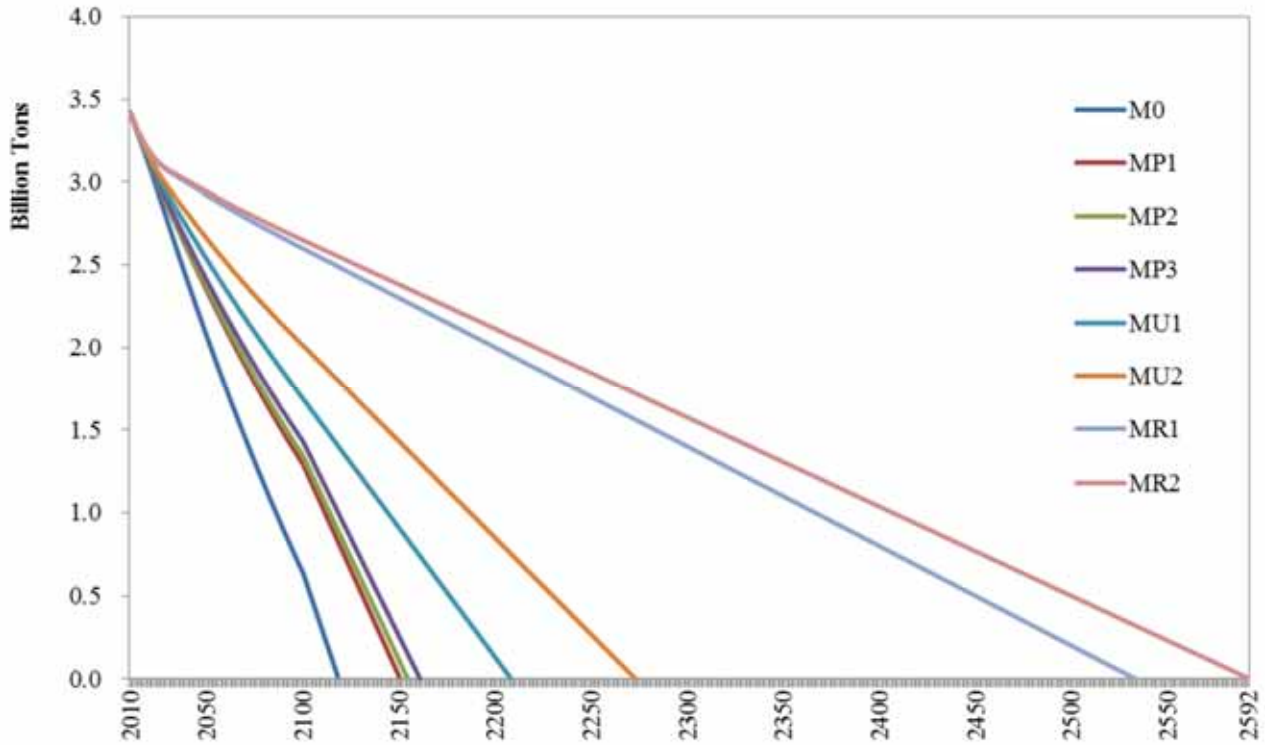


Fig.2. Greenhouse gas emissions associated with the N fertilizer chain in China. Emission amounts for 1980-2010 were calculated using emission factors (see Fig. 1) derived from a 2005 survey and annual N production and consumption records. Emission estimates for 2020 and 2030 consider four scenarios: Scenario 1 business-as-usual; Scenario 2 improved manufacturing technologies; Scenario 3 improved manufacturing technologies plus controlled N use; Scenario 4 improved manufacturing technologies with reduced N use on croplands.

Zhang et al., PNAS，2013

1. Fertilizer production and use in China

Improve whole chain management will prolong phosphorus reserve by 475 years



Scenarios of phosphate rock reserve time

P use efficiency（%）

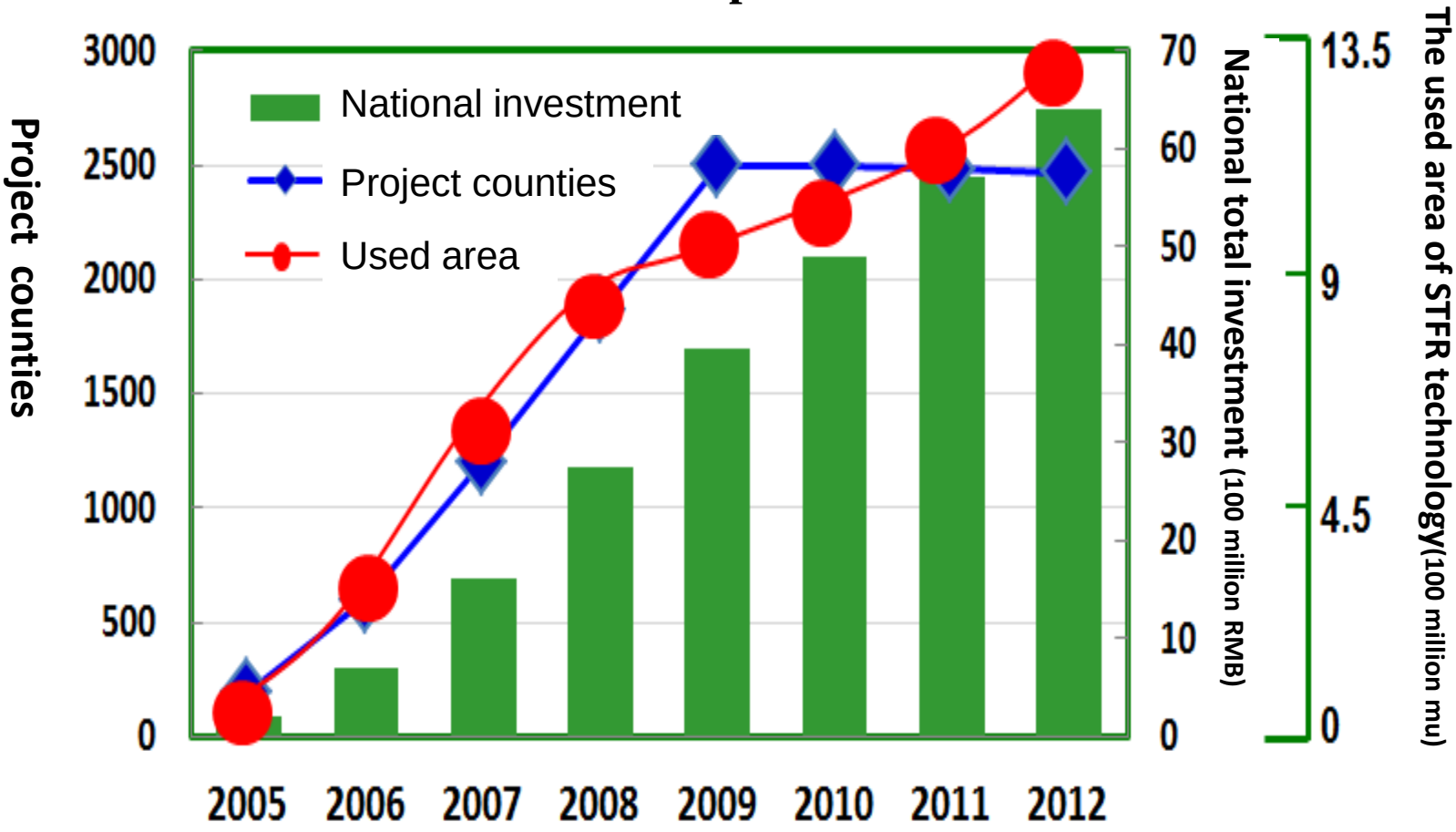
	Current average	Advanced technology
Mining	61	80
Fertilizer production	94	98
Fertilizer use	15	20
Feed use	25	65
Manure recycling	60	90
Sludge recycling	0	75

Huang et la. unpublished

2.Recent changes of technology and policies

National action of nutrient management

In last 9 years, totally 7.1 billion RMB has been invested to cover all agricultural areas (totally 2498 counties). The technology has been used on more than 9 million ha cropland



2.Recent changes of technology and policies

More and more farmers received government services. Adoption rate of various services increased from 22-80% in 2008 to 52-88% in 2013， on average by 21%.

Farmers who got government services （%）		
	2008 (n=1103)	2013 (n=1919)
Farmers who aware of soil testing	80	88
Farmers whose soil has been tested	34	71
Farmers who got the result of soil testing	22	52
Farmers who got recommendation card	52	52
Farmers who got suggestions from consultant	59	81
Farmers who got training	34	63
Farmers who got online service	4	8

2.Recent changes of technology and policies

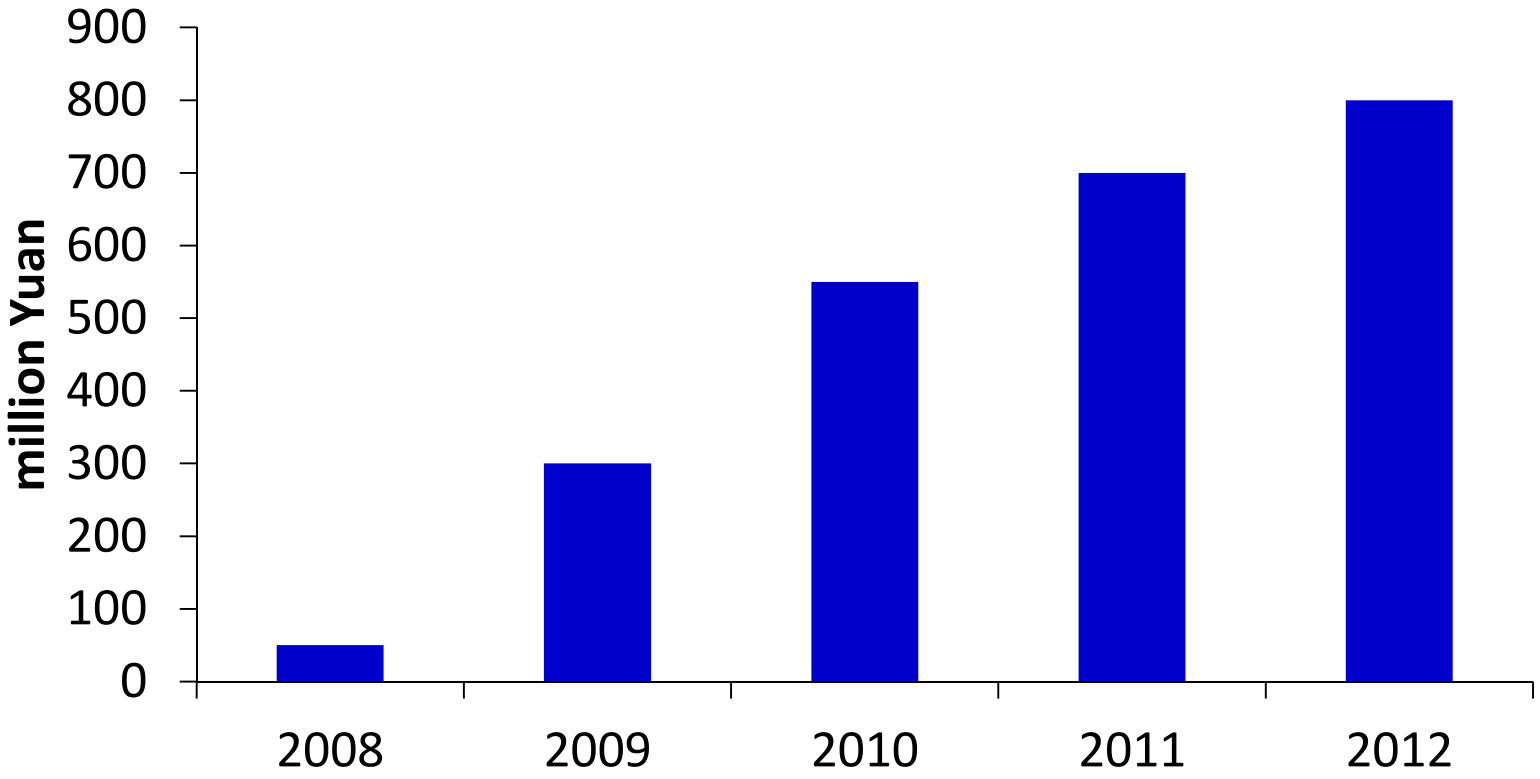
Services significantly improved farmers knowledge and practices

	Farmers who do not known soil testing	Farmers who know soil testing			
		but did not try soil test and train	Only got training	Only tried soil testing	Tried Soil testing and got training
Samples	N=181	N=326	N=201	N=415	N=796
Farmers can recognize NPK labeled on fertilizer bag（%）	19	34	43	46	56
Farmers can judge the nutrient content of fertilizer （%）	30	47	55	54	65
Farmers who can calculate nutrient demand for crop（%）	13	25	27	34	51
Farmers know fertilizer have environment risk(%)	38	52	56	63	73
Farmers with rational N application rate（%）	41	40	42	49	47

2.Recent changes of technology and policies

Subsidies to increase soil organic matter

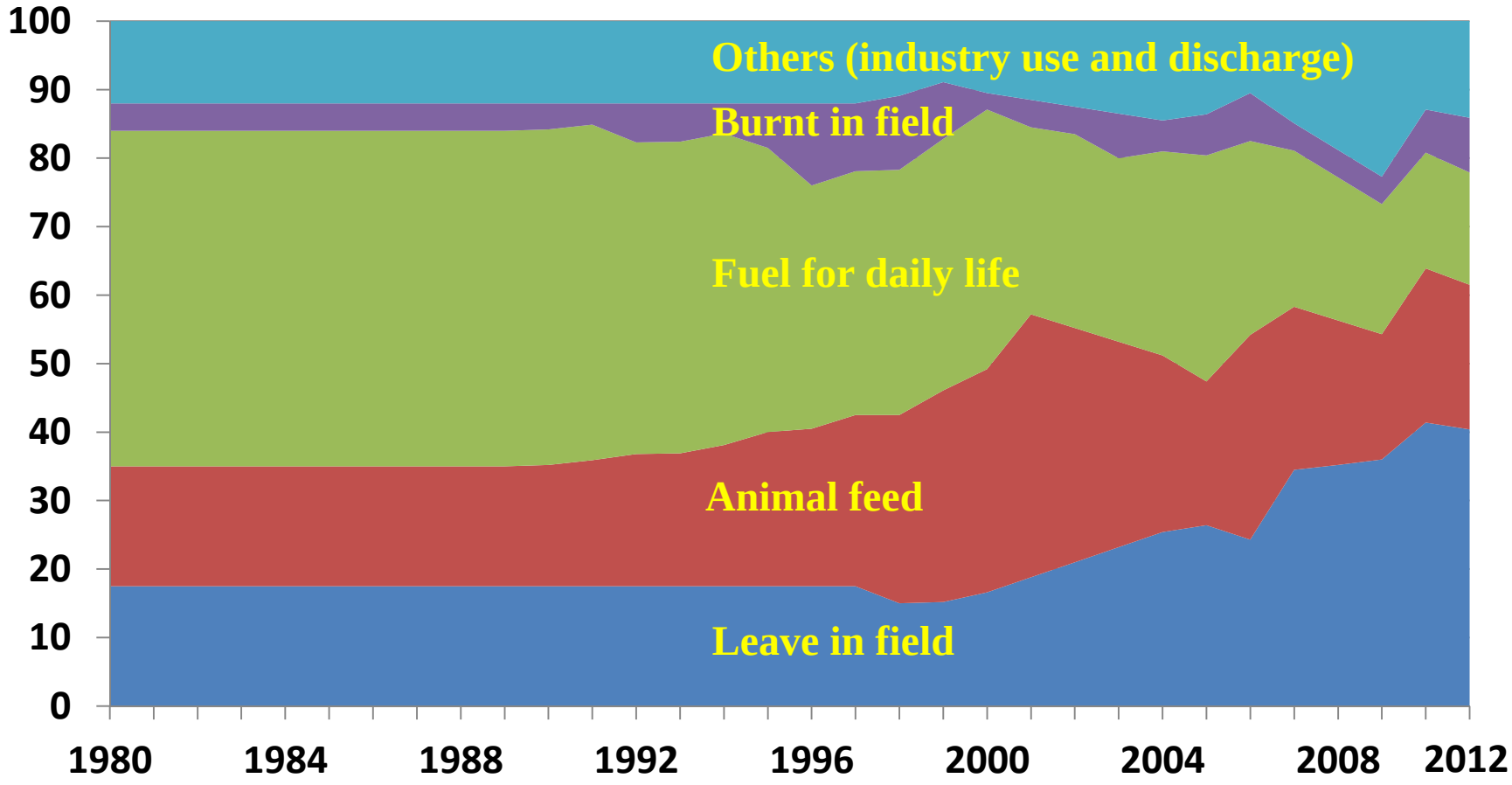
Including: Crop straw , Green fertilizer , Organic fertilizer, Soil remediation, Soil fertility improvement, covered 651 counties



Government investment for soil organic matter improvement

2.Recent changes of technology and policies

Fast development in returning of crop straw into field



Data from published literatures and statistic data from national technologies extension center，2013.

2.Recent changes of technology and policies

Subsidies for foliar application of fertilizers

Special subsidies for foliar application of fertilizer on winter wheat in later growth stage to defend heat\ logging and increase yield.

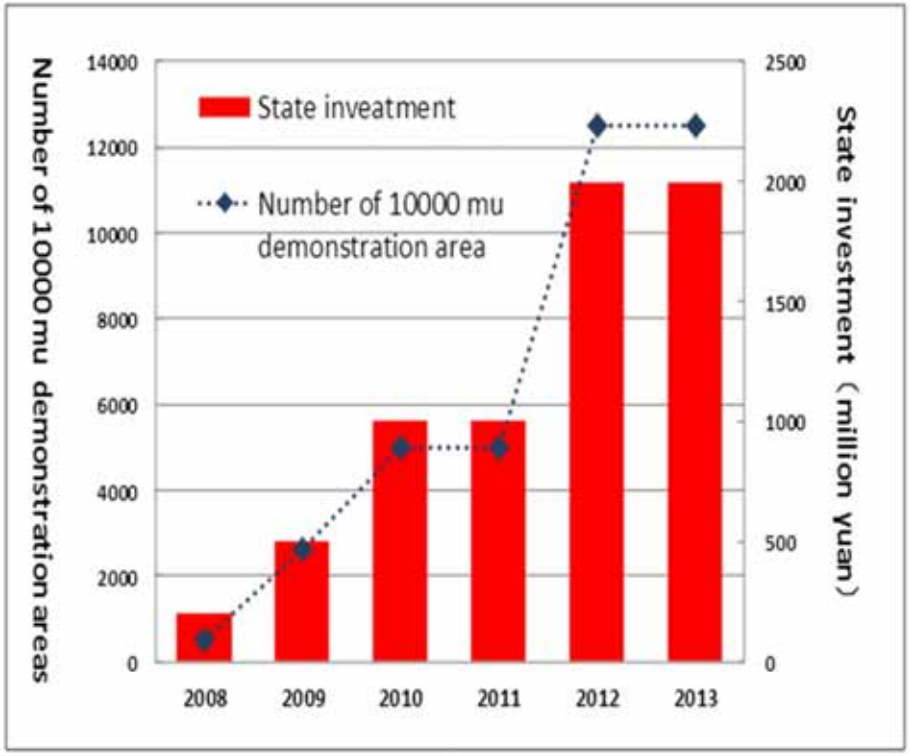
In 2012, 800 million Yuan for winter wheat；
In 2013, 1700 million Yuan for winter wheat;

Photo from Jingyuan Xia

2.Recent changes of technology and policies

National action on high yielding grain, cotton, oil and sugar crop production (since 2008-)

In last 6 years, totally 6.7 billion RMB has been invested to set up 12500 “10000 mu demonstration areas” .



Unit（t/ha）

Crops	Target yield	Farmers’ pratice	Increase rate(%)
Spring maize	12	7.6(1118)	58%
Summer maize	10.5	6.9(1709)	52%
Single rice	10.5	7.9(927)	33%
Double rice	13.5	12.6(1159)	7%
Irrigated wheat	9	6.6(1252)	36%
Dryland wheat	6	3.7(1192)	62%

Note:10000 mu=667 hectare; Farmers’ practice from farmer survey, including 7357 households in 2008-2009.

2.Recent changes of technology and policies

Government encourage farmers cooperatives organization development since 2006.

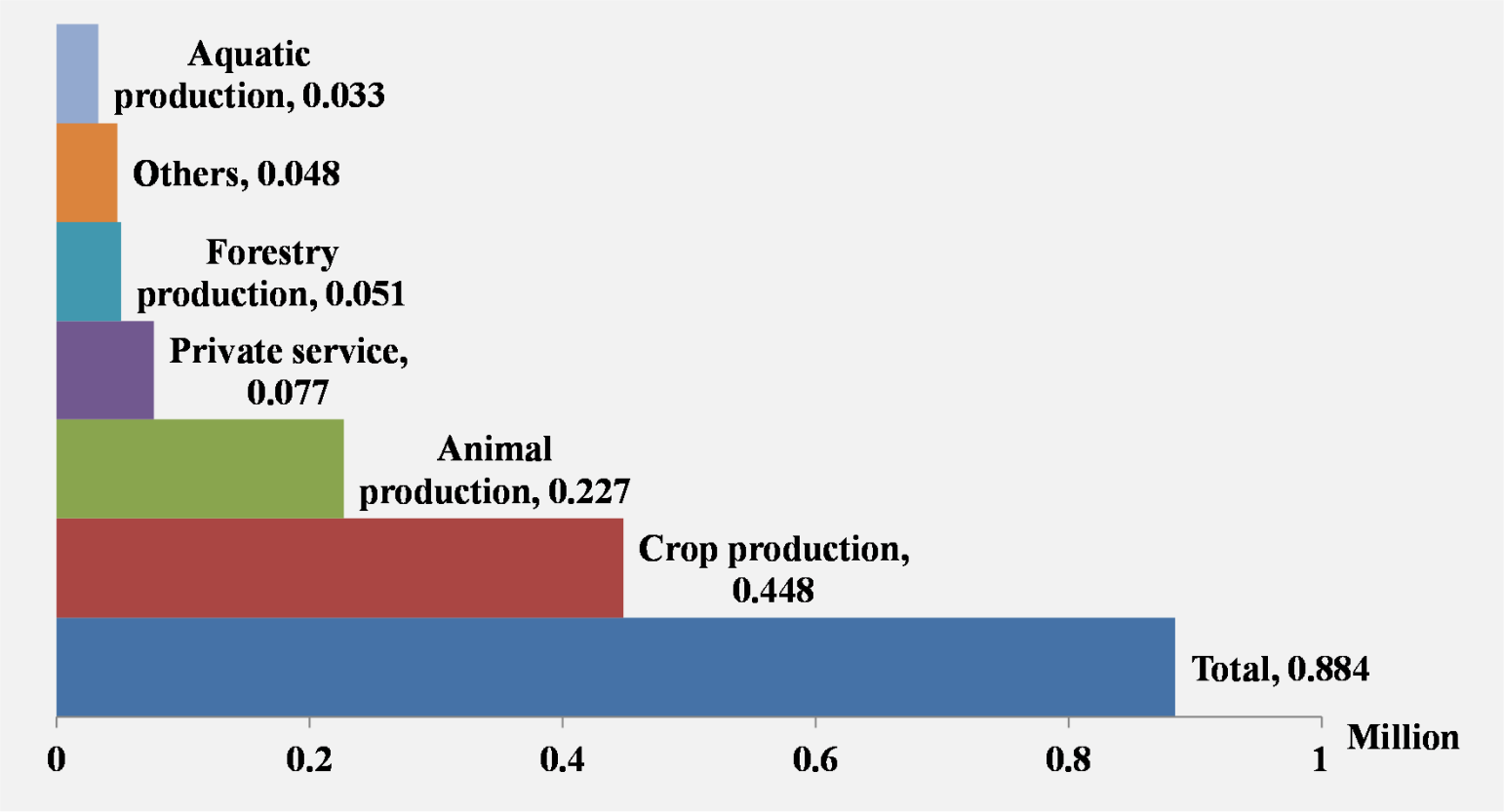
Some regional subsidies have been lunched to push forward ….

Regions	Requirement	Subsidies
Tengzhou, shandong province	>50 mu	100 Yuan/ mu to landlord
	50~100 mu	100 Yuan/ mu to tenant
	100-300mu	200 Yuan/ mu to tenant
	>300 mu	300 Yuan/ mu to tenant
Wuhan, Hubei province	≥1000 mu	50 Yuan/ mu to tenant
Nanning, Guangxi province	≥500 mu	200Yuan/ mu to tenant
Jiaxing, zhejiang province	≥ 100mu, more than 5 year	200Yuan/ mu to tenant
	≥300mu, new farmer cooperatives	20000 Yuan/ household

2.Recent changes of technology and policies

Small subsistence farmers are merging into bigger one

26% of land transferred into 884 thousand farmer cooperatives, 877 thousand family farms, and 2.87 million big farms (>3 ha) in China at the end of 2013

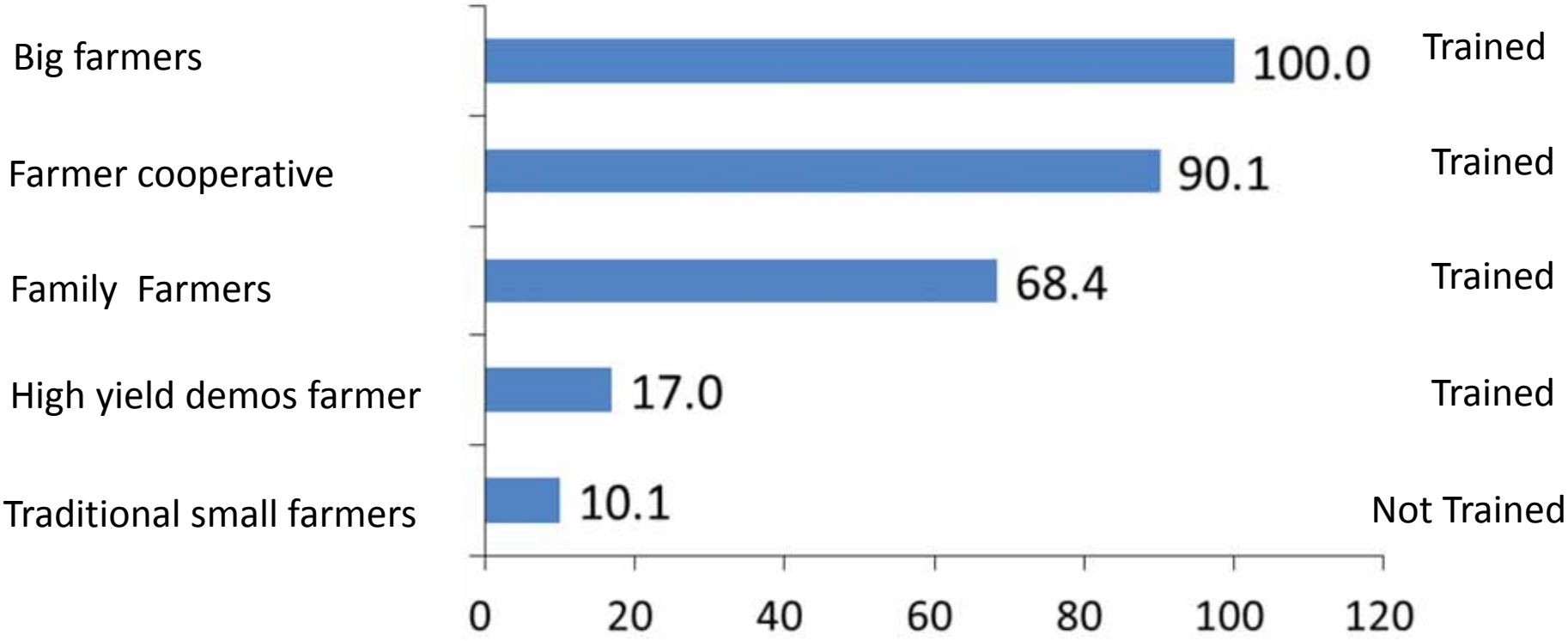


Number of various kinds of farmer cooperatives in China

Source: National Bureau of Statistics of China 2014

2.Recent changes of technology and policies

Enlarging land size and on-time training helps better use of fertilizer.



Adoption rate of precision topdressing during April 1st to 15th

Wang wenke, unpublished

2.Recent changes of technology and policies

Subsidies for machinery related to fertilizer application




Subsidy about 30% of price




Subsidy for well construction, facilities

2.Recent changes of technology and policies


Broadcasting by hand

Fertilizer broadcasting by hand resulted in low use efficiency, over fertilization and environmental risk


Bigger machine sowing and fertilization


Manpower sowing

Labor intensive, lower quality of seeding


Small machine sowing

More seeds applied, but lower quality of seeding.


Bigger machine sowing

High efficiency, less seeds applied, high quality of seeding, and high crop yield.


Seeding stage


Seeding stage

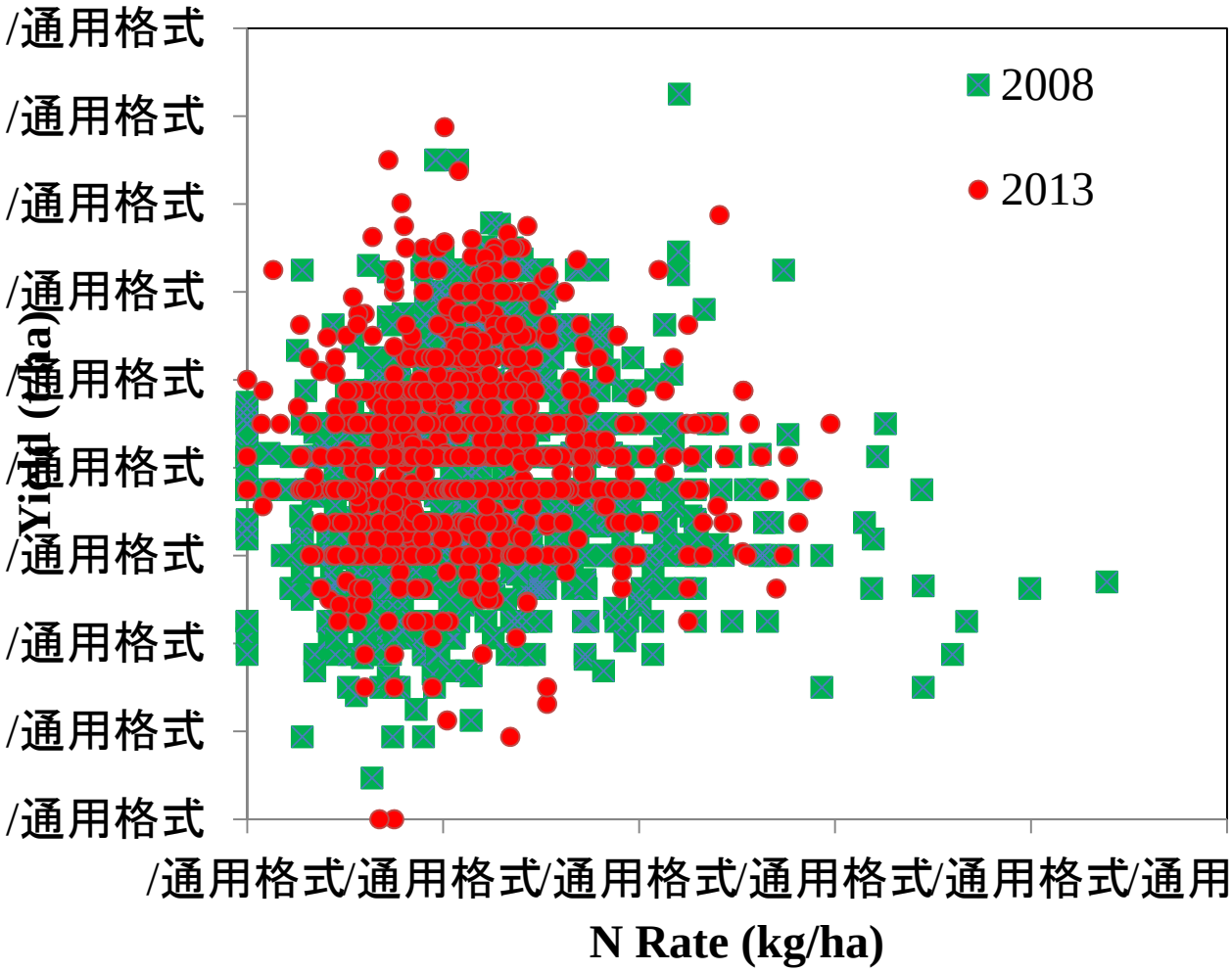
2.Recent changes of technology and policies

Farmers who adopted mechanized application of fertilizer(%)

	2008(n=1152)			2013(n=2112)		
Crops	Starter fertilizer	Basal fertilizer	Top dressing	Starter fertilizer	Basal fertilizer	Top dressing
Spring maize	0	55	0	100	65	2
Winter wheat	70	3	1	100	36	5
Sumer maize	80	3	0	100	62	11
Single rice	0	2	0	0	4	1
Early rice	0	0	0	0	3	0
Later rice	0	0	0	0	3	0
Average of grain	34	12	1	65	35	4

2.Recent changes of technology and policies

Variation of fertilizer application rate among farmers has been reduced significantly



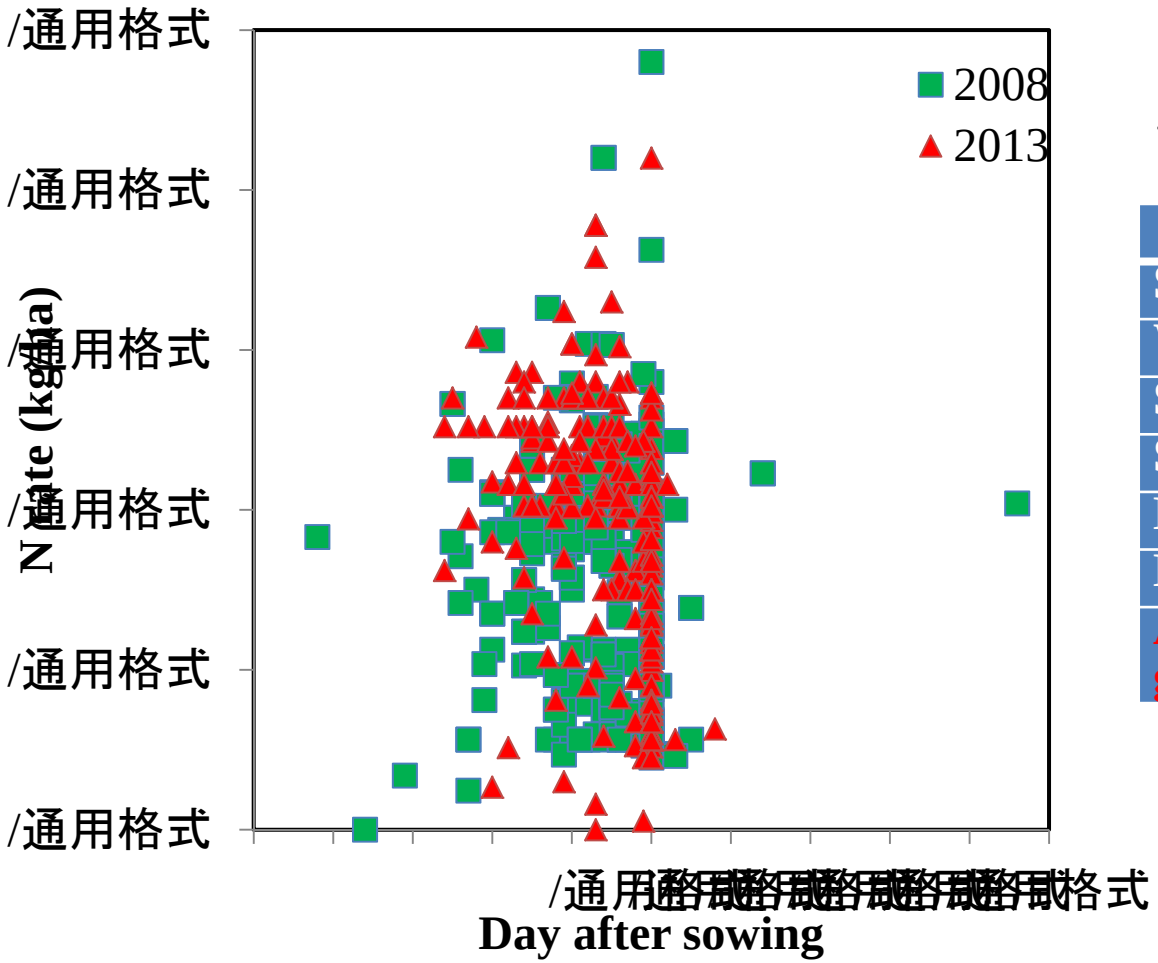
The coefficient of variation of nutrient input at County level between 2008 and 2013

N
42% to 35%
P
65% to 58%
K
99% to 81%

N application rate on maize in monitoring crop land in 2008 (n=1212) and 2013 (n=980)

2.Recent changes of technology and policies

Variation of fertilizer application time among farmers has been reduced significantly



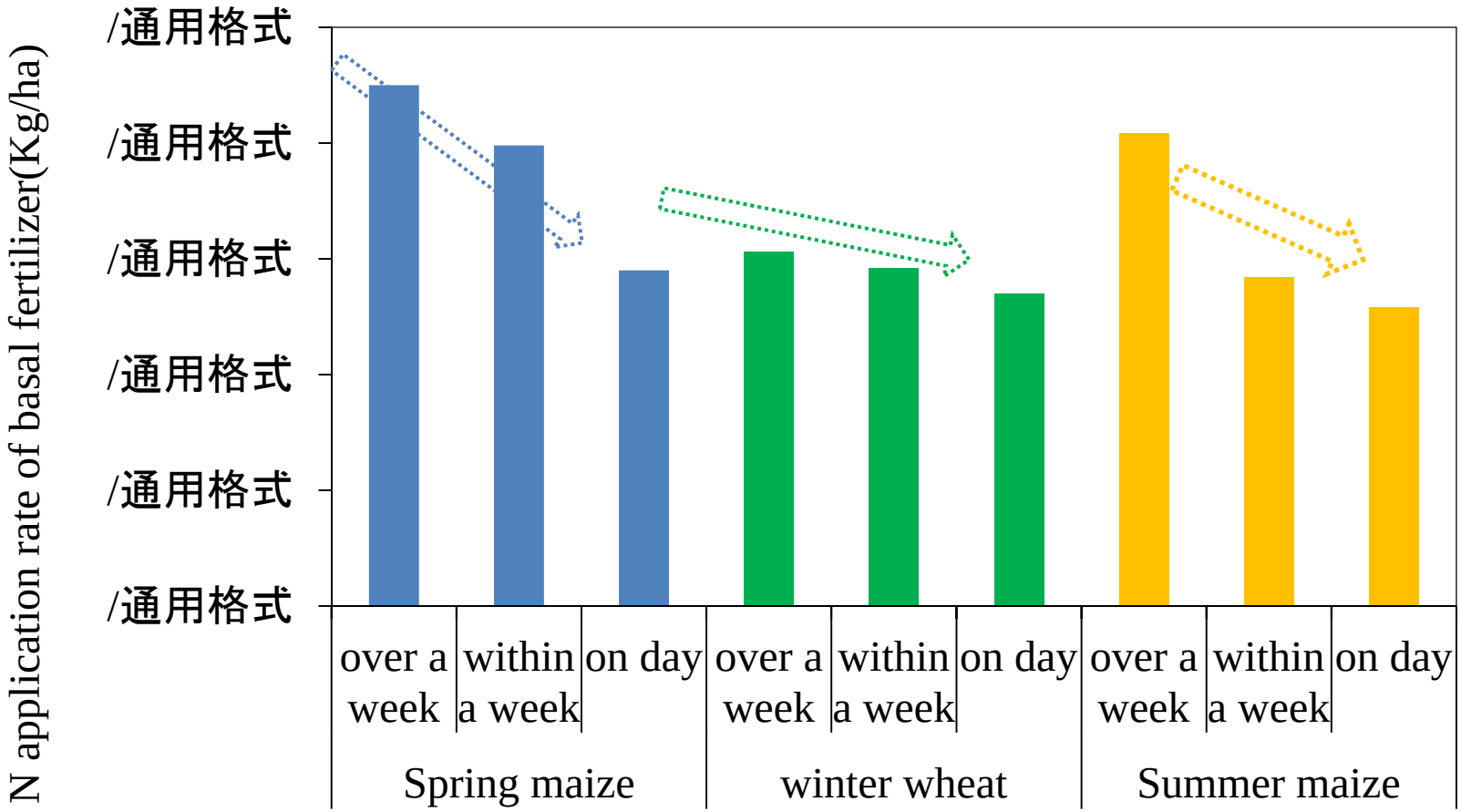
Farmers who are sowing and fertilizing within one day (%)

Crops	2008	2013
Spring maize	47	44
Winter wheat	55	62
Sumer maize	40	68
Single rice	38	46
Early rice	30	42
Later rice	26	38
Average of grain	43	53

Notes: The day after seeding below 0 means fertilization before seeding. The figure shows the relationship between N rate and the first base fertilizer time.

2.Recent changes of technology and policies

Usage of fertilizer too early than crop sowing resulted in too much of fertilizer input

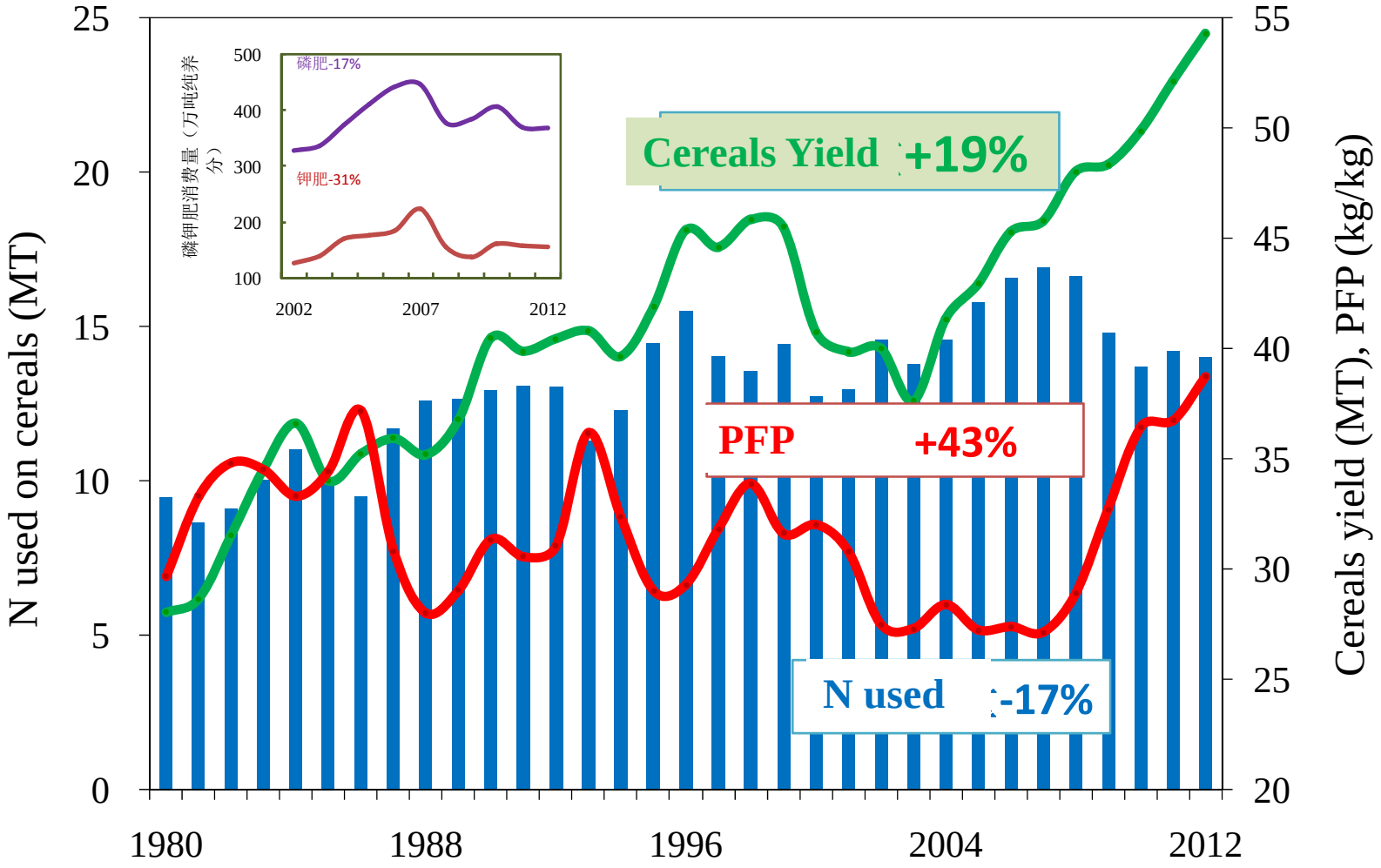


The difference of N application rate when farm use it on different time

2.Recent changes of technology and policies

Enhanced fertilizer use efficiency on grain crops

During 2007-2012, cereals yield increased by 19% while N, P_2O_5, K_2O application rate decreased by 17%、17%、31%，PFP_N increased by 43%



Zhang et al.,2013《national fertilizer development report, 2012》

2.Recent changes of technology and policies

Enhanced fertilizer use efficiency on grain crops

There is small increase of AE on N but high increase on P and K

Changes of agronomy efficiency of fertilizer on main grain crops

	Crop	2000-2005			2006-2010		
		Application rate (kg/hm²)	Yield (T/hm²)	AE (kg/kg)	Application rate (kg/hm²)	Yield (T/hm²)	AE (kg/kg)
Nitrogen	Rice	149	6.8	10.4	170	8.0	12.7
	Wheat	170	5.7	8.0	179	6.3	10.7
	Maize	163	7.0	9.8	183	8.8	11.9
Phosphate	Rice	72	5.9	7.4	61	7.1	23.3
	Wheat	95	4.7	8.1	95	5.8	15.1
	Maize	116	7.7	9.1	83	8.6	17.4
Potash	Rice	106	5.9	4.9	88	7.2	16.5
	Wheat	136	5.3	4.5	90	5.9	14.1
	Maize	126	7.6	4.4	83	7.7	12.4

Zhang et al.,2013《national fertilizer development report, 2012》

2.Recent changes of technology and policies

Enhanced fertilizer use efficiency on grain crops

There is small increase of RE on N and K, but high increase on P

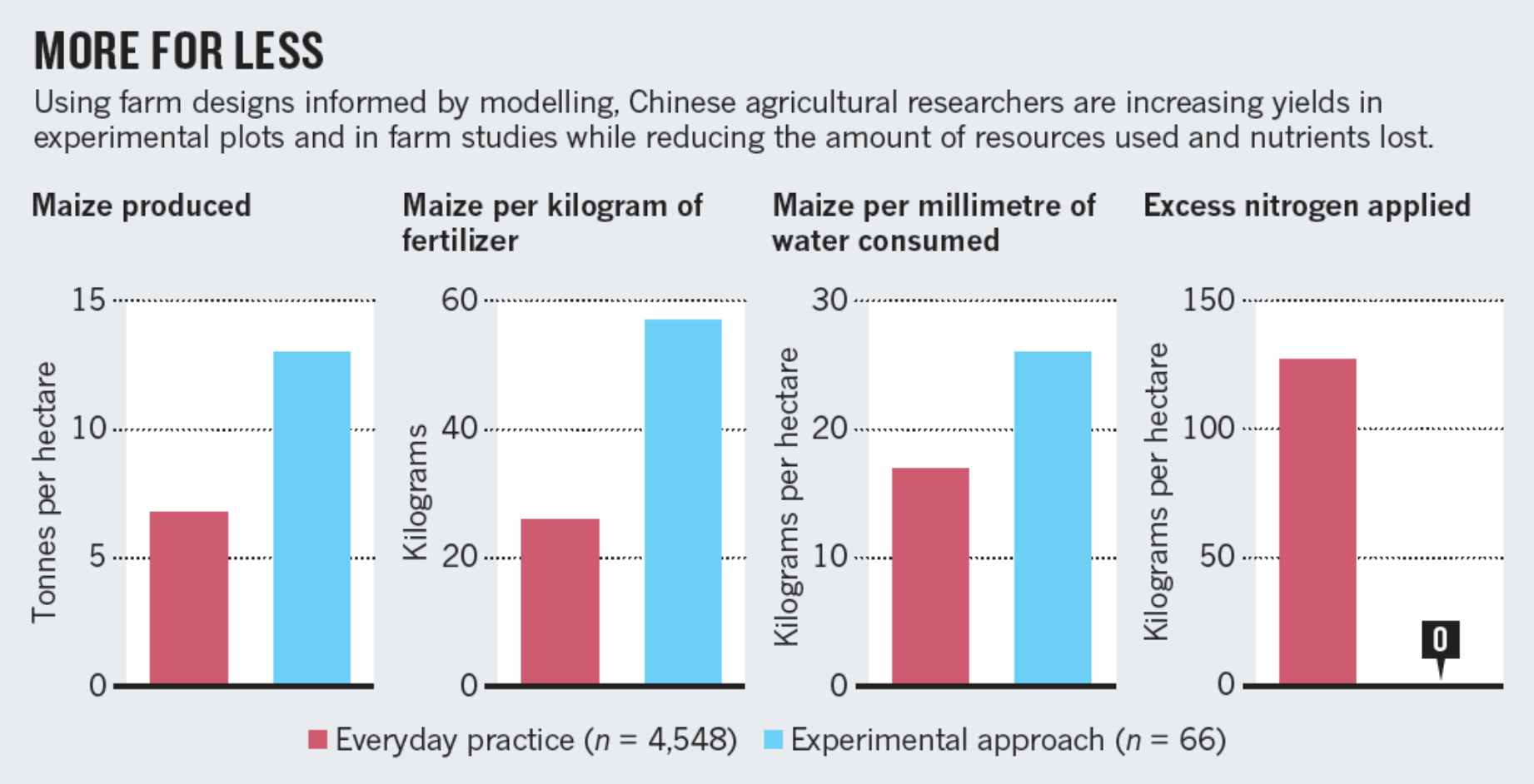
Recovery efficiency of fertilizer on main cereals crops

Period	Crops	Fertilizer use efficiency（RE, %）			Source
		Nitrogen	phosphate	Potash	
2011-2012	Wheat	32.0	19.2	44.4	MOA
	Maize	32.0	25.0	42.8	
	Rice	34.9	24.6	41.1	
2001-2005	Wheat	28.2	10.7	30.3	Fusuo Zhang.,2008
	Maize	26.1	11.0	31.9	
	Rice	28.3	13.1	32.4	
2002-2005	Wheat, maize, rice	28.7	13.1	27.3	Academy of agriculture science，2008
1981-1983	Wheat, maize, rice	30-35	15-20	35-50	Zhu, 2002

Zhang et al.,2013《national fertilizer development report, 2012》

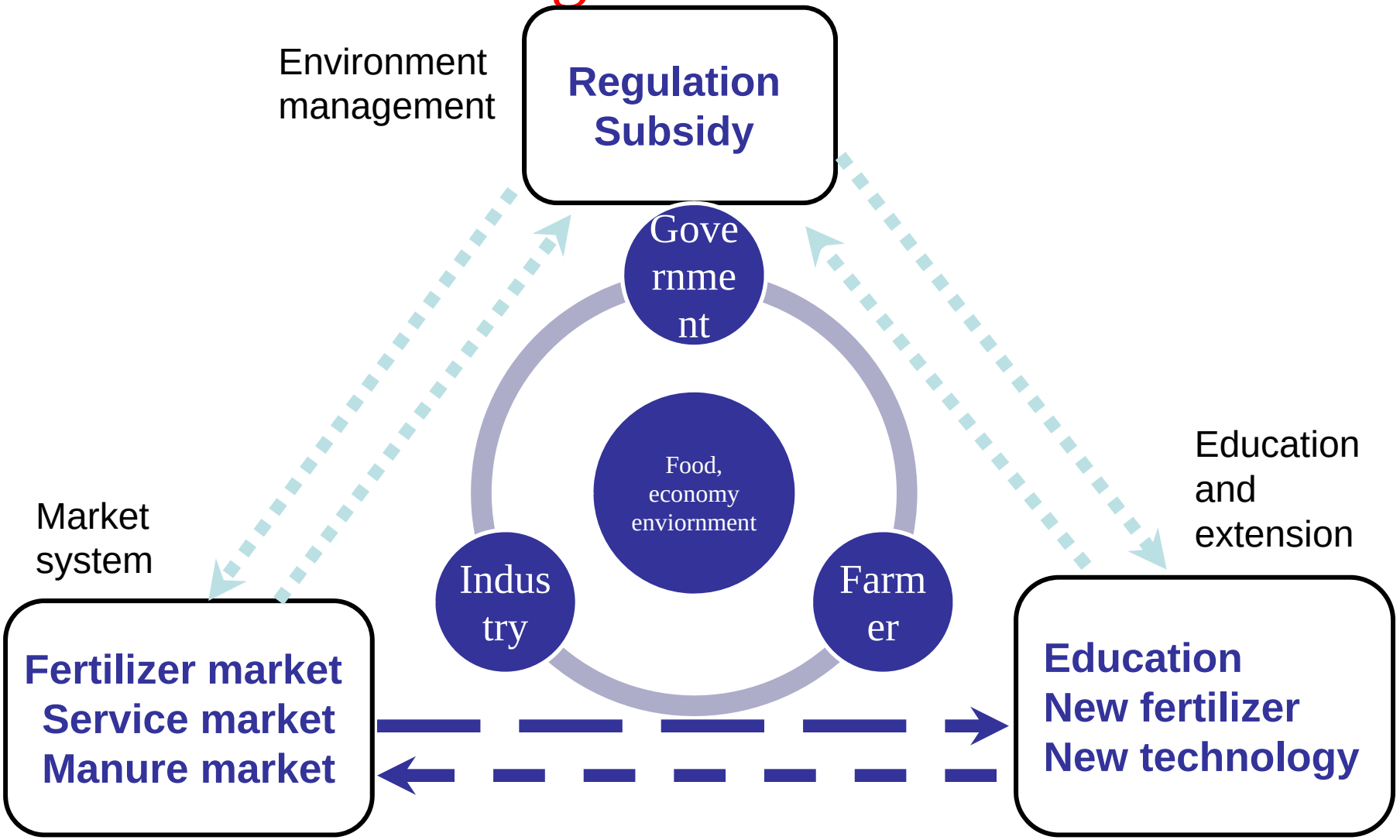
3. Challenges and perspective

We have a big potential and possibility to increase crop production, resources use efficiency with low environmental risk, but how to realize it at national scale?



3. Challenges and perspective

It is a big challenge to build up an integrated nutrient management scheme in China



3. Challenges and perspective

Market reform should supported by strong legislation and better service.

Why farmers test fertilizer by mouth?

① **No fertilizer law to standardize fertilizer quality.**

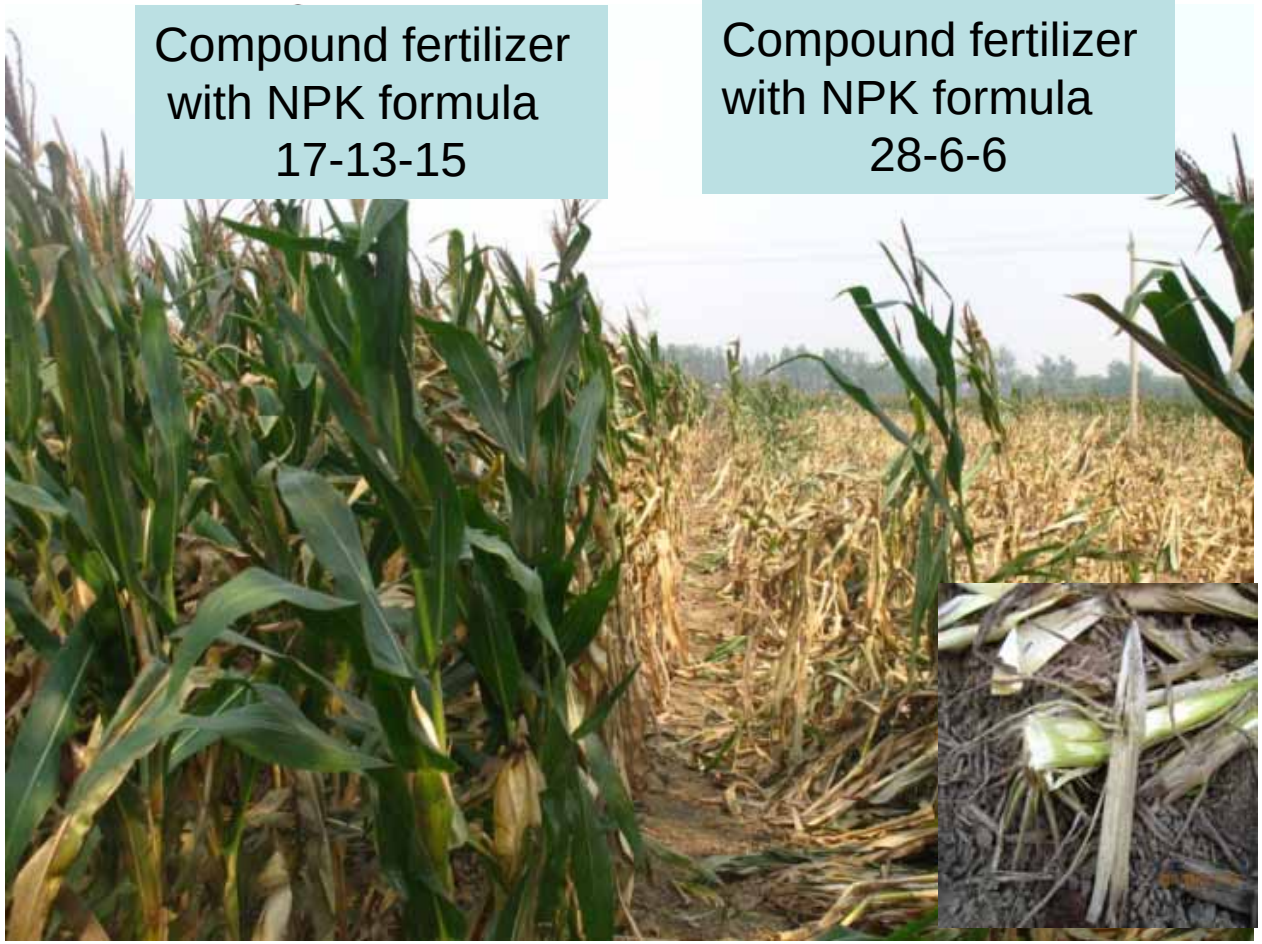
② **Farmers' knowledge is not enough to find other ways to distinguish true products.**

③ **No government services are available till date.**

3. Challenges and perspective

Wrong products with wrong application method resulted in 20% more fertilizer input with no increase in crop yield.

Better cooperation between fertilizer industry and agriculture is emergent required for food security and environmental safety .

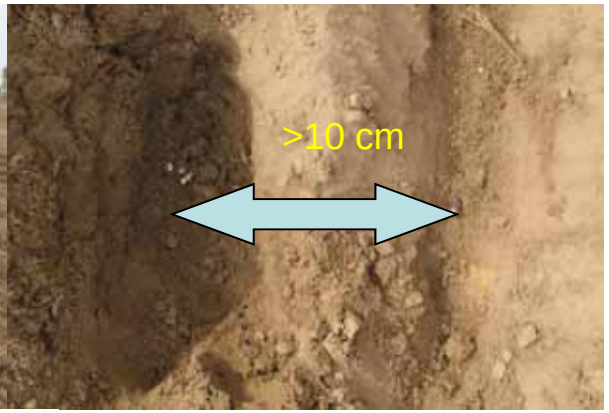


(photo from Anhui, 2011)

3. Challenges and perspective

Integrated innovation of machines, fertilizer products, and crop management are required to improve NUE in mechanized fertilization practice.

- Poor land preparation
- Machine did not match crop production system
- Fertilizer is easy to stick and block the pipe
- Machines are expensive for small farmers
- Farmers do not like to spend time on top dressing




The Last Food Mile Conference

Reducing Post-Harvest Food Wastage, Building a Sustainable Food System

December 8-9, 2014 Philadelphia

Scale of the Problem

- **Wasted food squanders resources** - land, water, energy, nutrients, biodiversity, resulting in pollution and increased food costs
- **49 million** Americans are food-insecure, including 16 million children

https://urbantimes.co/2014/06/food-waste-facts/

FOOD WASTED

31% available food ends up in the trash

FINANCIAL COST

$161 billion retail value for the annual food loss

ENVIRONMENTAL BURDEN

17 million tonnes CO_2 produced from wasted food, equivalent to CO_2 generated by 20% of cars in America

http://www.vet.upenn.edu/last-food-mile-conference/

Along the Supply Chain

Acknowledgments

MOA

谢 谢 ！

Plant Nutrition
CAU, Beijing, China