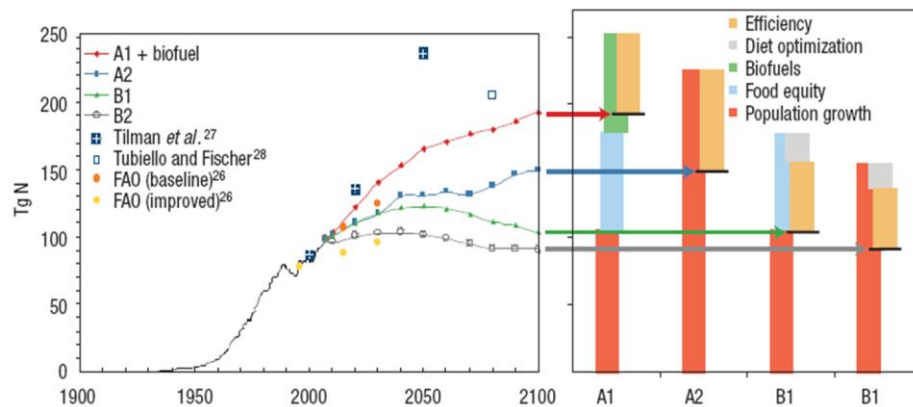


Fertilizer use by crops and outlook for fertilizer demand in China

Weifeng Zhang, Fusuo Zhang
Gaoqiang Huang, Liang Wu, Yuxuan Li
China Agricultural University

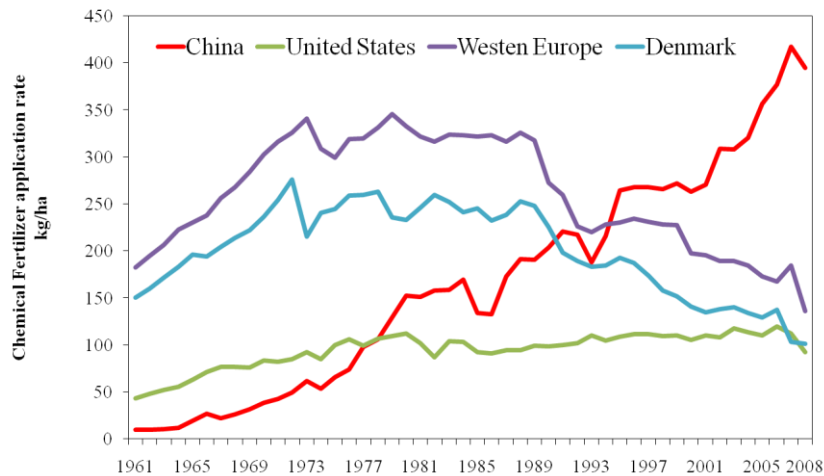
World fertilizer demand have very high uncertainty



Global nitrogen fertilizer consumption scenarios (left) and the impact of individual drivers on 2100 consumption (right).

(Erisman, 2008, Nature Geoscience)

Regional fertilizer consumption show different trends



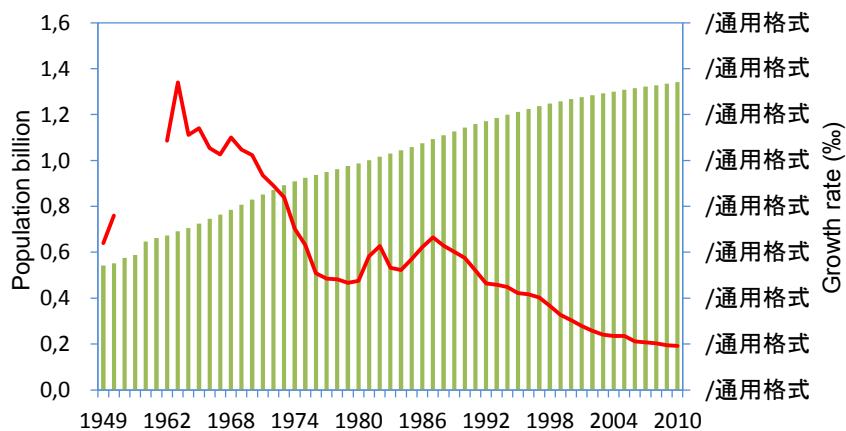
Gaoqiang Huang, unpublished results

Outline

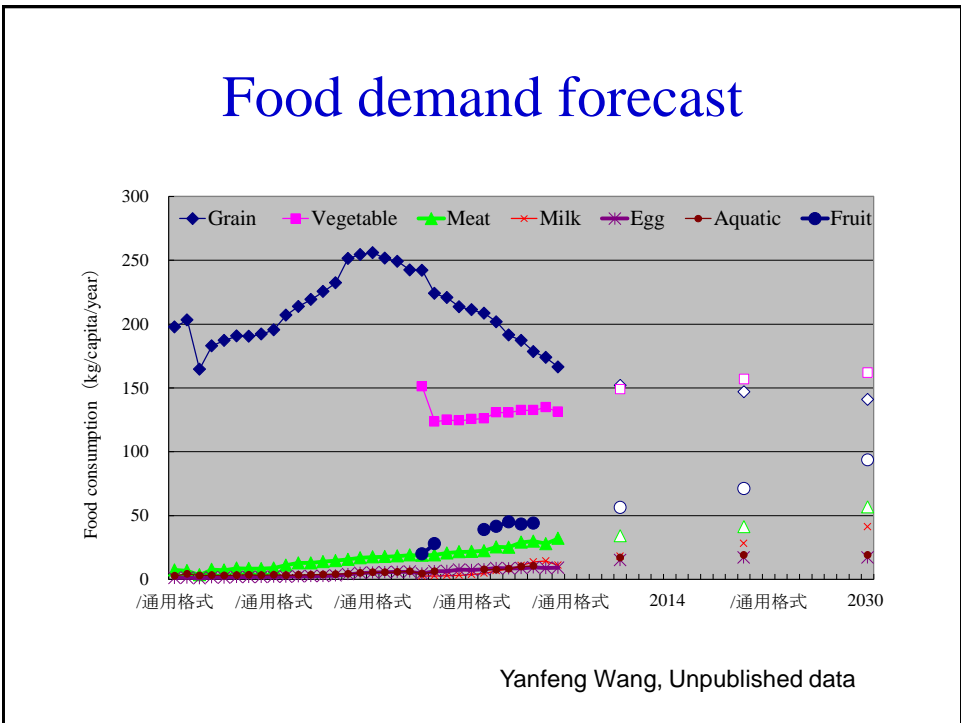
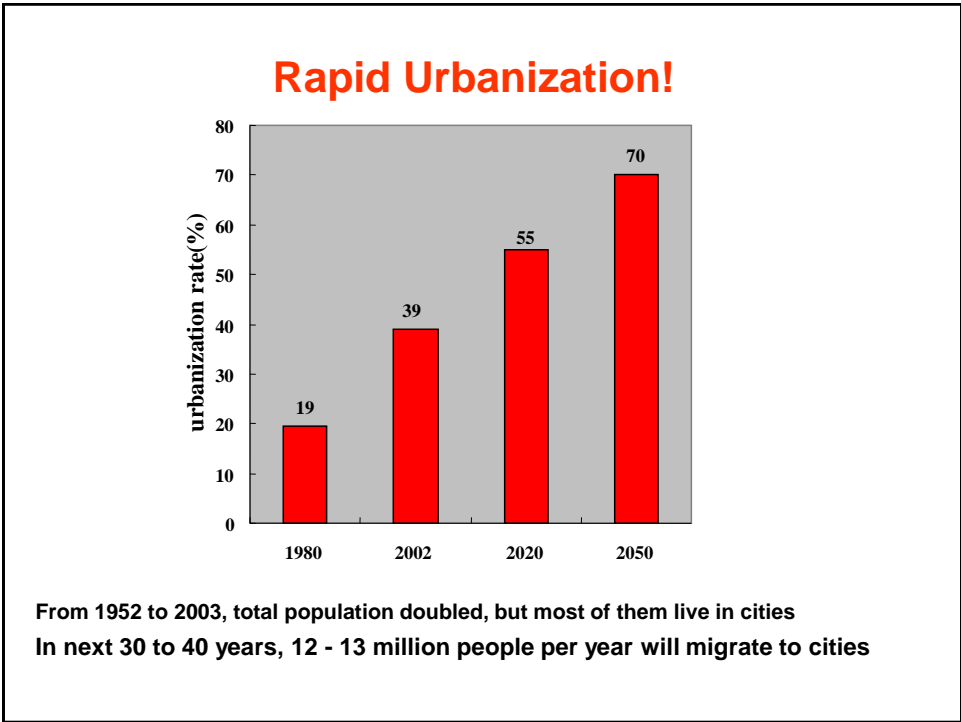
- Challenge for fertilizer development
- Long term fertilizer forecast
- Short term fertilizer forecast

1. Challenges for fertilizer in China

Population increased, but growth rate decreased very fast



Data from China statistic year book



Resources crisis

	Electricity (Million Kwh)	Coal (million t)	Natural gas (Million m3)	Phosphate rock (Mt, 30%P ₂ O ₅)	Sulfur (Mt)	Potash (Mt K ₂ O)
Consumed by fertilizer	6469	42.336	10960	67.3936	15.60	4.12
Share in total consumption	3%	55%	30%	85%	80%	90%
Situation of China's resources	Restrict to use for N fertilizer industry	High quality coal insufficient	Stop increase supply for N industry	2015 have to use low grade rock	56% relay on import	45% relay on import

Tremendous Environmental problems related to nutrients in China

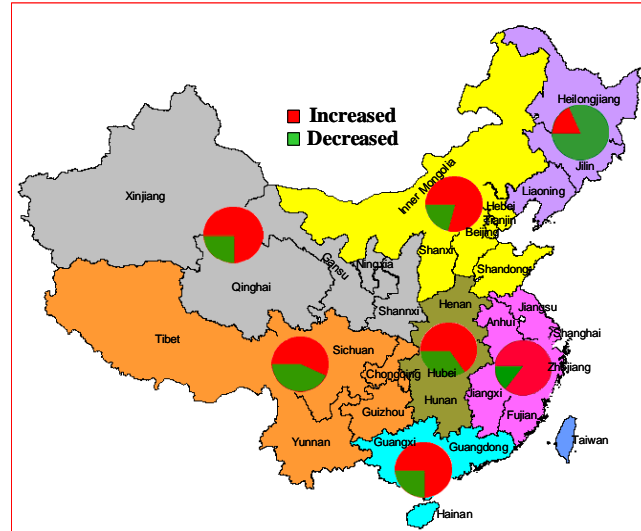
Environmental issue	Status	Contribution from fertilizer	Data source
Water pollution	60% lake got eutrophication	57-67%	National environmental protection bureau, 2010
Soil acidification	Soil Ph decreased by 0.5 from 1980s to 2000s	60%	Guo, et al.2010
Green house gases emission	7000 million tons	6-8%	FCO project

2. Long term forecast for fertilizer demand in China

Factors affecting long term forecast

- Chemical Fertilizer demand=
 - Population
 - Food demand
 - Nutrient uptake by crop
 - Nutrient came from fertilizer
 - Nutrient use efficiency

Soil organic carbon increased significantly in 60% cropping land



Changes of soil organic carbon from 1980 to 2000

(Huang et al., 2006)

Increased soil fertility helps to get high yield with same amount of fertilizer input

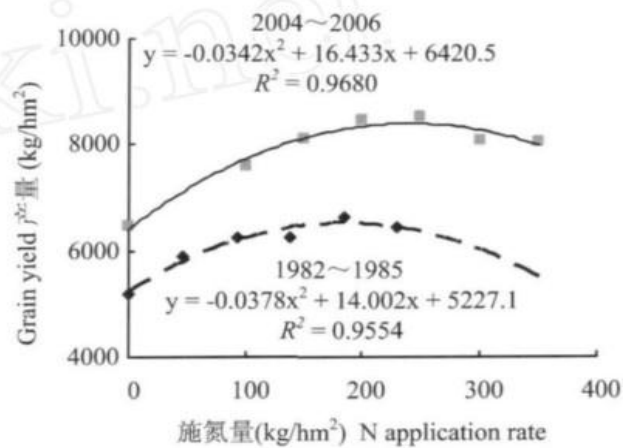
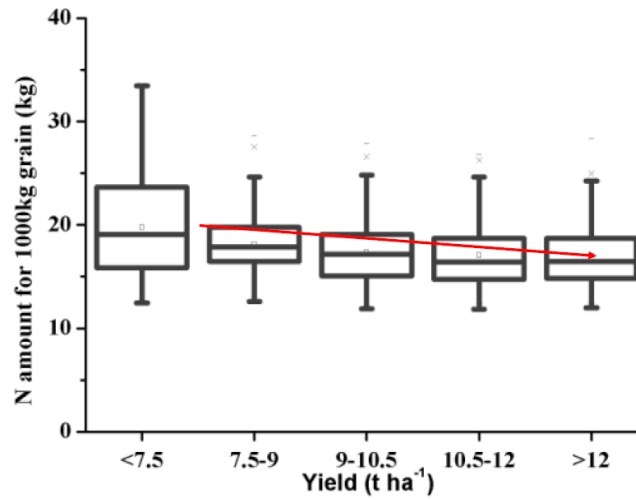


图1 水稻产量-施氮量反应曲线的历史比较

Zhaoliang Zhu, 2010

The N amount needed to produce 1 t maize grain



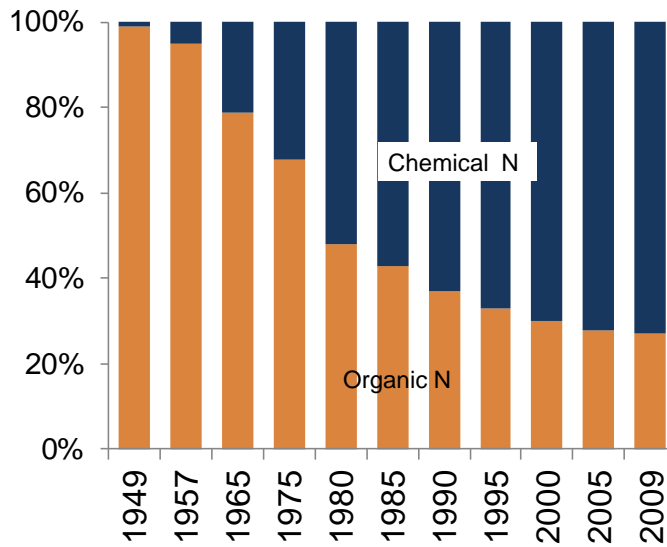
(Hou et al., 2011, in preparation)

Nutrient uptake per 100kg grains in different period in China (kg)

作物Crop	N	P ₂ O ₅	K ₂ O	时期Period	文献量Amount of reference
水稻 Rice	1.68	1.39	2.02	1979~1990	5
	2.00	0.98	3.22	1995~1999	19
	1.88	0.86	2.25	2000~2006	40
玉米 Maize	3.81	1.27	3.68	1935	1
	2.73	1.02	2.62	1979~1989	39
	2.29	0.66	2.55	1990~1999	18
	2.30	0.66	2.18	2000~2006	23
小麦 Wheat	3.25	1.16	3.02	1979~1983	6
	3.23	0.86	3.54	1990~1999	5
	2.78	0.73	3.00	2000~2006	34
棉花(皮棉) Cotton	11.48	1.98	9.75	1970~1979	3
	14.82	4.83	17.03	1990~1999	17
	10.1	1.8	4.2	2000~2002	3

Yanfeng Wang, unpublished data

N sources in Chinese crop land



Lin Ma et al, unpublished data

Agronomic efficiency

		1980s	1990-1999	2000-2005	2006-2010
Wheat	AE	10	9	8	10
	N (kg/ha)	59	210	153	220
	Samples	1462	108	704	262
Maize	AE	13	9	10	12
	N (kg/ha)	62.3	215	164	209
	Samples	728	52	442	154
rice	AE	9.1	11	11	14
	N (kg/ha)	63	202	196	179
	Samples	896	36	218	89

Guiliang Wang, unpublished data

Fertilizer recovery

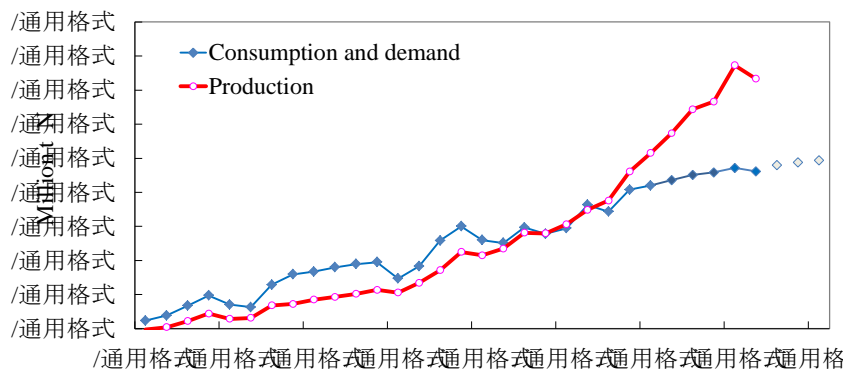
Year	N	P ₂ O ₅	K ₂ O	sources
1992	28% ~ 41%			Zhaoliang Zhu
1998	30% ~ 35%	15% ~ 20%	35% ~ 50%	zhaoliang Zhu
1997-2003	27.5%	11.6%	31.3%	F.S Zhang

N fertilizer demand and supply balance

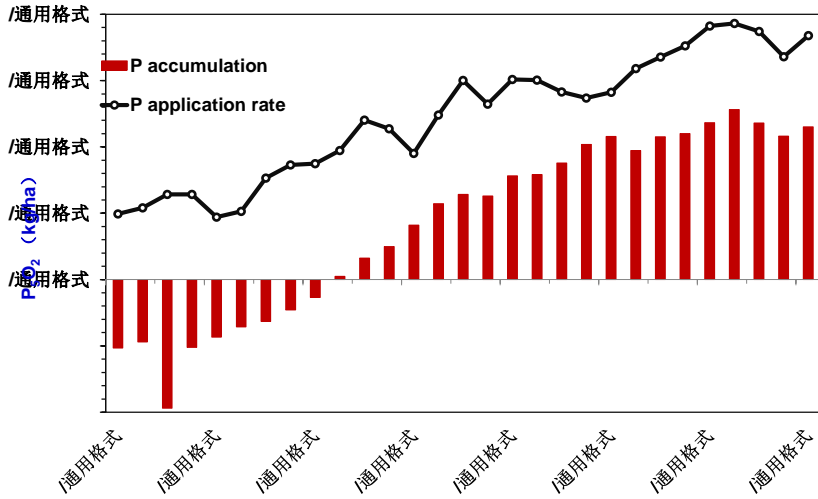
680 million ton of N fertilizer have been input into crop land of China since 1949;

Currently, surplus N in soil and environment is 167kg/ha which is 62% of annual chemical N fertilizer input.

To keep the balance, 12.5 million ton N is need in China

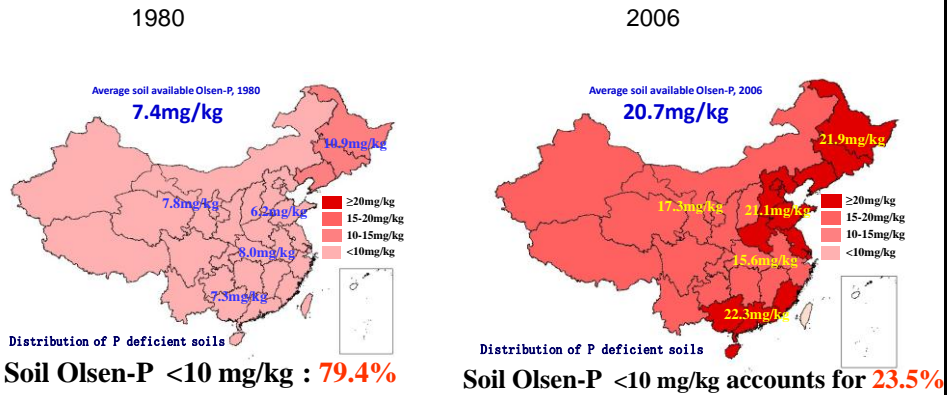


High input leads to large amount of P accumulation



P application rate is increased by 5% per year.
 85 million tones of P₂O₅ have been accumulated in soil since 1980

Soil phosphate content changed significantly

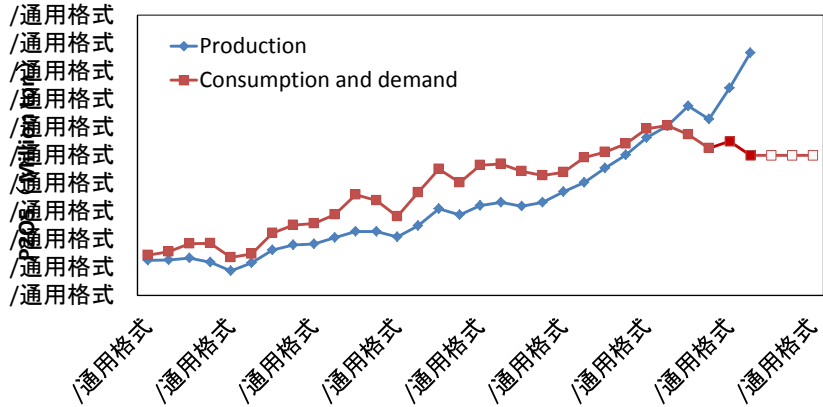


Li et al., JEQ, 2011

fertilizer demand and supply balance

Keep soil Olsen-P as 20mg/kg, 10 million ton P₂O₅

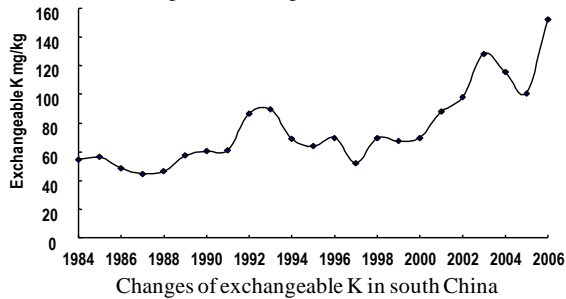
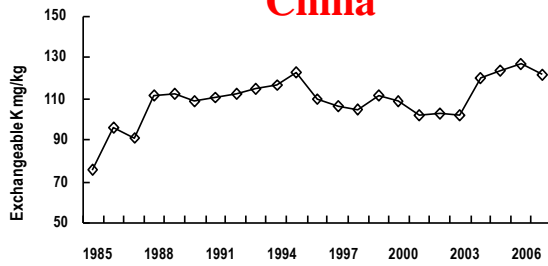
Keep soil Olsen-P as 40mg/kg, 13 million ton P₂O₅



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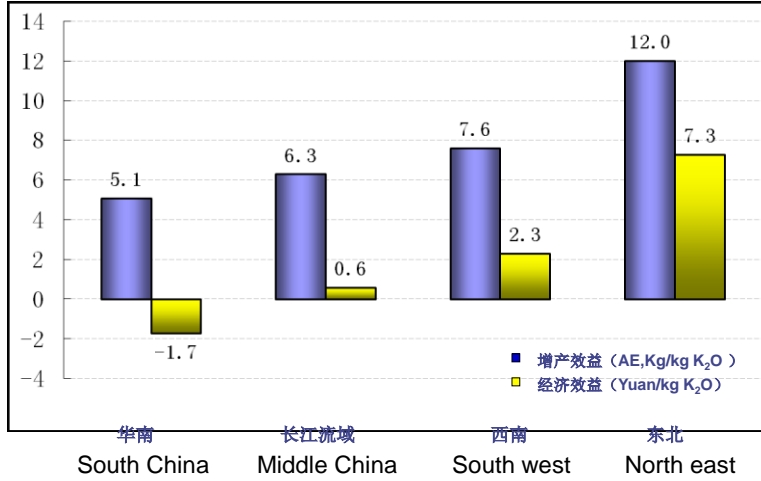
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Soil K fertility increased significantly in South China



Data from NATESC

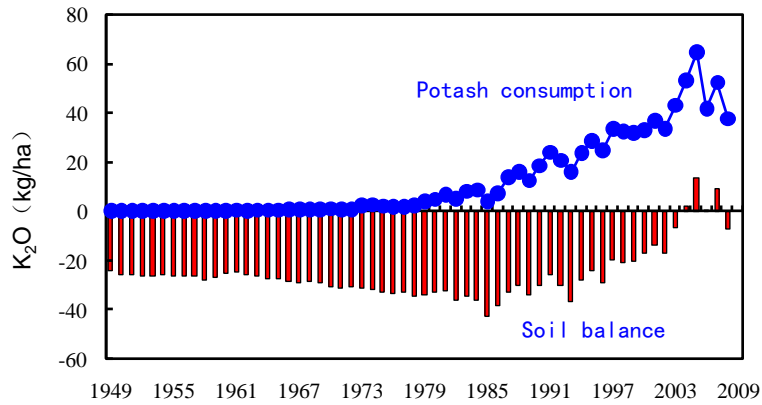
Efficiency of fertilizer K in south China is lower than other regions



Data from national soil testing program

K fertilizer demand and soil balance

5.5 million ton Chemical K₂O can keep soil balance



Soil balance = Chemical K input - crop uptake

3. Short term forecast in China

Factors affecting short term forecast

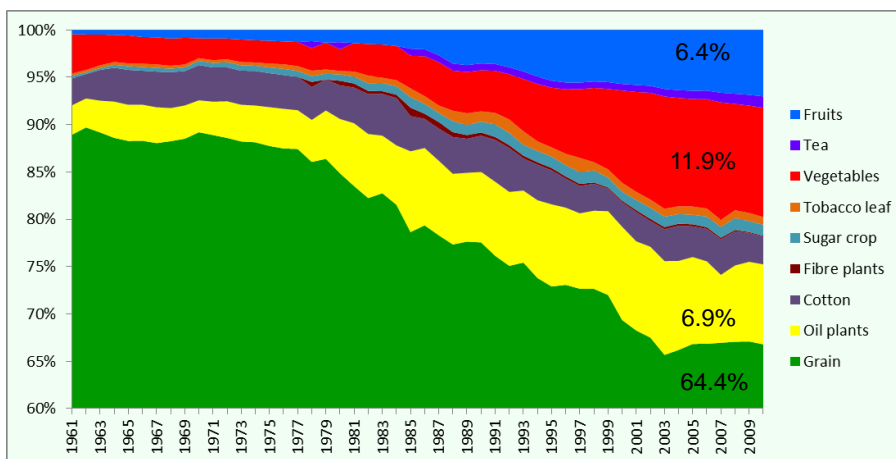
- Positive Factors
 - Price of primary commodity
 - Price of fertilizer
 - Policies
 - Fertilizer industry
- Negative Factors
 - Farmers behaviors
 - Technologies changes

A little increase of N input on grain crops

	Rice		Wheat		Maize	
	N Kg hm ⁻²	PFP Kg kg ⁻¹	N Kg hm ⁻²	PFP Kg kg ⁻¹	N Kg hm ⁻²	PFP Kg kg ⁻¹
1970s	45-60	67.5-90.0	45-60	31.3-41.6	45-60	49.3-65.8
1980s	126	45.4	117	26.2	125	32.5
1990-1994	141	44.5	166	20.1	146	32.1
1995-1999	196	31.9	177	29.3	203	24.2
2000-2003	191	35.9	181	26.8	192	29.2
2007-2009	195	37.0	215	26.7	209	36.6

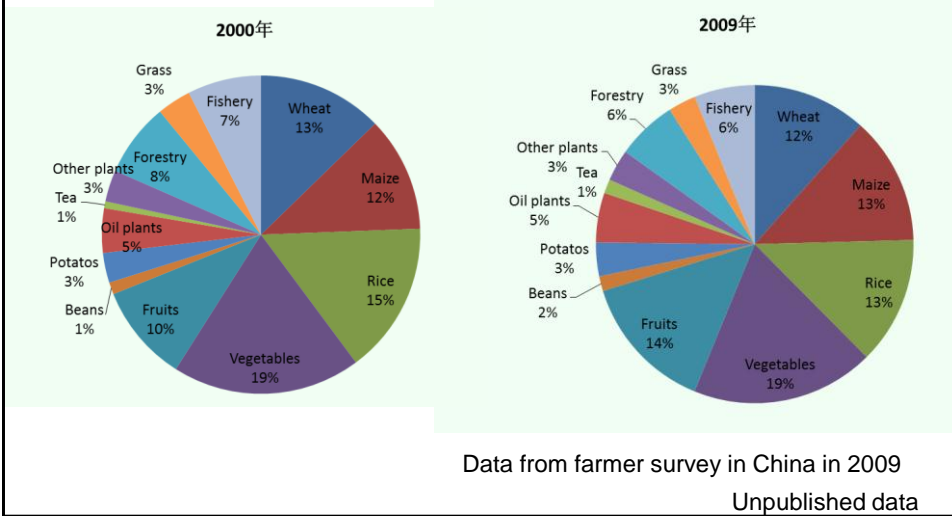
Liang Wu, Unpublished data

Land use changed greatly in China

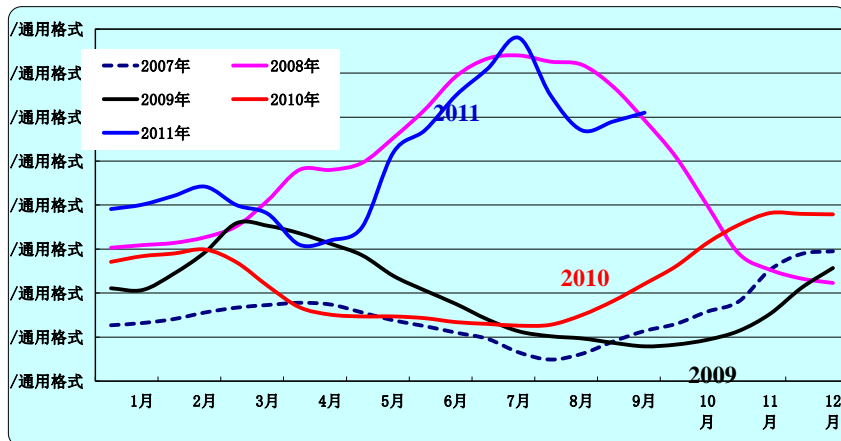


Planting area of vegetables and fruits increased by 1.7% and 2.1% respectively

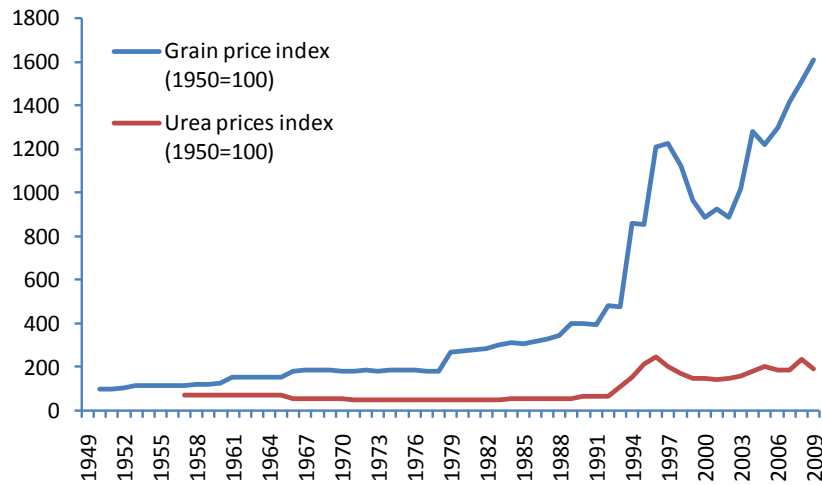
N fertilizer distribution in various agriculture fields



Urea price keep high level



Relative Low fertilizer price is supporting the growth of fertilizer consumption in recent years



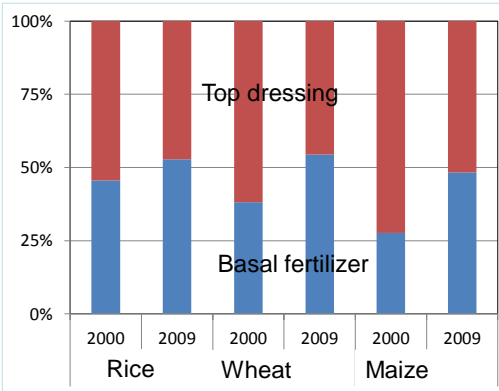
Data source, 50 years price statistic in China Summarized by Jing Li, unpublished data

More and more Agriculture subsidy in recent years

Name	Start time	Accumulated funding till 2010 (billion Yuan)	Implementing
Grain subsidy	2004	118.7	For grain growers based on grain sown area
Chemicals input subsidy	2006	336.6	Direct to farmers in order to defend high fertilizer price
Removing Tax	2006	-300.0	Stop to levy taxes from farmers
Seeds subsidy	2004	87.23	Direct to farmers for high quality crop seeds
Agriculture machine subsidy	2004	52.97	Subsidy 1/3 price of Agriculture machine
Protecting Price	2006		Government will buy grain if market price is lower than a risk level

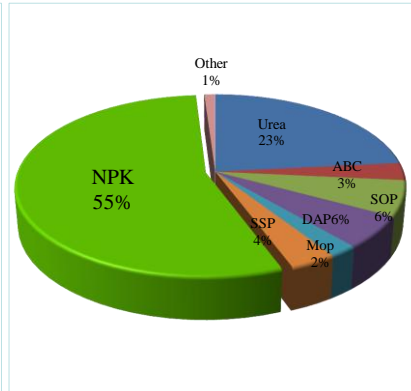
More and more

Improve compound fertilizer is top priority for fertilizer development



N fertilizer distribution in different time

Farmer survey in 2000 (n=10877) and 2009 (n=9384)



Fertilizer cost for grain crops

Farmer survey in 6 province (n=1152)



Innovate new fertilizer to support modern agriculture development



Government supply crop protection service for farmers
(hundred counties, thousand district, and ten thousands demonstration FCOs in 2010)

600 Million Yuan subsidy for in 2009 and 2010
2700 million Yuan subsidy in 2011



Photo from Jingyuan Xia