

# Improving fertilizer use efficiency through management practices – China experience

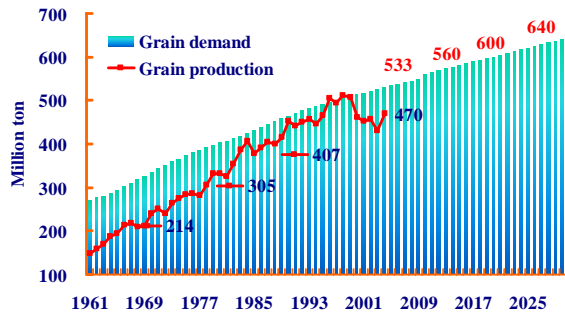
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## Outline

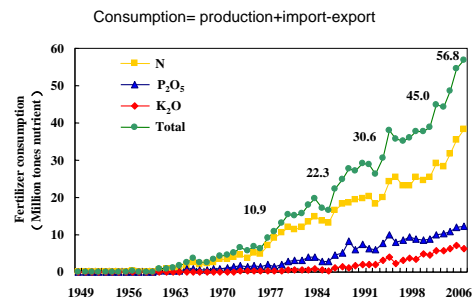
- Importance and problem of fertilizer production and consumption in China
- Principles, dissemination and performance of fertilizer best management practices (FBMPs) in crop production
- Conclusions and perspectives

### It took nearly 50 yrs to realize the dream of food sufficiency in China with massive inputs



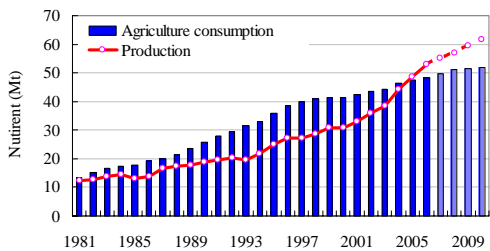
(Data from the Statistic Bureau of China  
 Demand was estimated by using average grain demand of 400 kg/capita/year)

### China consumed more than 56 million tones of NPK nutrients as inorganic fertilizer in 2006



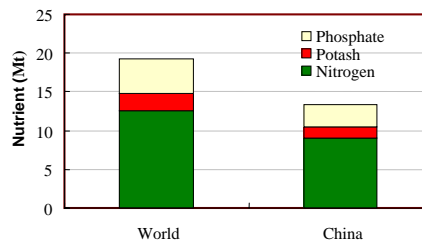
The trends of fertilizers consumption in China from 1949 to 2006

## Rapid Development of Chinese Fertilizer Industry



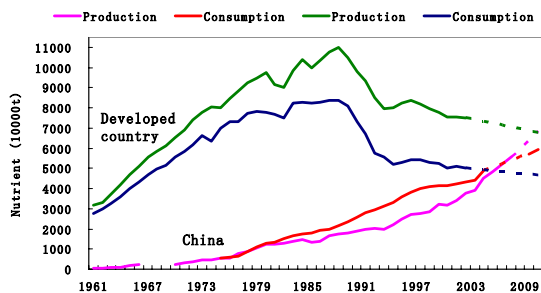
(Data for 1981-2006, The Statistics Bureau of China  
Data for 2007-2010, forecasted by industry survey-based model)

## More than 60% global new fertilizer production capacity will be in China in the next five years



(World data from IFADATA, data for China from industry survey)

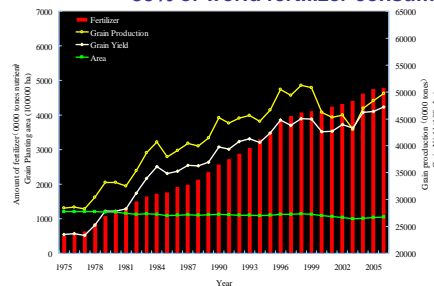
## Policies stimulate a rapid expansion of the fertilizer enterprises



(Forecast based on the increase rate of recent five years  
Data from FAO website and Chinese statistics)

## China

9% of world arable land  
21% of world population  
35% of world fertilizer consumption

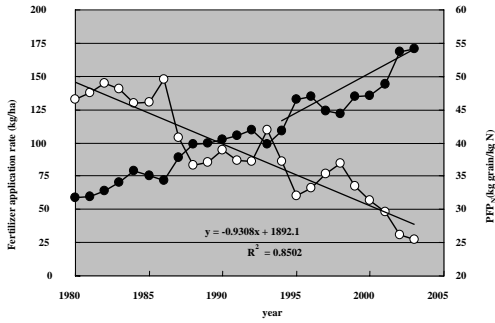


Trends of grain yield, production, grain area and fertilizer consumption (1975 - 2006)

- From 1984 to 1994, Fertilizer consumption increased by 90%, but the grain production increased by 9%;
- After 1996 no such a relationship can be demonstrated!

**Low nutrient use efficiency (NUE) ---Low PFP**

**Partial factor productivity:**  $PFP_N = \text{kg harvest product per kg N applied}$



**Substantial decrease in PFPN with increased rate of fertilization**

**Agronomic efficiency of N fertilizer in rice**

**Philippine** 15-18 kg grain/kg N

**China (1958-1963)** 15-20 kg grain/kg N

**China (1981-1983)** 9.1 kg grain/kg N

**China (2000-2004)** 3-5 kg grain/kg N

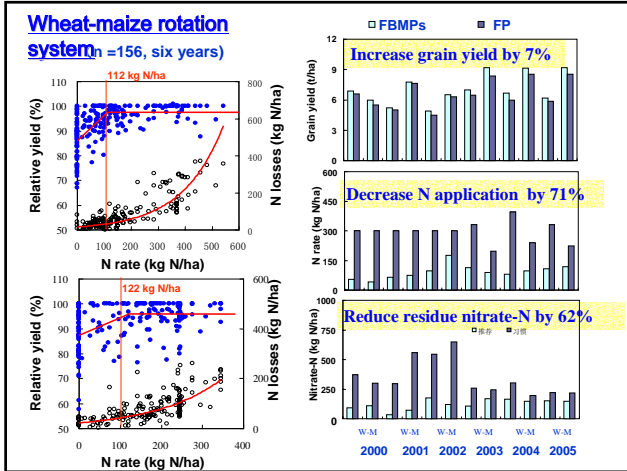
(Modified from Cassman et al., 1996; Li, 1991)

**Grain yield and N rate of rice crop**

Country	Grain yield* (t ha <sup>-1</sup> )	N rate (kg ha <sup>-1</sup> )
China	6.26	~200
Japan	6.42	70
South Korea	6.79	110

\*FAO, 2004





## Eutrophication

### Non-point source pollution

- Four fold increase in N inputs to estuaries since 1980
- Increased N inputs contribute to eutrophication, decreased fish production, and toxic algal bloom (red tides)
- The occurrence of red tides increased from 10/yr in the 1960s to 300/yr now

(Norse and Zhu, 2004)

## Fertilized to death

Nature 30 October 2003, 425:894 - 895

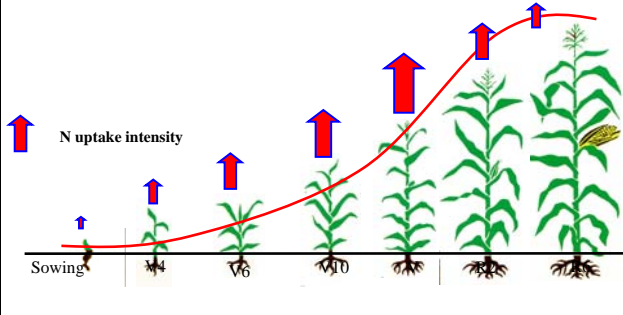
“Countries such as China have no intention of reducing their use of nitrogen”, says Moldan. “In fact they are firmly committed to increasing it.”

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- Importance and problem of fertilizer production and consumption in China
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**Principles:**

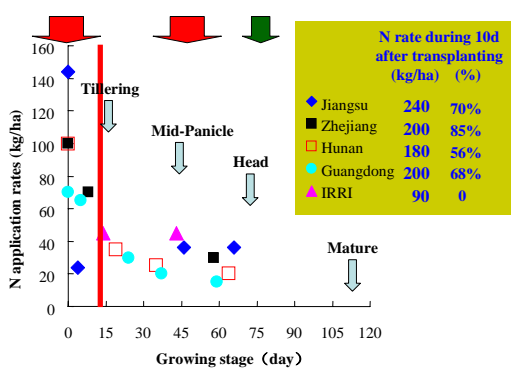
1) Match application to crop requirement, apply when crop is growing fast



**Timing of fertilizer application – at time of rapid crop uptake of nutrients**

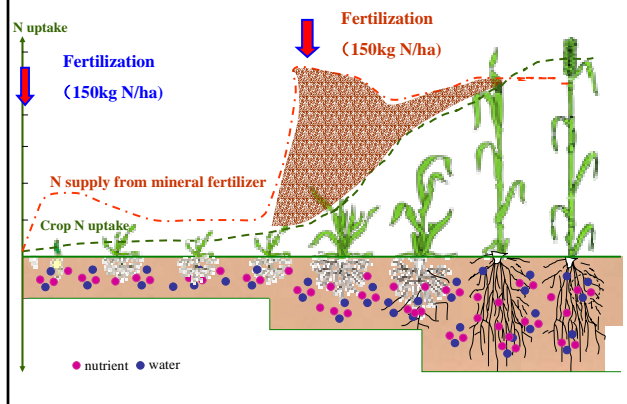
Seems obvious – but often ignored!

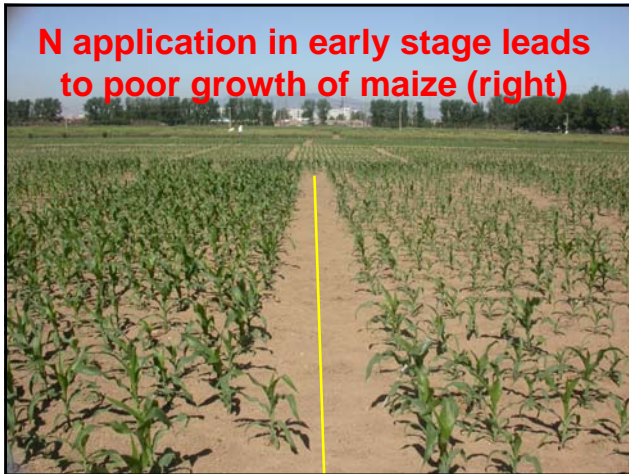
**Much was applied before/at planting time!**



**Problems of farmer's practice in rice production**

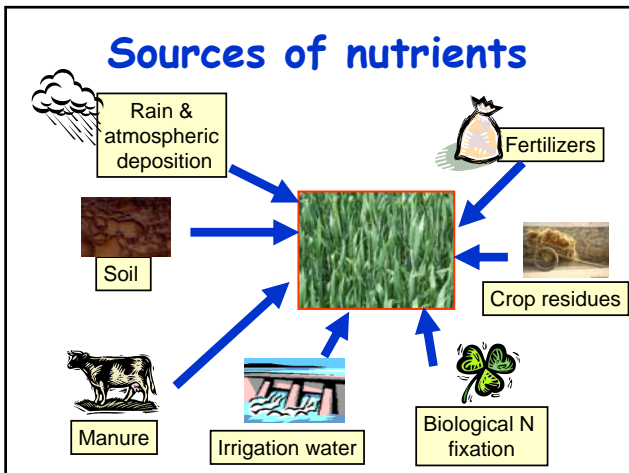
**Problems of farmer's practice in winter-wheat in north China**





**Principles:**

**2) Take all possible sources of nutrient into consideration!**

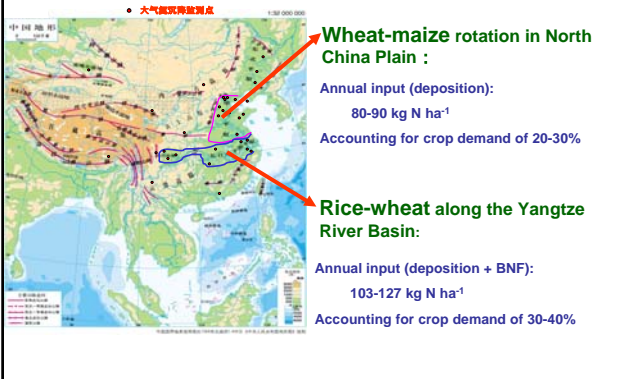


**Farmer (even expert) never knows that how much nutrient in organic fertilizer!**

**Amount of potential organic fertilizers in China**

**NPK nutrient in potential organic sources in 2000: 2869 10<sup>4</sup>t N, 1510 10<sup>4</sup>t P<sub>2</sub>O<sub>5</sub>, 2921 10<sup>4</sup>t K<sub>2</sub>O**

### Important N source- wet and dry deposition



### Large amount of nitrate accumulated in soil



N in 100cm	384(n=140)	1267(n=140)	651(n=206)
Crop demand	280	329	121

100cm

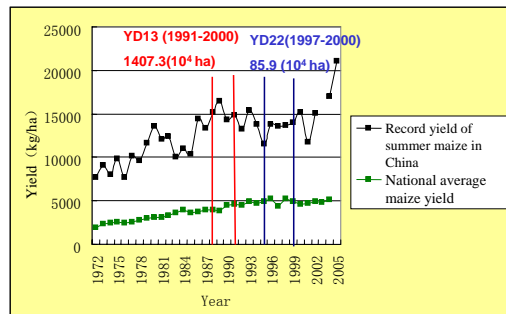
**N accumulation as nitrate in 0-100cm soil layer(kg/ha)**  
**in cereal, vegetable and fruit production systems in China**

Groundwater

### Principles:

3) Take all possible improving yield and reducing nutrient loss measures into consideration!

### A gap in yield



(Li, 2004; FAO; website: <http://www.cornexpert.com>, <http://www.denghai.com/>)

### Wheat and maize potential and actual yield:

#### Potential yield:

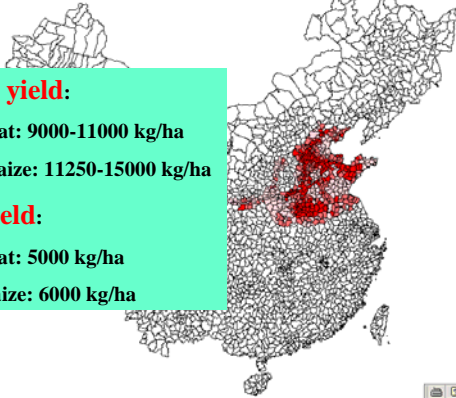
Winter wheat: 9000-11000 kg/ha

Summer maize: 11250-15000 kg/ha

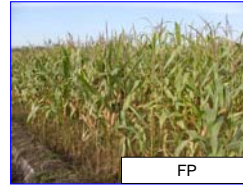
#### Actual yield:

Winter wheat: 5000 kg/ha

Summer maize: 6000 kg/ha

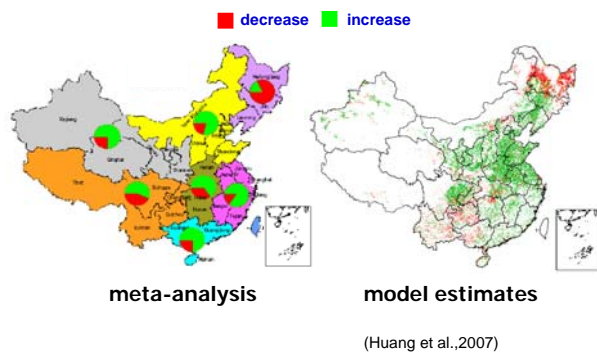


### Improving NUE by increasing crop yield

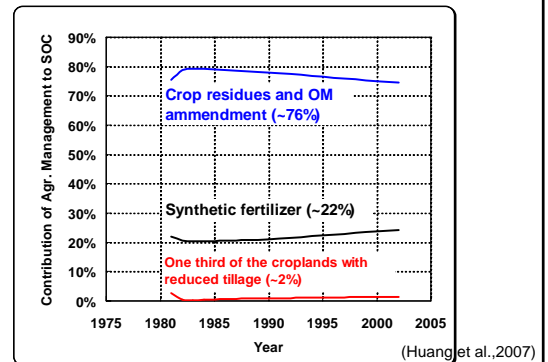


Yield(t/ha)	6	18
N rate (kg/ha)	300	889
RE (%)	15	25-30

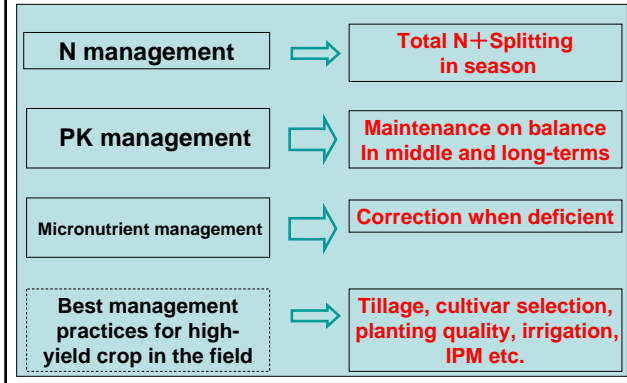
### Comparison of model estimates and meta-analysis of SOC change from 1980-2000 in Chinese crop land



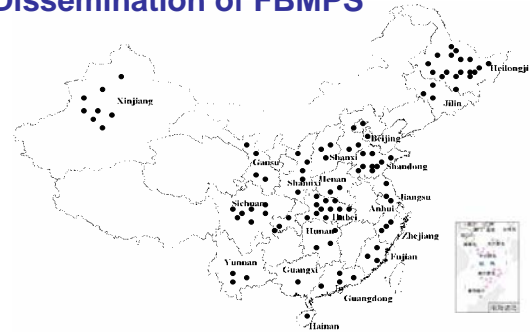
### Crop residues and OM amendment contributed greatly to the SOC



## Principal and technology of FBMPs



## Dissemination of FBMPs



The distribution of 127 experiment and extension bases or stations across 12 cropping systems throughout China

## Dissemination of FBMPs

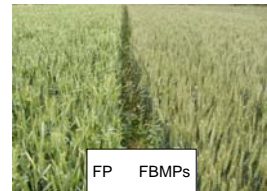
Technical manuals, leaflets and publications for teachers, officers, technicians and farmers



## Dissemination of FBMPs

In cooperation with fertilizer companies

focused on developing new types of fertilizer, investigation of fertilizer market, on-farm surveys of fertilizer application, and training staffs in fertilizer industry and public extension system



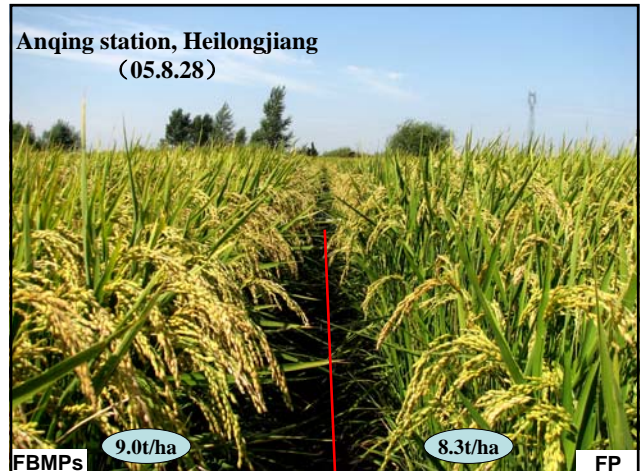
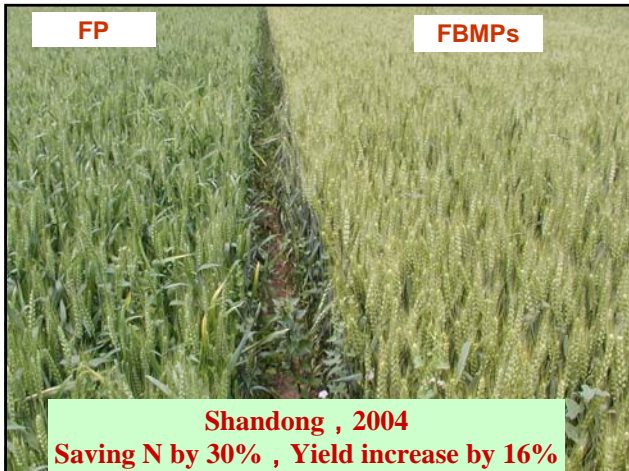
**Dissemination of FBMPs through farmers' special association at Jianyang base in Sichuan province**



**Performance of FBMPs**

Cropping system	N saving (%)	Yield increase (%)	N recovery increase (%)	N loss decrease (%)
Wheat/Maize rotation	41-59	5-10	12-15	43-69
Rice	22-32	8-12	10-15	40-50
Vegetable	30-50	2-10	5-15	40-65
Cotton	20-30	5-8	10-15	10-30
Oilseed rape	10-30	5-30	8-15	-
Rice/wheat rotation	30-50	8-20	8-30	30-50
Intercropping	20-50	0-10	8-13	20-45
Tobacco	10-30	0-10	7-20	40-50
Apple	10-50	5-15	2-12	-

**FBMP treatments on average have saved N by 20-40%, increase yields by 2-12%, increase N recovery rates by 10-15%, and decrease N losses by 10-50%**



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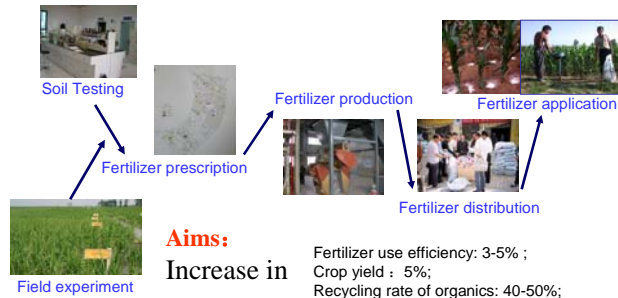
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**Technologically, FBMPs is a feasible solution to tackle or alleviate the problems of fertilizer overuse and misuse in cropping systems.**

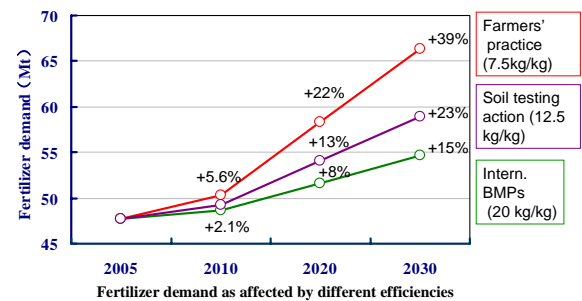
## Action of The Ministry of Agriculture

### National Program for Soil Testing and Fertilizer Recommendation

200 Million RMB¥ covers 200 counties in 2005, 500 Million RMB¥ covers 600 counties in 2006, and 900 Million RMB¥ covers 1200 counties in 2007



## 11.7 million tons fertilizer can be saved by the above actions



Note:  
Increased demand of cash crops is not included  
grain demand is 520 Mt, 580 Mt and 640 Mt in 2010, 2020 and 2030  
Efficiencies (AE) in three practices are 7.5kg/kg, 12.5kg/kg and 20kg/kg (W Zhang Unpublished)

**What are the determinants of the use of fertilizers by farmers?**

**Politically**

- High input and high output policy leads to higher use
- Modern varieties make it possible to apply more fertilizer
- Current extension system leads to higher use

**Perspectives**

**Change policies :**

**both in agriculture and fertilizer industry**

- Develop and extend fertilizer saving technologies
- Train farmers
- Reform current public agricultural extension system
- Make new technology policy:
  - Encourage the development of fertilizer-sensitive technologies

**Acknowledgments**

948 of MOA No. 2003-Z53  
FAI and IFA



**Thanks**

**for your attention !**

