The Fertilizer Situation and Outlook in China

Weifeng Zhang and Fusuo Zhang

China Agriculture University
(86)1062733941
(86)13391561503
Wfzhang@126.com
Outline

• The situation of fertilizer in China
• The outlook beyond 2007
• Challenges for fertilizer development in China
Unexpected Rapid Development of Chinese Fertilizer Industry

Note: Data for 1981-2006, The Statistics Bureau of China
Data for 2007-2010, forecasted by industry survey and crop based expert model
Growing and Changing of N fertilizer industry

Development trend of nitrogen fertilizer in China
Different trends of main N fertilizer products

<table>
<thead>
<tr>
<th></th>
<th>Urea</th>
<th>ABC</th>
<th>ACL</th>
<th>AN</th>
<th>AS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity in 2005</td>
<td>47.83</td>
<td>50.00</td>
<td>7.00</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>Production 2005</td>
<td>42.23</td>
<td>40.06</td>
<td>4.44</td>
<td>3.57</td>
<td>0.95</td>
</tr>
<tr>
<td>Production 2006</td>
<td>48.54</td>
<td>38.59</td>
<td>9.08</td>
<td>3.20</td>
<td>1.00</td>
</tr>
<tr>
<td>Growth rate in 2006</td>
<td>+15%</td>
<td>-3.7%</td>
<td>+105%</td>
<td>-10.4</td>
<td>+5%</td>
</tr>
</tbody>
</table>

Note: Data from the Nitrogen fertilizer association of China
Quickly development of Urea

Note: Data from the Nitrogen fertilizer association of China
Strong trends to export of Urea

Trends of Urea market of China

Note: Data from the Nitrogen fertilizer association of China and statistic bureau
Where is the potential demand of N fertilizer?

Nitrogen fertilizer distribution in different part of China

Note: Calculated by the crop based experts’ model
Growing production and Remarkable changing structure of phosphate fertilizer

Developing trends of phosphate fertilizer of China

Note: Data from China phosphate fertilizer industry association and statistic bureau of China
Strong capacity for AP

Forecast for the capacity of DAP and MAP in China

Note: Data from the China Phosphate fertilizer industry association
Forecast based on the industry survey
Changes of DAP market

Note: Data from China statistic bureau and China phosphate fertilizer association
Changes of compound fertilizer market

Note: Data from China statistic bureau and China phosphate fertilizer association
The total production capacity of compound fertilizer would be 200 million ton in 2007 and 300 million ton in 2008. But the real production is only 20 million tons.

Note: Data from China phosphate fertilizer association
Where is the potential demand?

Distribution of phosphate fertilizer in China

Potential demand for:
- Maize
- Potato
- Vegetable
- Fruits
- Oil rape and peanut

Calculated by the crop based experts’ model
We need more K, but.......

Note: Data from China statistic bureau and China Potash fertilizer association
Where is the potential demand?

- **Grain**: 38%
- **Sugar**: 2%
- **Oil**: 2%
- **Fruits**: 30%
- **Cotton**: 1%
- **Vegetable**: 19%
- **Others**: 8%

Potential demand for:
- Rice and maize
- Potato and soybean
- Vegetable
- Sugarcane
- Oilseeds and peanut

Note: Calculated by the crop based experts’ model
Outline

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1. Increasing population and food demand

Li et al. (2001) predicted, that “In 2030, we have to have at least 72 million tons of NPK fertilizer to meet the demand of food production and agricultural development.”
More and more subsidies for grain producers

<table>
<thead>
<tr>
<th>Items</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsidy (billion Yuan)</td>
<td>26.7</td>
<td>42.7</td>
<td>More</td>
</tr>
<tr>
<td>Subsidy per ha (Yuan/ha)</td>
<td>300</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>Subsidy per unit nutrients (Yuan/ton)</td>
<td>300</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Fertilizer prices changed compared to 2004 (Yuan/ton nutrient)</td>
<td>800</td>
<td>1000</td>
<td>More</td>
</tr>
</tbody>
</table>

Note: Subsidies includes direct subsidy for grain production, and indirectly subsidy for raw material consumption, such as oil, fertilizer and pesticide used for grain production.
2. Increasing cash crop production

More than 50% fertilizers were used on cash crops in China in 2005

Note: Data from statistic bureau and farmer survey
Planting structure changes affect the fertilizer demand

\[
\ln(CF) = a_0 + a_1 \ln(A) + a_2 \ln(Ar) + a_3 \ln(Aw) + a_4 \ln(Am) + a_5 \ln(As) + a_6 \ln(Ap) + a_7 \ln(Ao) \\
+ a_8 \ln(Ac) + a_9 \ln(Asb) + a_{10} \ln(At) + a_{11} \ln(Afv)
\]

### The elasticity of fertilizer consumption on planting structure

<table>
<thead>
<tr>
<th>Factors</th>
<th>Rice</th>
<th>Wheat</th>
<th>Corn</th>
<th>Potato</th>
<th>Oil crop</th>
<th>Cotton</th>
<th>Sugar</th>
<th>Tobacc o</th>
<th>Fruits and vegetable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>5.132</td>
<td>-2.068</td>
<td>2.222</td>
<td>2.37</td>
<td>0.996</td>
<td>0.931</td>
<td></td>
<td></td>
<td>0.951</td>
</tr>
<tr>
<td>N</td>
<td>4.686</td>
<td>-2.054</td>
<td>2.594</td>
<td>2.418</td>
<td>1.048</td>
<td>0.901</td>
<td></td>
<td></td>
<td>0.821</td>
</tr>
<tr>
<td>P\textsubscript{2}O\textsubscript{5}</td>
<td>6.585</td>
<td>-2.017</td>
<td></td>
<td></td>
<td>0.767</td>
<td>0.887</td>
<td>0.946</td>
<td></td>
<td>1.142</td>
</tr>
<tr>
<td>K\textsubscript{2}O</td>
<td>6.086</td>
<td></td>
<td></td>
<td></td>
<td>0.997</td>
<td>1.523</td>
<td>1.003</td>
<td>-0.534</td>
<td>2.634</td>
</tr>
</tbody>
</table>
Planting area changed in 2005 and 2006 in China

Totally, 1% increased in 2006
Fertilizer demand changed in 2005 and 2006

Total increased N, P$_2$O$_5$ and K$_2$O is 550kt, 237 kt and 239kt

Note: Calculated based on the crop based experts model of China
3. Increasing animal production

![Diagram showing food consumption in different countries and food demand in China.]

**Note:** Data came from the Statistics Bureau of China and FAO. Forecasted data from the reference of Liu Jiang (2000); Xu Shiwei (2003).
Compared with 1980, grain production increased 89%, while the production of meat, egg and milk increased 6.4, 11.2 and 20.8 times respectively in 2005.
## 4. Increasing production of bio-energy crops

<table>
<thead>
<tr>
<th></th>
<th>2010 (Mt)</th>
<th>2020 (Mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Biofuel accounting for 1% of total energy demand)</td>
<td>(Biofuel accounting for 4% of total energy demand)</td>
</tr>
<tr>
<td><strong>Biofuel Production</strong></td>
<td><strong>Crop demand</strong></td>
<td><strong>Fertilizer demand</strong></td>
</tr>
<tr>
<td>Ethanol</td>
<td>2</td>
<td>5.76 corn</td>
</tr>
<tr>
<td>Diesel</td>
<td>0.5</td>
<td>3.68 soybean</td>
</tr>
<tr>
<td>Sum</td>
<td>2.5</td>
<td>9.44</td>
</tr>
</tbody>
</table>

**Data source:**

*Medium term forecast for biofuel development,*
- China reform and development committee, 2006
Forecast of chemical fertilizer production and demand by China in 2010
Outline

• The situation of fertilizer in China

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1. Impact of changing environmental policies

➢ “Create a no fertilizer county” — 《Miyun County Director 24》 2001-3-28

➢ “Pesticide and fertilizer are not allowed to be used within 5 km to the sea in Dalian city” — 《Dalian Environmental Director》 2002-6-24

➢ “The pesticide and nitrogen fertilizer consumption should be reduced by 30% and 20% in Tai Lake in 2010 ” — 《Jiangsu Government Director 97》 2007-9-10

➢ More and more…………………………….
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)
Substantial decrease in fertilizer use efficiency --- Low PFP

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

$y = -0.9308x + 1892.1$

$R^2 = 0.8502$
# Grain yield and N rate of rice crop

<table>
<thead>
<tr>
<th>Country</th>
<th>Grain yield* (t ha(^{-1}))</th>
<th>N rate (kg ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>6.26</td>
<td>~200</td>
</tr>
<tr>
<td>Japan</td>
<td>6.42</td>
<td>70</td>
</tr>
<tr>
<td>South Korea</td>
<td>6.79</td>
<td>110</td>
</tr>
</tbody>
</table>

*FAO, 2004*
The challenge - Can we increase crop yield and nutrient use efficiency at the same time? How?
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

Soil Testing

Fertilizer prescription

Fertilizer production

Fertilizer distribution

Fertilizer application

Field experiment

Aims:

Increase in

Fertilizer use efficiency: 3-5% ;
Crop yield : 5%;
Recycling rate of organics: 40-50%;
11.7 million tons fertilizer can be saved by the above actions

Fertilizer demand as affected by different efficiencies

- Farmers’ practice (7.5kg/kg)
  - +39%
- Soil testing action (12.5 kg/kg)
  - +23%
- Intern. BMPs (20 kg/kg)
  - +15%

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)
2. Reuse of organic wastes impacts chemical fertilizer production

<table>
<thead>
<tr>
<th>Source</th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
<th>Amount</th>
<th>Relative%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excreta</td>
<td>1614</td>
<td>1029</td>
<td>1102</td>
<td>3745</td>
<td>51.30</td>
</tr>
<tr>
<td>Straw</td>
<td>690</td>
<td>210</td>
<td>1164</td>
<td>2064</td>
<td>28.27</td>
</tr>
<tr>
<td>Green manure</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>28</td>
<td>0.38</td>
</tr>
<tr>
<td>Oil cakes</td>
<td>186</td>
<td>36</td>
<td>38</td>
<td>260</td>
<td>3.56</td>
</tr>
<tr>
<td>Garbage</td>
<td>300</td>
<td>180</td>
<td>600</td>
<td>1080</td>
<td>14.79</td>
</tr>
<tr>
<td>Sludge (DW)</td>
<td>51</td>
<td>55</td>
<td>17</td>
<td>123</td>
<td>1.68</td>
</tr>
<tr>
<td>Total</td>
<td>2869</td>
<td>1510</td>
<td>2921</td>
<td>7300</td>
<td>100</td>
</tr>
</tbody>
</table>
Increased crop residues returning

On province-weighted average, returning rates of harvested crop straw were 23.5% in 1994 and 34.8% in 2000, respectively.

(Sources: Gao et al., 2002; Zheng et al., 2004)
Extension of biogas technology in China

Current

<table>
<thead>
<tr>
<th>Field</th>
<th>Animal</th>
<th>House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Fertilizer</td>
<td>Energy</td>
</tr>
</tbody>
</table>

Lost to air

Lost to Water

Extension biogas tech

<table>
<thead>
<tr>
<th>Field</th>
<th>Animal</th>
<th>House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>Fertilizer</td>
<td>Energy</td>
</tr>
</tbody>
</table>

Air N -20%

Water N -30%

Energy -37%

Fertilizer -42%
## Extension of biogas technology

<table>
<thead>
<tr>
<th>Items</th>
<th>2005</th>
<th>2010</th>
<th>2015</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer biogas ( 10000 )</td>
<td>1807</td>
<td>4000</td>
<td>6000</td>
<td>14600</td>
</tr>
<tr>
<td>Biogas in animal plant</td>
<td>3556</td>
<td>4000</td>
<td>8000</td>
<td>40000</td>
</tr>
<tr>
<td>Coal saved ( 10000 t )</td>
<td>3006</td>
<td>6531</td>
<td>9886</td>
<td>24588</td>
</tr>
<tr>
<td>Urea saved ( 10000 t )</td>
<td>331</td>
<td>719</td>
<td>1089</td>
<td>2707</td>
</tr>
<tr>
<td>DAP saved ( 10000 t )</td>
<td>141</td>
<td>306</td>
<td>464</td>
<td>1153</td>
</tr>
<tr>
<td>Mop saved ( 10000 t )</td>
<td>238</td>
<td>517</td>
<td>783</td>
<td>1947</td>
</tr>
</tbody>
</table>

Calculated with data from 《Biofuel Strategy of China (2007~2015)》

Potentially, biogas can substitute **37% energy demand** in rural area, and substitute **46.7% N**, **45% P₂O₅** and **106.8% K₂O** demand of crop land.
• **The challenge** — Fertilizer overuse is an issue, which leads to reduced income, low productivity and non-point source pollution

  What are the determinants of the use of fertilizers by farmers?
  - High input and high output policy leads to higher use
  - Modern varieties make it possible to apply more fertilizer
  - Extension leads to higher use

• **Perspectives:**
  - Reform policies: agriculture and fertilizer industry
  - Develop and extend fertilizer saving technologies
  - Train farmers
  - Reform current public agricultural extension system:
    - Stop the business of public agricultural extension agents
  - Make new technology policy:
    - Encourage the development of fertilizer-sensitive technologies
Acknowledgments

MOA (No. 2003-Z53)

Thanks for your attention!

Welcome to Beijing