Improving Nitrogen Use Efficiency through Slow & Controlled Release Fertilizers

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New Delhi, India
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Topics

1. What’s SCRF?
2. Advantages of SCRF
3. China SCRF Review & Outlook
Kingenta's Vision

To be:
The world’s leading expert in plant nutrition and a provider of crop solutions

Key Data About Kingenta

<table>
<thead>
<tr>
<th>Data</th>
<th>Represents</th>
</tr>
</thead>
<tbody>
<tr>
<td>US$2.2 B</td>
<td>Revenue in 2014</td>
</tr>
<tr>
<td>US$140 M</td>
<td>Net profit in 2014</td>
</tr>
<tr>
<td>7 Mmt</td>
<td>Total Annual Fertilizer Production Capacity</td>
</tr>
<tr>
<td></td>
<td>SCRF, Nitrate-based compound, MKP, NOP, WSF, Conventional NPKs, Bio-fertilizer, MAP, Chelated-TE etc.</td>
</tr>
<tr>
<td>10000 - 1500 - 200</td>
<td>Total Employees Employees working for marketing, sales, Service Researchers working in R&amp;D center</td>
</tr>
<tr>
<td>10</td>
<td>Production Subsidiaries located in 8 provinces in China</td>
</tr>
<tr>
<td>183</td>
<td>Patents</td>
</tr>
<tr>
<td>1998</td>
<td>Company established</td>
</tr>
<tr>
<td>2010-(002470)</td>
<td>Going public, listed in Shenzhen Stock Exchange (002470)</td>
</tr>
</tbody>
</table>
Kingenta's Innovative New Products

- Bio-Fertilizers, Biostimulants, Liquids
- WSFs+TE, MAP, MKP, NOP
- Nitrate Based NPKs
- SCRFs

NPKs


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More than 150 million tons of urea are applied worldwide every year. Wasted: 2/3 of all applied urea is lost.

Overall Efficiency

Overall: $\eta \approx 10\%$
The world needs new smart fertilizers!

- Organic or synthetic source of plant nutrients
- Help to achieve efficient use of nutrients by plants.
- Release nutrients only at a time and an amount needed to increase crop production and decrease waste and pollutants.
- Include both slow-release and controlled release fertilizers (SCRF)

Main Product Types:

<table>
<thead>
<tr>
<th>Slow Release Fertilizer (SRF)</th>
<th>Controlled Release Fertilizer (CRF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea-Formaldehyde Formulations (UF)</td>
<td>Sulfur Coated Urea (SCU)</td>
</tr>
<tr>
<td>Isobutyledeene-Diurea Formulations (IBDU)</td>
<td>Polymer and Sulfur Coated Urea (PSCU)</td>
</tr>
<tr>
<td></td>
<td>Polymer Coated Urea (PCU)</td>
</tr>
<tr>
<td></td>
<td>Polymer Coated Compound Fertilizer (PCF)</td>
</tr>
</tbody>
</table>
### History of SRF/CRF materials

<table>
<thead>
<tr>
<th>Decade</th>
<th>Material Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1940s</td>
<td>Urea formaldehyde (UF)</td>
</tr>
<tr>
<td>1960s</td>
<td>Sulfur-coated urea (SCU)</td>
</tr>
<tr>
<td>1970s</td>
<td>Isobutylidene diurea (IBDU)  &lt;br&gt; Methylene urea (MU)</td>
</tr>
<tr>
<td>1980s</td>
<td>Plastic-coated urea (PCU)</td>
</tr>
<tr>
<td>1990s</td>
<td>Plastic-coated, S-coated urea (PCSCU)  &lt;br&gt; Resin-coated N-P-K</td>
</tr>
<tr>
<td>2000s</td>
<td>Refinement of earlier technologies</td>
</tr>
</tbody>
</table>

### Key Driving Factors for SCRF Development

- **1960s**: Golf transitions from recreation to a business
- **1970s**: Suburbanization creates new homeowner markets
- **1980s**: Urban/suburban development increases nursery plant demand
- **1990s**: More vegetables in diets
- **2000s**: Environmental implications of intensive ag.
- **2010s**: Environmental compliance and price
UF/IBDU Decomposition and Nitrogen Supply Mechanism

Microbial decomposition → Urease decomposition → Nitrite bacteria → Nitrate bacteria

UF/IBDU → Urea → Ammonium nitrogen NH4+ → Nitrite nitrogen NO2 → Nitrate nitrogen NO3

The Release Mechanism of SCRF

1. Sulfur/polymer Coated granule
2. Water vapor penetrates the semi-impermeable membrane
3. The moisture dissolves the water soluble fertilizer core
4. Dissolved nutrients diffuse through the coat into the soil
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The focus problems of SCRF application

- Stabilized or better crop yield
- Agricultural?
- Economic?
- Labor saving or better harvest to farmers
- Environmental?
- Non-surface pollution and CO2 emission reduction
Nutrient Release Curve

Cumulative N Uptake Curve

SCRF delivered in synchrony with the plant uptake
N losses comparison of PCU with conventional urea

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nitrogen Applied kgN/ha</th>
<th>N losses in runoff (N%)</th>
<th>The leaching loss of N (N%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCU</td>
<td>240</td>
<td>9.22</td>
<td>8.55</td>
</tr>
<tr>
<td>Urea</td>
<td>240</td>
<td>12.6</td>
<td>10.2</td>
</tr>
<tr>
<td>PCU-Urea</td>
<td>--</td>
<td>-3.38 (-27%)</td>
<td>-1.65 (-16%)</td>
</tr>
</tbody>
</table>

Compared PCU with common urea, N-runoff is 27% less, N-leaching is 16% less.

CRF field trial and demonstration for different crops in China

rice | corn | wheat | cotton | peanut |
tobacco | Fruit tree | vegetable | turf | flower |
Peanut Yield Increase by 33.3%

Potato Yield Increase by 15.85%
**Water Melon Yield Increase by 20.13%**

![Water Melon Field]

**Ginger Yield Increase by 21.33%**

![Ginger Field]
Results of Trial and Demonstration

In field experiments in China, SCRF increased crop yield significantly compared to those with urea. Even when a third less N was used, CRF increased rice yield by 15%.

These results clearly demonstrate that the use of polymer-coated urea, though more expensive than conventional urea, is also profitable in field crops like corn, rice, wheat and potatoes.

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Numbers Related to Fertilizers in China

<table>
<thead>
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<th>Represents</th>
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</thead>
<tbody>
<tr>
<td>9%</td>
<td>of the world arable land</td>
</tr>
<tr>
<td>22%</td>
<td>of the world population</td>
</tr>
<tr>
<td>40%</td>
<td>Crop yields are contributed by fertilizers</td>
</tr>
<tr>
<td>1/3</td>
<td>of the world fertilizer production</td>
</tr>
<tr>
<td>30%-35%</td>
<td>Nitrogen using efficiency</td>
</tr>
<tr>
<td>15%-20%</td>
<td>Phosphate using efficiency</td>
</tr>
<tr>
<td>35%-40%</td>
<td>Potash using efficiency</td>
</tr>
<tr>
<td>21Mmt</td>
<td>Nitrogen nutrients consumption every year</td>
</tr>
<tr>
<td>45%</td>
<td>Applicated nitrogen volatilized, leaching or running off every year</td>
</tr>
<tr>
<td>9.45 Mmt</td>
<td>Nitrogen nutrients (equal to 20.5 million tons urea) lost every year</td>
</tr>
</tbody>
</table>

SCRF Development in China

- 2000s: Start-up, Oil Coated Fertilizers, Stabilized Fertilizers, Urea formaldehyde fertilizer
- 1990s: PCU/PCF, Initial achievements
- 1980s: Research and Development
- 1970s: Development
China SCRF Production Trend (Coated Fertilizers)

China SCRF Main Producers and Production Capacity (Kmt/a)
Kingenta has conducted SCRF application experiment demonstration and evaluation broadly

- Built than 2000 demonstration fields in China and 13 demonstration fields abroad, covered 12000MU.
- Cooperate with 6 American Universities and 3 experimental station of USDA.

In 2014, Kingenta cooperated with National Agro-Tech Extension and Service Center (NATESC), built 92 demonstration fields in 25 provinces in China.
Average corn yield increase through Kingenta SCRF application

Compare with conventional fertilization
- Kingenta SCRF application: 10.4%
- Conventional fertilization: 0.0%

Compare with formulated fertilization
- Formulated fertilization: 6.4%

Yield increase through Kingenta SCRF application -- Compare with conventional fertilization

- Apple: 9.2%
- Cotton: 6.9%
- Rice: 9.8%
- Wheat: 5.2%
- Citrus: 9.6%
Seed-Fertilizer Sowing Machine

Kingenta has been bought more than 30,000 seeds & fertilizer sowing machines for farmers and has trained more than 50,000 machine operators.

Organizing SCRF fertilization educational activities and training class more than 3600 times, trained farmers more than 320000 people.

Freely distributing fertilization manual more than 2 million volumes.

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Agrochemical Service to Farmers
1. China has more than 30 SCRF science & technology Research institutions and more than 70 SCRF Industrial development and application units.
2. In 2014, SCRF production was over 2 million tons.
3. The yearly average increasing rate of SCRF production capacity is about 30%, while the yearly average increasing rate of SCRF consumption is about 20%.
4. But the ratio of SCRF in the total fertilizer consumption is still very low, about 1%.
5. With the strong support of Chinese government, the SCRF market in China is going to be booming in coming years.
Future Fertilizer Innovations

- Improvement of Nutrient Uptake Efficiency
- Precise Application to Reduce Losses, Air & Water Quality Concerns
- Nutrient Release Synchronized with Plant needs
- Easy & Convenient Application, Labor and Time Saving
- Mechanically Applied, Fertigation & Irrigation
- Economical & Environmentally Sustainable
- Wide Application, Agri-/Horti-culture, from farming to landscaping, from field to home.

Thank You For Your Attention!

Welcome to Cooperate with Kingenta
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