Fertilizer and Global Food Security

By
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- Population, Fertilizer and Food
- Population and Diet
- Resource Constraints
- Biofuels
- Africa
- Short- and Long-Term Options for Africa
  - Fertilizer procurement and distribution
  - Site & Crop Specific Nutrient Management
  - Policy Interventions—Rwanda Auction/Voucher
- Conclusions
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Fertilizer(s)

- Provide plants with nutrients for growth and development
- Increase agricultural outputs, soil organic matter
- Result in less extensive land use
- Integral part of ‘Green Revolution’
- Catalyst for economic growth and development
Cereal Production in Developed and Developing Countries, 1961-2007

Source: Derived from FAO data.

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Developing Countries: Total Cereal Production and Total Fertilizer Use, 1961/62–2007/08

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Looking Back

- Food production per person increased by 30% over past 5 decades, despite doubling of population
- Discontinuous productivity rise
- Major role for technology
  - Variety improvement (rice, wheat, maize)
  - Fertilizers
  - Mechanization
  - Irrigation
  - Biocides
- Proper institutions in place
But Can We Sustain and Provide for 9 Billion…?
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Growth and Changes in Demand for Food

- Population growth
  - 75 million per year
  - Over 9 billion by 2050
  - 95% of growth in developing countries
  - Highest growth: absolute in Asia, relative in sub-Saharan Africa
  - Urban population in developing world to double in 25 years
World Per Capita Food Consumption (kcal/person/day)

Note: Latin America include Caribbean countries. Arabs include Near East and North Africa. Ex-communists include Eastern Europe and CIS countries. Source: FAO (2006).
Global demand for food

World population increase
2000: 6,000,000,000
2050: >9,000,000,000

Increasing wealth → meat consumption increases

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Pounds of grain needed to produce one pound of bread or one pound of live weight gain in each animal
Agro Production Area

- 2 m$^2$ for 10 roses per week
- X 100 m$^2$ for a vegetarian diet
- X 1000 m$^2$ for a diet with meat
One kg of beef requires 15 times more water to produce than one kg of wheat.
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Resource Constraints

- Land Constraint
  - Arable land areas may increase in some countries but will decrease in most
  - Gains will be offset by losses due to land degradation and urbanization
Availability of Arable Land Per Person

<table>
<thead>
<tr>
<th>Region</th>
<th>1961</th>
<th>1990</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>1.2</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>0.8</td>
<td>0.6</td>
<td>0.4</td>
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<tr>
<td>India</td>
<td>0.6</td>
<td>0.4</td>
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<tr>
<td>China</td>
<td>0.4</td>
<td>0.2</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Hectares per person

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Resource Constraints

- Water Constraints
  - Globally agriculture accounts for 70% of water used
  - Considerable disparity in water availability among regions and sub regions
  - People living in water-scarce countries will increase from 245 million (2000) to more than 850 million (2025)
Availability of Fresh Water Per Person

- North America
- Sub-Saharan Africa
- North Africa
- India

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Any water?
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World Production
(million tons, 2005)

FOSSIL

Raw Material

Petroleum
4,252 MT
(184.9 BGJ)

Fuel

Gasoline
1,237 MT
(53.8 BGJ)

Diesel*
1,077 MT
(46.1 BGJ)

LPG
301 MT
(11.9 BGJ)

Kerosene
82 MT
(3.8 BGJ)

Total (Energy Equiv.)** =
115.7 BGJ

RENEWABLES

Fuel

Ethanol
36 MT
(0.96 BGJ)

Biodiesel
3.2 MT
(0.12 BGJ)

Raw Material

Sugar Cane
1,292 MT

Corn
702 MT

Wheat
628 MT

Soy
214 MT

Rapeseed
47 MT

Palm
8 MT

Sunflower
31 MT

Castor Seed
1.4 MT

Renewables/Total: 0.9%

Sources: FAO, Gil World, F.O. Licht, LCM, EIA. Elaboration: ICONE.
Feeding the World while Producing Biofuels

Ethanol (Bgal)

Biodiesel (Bgal)

Source: FAPRI
Estimates of Global Fertilizer Use on Biofuel Crops: 2007/08 (Mt nutrients)

Source: IFA

Total = 5.5 Mt nutrients or 3.3% of world demand

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Global climate change and declining soil fertility adds to the challenges to food production
Increasing Population, Changes in Diet, Biofuels production Land and Water Constraints Climate change and Soil Health will Require Agriculture to be more Adaptive Efficient and Productive
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The Enormity of Africa
Cereal Yields Per Hectare by Regions, 2006/07 (mt/ha)

- Sub-Saharan Africa: 1.16
- Africa: 1.44
- Near East and North Africa: 2.43
- South Asia: 2.63
- World: 3.26
- Latin America: 3.26
Cereal Production, 1961–2007
(Index: 1961 = 100)

South Asia

Sub-Saharan Africa

Derived from FAO data.

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Africa Has Lowest Per Hectare Use Fertilizers (kg/ha)

- Sub-Saharan Africa: 9 kg/ha
- Africa: 24 kg/ha
- Near East and North Africa: 91 kg/ha
- Latin America: 94 kg/ha
- South Asia: 115 kg/ha
- World: 118 kg/ha

Source: Derived from FAO data.

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Continent in need of fertilizer is well endowed with fertilizer resources.
Significant Potential Nitrogen and Potash Resources of Africa

Sources for Nitrogen Production
Oil, Natural Gas, Coal
Potash Sources
The Africa Fertilizer Summit

June 9 – 13, 2006
Abuja Declaration

Fertilizer is Crucial for Achieving an African Green Revolution

Fertilizer is a Strategic Commodity Without Borders

Twelve Resolutions Adopted
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**Short- and Long-Term Options for Africa**

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Fertilizer Price Formation:
Thailand vs. Sub-Saharan Africa

Retail Price

Thailand: 81% + 3% + 2% + 3% = X

Tanzania: 65% + 22% + 0.5% + 4% + 6% = X + 49%

Mali: 49% + 32% + 6% + 4% + 8% = X + 80%

Product Cost (FOB + Bagging)
Taxes and Levies
Total Overheads
Transport Cost
Finance Costs
Total Margins

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Nitrogen Use Efficiency
Nitrogen

Air (80% Nitrogen) → Ammonia → Urea

Energy and Feedstock (Natural Gas) → Energy (Natural Gas) and Carbon Dioxide

One Ton Urea Requires Energy Contained in 4 Barrels of Oil
2 out of 3 bags of Urea lost for split application in Wetland Rice
A Simple Technology

Urea Deep Placement
UDP: Background and Benefits

- 1-3 g briquettes, in root zone at transplanting
- Slower release = nutrient use efficiency improves
- Expanded in Bangladesh, and Introduced in Central and West Africa

2 out of 3 bags of Urea lost for split application in Wetland Rice
Prilled Urea and USG

1. Prilled Urea
2. Spherical
3. Tablet
4. Pillow (Briquettes)
Conversion of Prilled Urea to USG Using an IFDC-Designed Briquetter
Deep placement of USG in paddy field
Comparison Yields Between Broadcast and Urea Deep Placement Methods—Bangladesh

![Graph showing comparison of paddy yields between broadcast and deep placement methods. The graph indicates that deep placement yields higher paddy yields with 7,676 kg/ha compared to broadcast method's 6,432 kg/ha. There is also a note on nitrogen application, 125 kg N/ha for broadcast and 77 kg N/ha for deep placement.](www.ifdc.org)
Crop Specific Nutrient management
Effect of Balanced Fertilization
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- *Policy Interventions—Rwanda Auction/Voucher*

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Fertilizer Auction Objectives

- Transfer fertilizer retail business to the private sector to catalyze development of a competitive system

- Reduce impact of unprecedented high international market prices by providing 25% subsidy to all users

Source: Dr. Agnes Kalibatta, Minister of Agriculture, Rwanda
Voucher Program Objectives

- Target resource limited maize and wheat farmers in the districts to provide Product Purchase Support (PPS)

- Wheat and maize chosen as fertilizer use is less known and less profitable. Subsidy + Voucher: urea 62% DAP 69%

- Introduce use of fertilizers and improved variety seed and other modern agricultural practices to these farmers thereby helping in increasing agricultural production to improve food security

- Encourage establishment of private sector distribution network to take on this function in the future

Source: Dr. Agnes Kalibatta, Minister of Agriculture, Rwanda
## Growth (2008)

<table>
<thead>
<tr>
<th>Sector</th>
<th>2008</th>
<th>2007</th>
<th>2002-2006 average</th>
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<tbody>
<tr>
<td>Real growth</td>
<td>GDP</td>
<td>Agriculture</td>
<td>Industry</td>
</tr>
<tr>
<td></td>
<td>11.2%</td>
<td>7.9%</td>
<td>6.2%</td>
</tr>
<tr>
<td>GDP</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Agriculture</td>
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<td></td>
</tr>
<tr>
<td>Industry</td>
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<tr>
<td>Services</td>
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</tr>
</tbody>
</table>

*Source: Dr. Agnes Kalibatta, Minister of Agriculture, Rwanda*
Food consumption versus production

![Graph showing food consumption versus production from 2004 to 2009. The graph compares requirements and production in 1000 MT cereals equivalent. The requirements line shows a steady increase, while the production line shows fluctuations.](image-url)
Improved food security

2007A = 1,800 kcal/per/day

2009A = 2,500 kcal/per/day

- 13 districts below average
- 2 districts below avg. with 9 districts with excess

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Conclusions

- World food security can be attained
- High productive agriculture is needed, productivity increase per hectare indispensable
- Fuel from biomass may have detrimental side-effects
- Africa can achieve food security through focused interventions
  - Efficient fertilizer procurement and distribution
  - Site & crop specific nutrient management:
  - Targeted subsidies/purchasing power support to farmers