Energy Efficiency and Food Security for All -

# The Impact of Fertilizer

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**Presented by**
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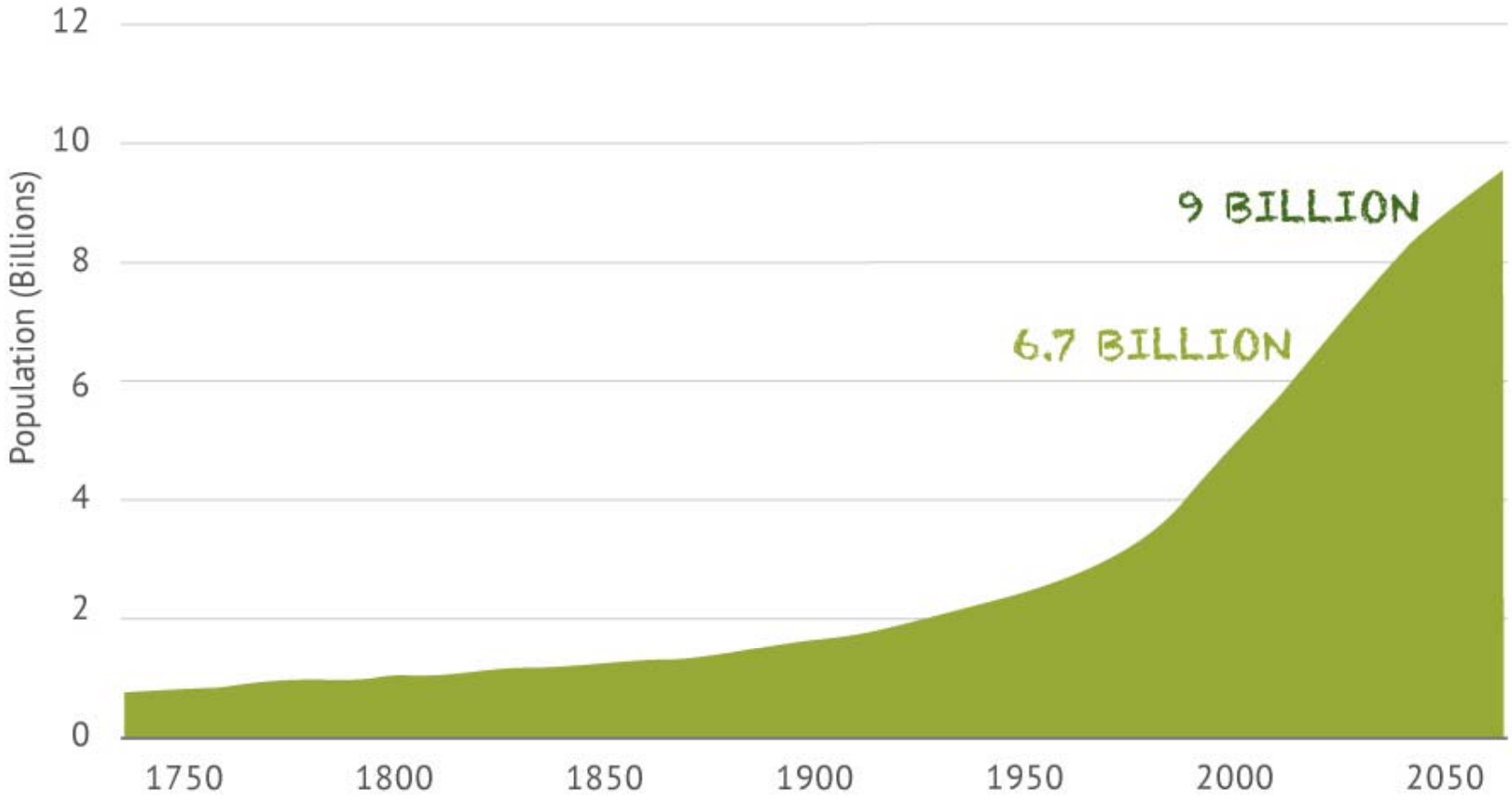
# Global Population Growth

There will be more than 9 billion people living in the world by 2050.




*Source: United Nations Estimates*

To meet the demand and prevent hunger and malnutrition, global food production must **increase by 70% and possibly double by 2050, using less land and water while decreasing environmental protection.**

*Source: Guardian, 2007, Global Food Crisis Looms as Climate Change and Population Growth Strip Fertile Land*

# Two Ways to Meet Food Production Needs

- **Increase the area under cultivation**
- **Intensify farm production**

# Take Away Message

- **The world cannot afford to continue:**
  - **Wasting natural resources**
  - **Polluting the environment**

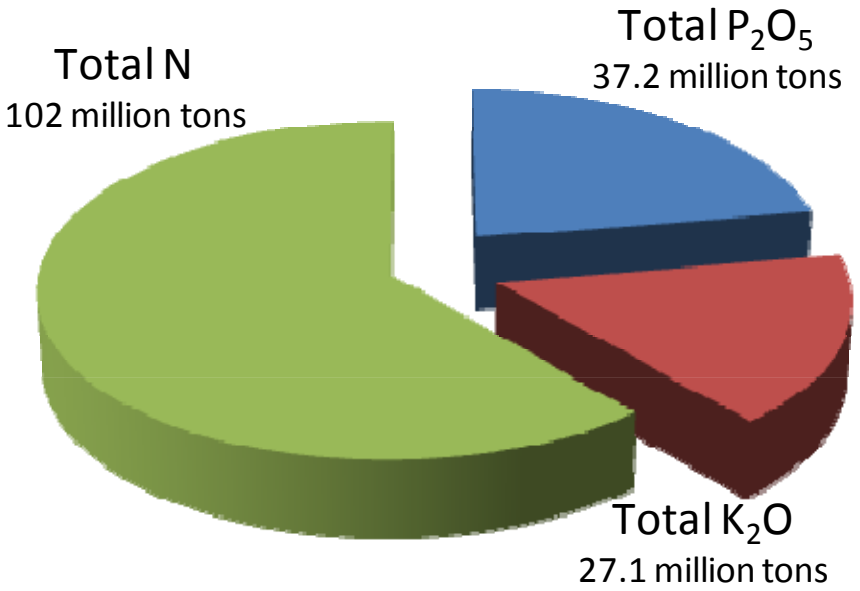
- **Therefore: We must improve the efficiency of food production**

# Why Improve Fertilizer Production and Use Efficiency?

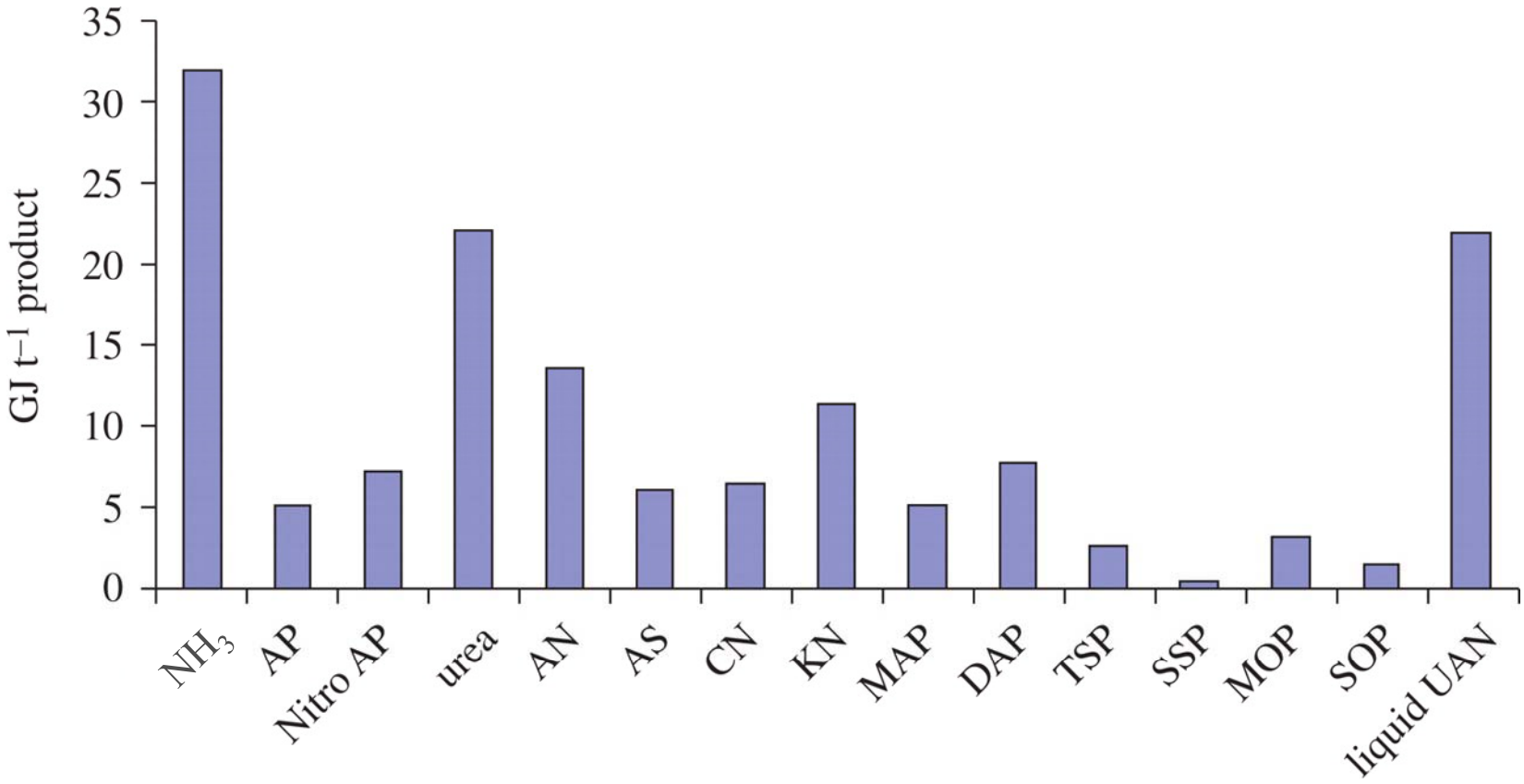
- **Growth in World's Demand for Fertilizer**

  1.2 billion metric tons fertilizer-N consumption over the next decade.

- **Low Efficiency**
  - 30%-40% of N applied to cereals in developing countries is used by crops.
  - 10-25% for initial P application

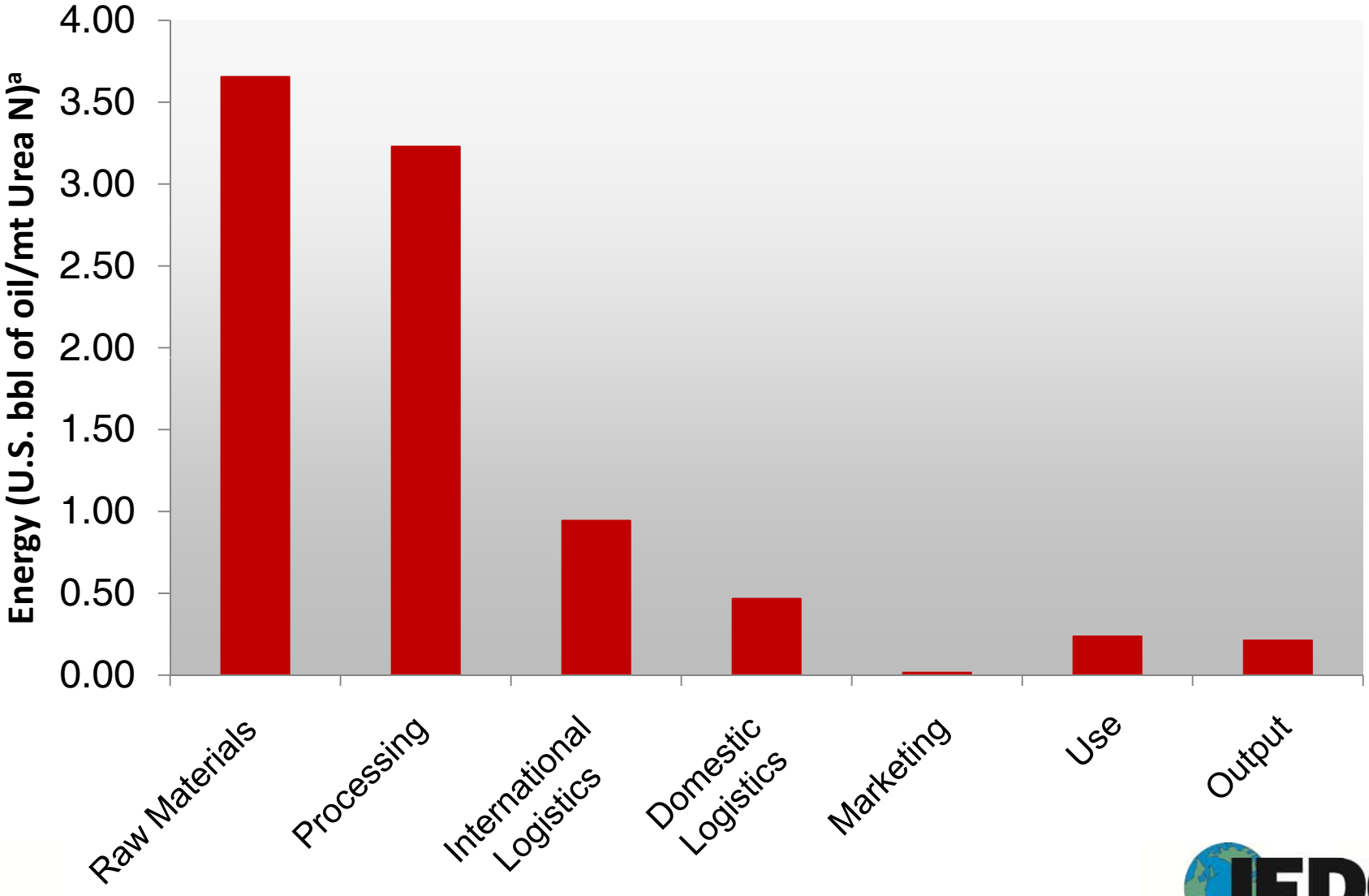


# Energy Inputs Into Important Fertilizers




Sources: Jenssen and Kongshaug, 2003; Woods, J. et al. 2011.

# Urea N

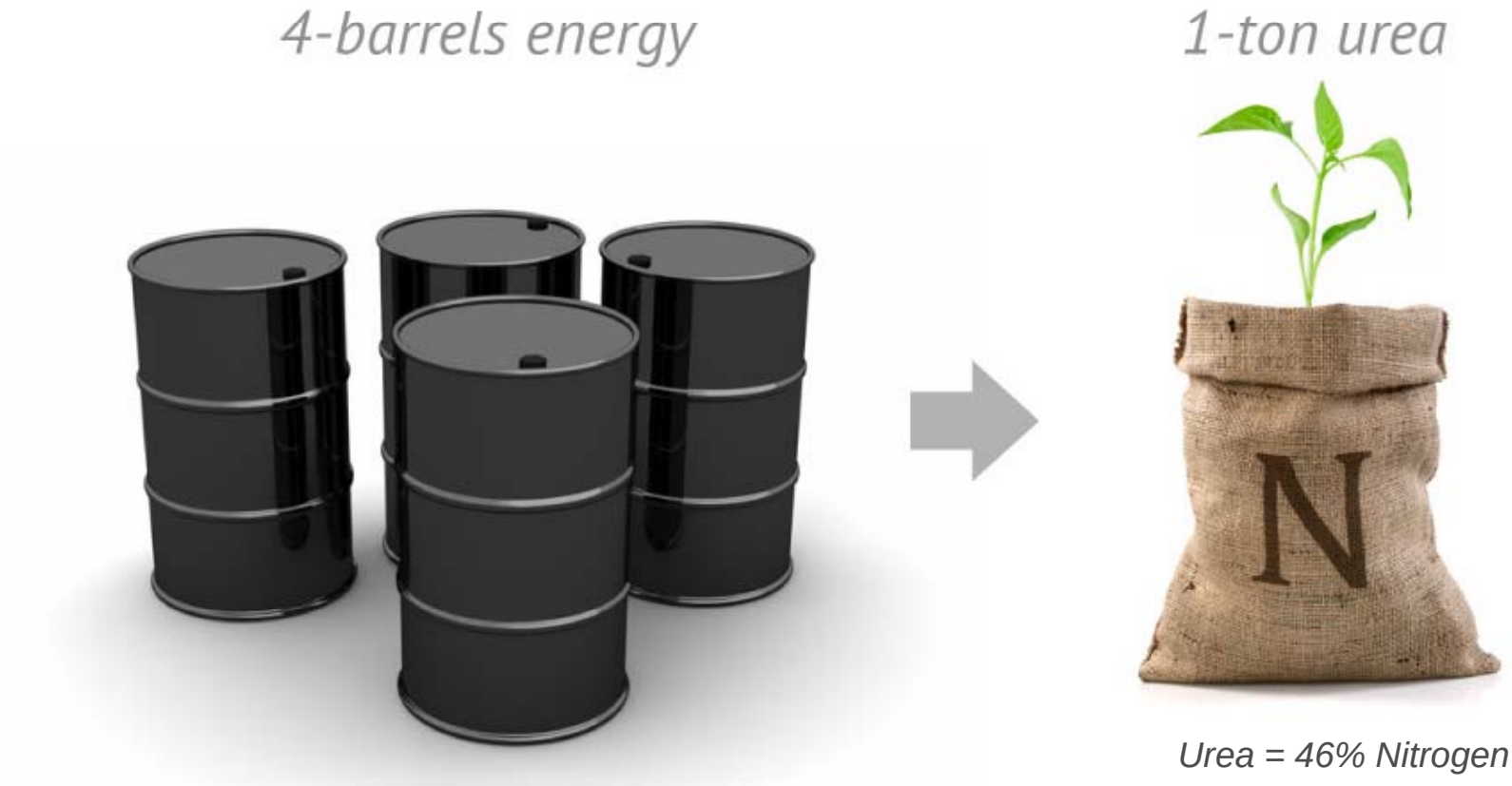



a. 1 U.S. bbl of crude oil = 6.12 GJ

Source: IFDC, 2009

# Urea production requires fossil fuels.

Current methods require the equivalent of four barrels of oil to produce one ton of urea.

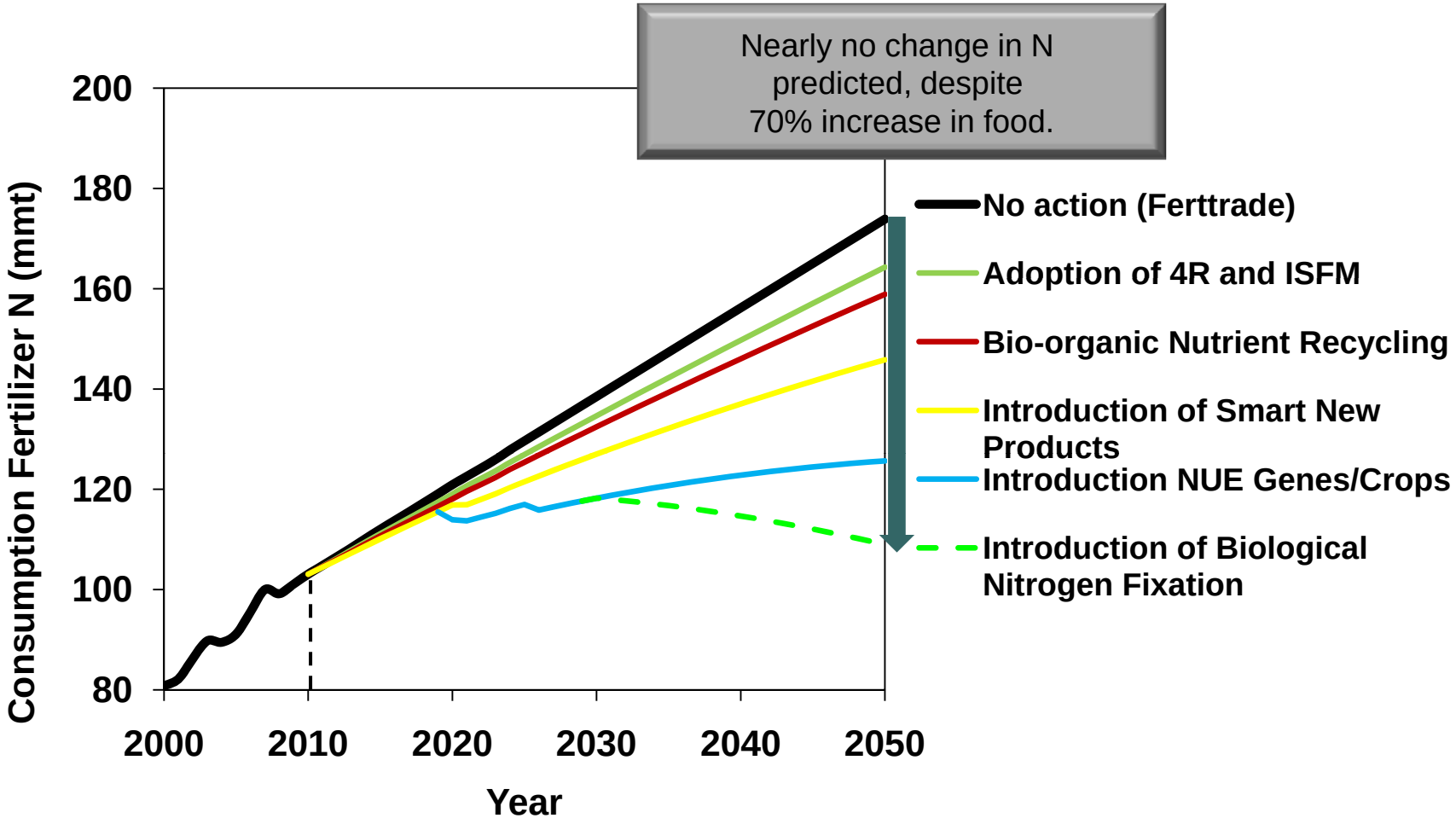



*Urea = 46% Nitrogen*

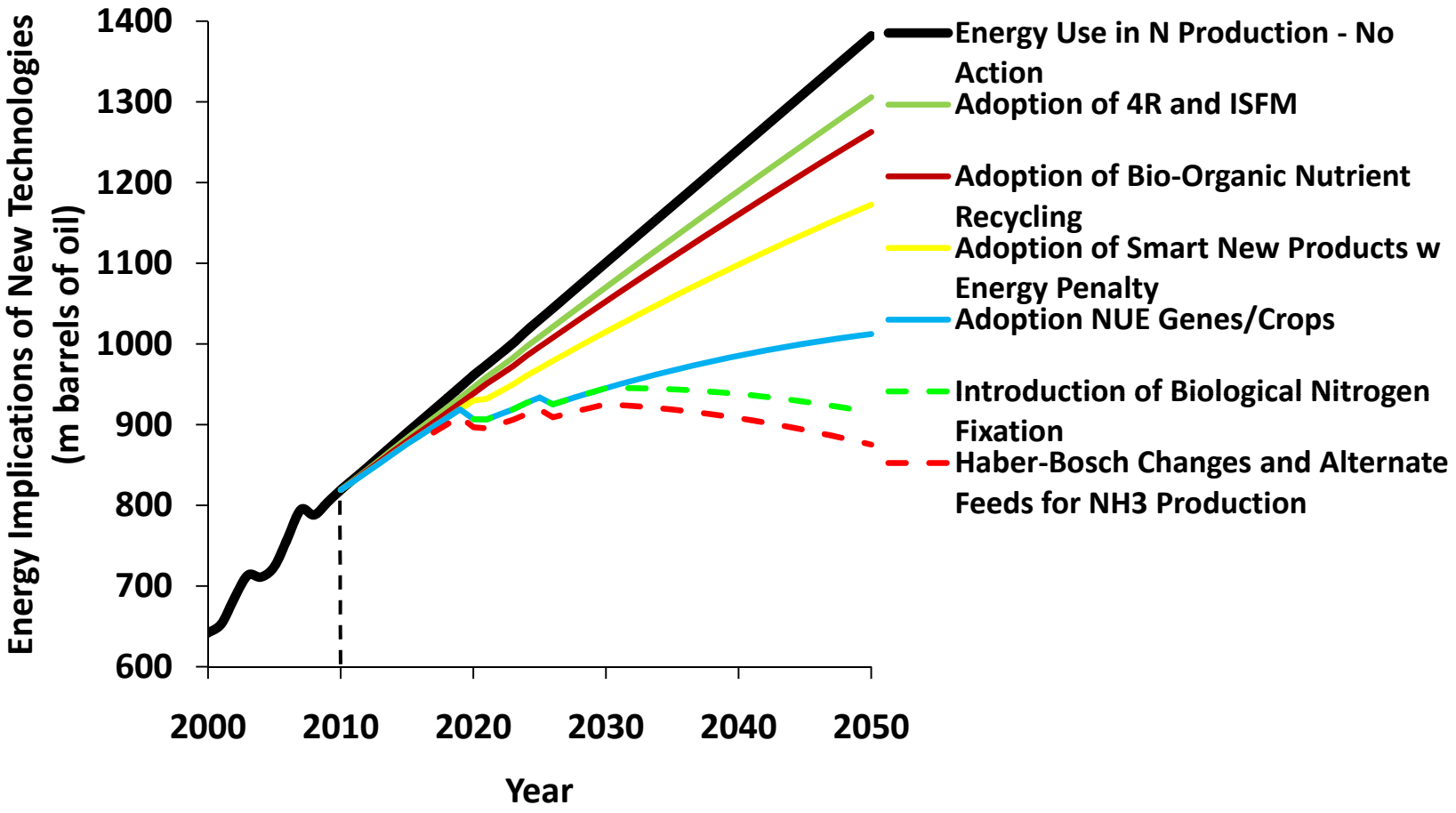

2 out of 3 bags of Urea
lost for split application
in Wetland Rice

# What Are the Energy and Environmental Implications for N Use Efficiencies and What Are the Mechanisms of Actions?

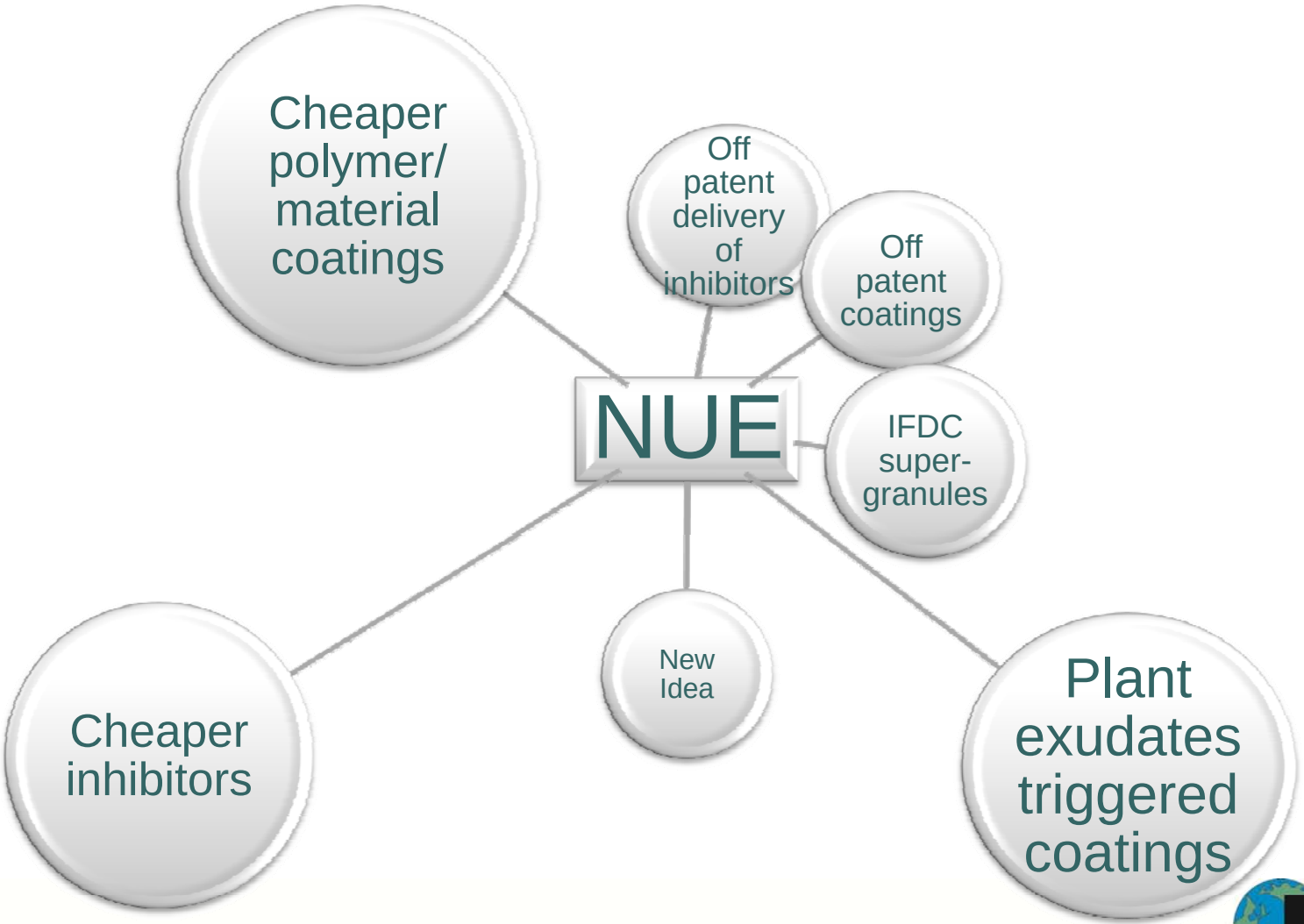
- Adoption of 4Rs and Integrated Soil Fertility Management (ISFM)
- Introduction of smart new products
- Introduction of NUE genes in crops
- Introduction of biological nitrogen fixation into non-legume crops


Nearly no change in N predicted, despite 70% increase in food.
Consumption Fertilizer N (mmt)
200
180
160
140
120
100
80
2000
2010
2020
2030
2040
2050
Year
No action (Ferttrade)
Adoption of 4R and ISFM
Bio-organic Nutrient Recycling
Introduction of Smart New Products
Introduction NUE Genes/Crops
Introduction of Biological Nitrogen Fixation

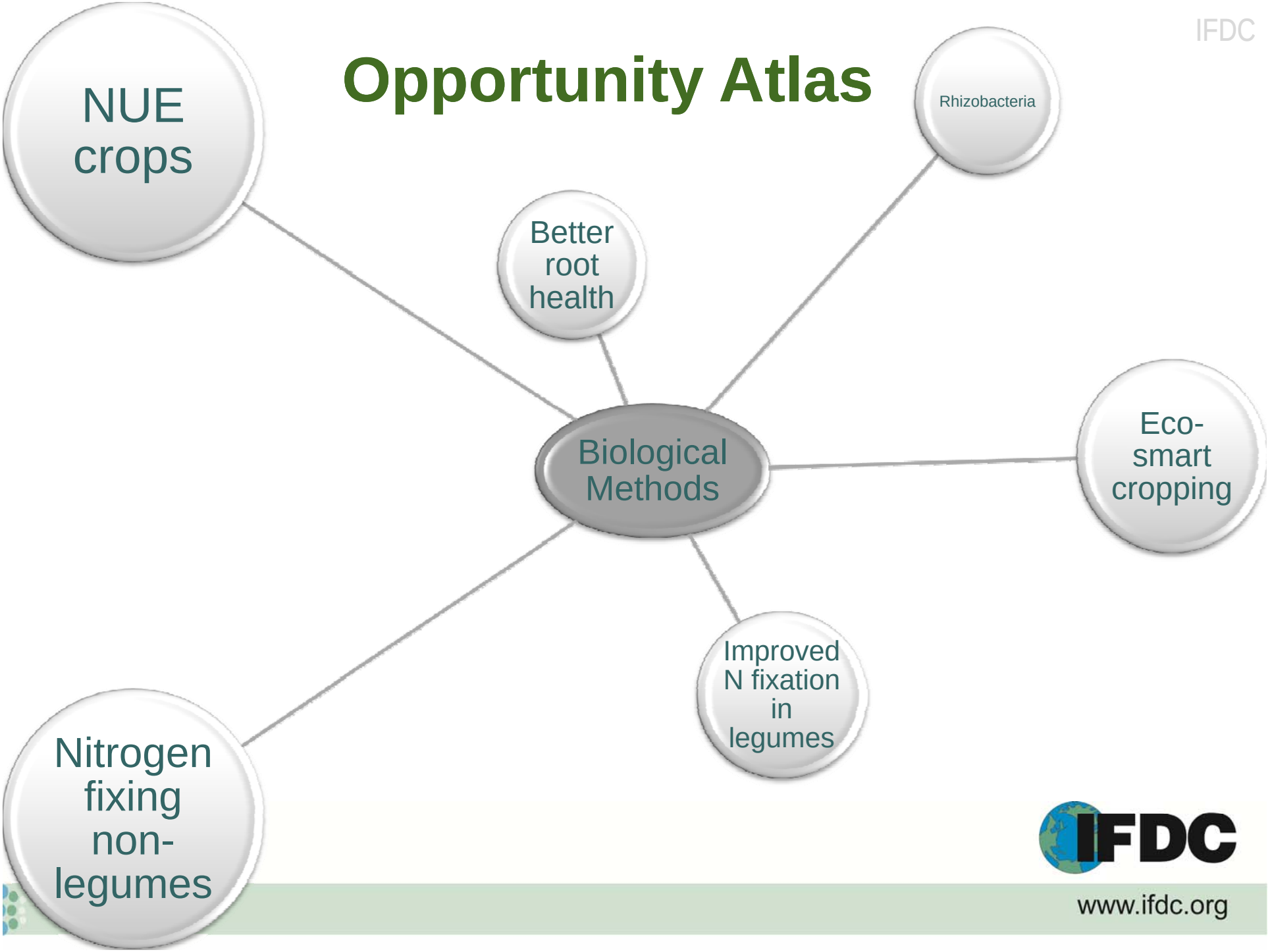
# N Energy Slide



# Opportunity Atlas: Cheaper and Greener

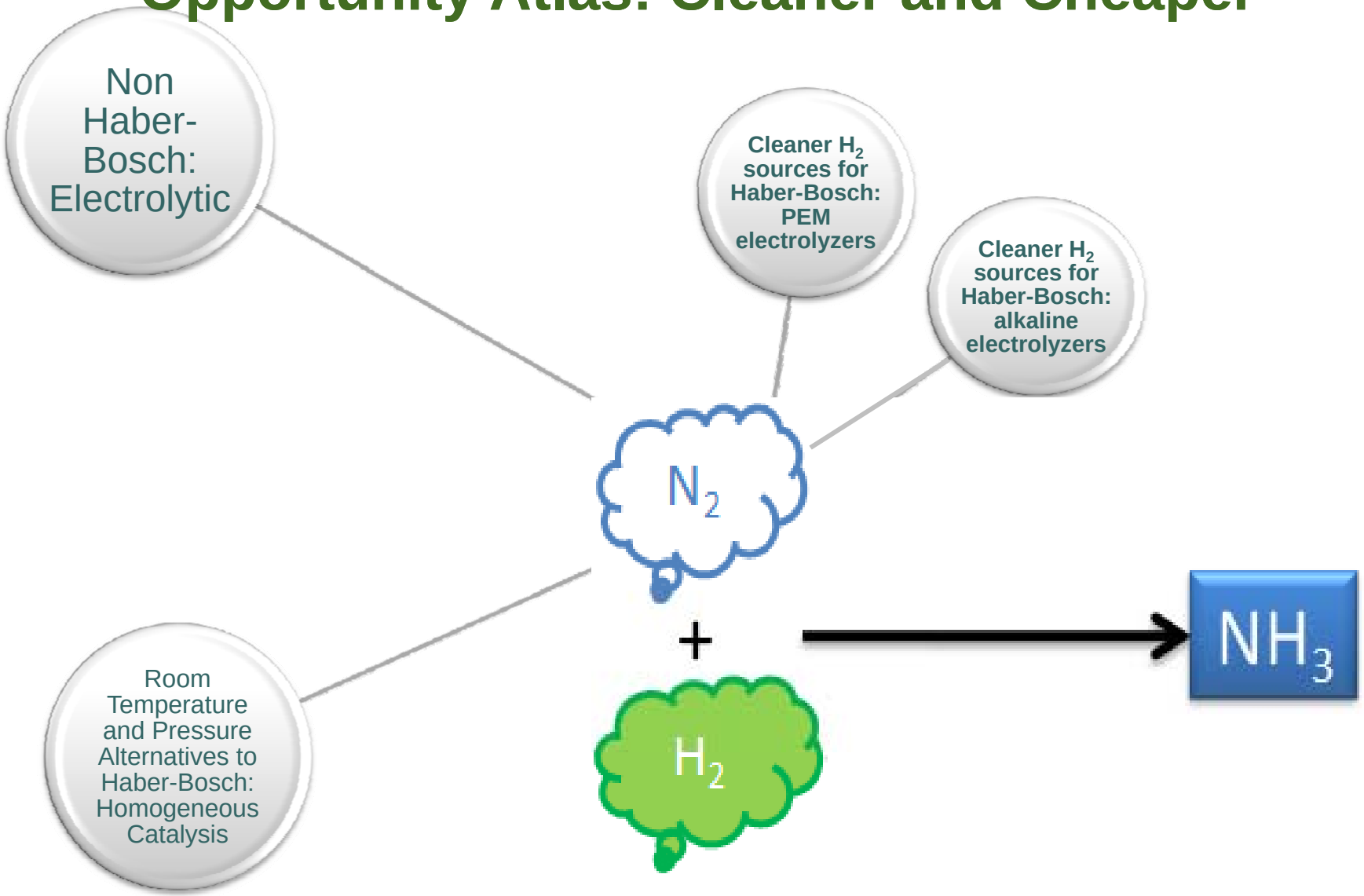


# Opportunity Atlas



# Opportunity Atlas: Cleaner and Cheaper



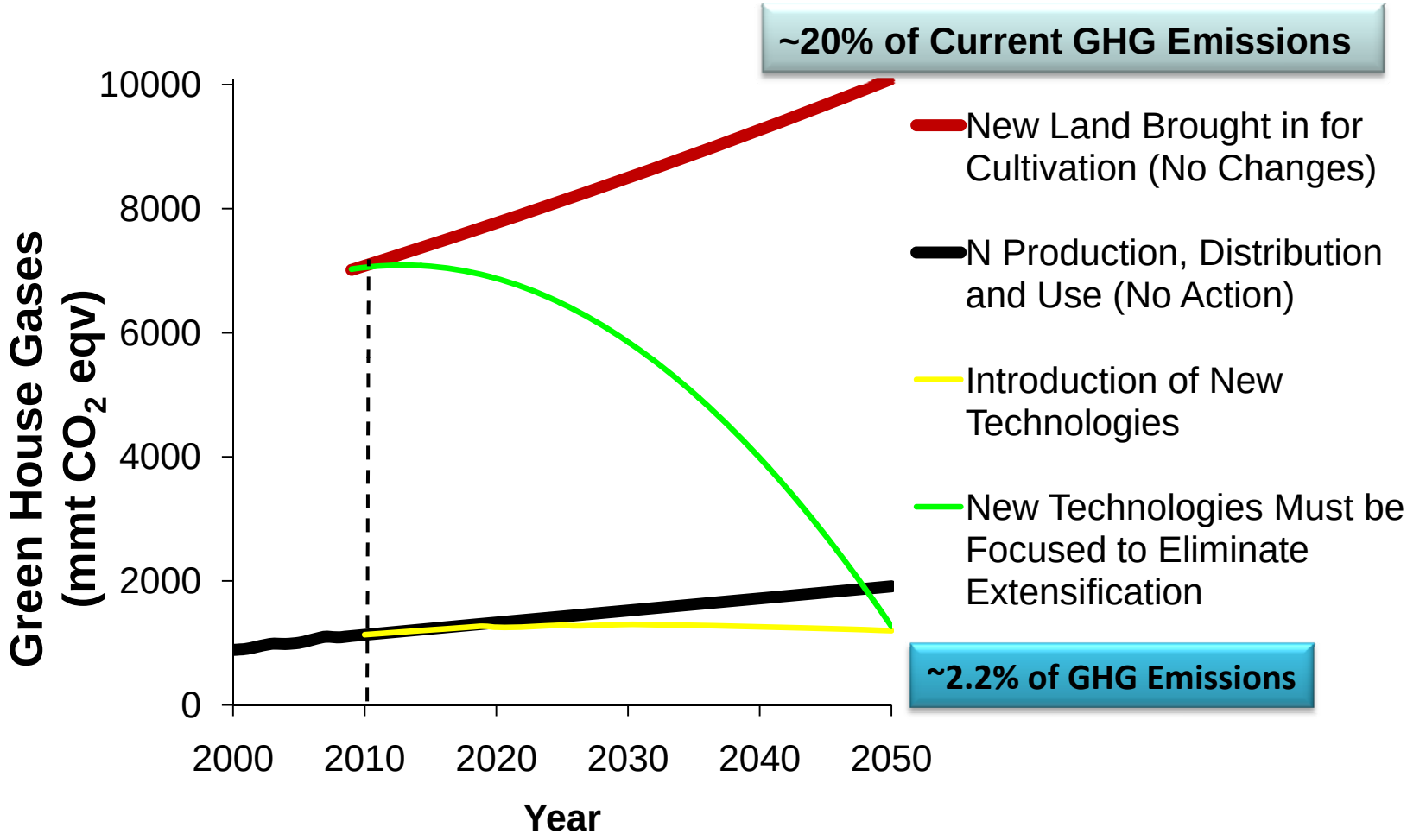


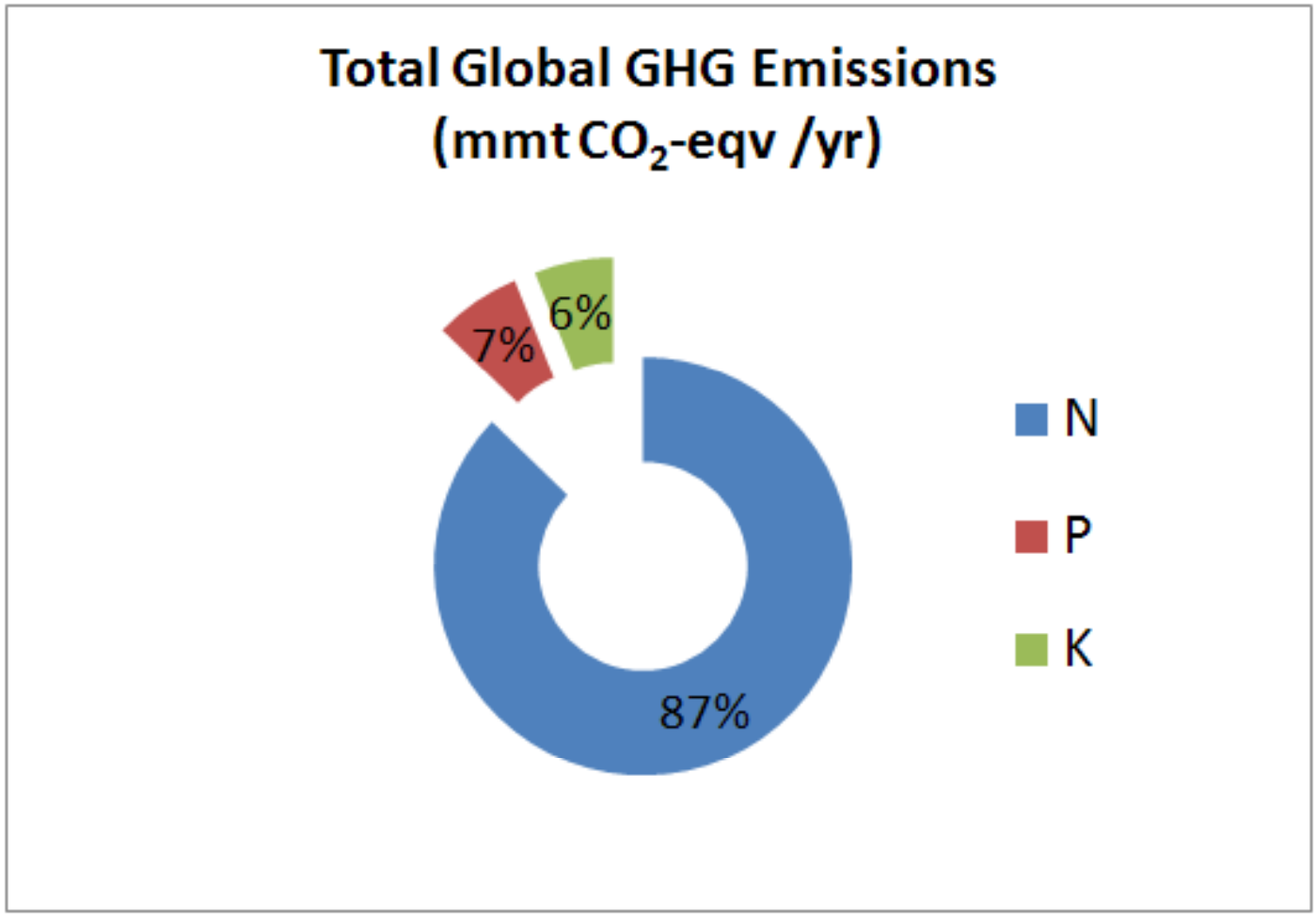
# Potential Impact of Non-Fossil Fuel $H_2$ Source for Urea Production

- **85 mmt $NH_3$ → 2008 global urea production of 146 mmt***
- **1.2 tons $CO_2$ produced per ton of $NH_3$ from natural gas**
- **If non-fossil fuel $H_2$ source used:**
  - **Reduce annual emissions of $CO_2$ to atmosphere by 102 mmt**
  - **Potential to use flue gas $CO_2$ from power plants (coal-fired plants produce 1.02 ton $CO_2$ / MWh)**
  - **2009 U.S. power generation from coal – 1750 m MWh (US EIA)**

* 0.58 ton $NH_3$ and 0.73 to 0.76 ton $CO_2$ required per ton urea

# N $CO_2$ Slide


~20% of Current GHG Emissions
10000
8000
6000
4000
2000
0
Green House Gases (mmt $CO_2$ eqv)
2000
2010
2020
2030
2040
2050
Year
New Land Brought in for Cultivation (No Changes)
N Production, Distribution and Use (No Action)
Introduction of New Technologies
New Technologies Must be Focused to Eliminate Extensification
~2.2% of GHG Emissions




**Source: IFDC, 2011**

# Phosphate

- Phosphate (P) fertilizers come from phosphate rock – a non-renewable resource.
- World phosphates reserves declining in amount and quality.
- Conversion to water-soluble products – more expensive/less efficient.

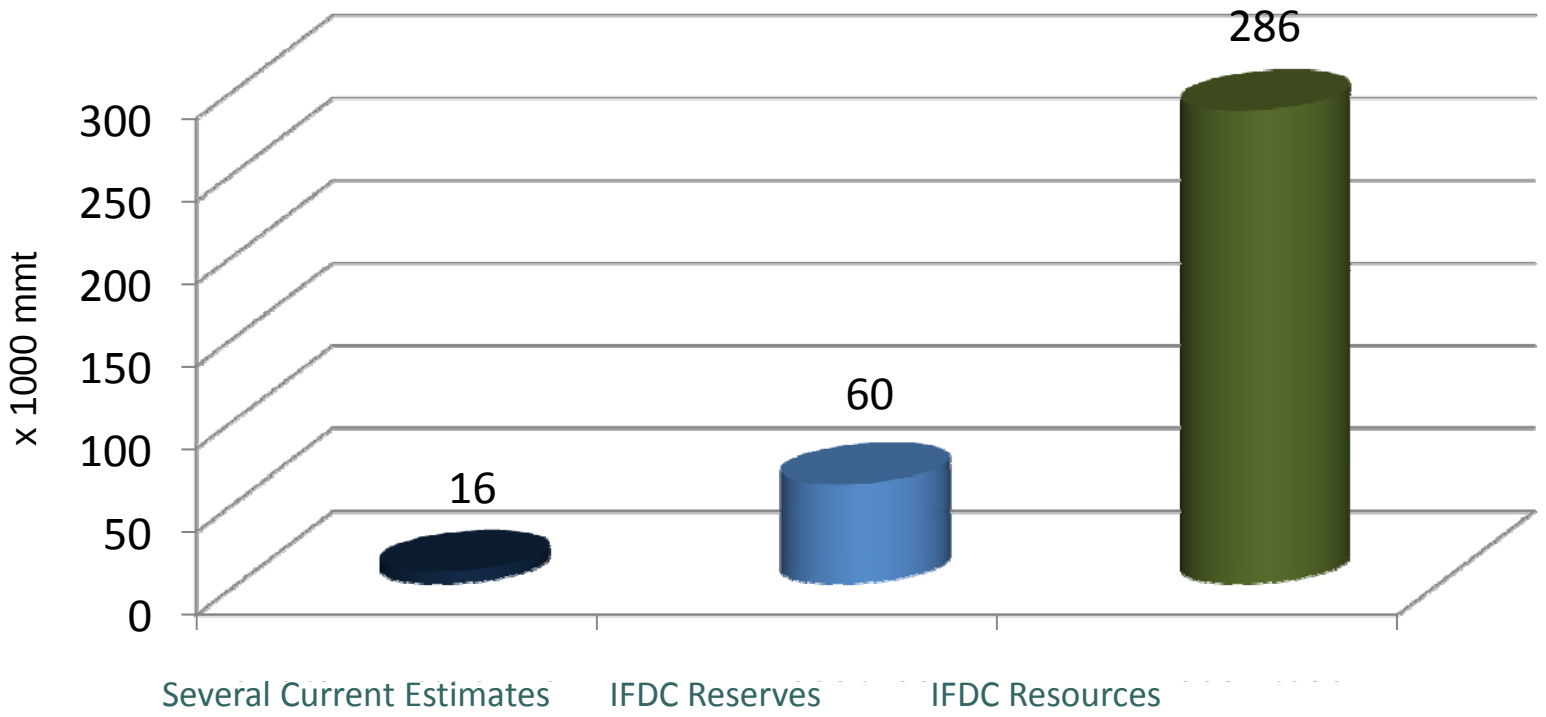
# Global Phosphate Rock Production

## Phosphate: Majority used as fertilizer

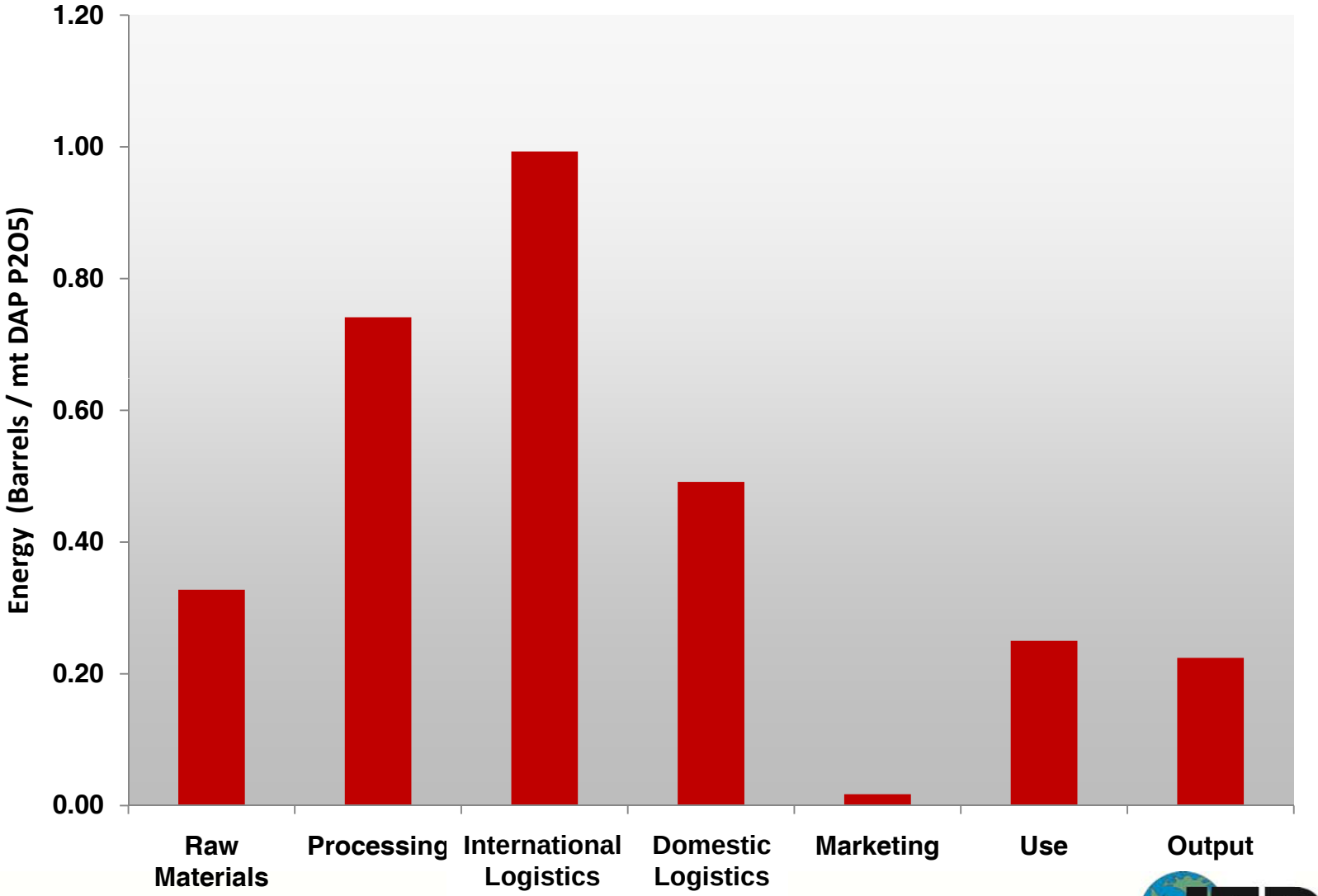

- 160 mmt (2008)*
- 82% $P_2O_5$ for fertilizer

*Source: USGS

# Reserves and Resources



# Phosphate




Source: IFDC, 2010

# Innovations in P

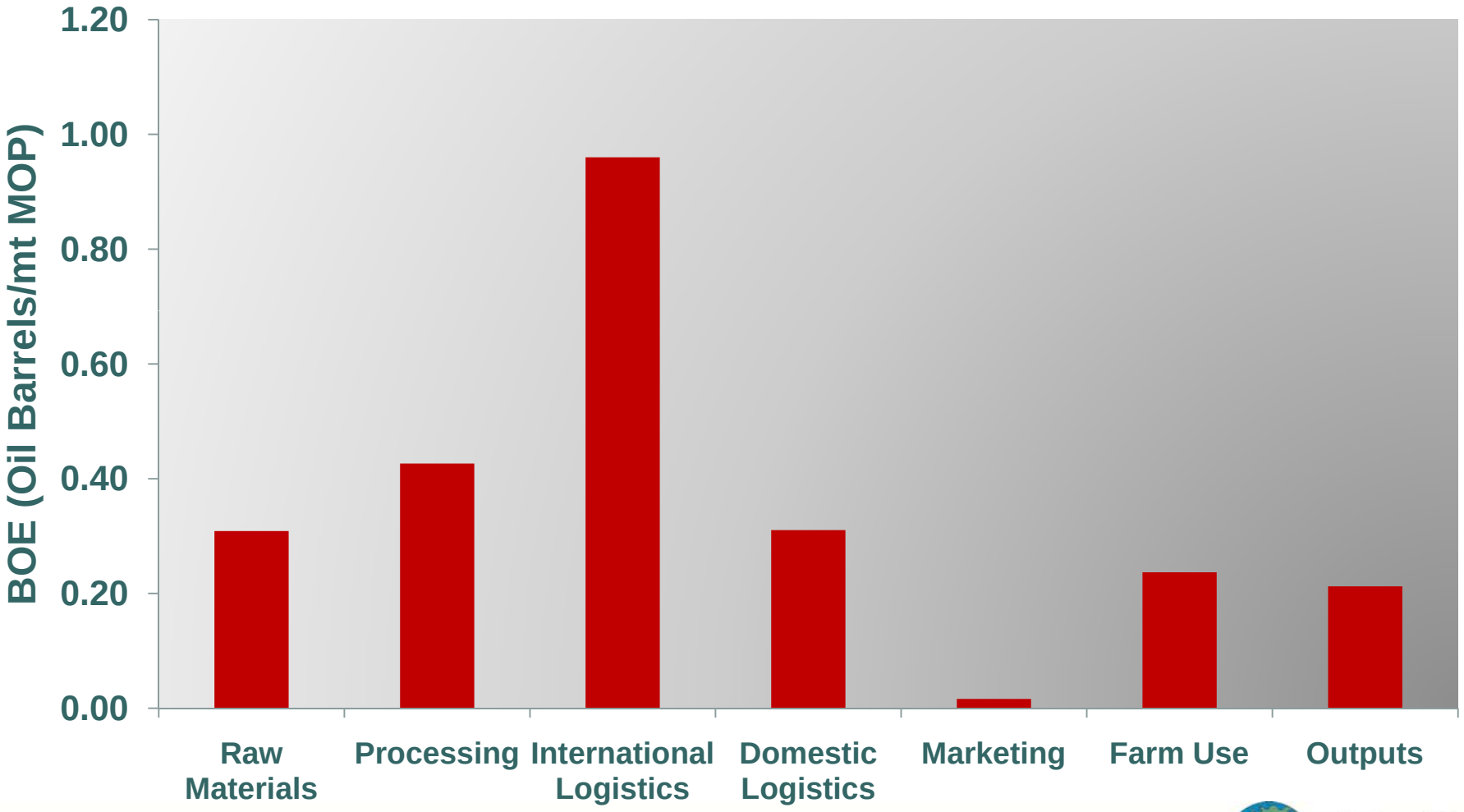
## Three Options

- New Processes/Product
  - Increase efficiency of mining and processing
  - Recover phosphates from fine wastes (ponds, piles)
  - Direct application of phosphate rock
  - Fertilizer Modifications
- Soil Modifications and Additions
- Plant Genome Modification

# Potash

- Potassium (K) fertilizers come from potassium-bearing minerals – a non-renewable resource.
- World potassium-bearing reserves is adequate to meet world demand for more than 300 years.
- Investment cost to open a new mine is high.

# Potash

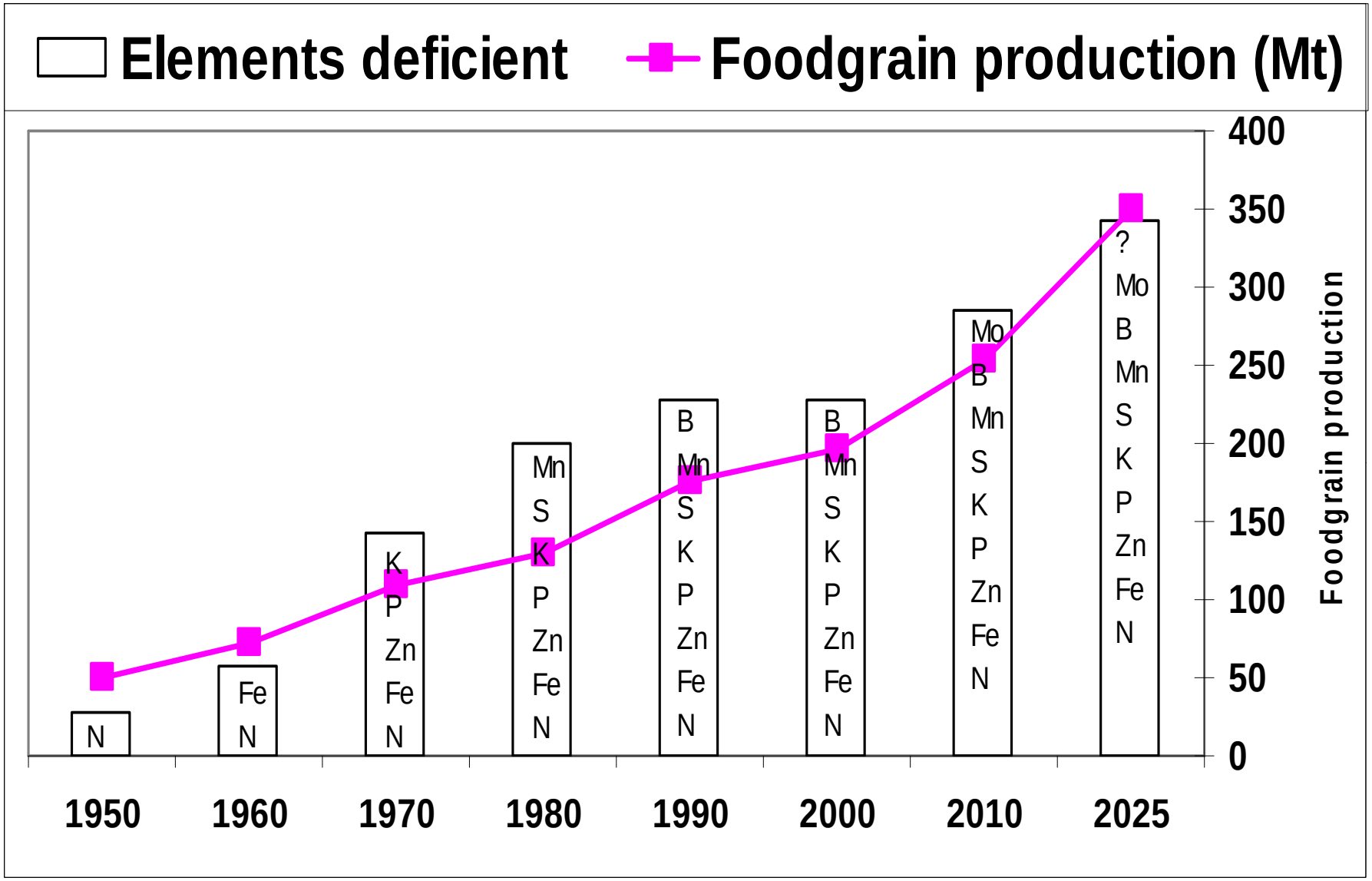



Source: IFDC, 2010

# Innovations in K

## Options

- Non-Conventional Sources of mining K
- Fertilizer Modifications
- Soil Modifications and Additions
- Plant Genome Modification




Source: Singh, A.K., 2011

**We must take a global approach to solving this problem.**

**We must invest in new fertilizer research.**

**VFRC Vision:**
**The world's smallholder farmers have ready access to sustainable, affordable, efficient and environmentally friendly fertilizer technologies.**

IFDC

www.ifdc.org

# Virtual Fertilizer Research Center (VFRC)

**To develop the next generation of fertilizer products and processes.**

- **More cost effective**
- **More conserving of natural resources**
- **More protective of the environment**

# Thank you