Arcadia
BIOSCIENCES

Finding New Business Opportunities with Sustainability in-mind

ABIC 2010, Saskatoon, Sep 13, 2010

Mission

Arcadia develops plants that improve the environment and human health

Arcadia Corporate Background

Activity: to develop solid proof of concept for budding technologies by several years of testing under greenhouse and field conditions

- Founded in 2003
- Privately Owned
  - Exeter Life Sciences (majority)
  - Vilmorin
  - CMEA Ventures
  - BASF Ventures
  - Saints Capital
- Headquarters & main R&D facilities in Davis, California
- Additional facilities in Seattle, WA and Phoenix, AZ
- Total staff 80; R&D staff 60

Global Warming

Whatever the cause, climate change/global warming is a fact

Challenge

1. Reduce further global warming/greenhouse gas emissions
2. Secure food supply in changing climate
3. Keep agriculture-food complex in business

Combine affordable high food production, sufficient for nourishing world population, with sustainable agriculture

Low impact on environment and human health

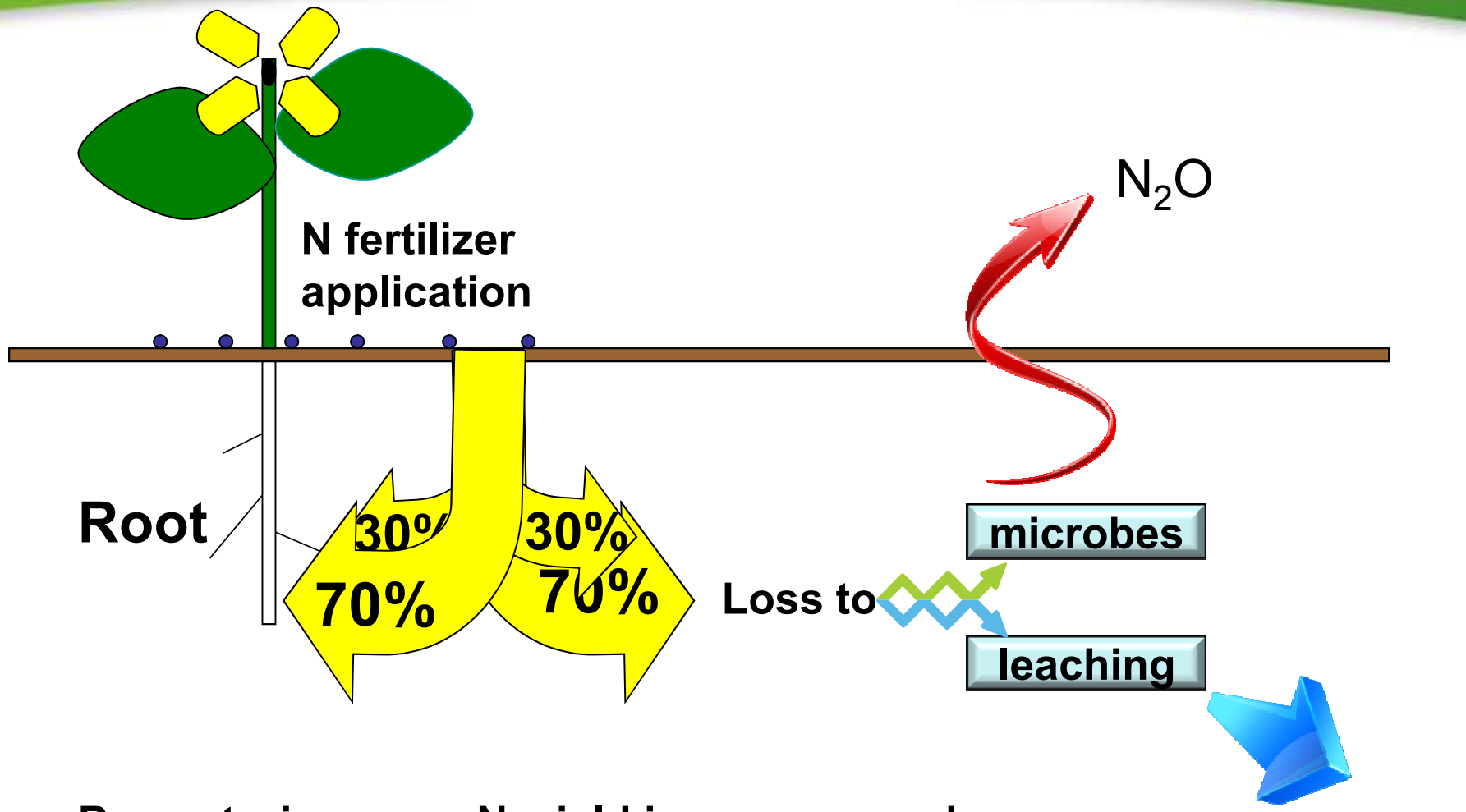
Sustainability of High Yields

- Increased yields needed to meet production demands
  - Increased agricultural inputs (fertilizer and water) are needed to sustain high yields
- Challenges of High Yield
  - Environmental damage from industrial growing practices
  - Heavy fertilizer use contributes to GHG emissions and pollution of water ways
  - Increasing burden on use of fresh water

Nitrogen Efficiency – Situation

- Nitrogen fertilizer is the “fuel” of agriculture
- $60 billion annual market; tied to natural gas
- Less than 50% of applied nitrogen is used by plants
- The remainder contributes to pollution
  - Water runoff ➔ “Dead Zones”
  - Air emissions ➔ Greenhouse Gas Emissions

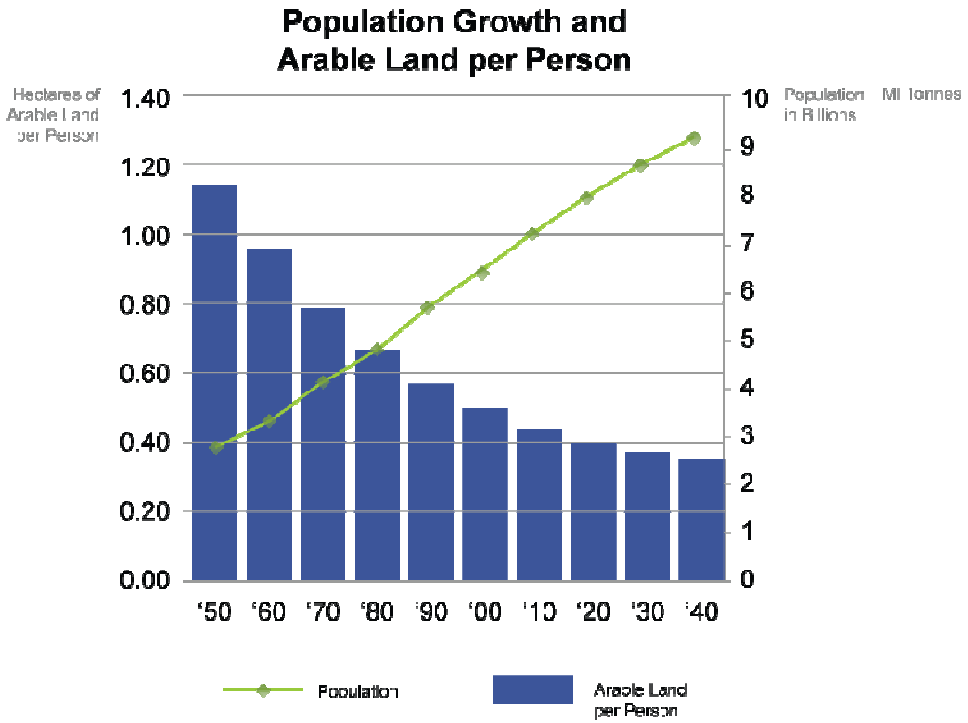
70% of Nitrogen Fertilizer is Lost



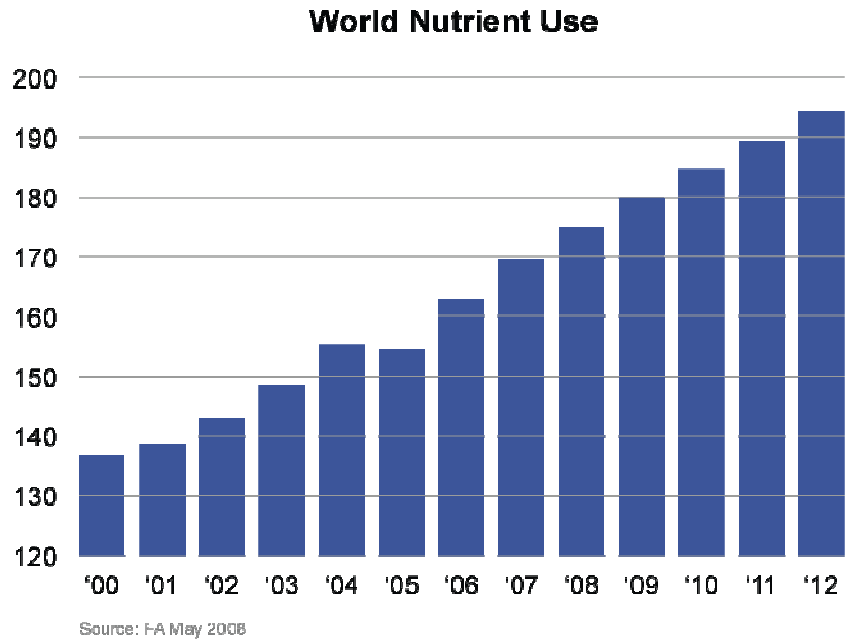
By capturing more N, yield increases can be gained = Nitrogen Use Efficiency (NUE)

Nitrogen Efficiency – Situation

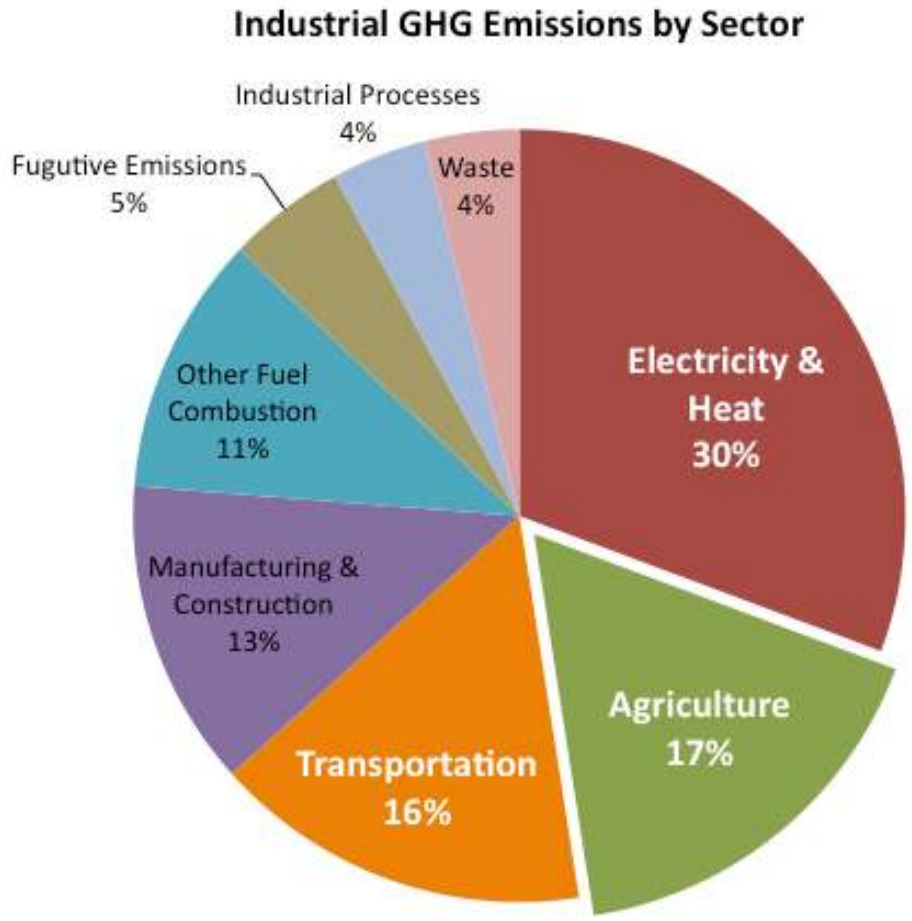
Land per person declining



Agricultural productivity driven by fertilizer



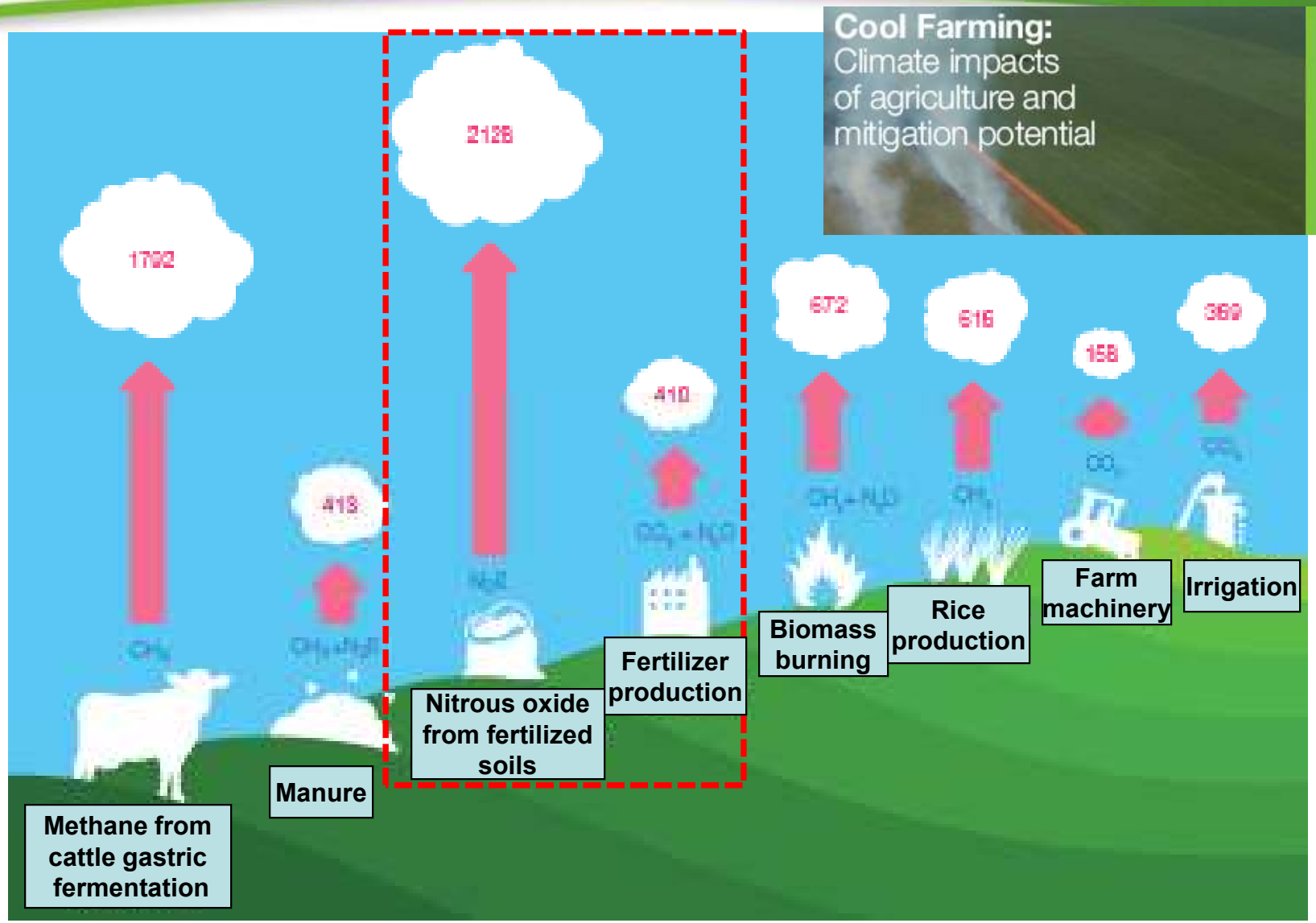
Nitrogen and the Environment



Climate Analysis Indicators Test (CAIT) Version 4.0 (Washington, DC: World Resources Initiative, 2008)

- Agriculture is the world's #2 industrial source of greenhouse gasses
  - Nitrogen fertilizer is the key driver
  - Nitrogen converts to nitrous oxide in the soil
  - Nitrous oxide is 300 times as potent as carbon dioxide

Greenpeace Agrees



Nitrous Oxide is a Potent Greenhouse Gas

Nitrous Oxide has 300 times the global warming potential of CO_2.

Table 8.1 Characteristics of Kyoto Greenhouse Gases

Despite the higher GWP of other greenhouse gases over a 100-year time horizon, carbon dioxide constitutes around three-quarters of the total GWP of emissions. This is because the vast majority of emissions, by weight, are carbon dioxide. HFCs and PFCs include many individual gases; the data shown are approximate ranges across these gases.

	Lifetime in the atmosphere (years)	100-year Global Warming Potential (GWP)	Percentage of 2000 emissions in CO_2e
Carbon dioxide	5-200	1	77%
Methane	10	23	14%
Nitrous Oxide	115	296	8%
Hydrofluorocarbons (HFCs)	1 – 250	10 – 12,000	0.5%
Perfluorocarbons (PFCs)	>2500	>5,500	0.2%
Sulphur Hexafluoride (SF_6)	3,200	22,200	1%

Source: Ramaswamy et al. (2001)[8] and emissions data from the WRI CAIT database[9].

Example: Global Rice Production and Greenhouse Gas Emissions

12 million metric tons (MT) nitrogen causes 100 million MT Greenhouse Gas

100 MM MT CO_2e

30 MM MT CO_2e (as CO_2)

20 MM MT CO_2e (as N_2O)

50 MM MT CO_2e (as 169,000 MT N_2O)

Natural Gas

12.2 Million MT Nitrogen

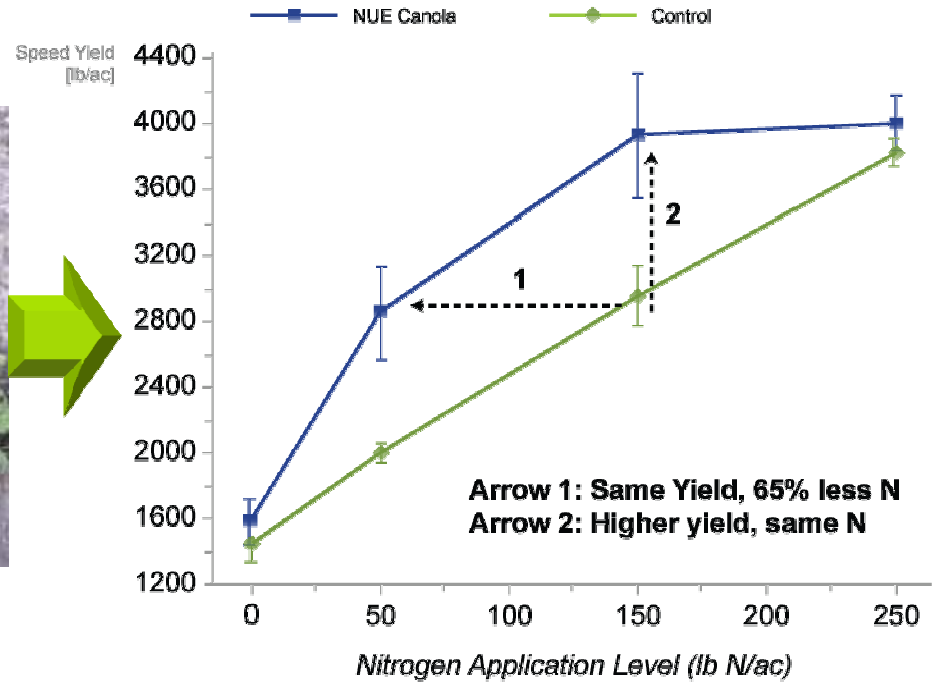
Natural Gas | N Fertilizer Manufacture | Global Rice Production

Arcadia's Nitrogen Use Efficiency Technology

- Technology: U of Alberta, Good lab
- Proof of concept: canola and rice
- Mode of action: stress-induced action of an amino transferase leads to more efficient remobilization of N in the plant
- Effect: increased biomass and grain yield under low N growth conditions
- Published: Muench et al (1994) Plant Mol Biol 24, 417-27
  Shrawat et al (2008) Plant Biotech J 6, 722-32

Nitrogen Use Efficiency (NUE) Technology

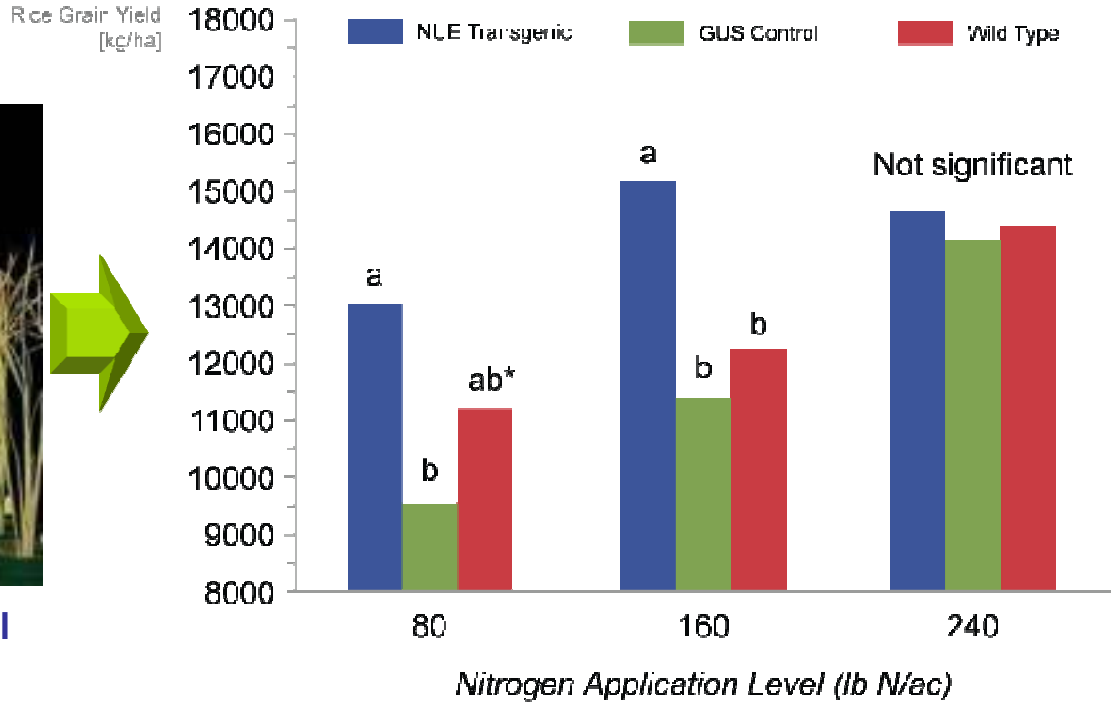
Increased Yield per Unit of Nitrogen



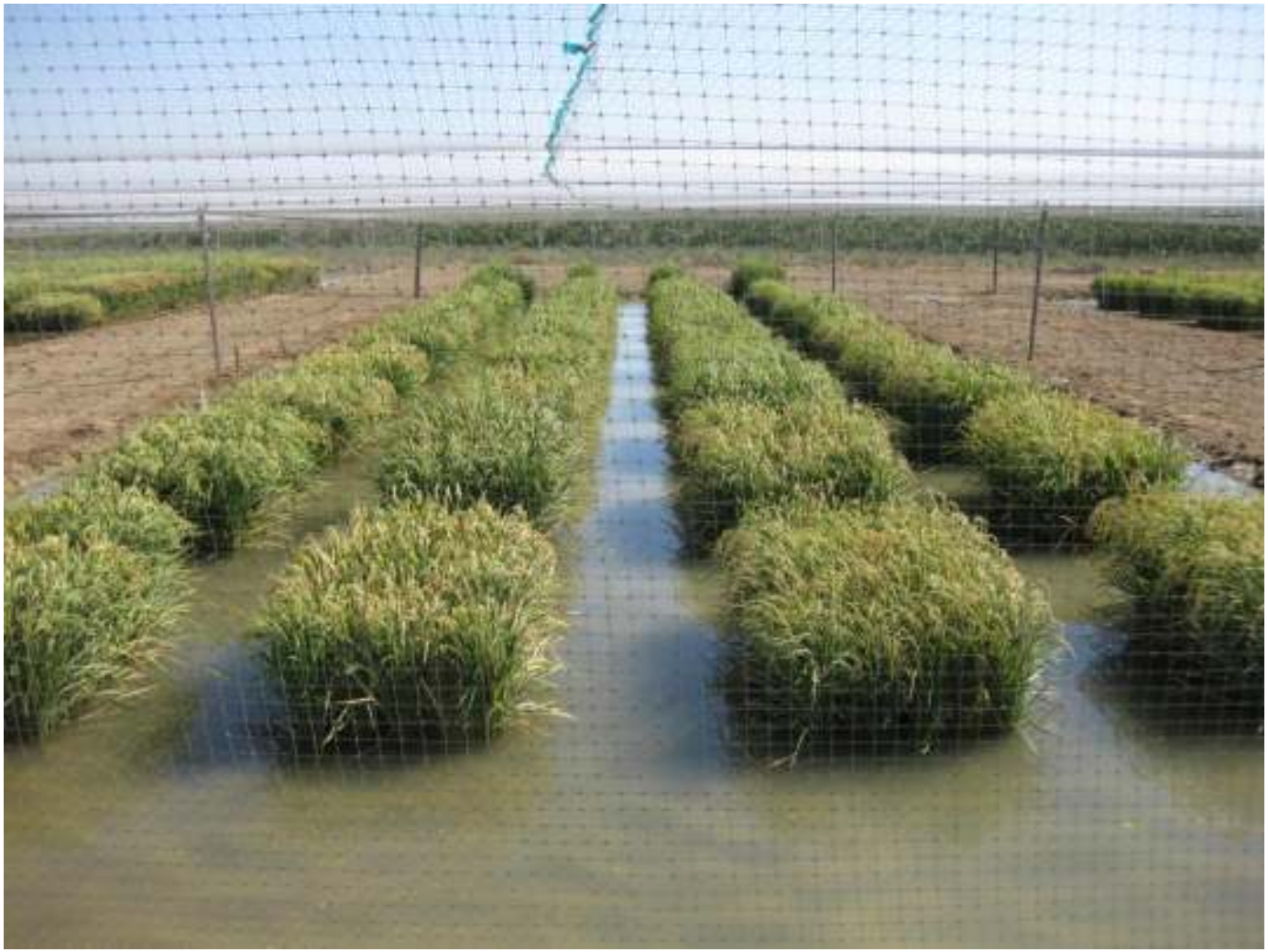
Nitrogen Use Efficiency Technology

Increased Yield per Unit of Nitrogen

NUE Rice **Control**

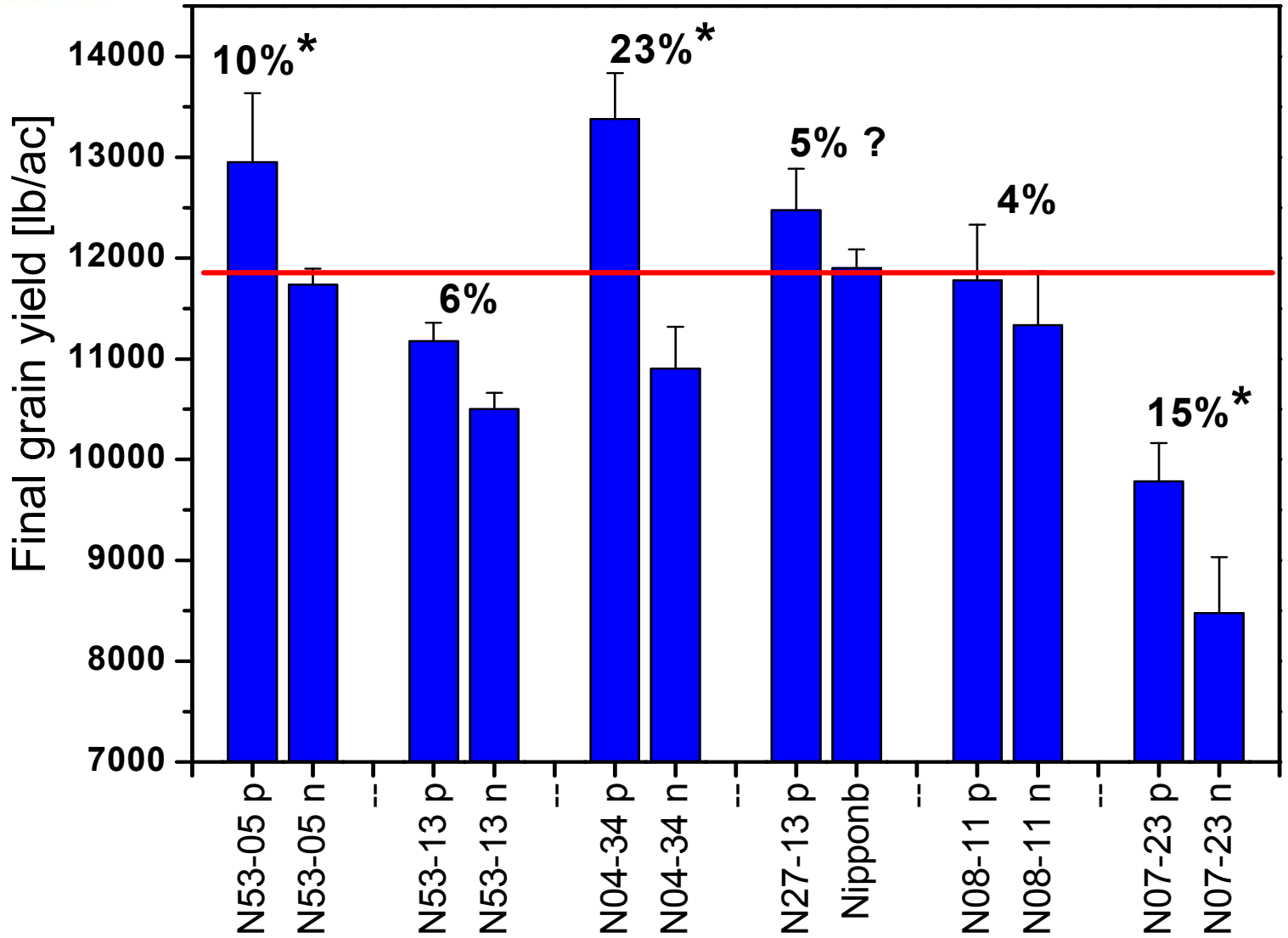


2009 NUE Rice Field Trial in California



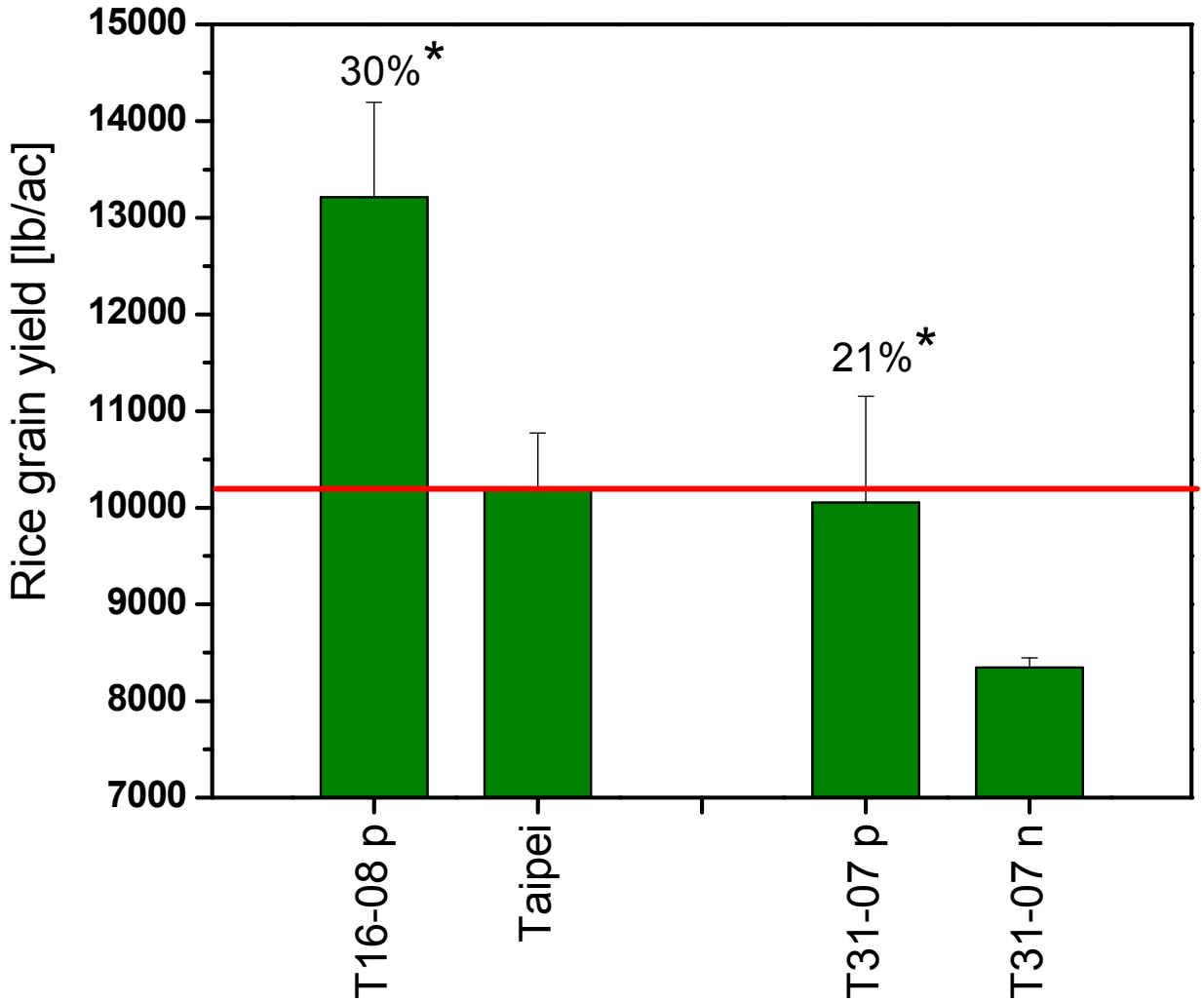
Nipponbare Events at 116 lbs N/ac in 2009

(Final grain yield with grain moisture adjusted @12%)



Taipei Events at 117 lbs N/ac in 2009

(Final grain yield with grain moisture adjusted @12%)



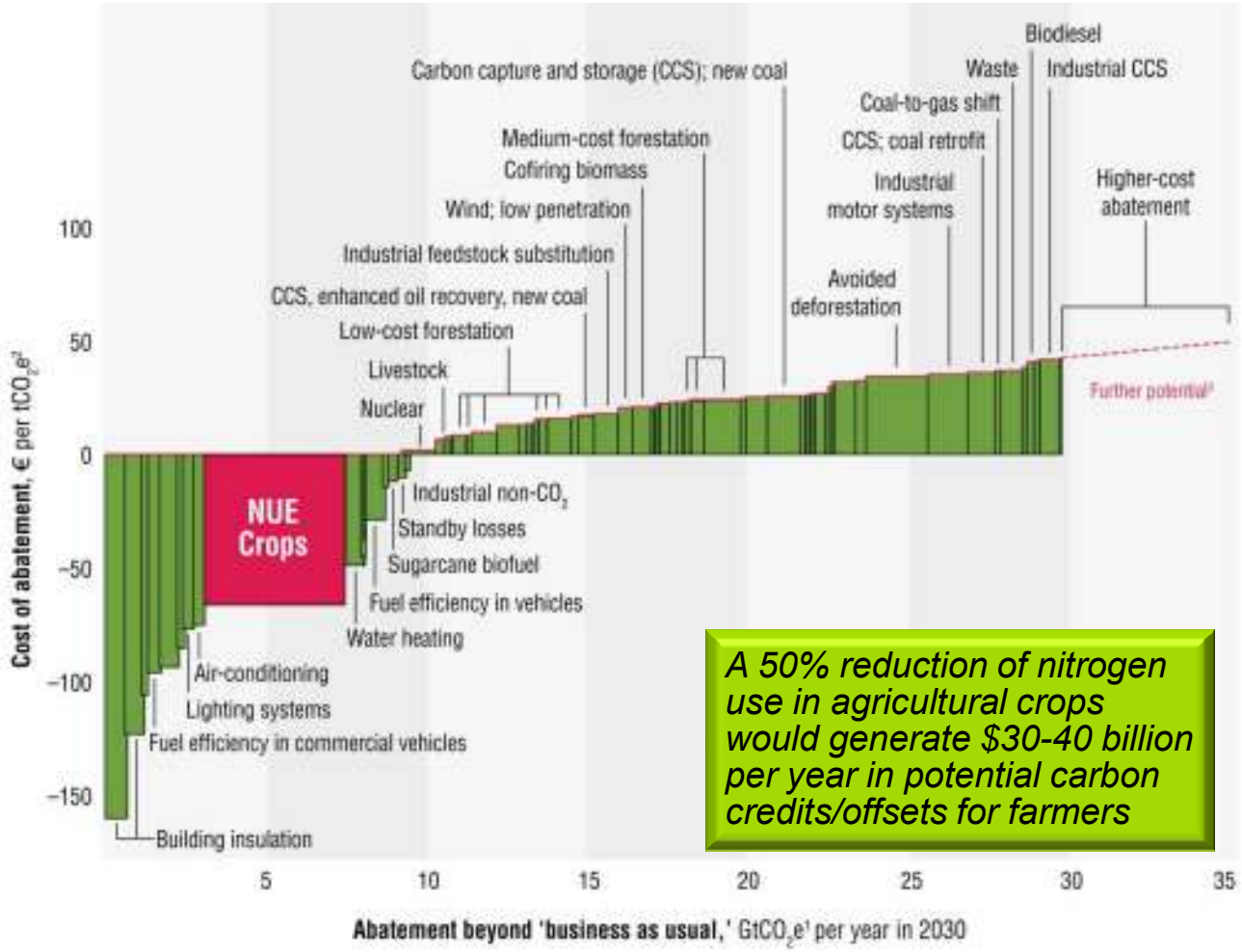
2010 NUE Rice Field Trial - Aerial View

2010 NUE Rice Field Trial – July 28

Finding New Business Opportunities with Sustainability in-mind

Carbon Reduction Opportunities

NUE Crops: Low Cost, High Volume GHG Reduction

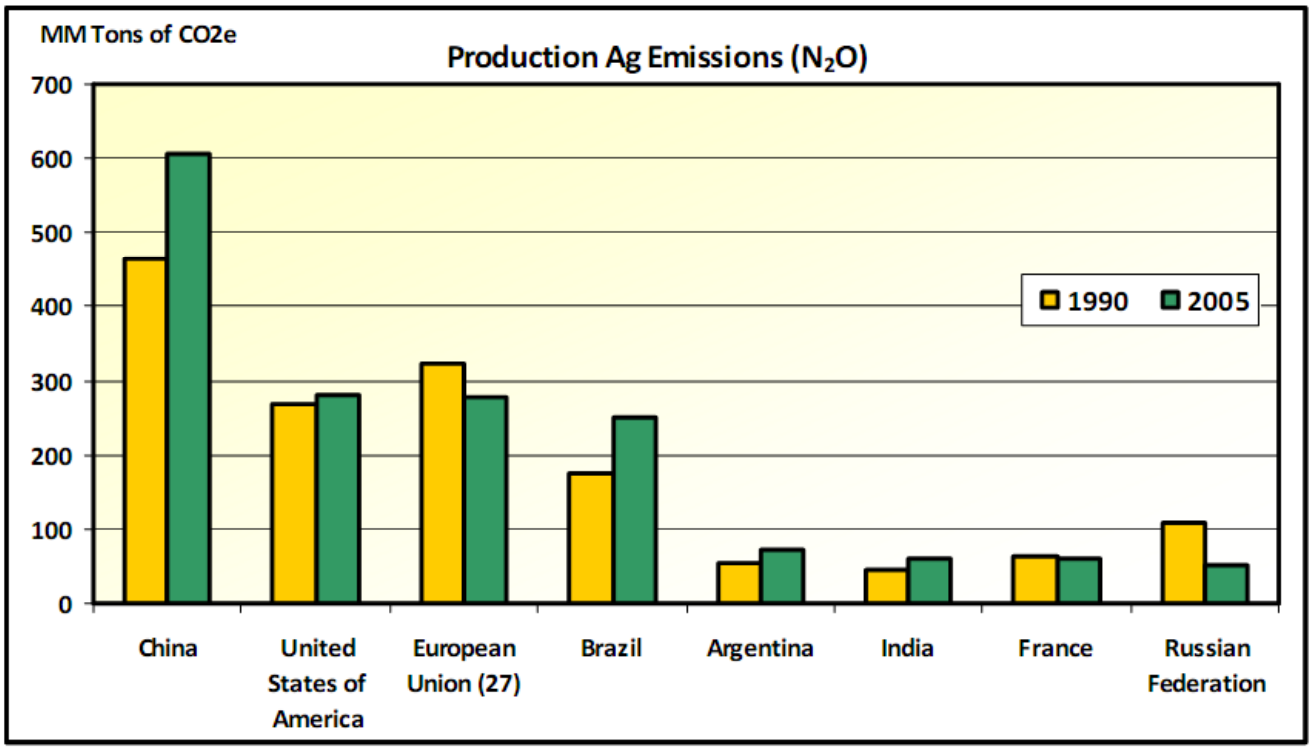


A 50% reduction of nitrogen use in agricultural crops would generate $30-40 billion per year in potential carbon credits/offsets for farmers

Adapted from: *A cost curve for greenhouse gas reduction,* The McKinsey Quarterly, 2007 Number 1.

N_2O emissions from Agricultural Production per geographic region

Agricultural N_2O Emissions (World Resources Institute)

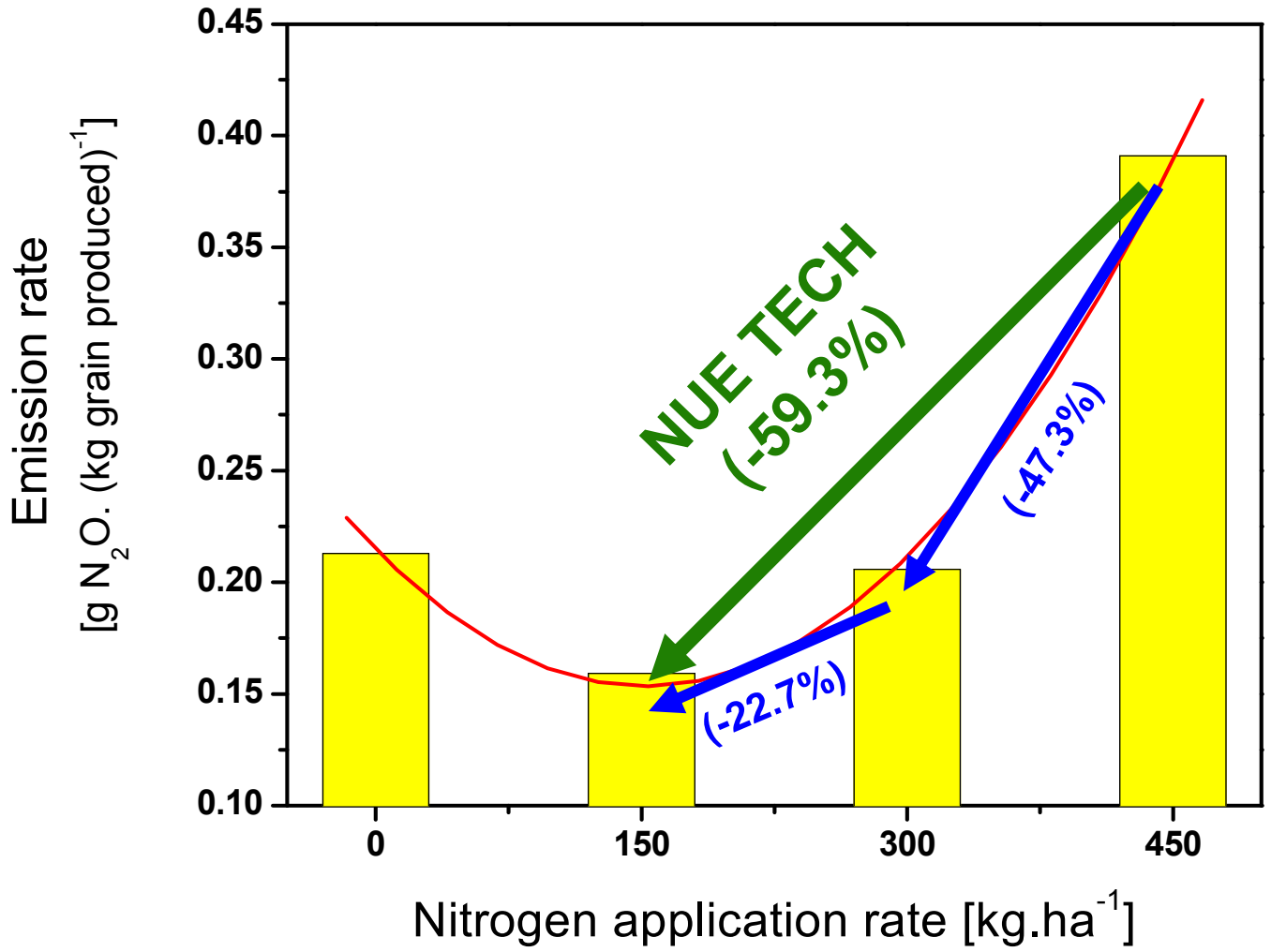


Methodology Development N_2O Emissions Capture - China efforts (2007-2010)

Ningxia Hui (Islamic) Autonomous Region

Gas Monitoring throughout the Crop Cycle

China Rice GHG Emissions Data



Methodology Development N_2O Emissions Capture - India efforts (2010)

IRRI Karnal Platform
Western Indo-Gangetic Plains

IRRI Aduthurai Platform
Subtropical Southern India

Overall Goals of Rice Carbon Project

Establish basis of methodology to capture nitrous oxide (N_2O) emissions from agricultural field of crops such as rice

Development of New Methodology

- Field data collection by Arcadia, IRRI and the Ningxia Academy of Agriculture and Forestry Sciences (NAAFS),
- Develop documents necessary for submission of a new methodology to the UNFCCC/CDM (Clean Dev. Mechanism) Executive Board,
- Working with relevant CDM authorities and/or other experts within and outside China/India to achieve approval by Executive Board.

Establishment of Agricultural Carbon Credit and Trading System.

- The NAAFS/IRRI coordinates with the appropriate authorities in Ningxia/Haryana/Tamilnadu to establish an agricultural carbon credit and trading system within the regions,
- System is based upon methodologies approved by the UNFCCC/CDM Executive Board and conform to international standards.

News Clipping

THE WALL STREET JOURNAL.

TUESDAY, OCTOBER 9, 2007 - VOL. CCL NO. 84 ★★★★ $1.50

-0.2% NASDAQ 2787.37 ▲0.3% NIKKEI Closed (17065.04) DJ STOXX 50 3884.72 ▼0.5% 10-YR TREAS Closed (yield 4.640%) OIL $79.02 ▼$2.20 GOLD $732.80 ▼$8.50 EURO $1.4042 YEN 117.41

POWER PLANT

In China, a Plan to Turn Rice Into Carbon Credits

Biotech Firm Pushes Using Less Fertilizer;

Steamed
The market for carbon credits is growing

Value of NUE Trait to Grower

- Yield Increase: $282 / acre
- Fertilizer Savings: $100 / acre
- Carbon trade: $23 / acre

- Assumptions:
  - 20% improvement in yield
  - 25% N use reduction
  - N price of $350/metric ton yield
  - Carbon price of $10/metric ton of CO_2 equiv

Agricultural GHG Reduction Opportunity

Lowering of costs

- A carbon credit/offset system can be applied to agriculture, as for other industries
- A 50% reduction of nitrogen use in agricultural crops would generate $30-40 billion per year in potential carbon credits for farmers
- A 50% reduction of nitrogen use in the top 6 crops would have the equivalent impact of eliminating all of the automobiles in the US, UK, and Germany
- The carbon credit effect of reducing costs can be achieved by using Nitrogen Use Efficient crops, like Arcadia's

Potential Sources of Biofuel Feedstock

Non-food crops: perennial grasses, trees

New use for current non-food crops: tobacco

Combined food/biofuel crops: straw/stover from corn, wheat, sweet sorghum

Application into Sweet/forage Sorghum

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