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Date
April 24, 2013

Fertilizer Deep Placement Technology

A Useful Tool in Food Security Improvement

Speakers

Samba Kawa, *USAID/BFS*

Upendra Singh, *IFDC*

John H. Allgood, *IFDC*

Facilitator

Zachary Baquet, *USAID Bureau for Food Security*

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Upcoming Agrilinks Events:

- InnovATE e-Consultation | May 7-8
- Ag Sector Council | May 29 | Horticulture

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Discovery Report

Creating a culture of learning involves changing the way staff conducts its work. To gain a better sense of how learning is already happening, USAID recently completed an in-depth study on the state of learning in the Agency's Bureaus and Offices.

LEARN MORE

Samba Kawa

USAID/BFS

Samba Kawa is an Agriculture Development Officer with USAID/BFS. Samba currently manages two USAID-funded programs being implemented by IFDC and SANREM. Prior to USAID Kawa had over 7 years of experience in seed multiplication, farmer training and agricultural extension and research while working with the Seed Multiplication Project. Samba was also a New York City Teaching Fellow and taught middle school science. Samba holds a Ph.D. in Soil Science from NC State University, Raleigh, an MS in Soil Science from China, an MA in Education from NYC and a B.Sc. from the University of Sierra Leone.

Upendra Singh

IFDC

Dr. Singh has extensive research experience in many aspects of soil fertility improvement. Dr Singh is leading the IFDC research activity to assess the environmental consequence of FDP technology vis-à-vis conventional surface application of urea on flooded rice. Over the last 20 years he has been responsible for the development of the lowland nitrogen model, phosphorus model, crop growth models and the Phosphate Rock Decision Support System. Dr Singh also coordinated the IFDC/IRRI Collaborative Program in Los Banos, Philippines from 1992-97, where his research was on appropriate nutrient management for rice-based cropping systems.

John H. Allgood

IFDC

John H. Allgood has more than 35 years of experience in fertilizer marketing including marketing system design and development, human capacity building, institutional development, market information systems development, credit system development, and policy analyses. One of the many projects he manages is the Accelerating Agriculture Productivity Improvement (AAPI) Project in Bangladesh. The AAPI project is achieving rapid diffusion of FDP technology through a business model that incorporates interventions that build both supply and demand and that support sustainability through strong public and private sector linkages.

Fertilizer Deep Placement Technology Diffusion: A Case Study in Building Farmer Demand and Affording Farmer Access to High-Quality FDP Products

Accelerating Agriculture Productivity Improvement (AAPI) in Bangladesh

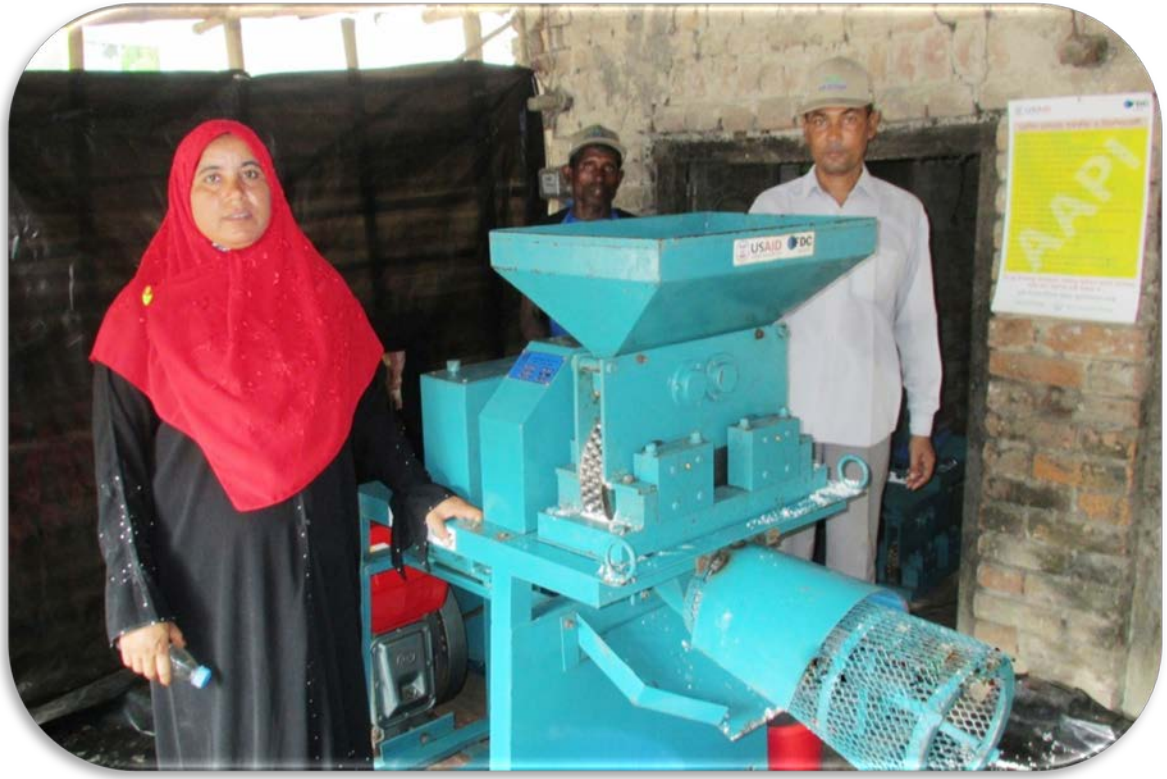
- ✓ **Goal** – Improve food security and accelerate income growth in rural areas by sustainably increasing agriculture productivity
- ✓ **Objectives** – Improve agriculture productivity through increased efficiencies
  - Improve farmer awareness and knowledge
  - Improve farmer access to technologies
  - Strengthen support systems needed for sustainability

✓ Strategic Approach:

- Employ Market-Oriented Concepts:
  - *Supply system development*
  - *Create awareness and demand for FDP products*
- Achieve Stakeholder Participation at All Levels
  - Research and technology validation
  - Farmer education
  - Policy constraint alleviation
- Design and Implement M&E System and Information Dissemination
  - Measuring progress and impact
  - Lessons learned

FDP Technology Dissemination: Cross-Cutting Issues

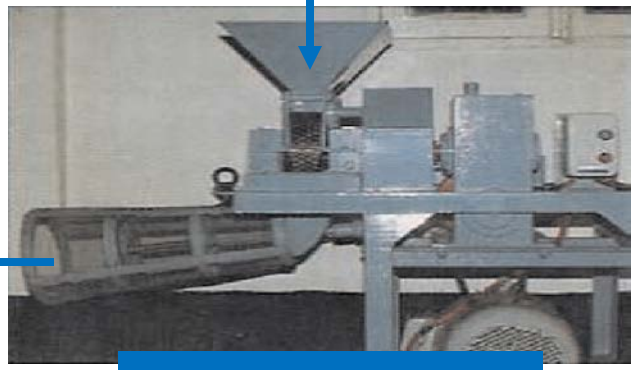
- Capacity Building
  - Public Sector: NARS/MOA/DAE
  - Private: BFA/Other
- Gender Dimensions
- Environmental



How to Prepare USG

USG is produced from prilled or granular urea by pressing with rollers in a briquette machine to produce granules 1.8 and 2.7 grams

Prilled Urea



Briquette Machine for USG

USG

Prilled Urea ***Urea Briquettes***

Briquette Production in the Village

AAPI End-of-Project Result Indicators

Indicator	Units	Target
Rice area under FDP technology	Million ha	1.8
Farmers using FDP technologies	Million	3.5
Micro-enterprises producing USG and/or NPK briquettes	No.	1,800
Farmers using an applicator	Million	1
GOB savings from decreased application of urea	Million $	84.50
Increase in rice production	Million mt	3.32
Value of increase in rice production	Million $	1,100
Increased income per farm per annum	USD	262

Boro 2013 AAPI Activities

Activities	Units	Accomplished
Farmer Training	Batches (40/Batch)	2,828
Technology Demonstrations	Number	482
Stakeholders Workshop	Number	40
Bill Board (Established different period)	Number	12
Field Days (Planned)	Number	67
Crop Cuts (Planned) • Demo plots (435) • Trial plots (31) • Farmers plots (1,000)	Number	1,466

Boro 2012 (Dry Season Rice)

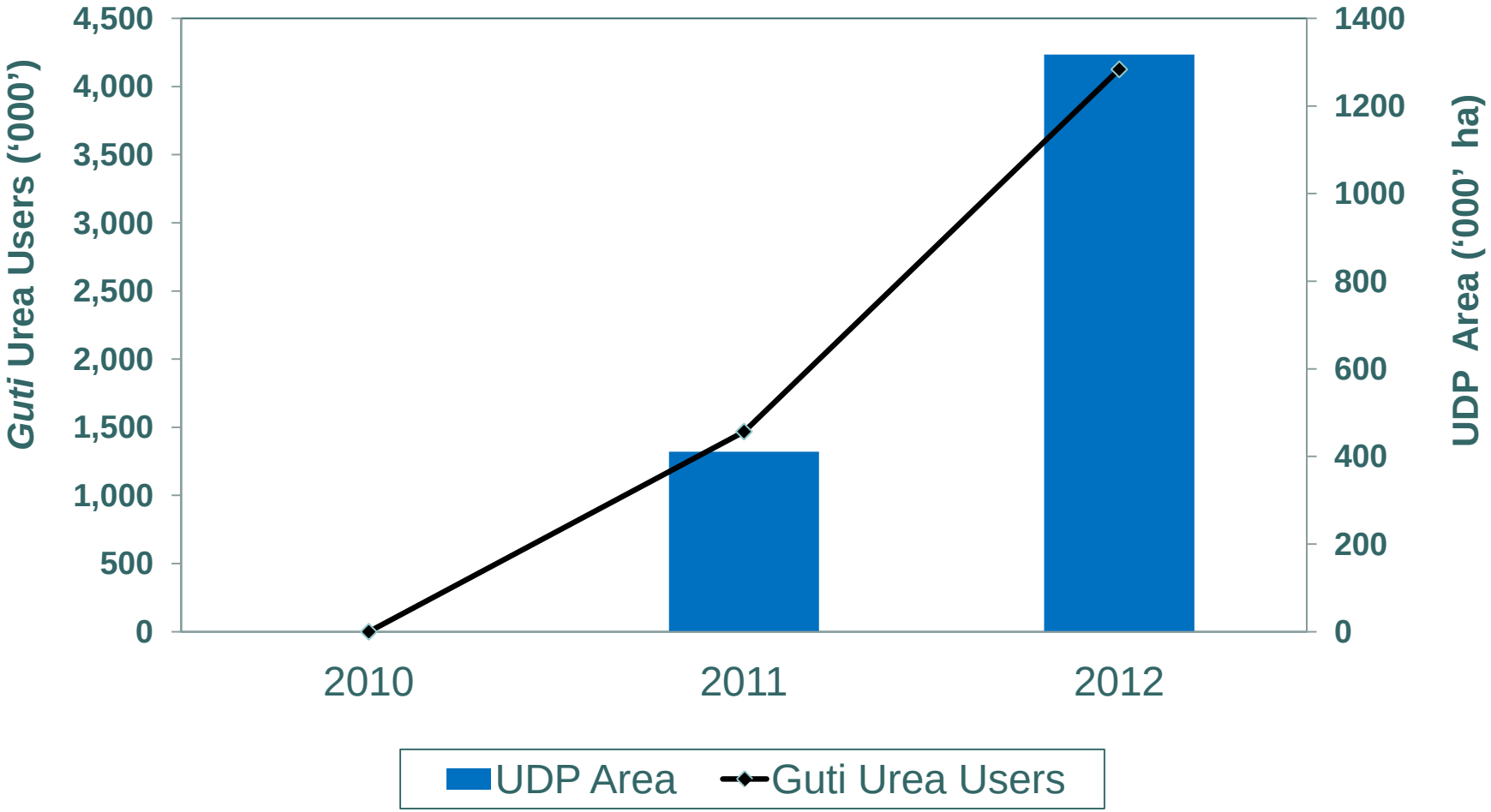
	Guti Urea Applied Plot	Broadcasted Urea Applied Plot	Yield Increment
Rice Yield (kg/ha)	4,624	4,005	619

	Guti Urea Applied Plot	Broadcasted Urea Applied Plot	Urea Saving
Urea Application (kg/ha)	167	269	102

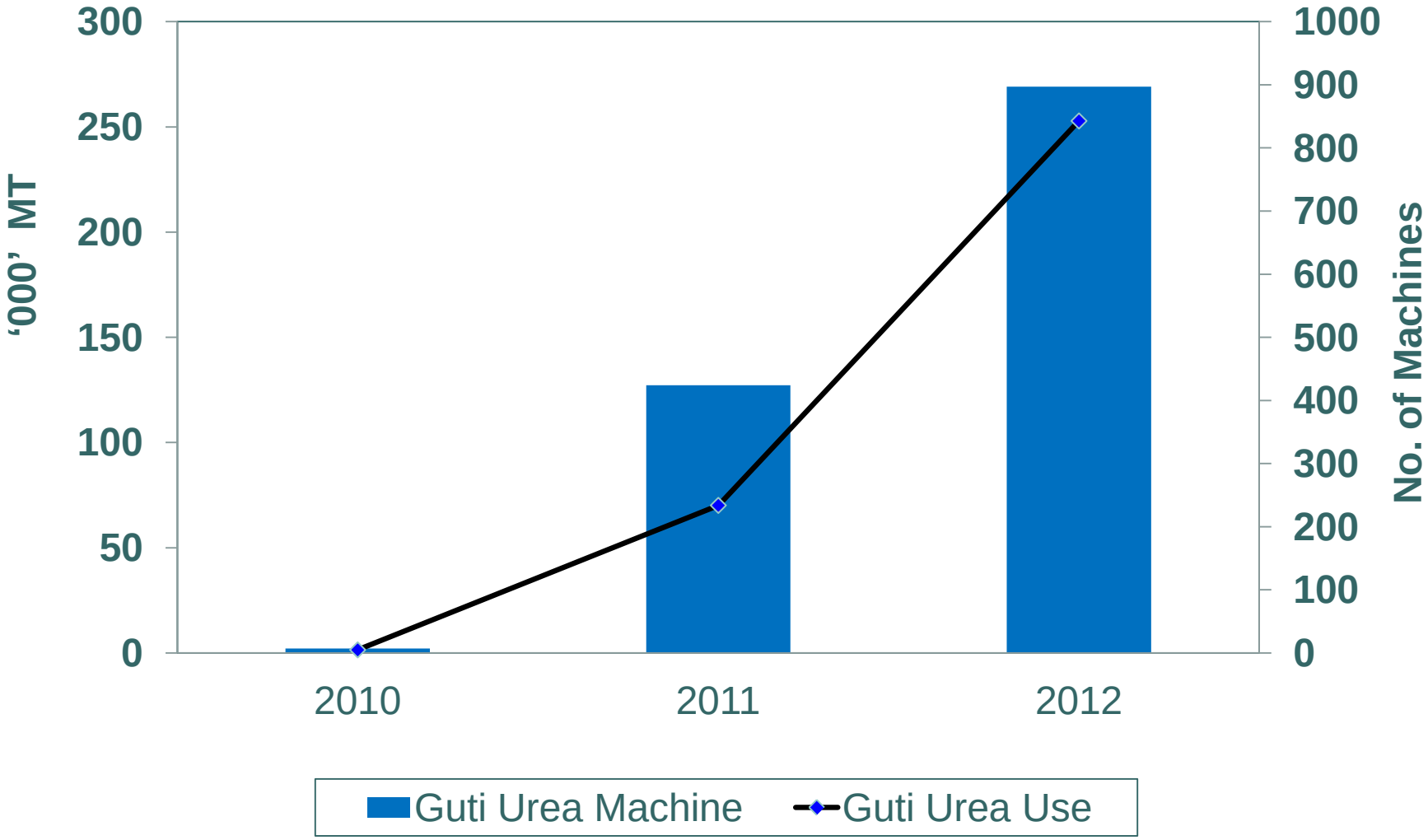
	Guti Urea Applied Plot	Broadcasted Urea Applied Plot	Value of Urea Saving
Cost of Urea ($/ha)	3,674	5,380	$21

Demand Growth of *Guti* Urea under AAPI

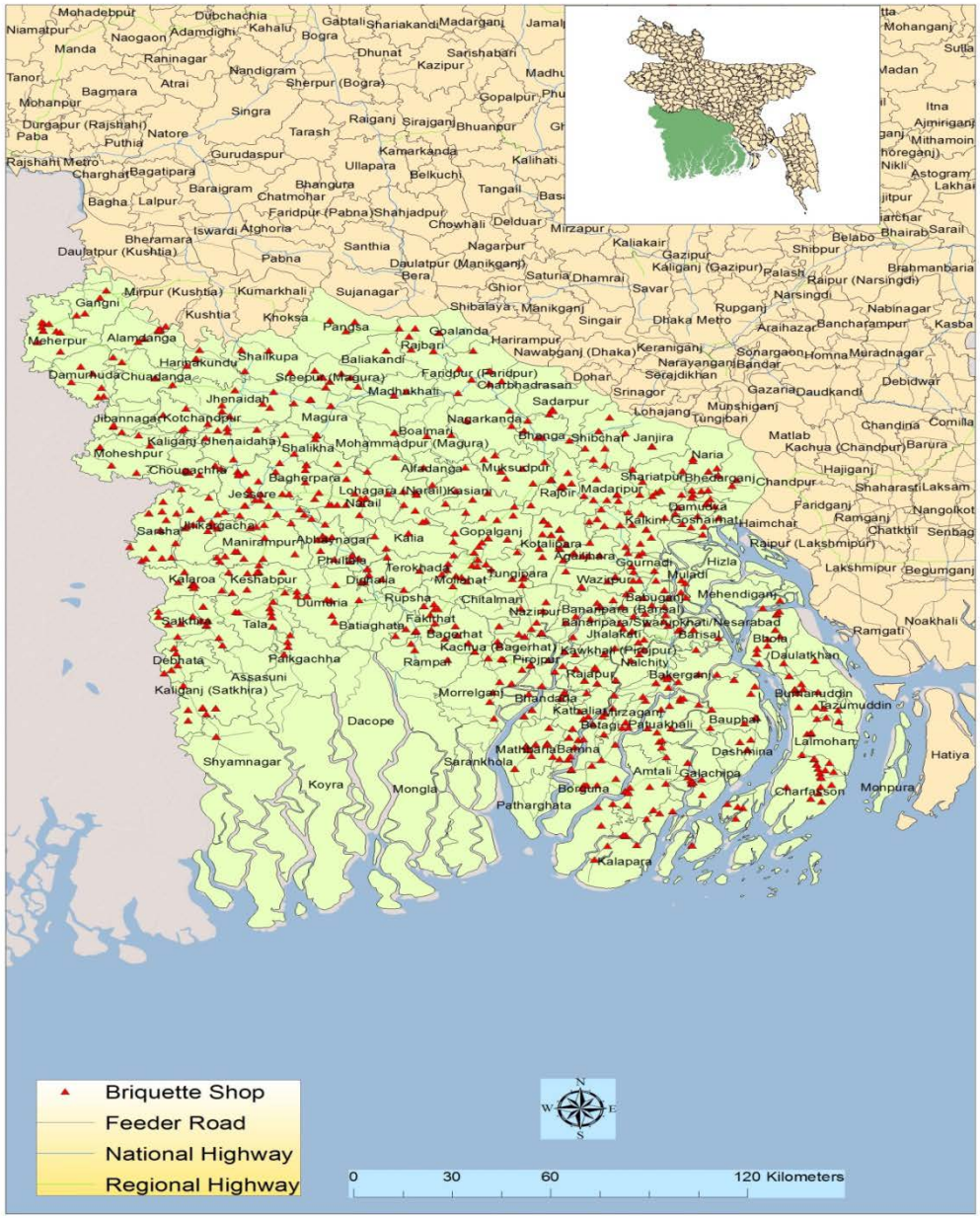
– cumulative –



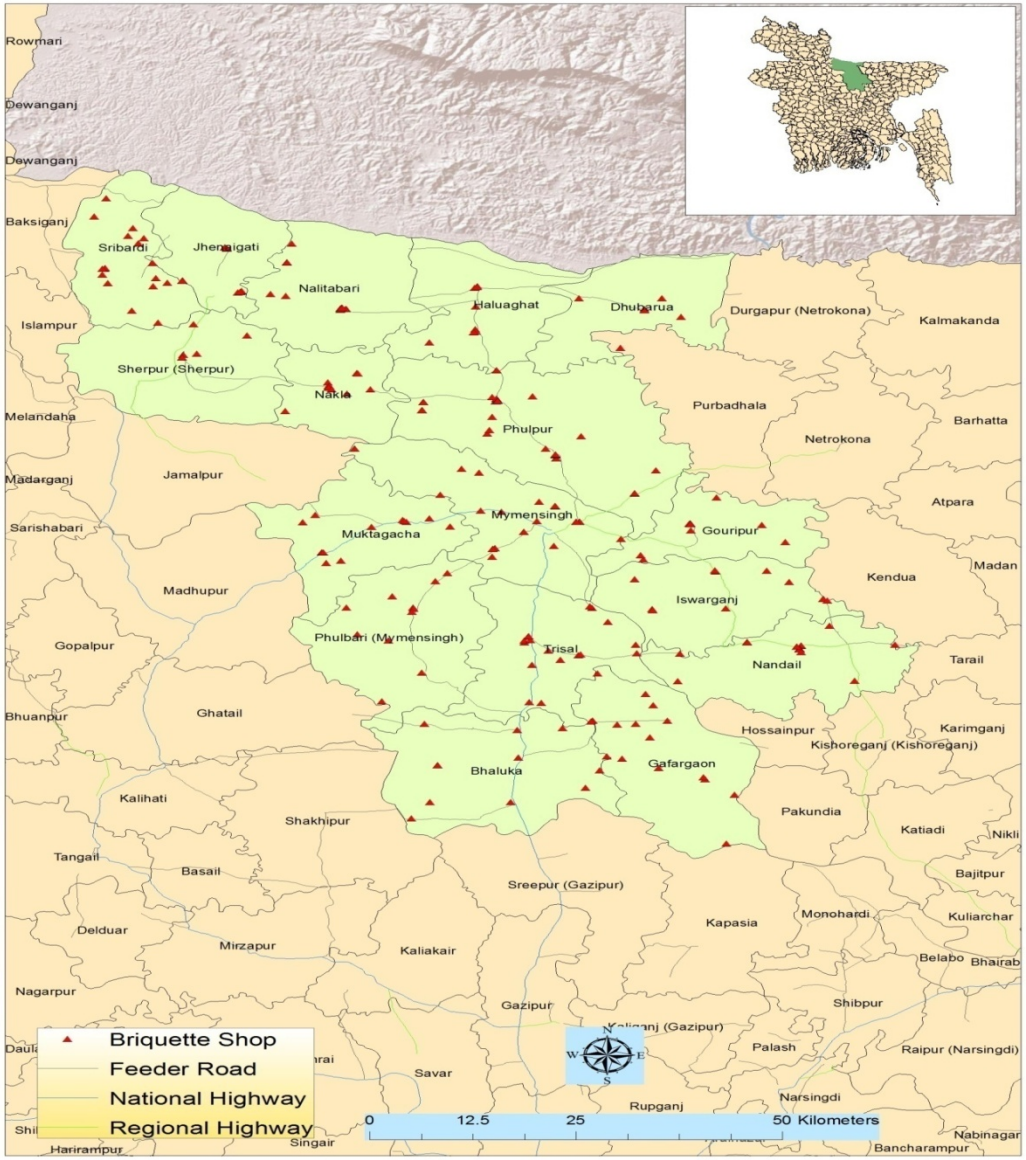
Supply Growth of *Guti* Urea under AAPI



AAPI
Urea Briquette Shop, FtF Zone



AAPI
Urea Briquette Shop, M&S Zone



Urea Briquette Shop

Payback Period: Urea Briquette Producer Investment

Item	Amount
Total variable cost per mt (US $)	262
Selling price per mt (US $)	275
Contribution (to fixed cost) (US $)	13
Payback sales volume (mt)	**179**
Payback period (months)	**18-24**

Source: Urea Briquette Producers Survey, January 2013.

NOTE: Total cost is US $2,320 and planned useful life is 7.5 years.

AAPI Results Achieved through December 2012

Result Indicators	Units	Target	Actual	% of Achievement
Guti Urea Manufactured/Sold	Metric Ton	-	252,817	-
Guti Urea Dealers/Machines Installed	Number	730	897	123%
Farmers Applied *Guti* Urea in last three rice seasons	Number	2,516,732	4,125,860	164%
Rice Area under *Guti* Urea in last three rice seasons	Hectare	1,258,366	1,317,652	105%

AAPI Results Achieved through December 2012

Result Indicators	Units	Target	Actual	% of Achievement
Incremental Rice Production	Metric Ton	983,287	863,432	88%
Increased Value of Rice	Million US $	314.65	299.88	95%
Urea Saved	Metric Ton	120,114	120,237	100%
Value of Urea Saved	Million US $	40.83	67.43	165%
GOB Savings on Urea Subsidy	Million US $	22.89	42.47	186%

Sustainability of Progress
(Opportunities and Challenges)

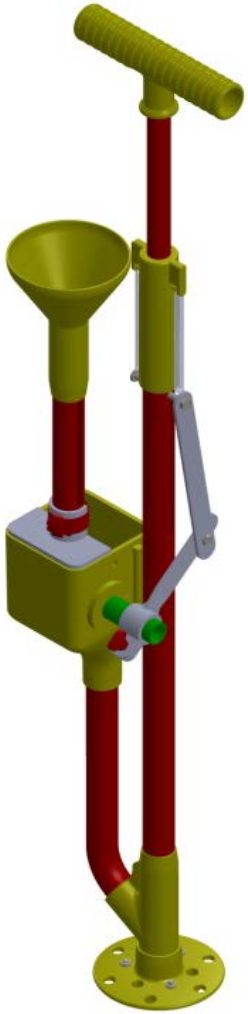
*Demand-Side

- ✓ Farmer Education
- ✓ Ease of Application
- ✓ Technology Promotion
- ✓ Economic Returns
- ✓ Product Enhancement (NPK) and Performance
- ✓ Extension to Other crops

*Supply-Side

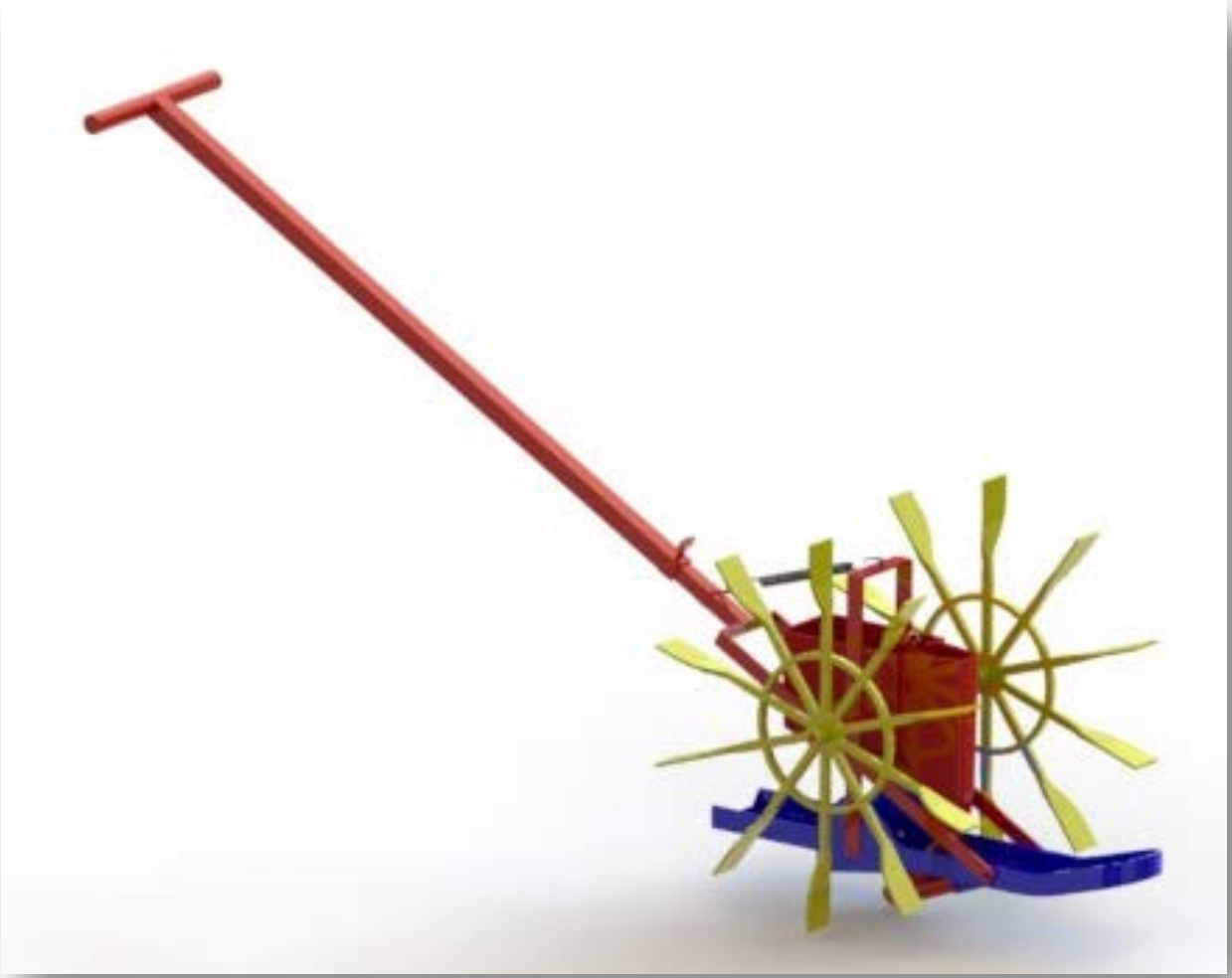
- ✓ GOB Policy
- ✓ Profitability
- ✓ Quality Control
- ✓ Business Linkage Development
- ✓ Dealer Capacity (Knowledge) Building

Injector-Type Self-Loaded Applicator



Applicator in Field Operation

Single Row Applicator



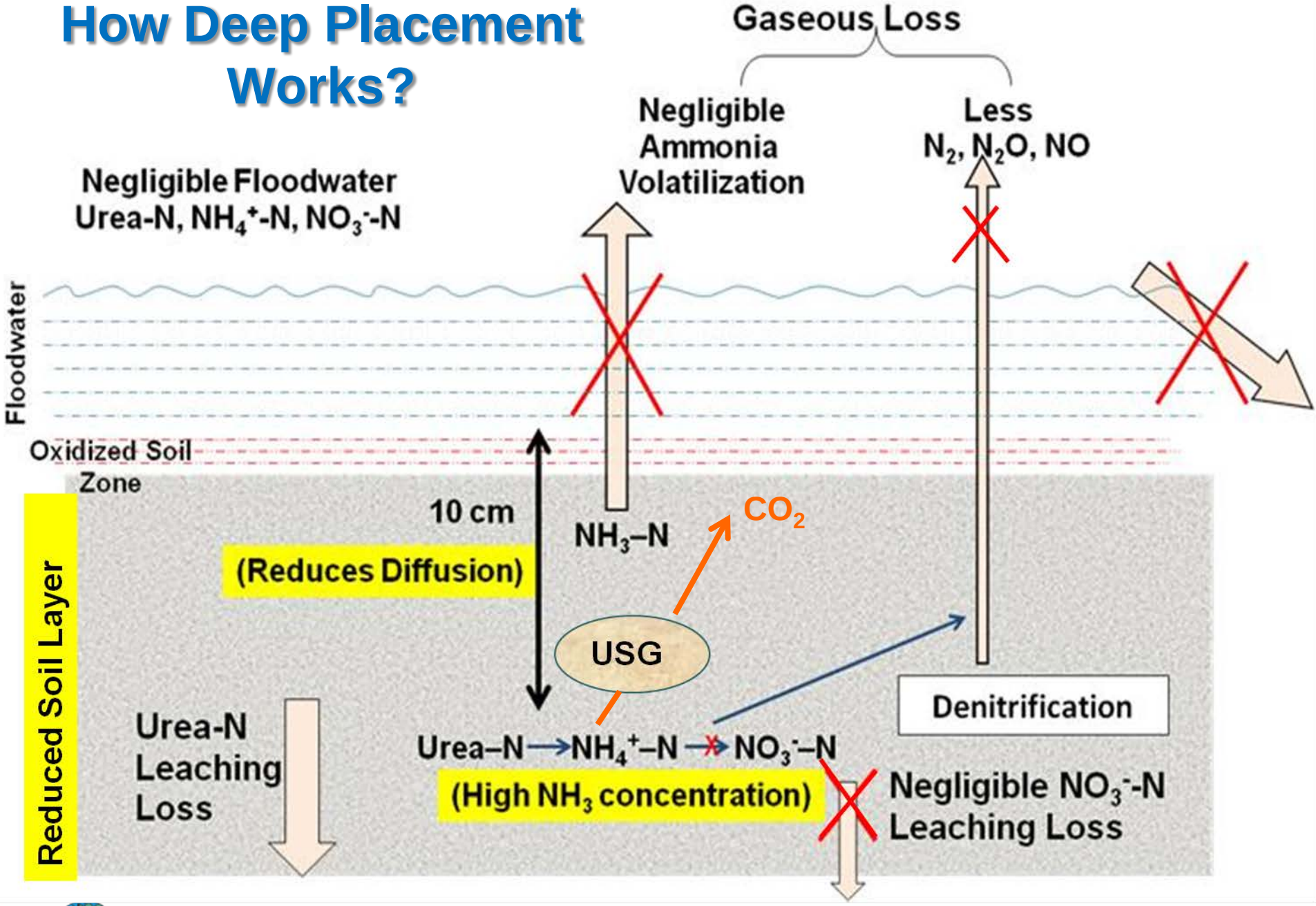
Single Row Applicator Field Operation

Deep Placement Technology: Sub-Surface Application of Urea

- ✓ **Goal of APPI**– Improve food security and accelerate income growth in rural areas by sustainably increasing agriculture productivity

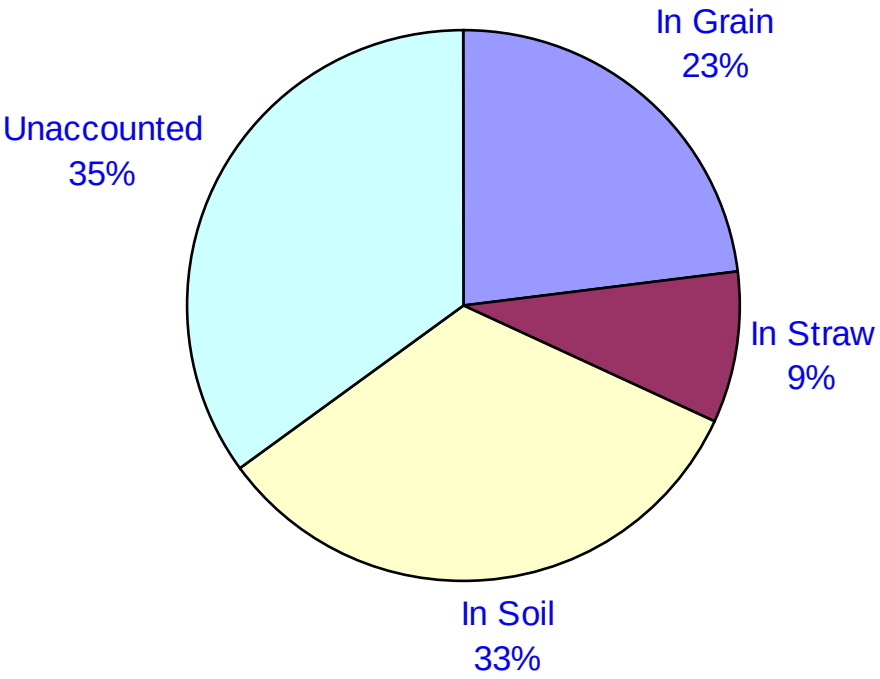
- ✓ Global food security is challenged by many issues, including weather and climate variability, degraded soils and persistent poverty.
- ✓ **Objective** – Improve agriculture productivity through increased efficiencies of resources

How Deep Placement Works?

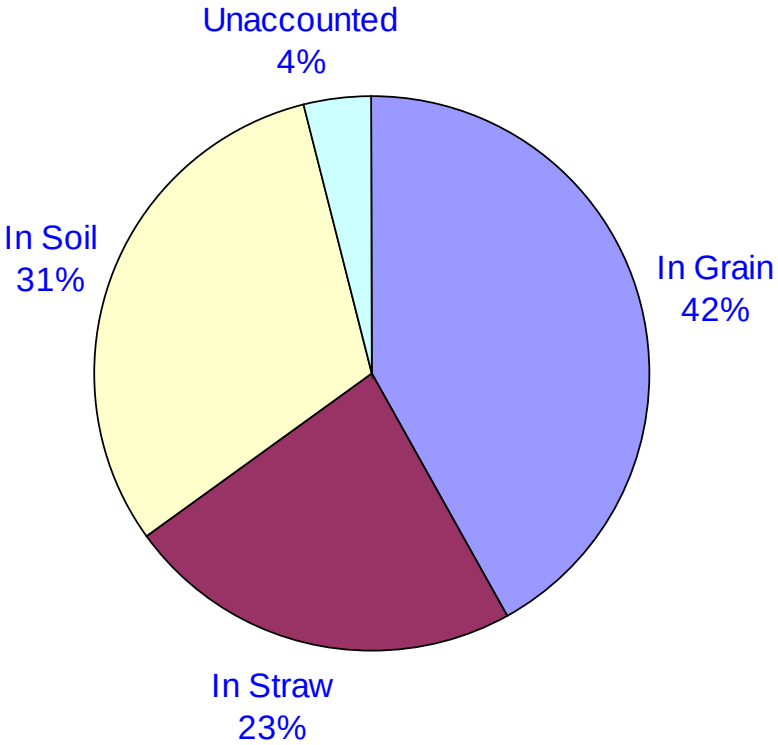


N Balance for UDP and Split Applied Urea in Wetland Rice. IRRI-IFDC

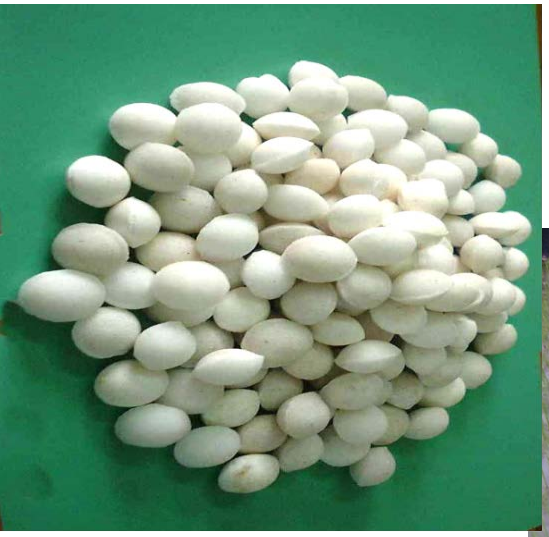
Split Application



Deep Placed Urea Briquette



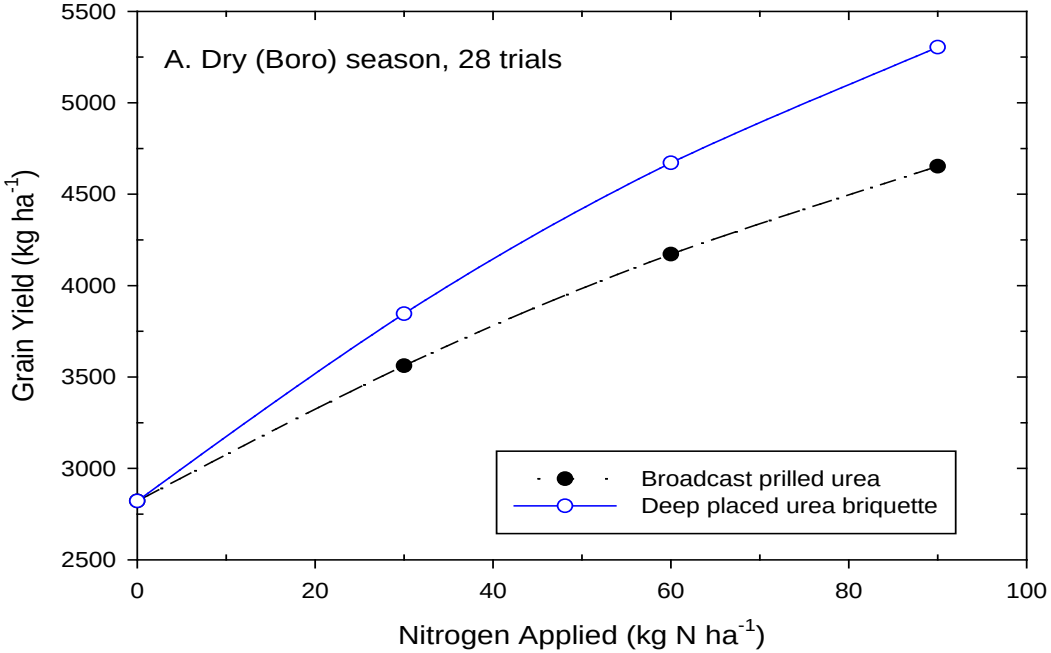
Productivity Gains with Deep Placement



Urea Briquette

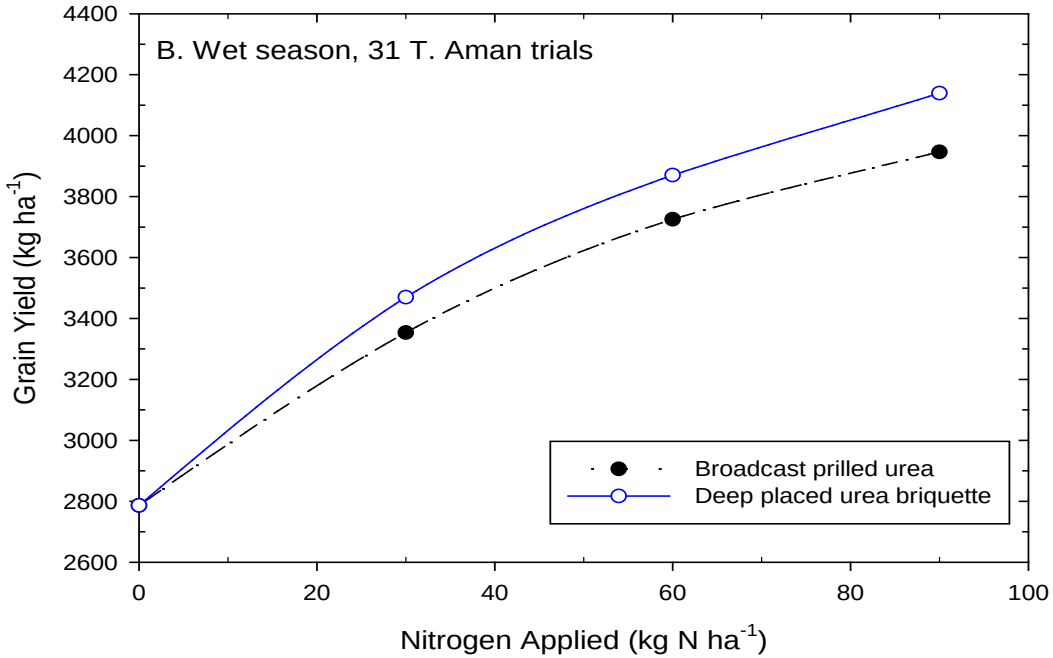
NPK Briquette

Grain Yield Increases:



Research Trials on UDP Conducted by Bangladesh Research Institutions (BRRI, BARI, and BINA)

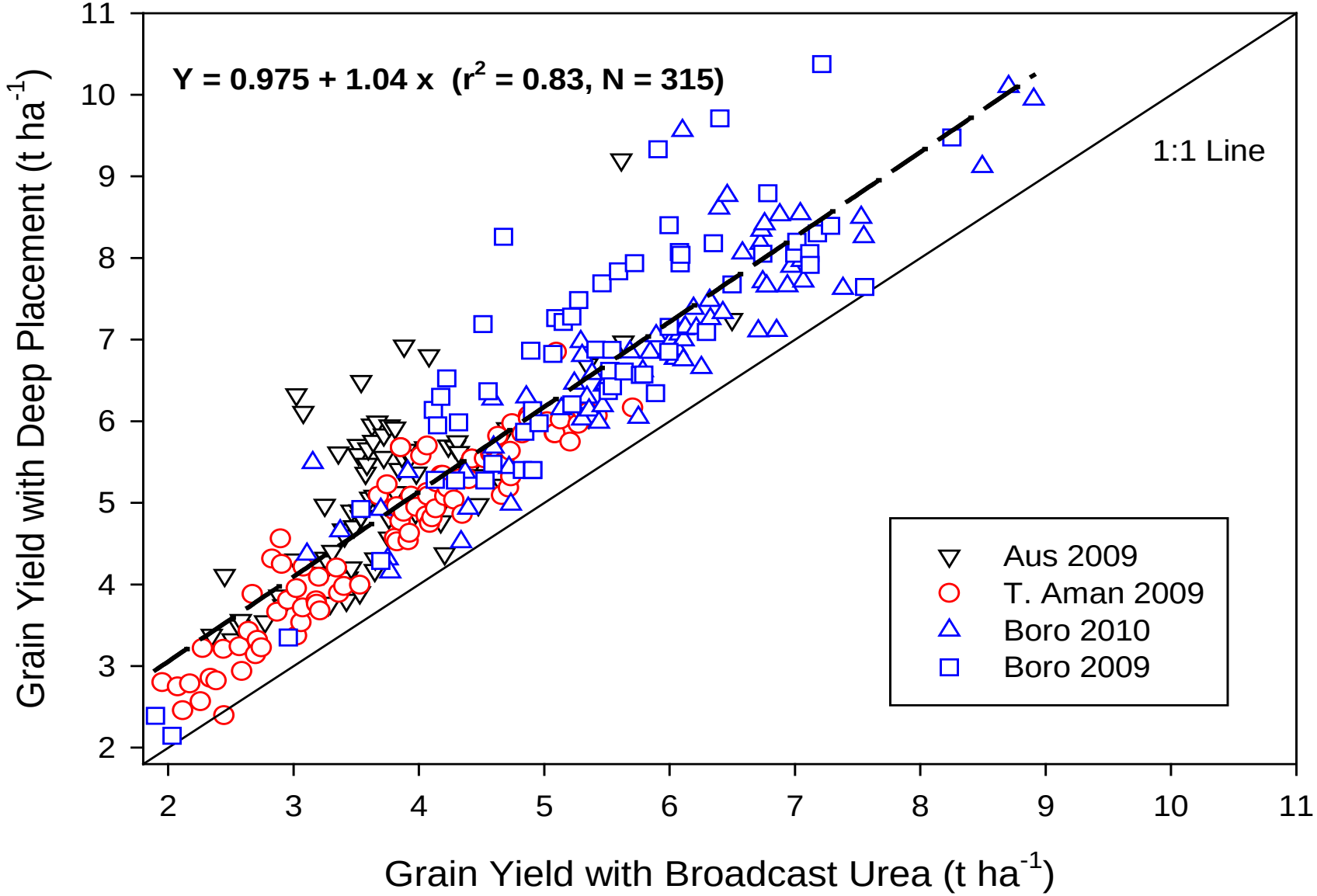
(Source: Annual reports, Bhuiyan et al., 1998)



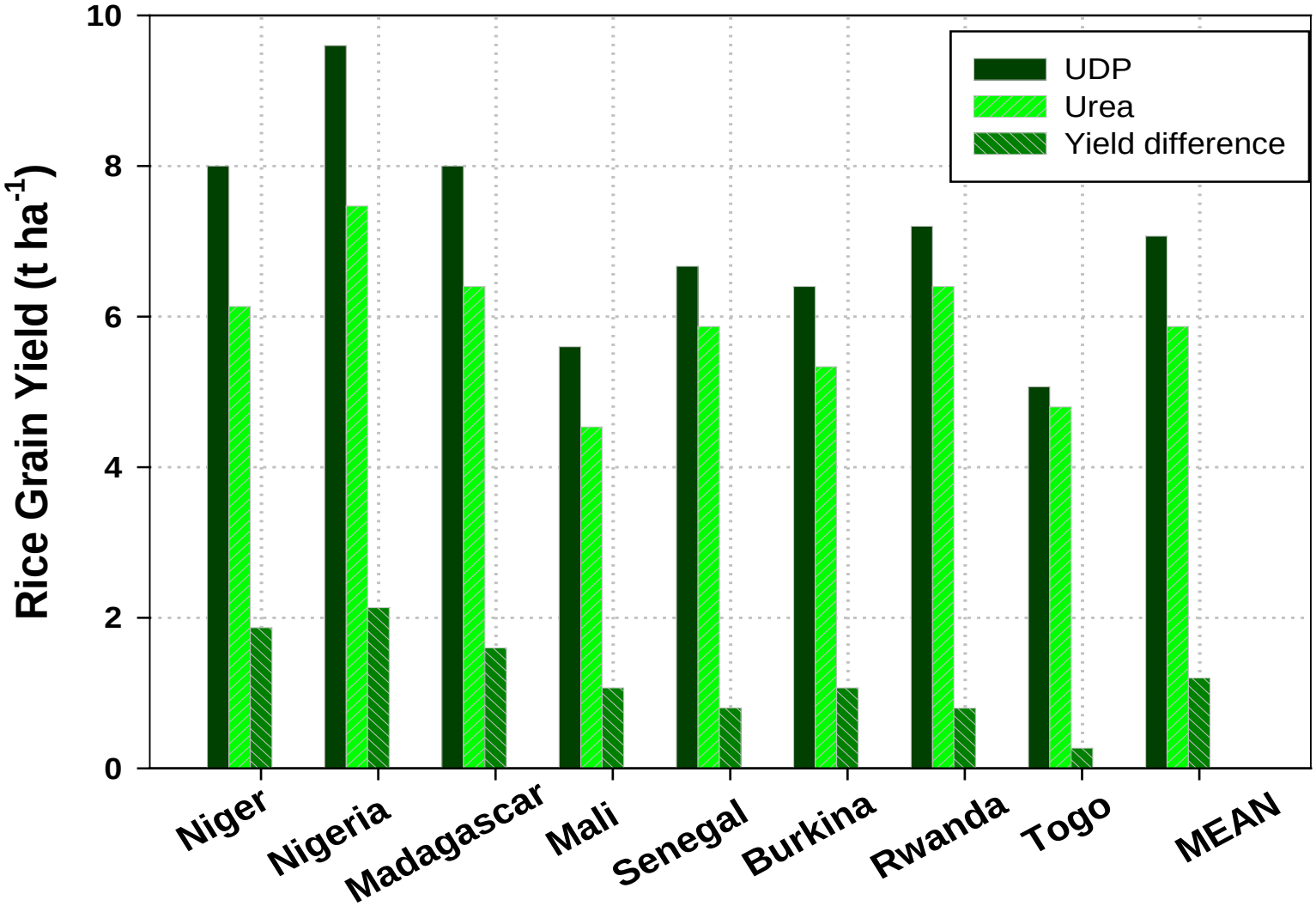
Consistent Yield Increase – Across Seasons

IFDC

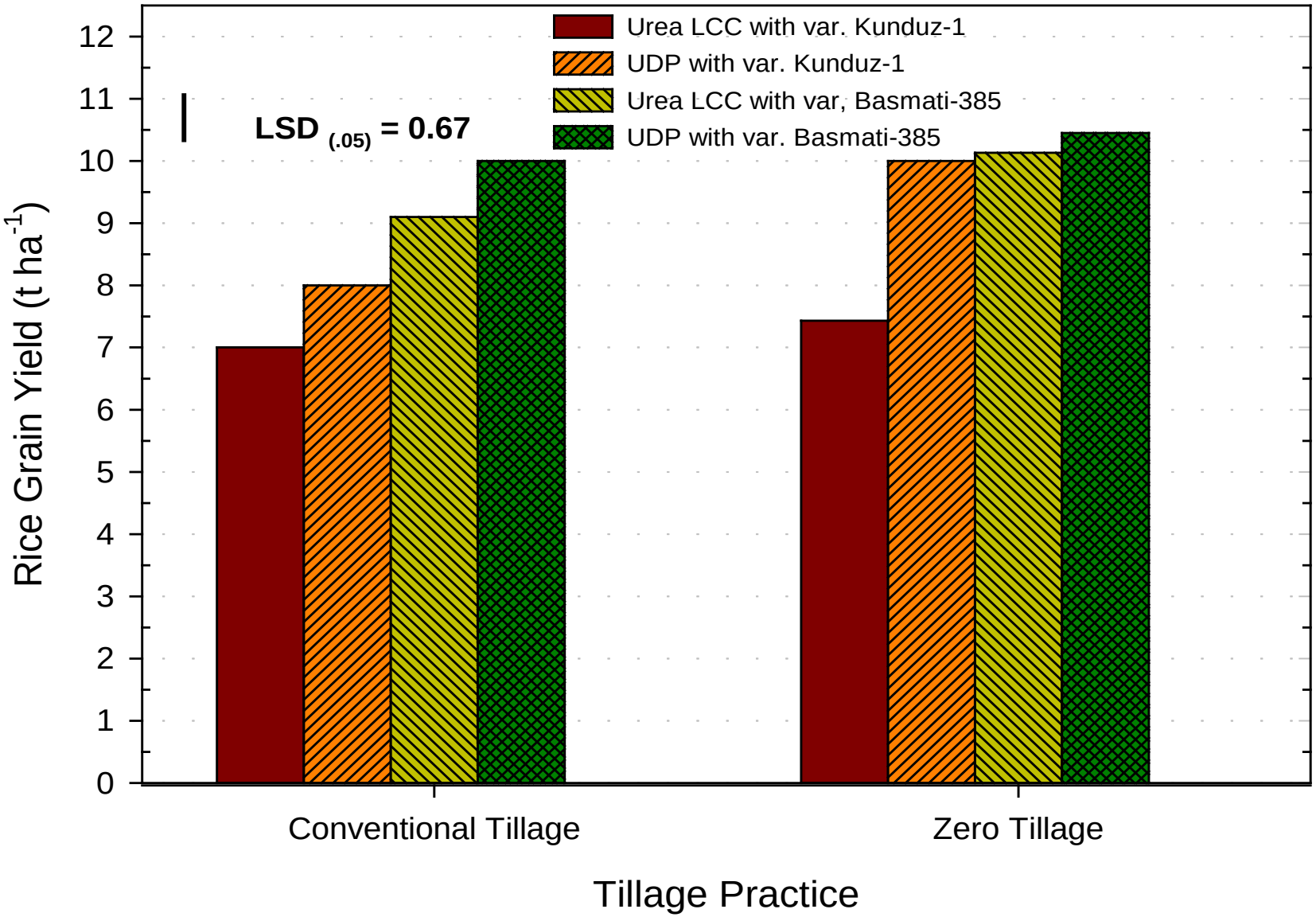
Comparison of Rice Grain Yield with Urea Briquette Deep Placement and Broadcast Split Urea Application from 2009-2010 Demonstration Plots



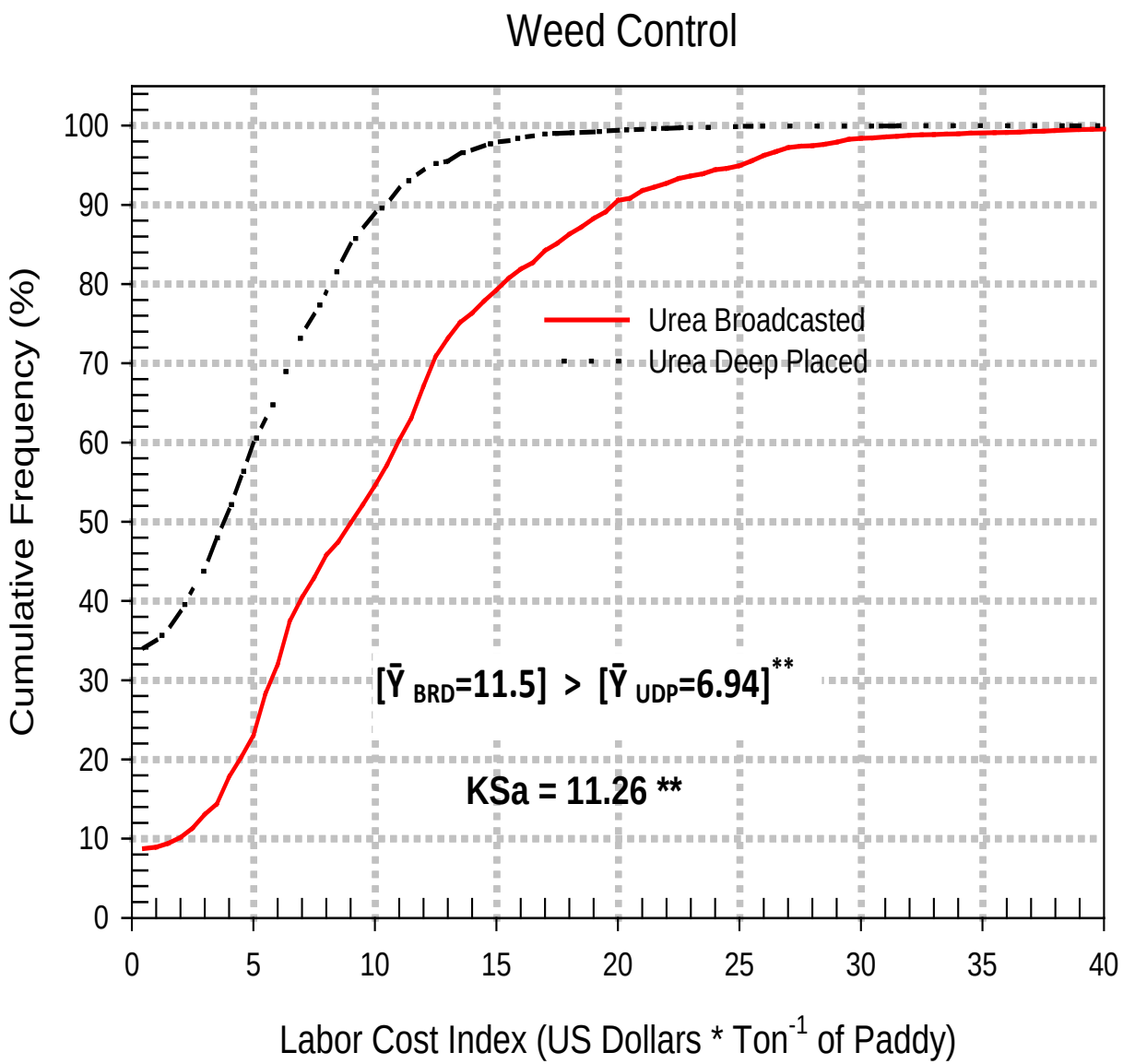
Gains in Sub-Saharan Africa



Rice Grain Yield, Nangarhar, Afghanistan



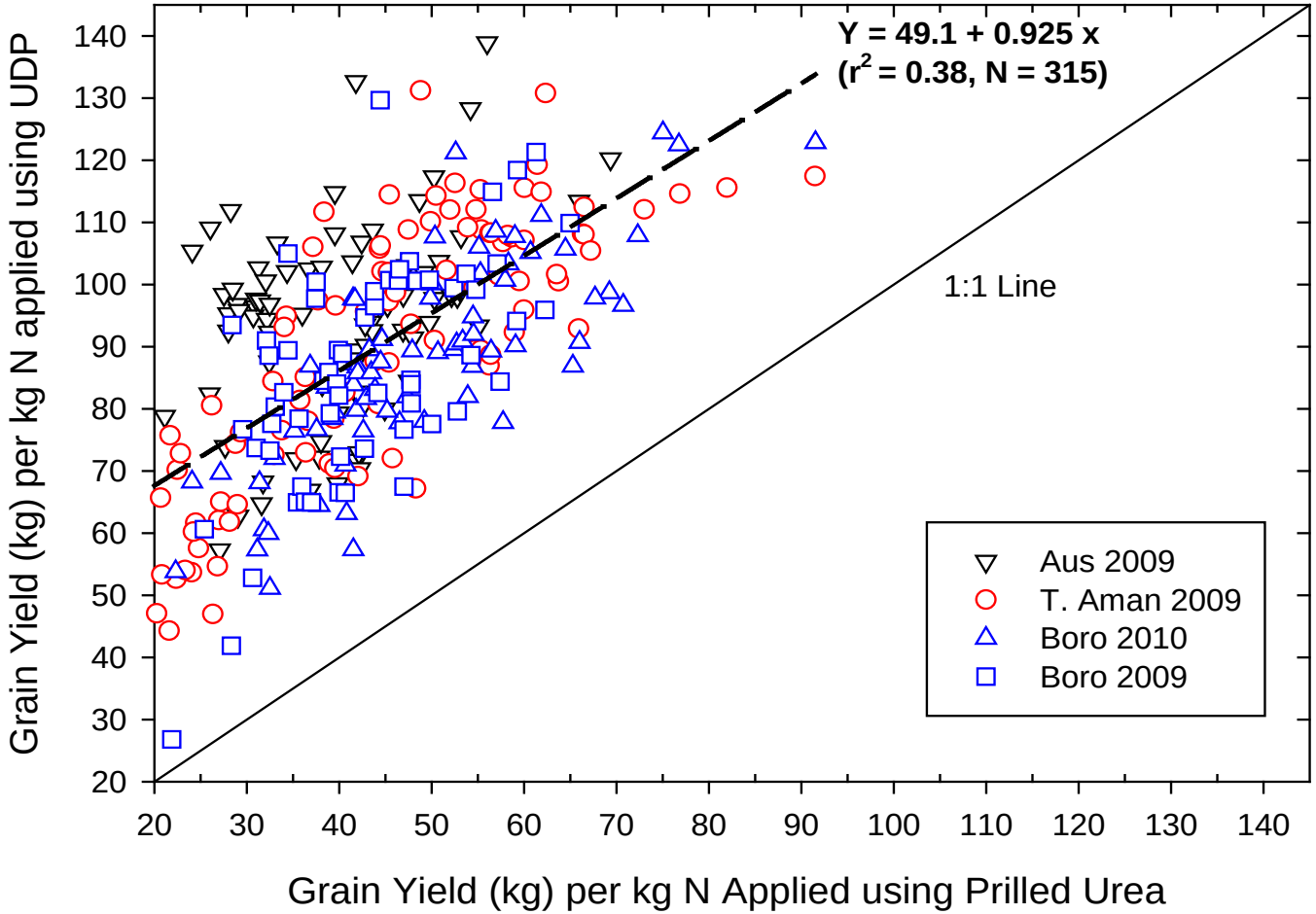
Less Weeds (Labor, Herbicide)



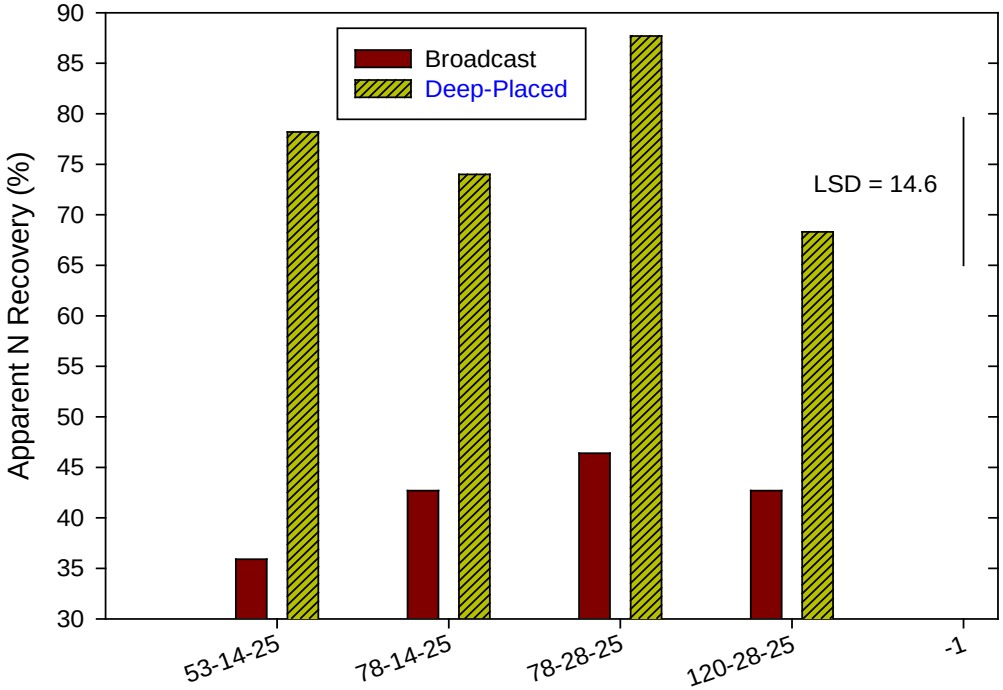
Improved N Efficiency

– Partial Factor Productivity

Comparison of Partial Factor Productivity
(Grain Yield with Soil N and Fertilizer N per kg Applied N)
for 2009-2010 Demonstration Plots



Improved N Efficiency



Country	Technology			
	Farmer Practice-Urea		Urea Deep Placement	
	AE_N	VCR	AE_N	VCR
Niger	36	3.5	59	5.9
Nigeria	49	4.8	70	7.0
Madagascar	44	5.5	63	8.0
Mali	41	3.3	64	6.7
Senegal	50	3.5	69	7.3
Burkina	31	3.1	44	4.3
Rwanda	35	3.5	46	4.6
Togo	28	2.7	33	3.2
Mean	39	3.7	56	6.0

NPK Briquette

Urea Briquette

Environmental Gains with Deep Placement

- **Deep Placement = reduced zone soil placement**

- **Point Placement = high ammoniacal N concentration (NH_4-N > 3,000 ppm)**
➔ inhibition of nitrification

- **Less N Loss = N Fertilizer Savings**

Air (80% Nitrogen) → Ammonia → Urea

↑ Energy and **Feedstock** (Natural Gas)

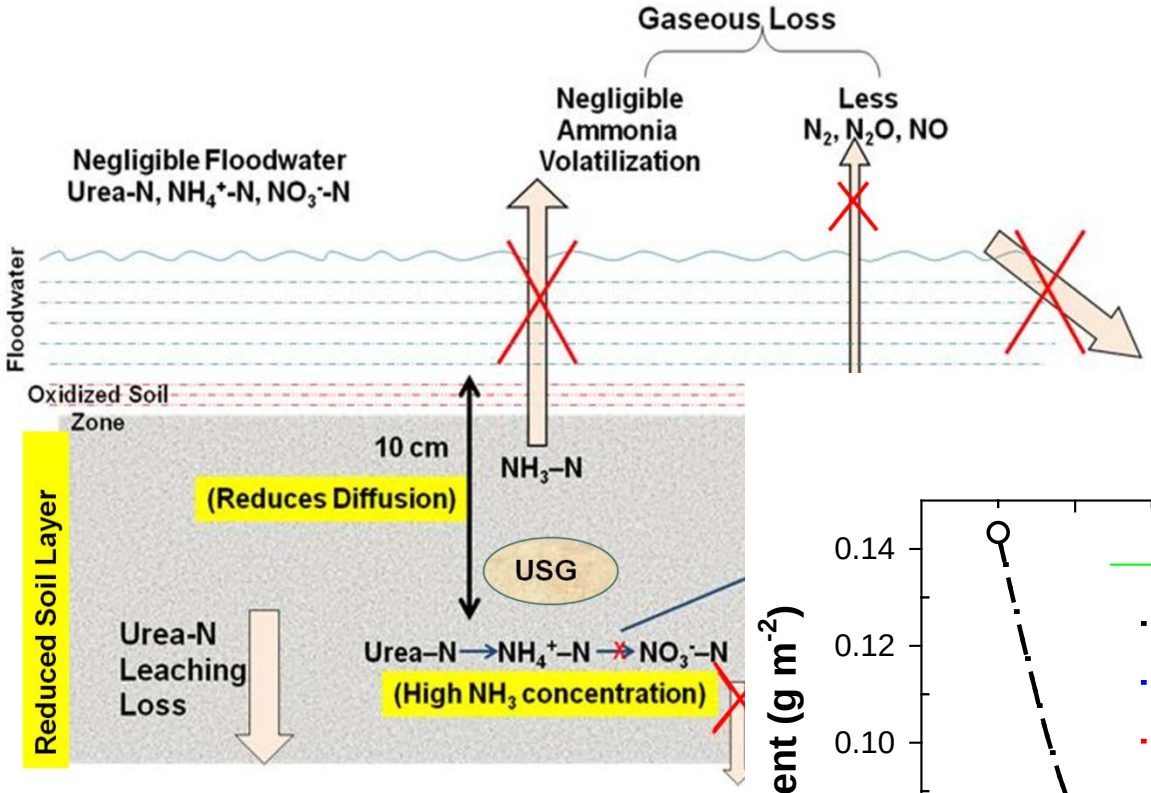
↑ Energy (Natural Gas) and Carbon Dioxide

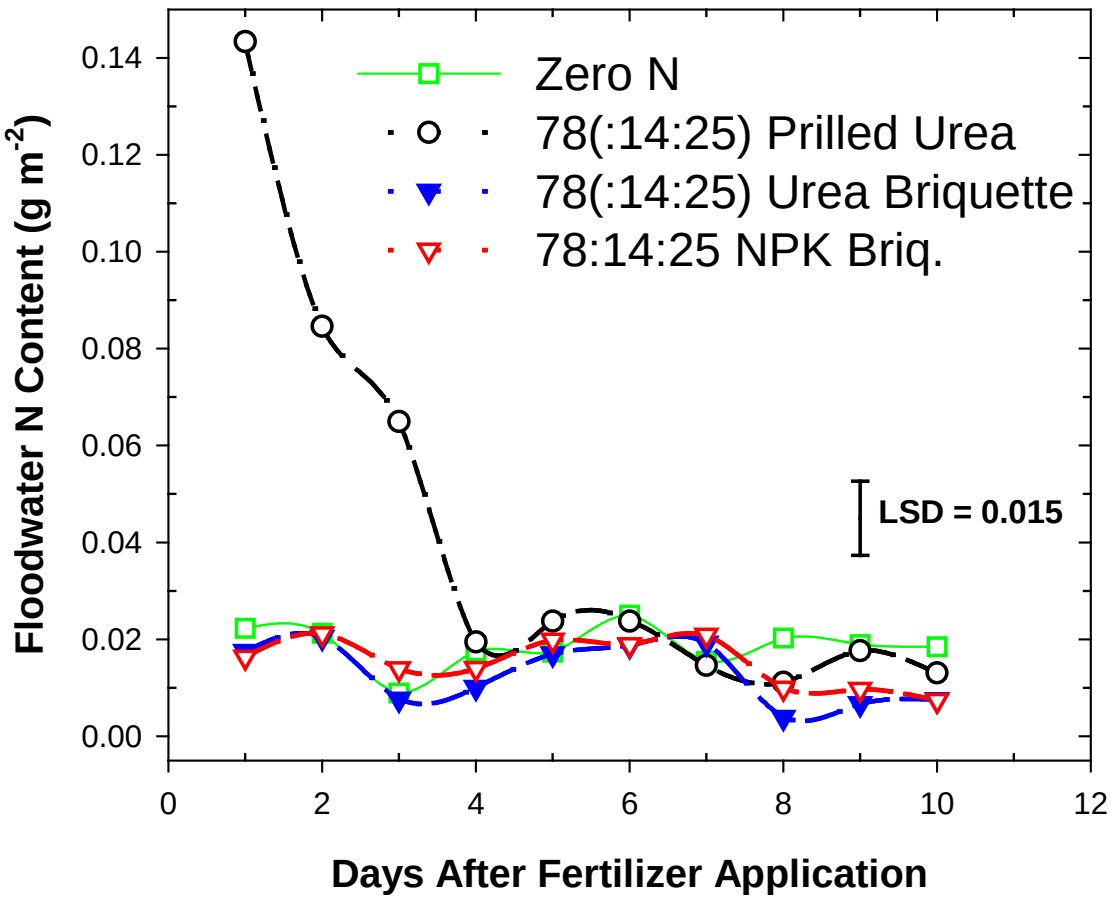
4-Barrels Energy

1 ton Urea

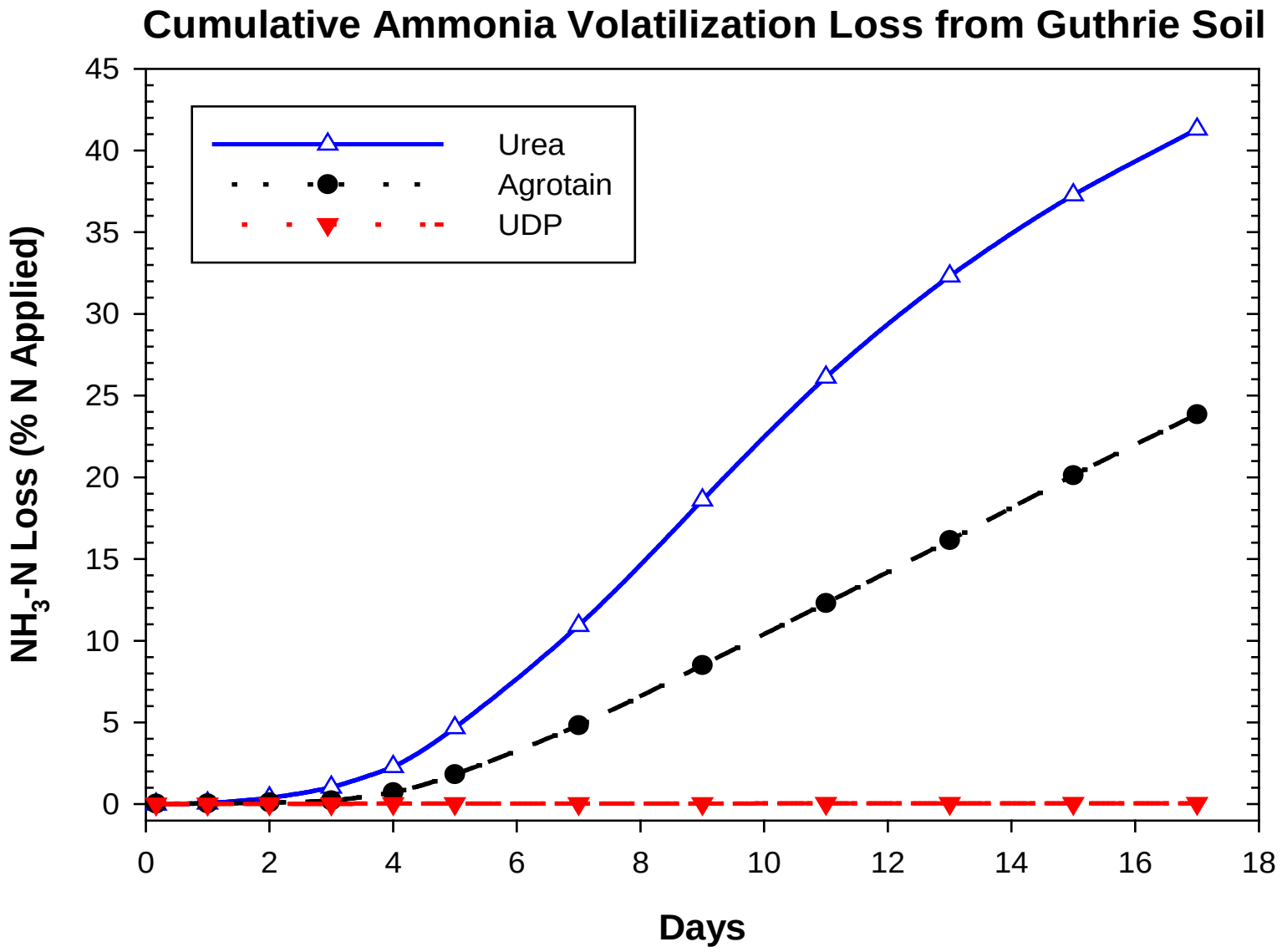
980 kg CO_2 Equivalent GHG Emission

Reduced N Loss



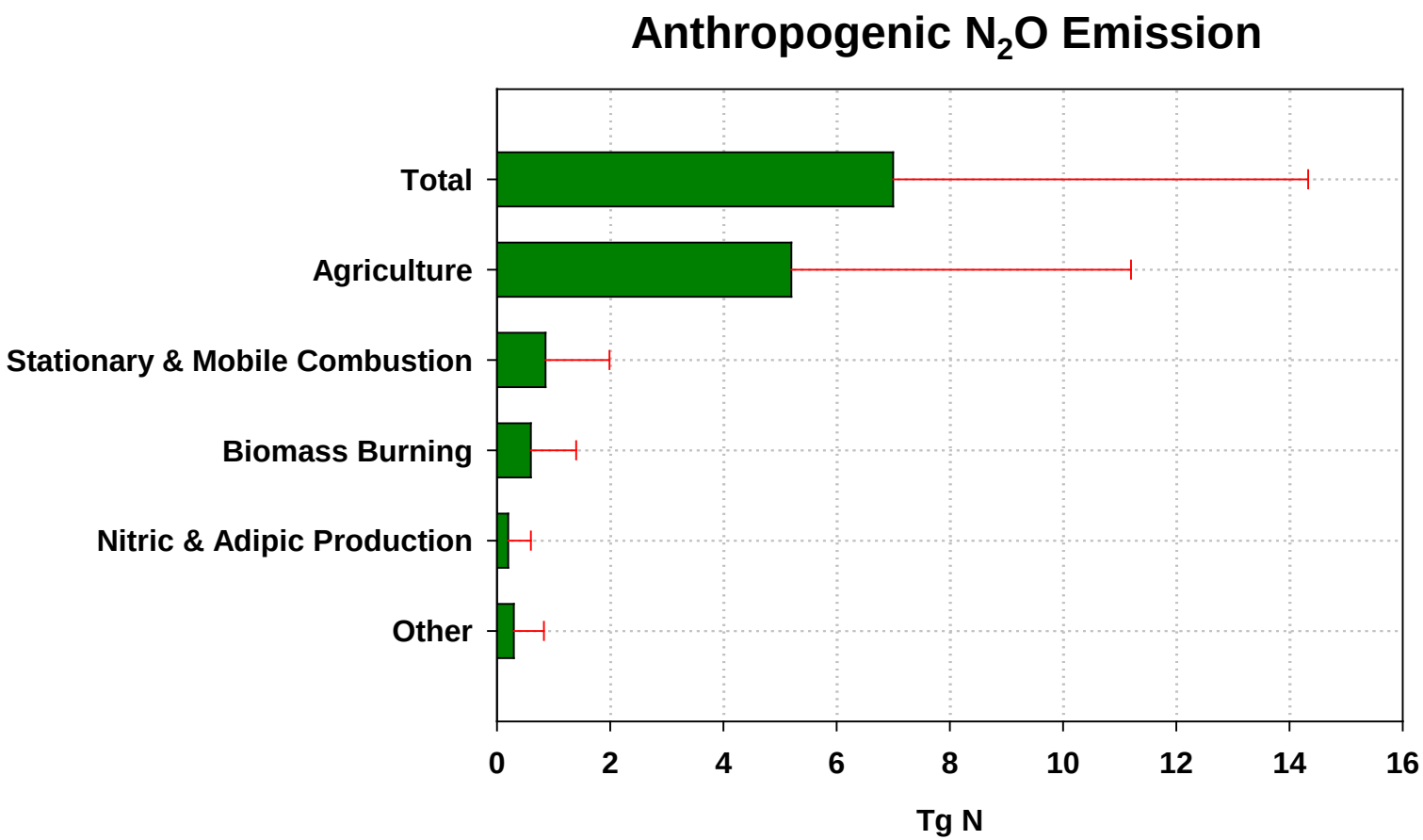


Environmental Gains with Deep Placement

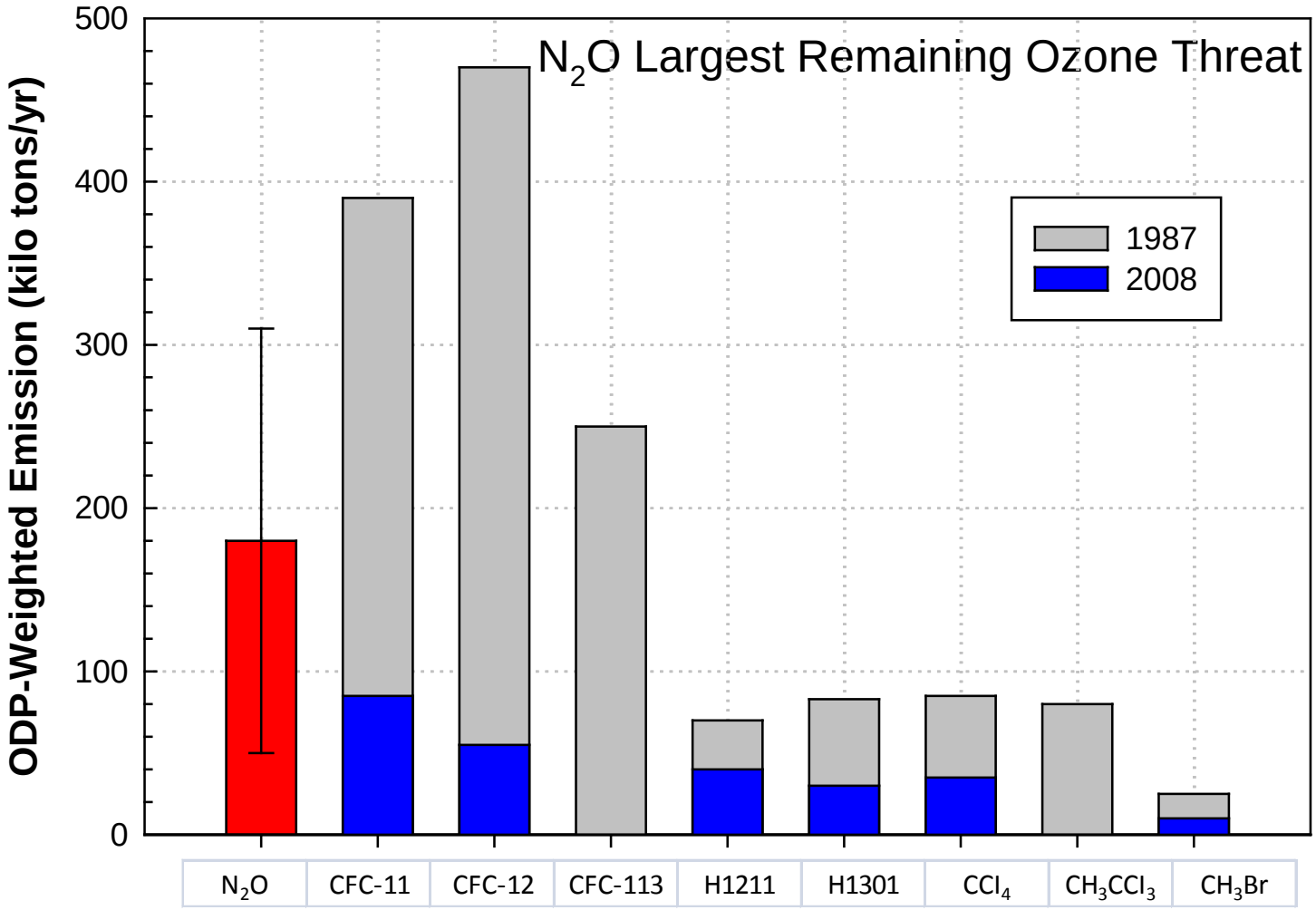


Agricultural N_2O Emissions

- N_2O contribution to global warming was about 6% in 2007.
- Agricultural accounts for 10-27% of the total N_2O emission



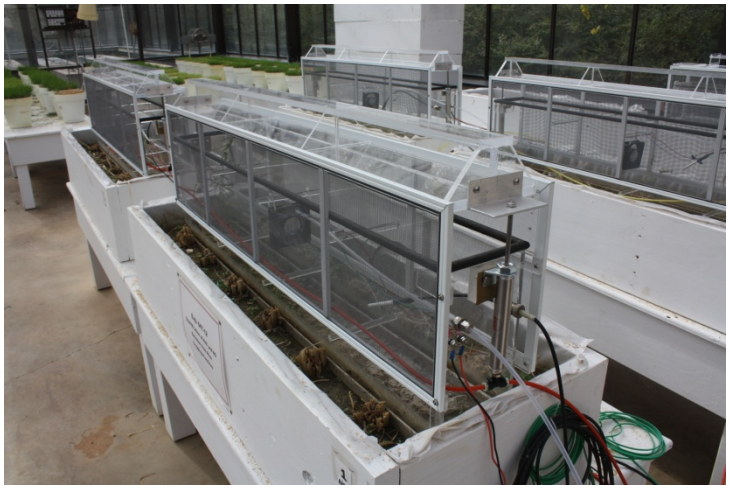
Importance of Quantifying N_2O Emission

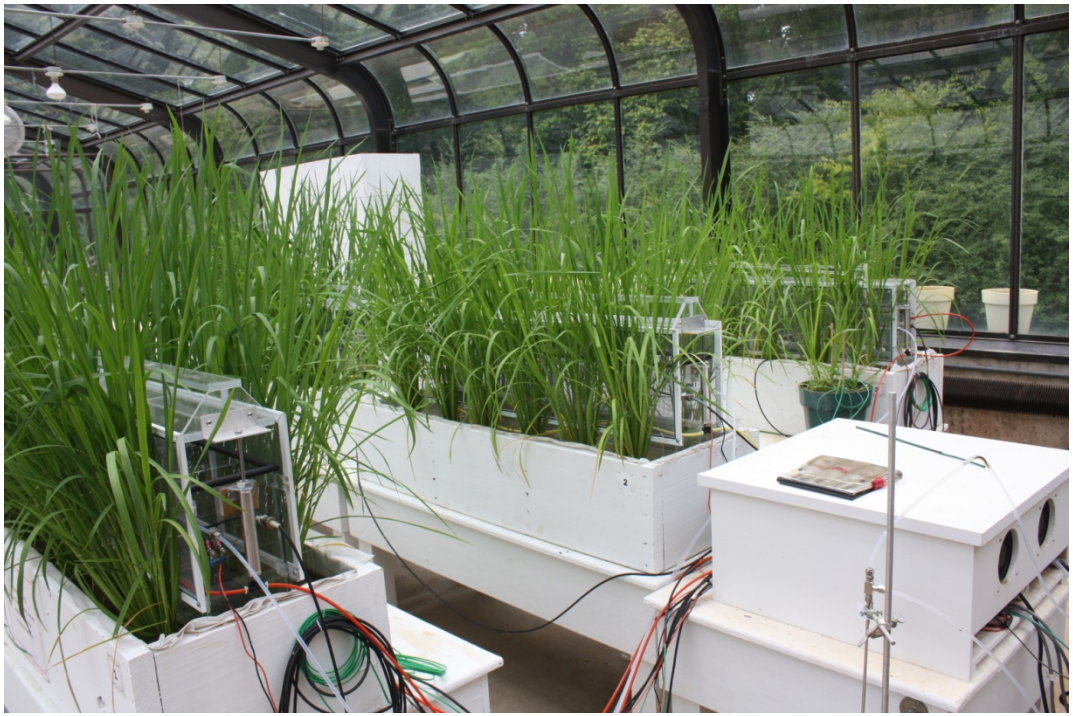


Ravishankara et al. (2009)

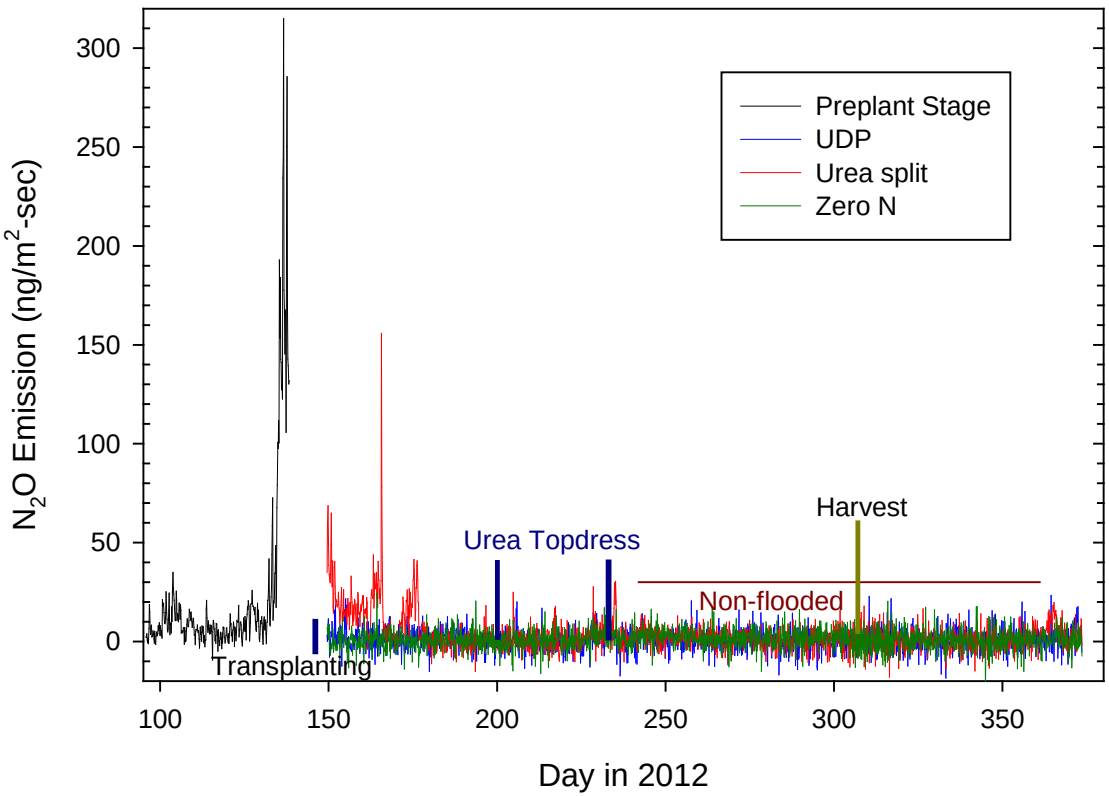
Methodology

- Continuous measurement using Gas Filter Correlation N_2O analyzer (Model 320EU, Teledyne API) and Chemiluminescence NO-NOx Analyzer (Model 200E, Teledyne API)
- Data recorded using CR3000 (Campbell Scientific)
- Each chamber (57.1 liter) is sampled 8 times a day (3 hour interval)
- Chamber remains closed only for 40 minutes during each sampling time



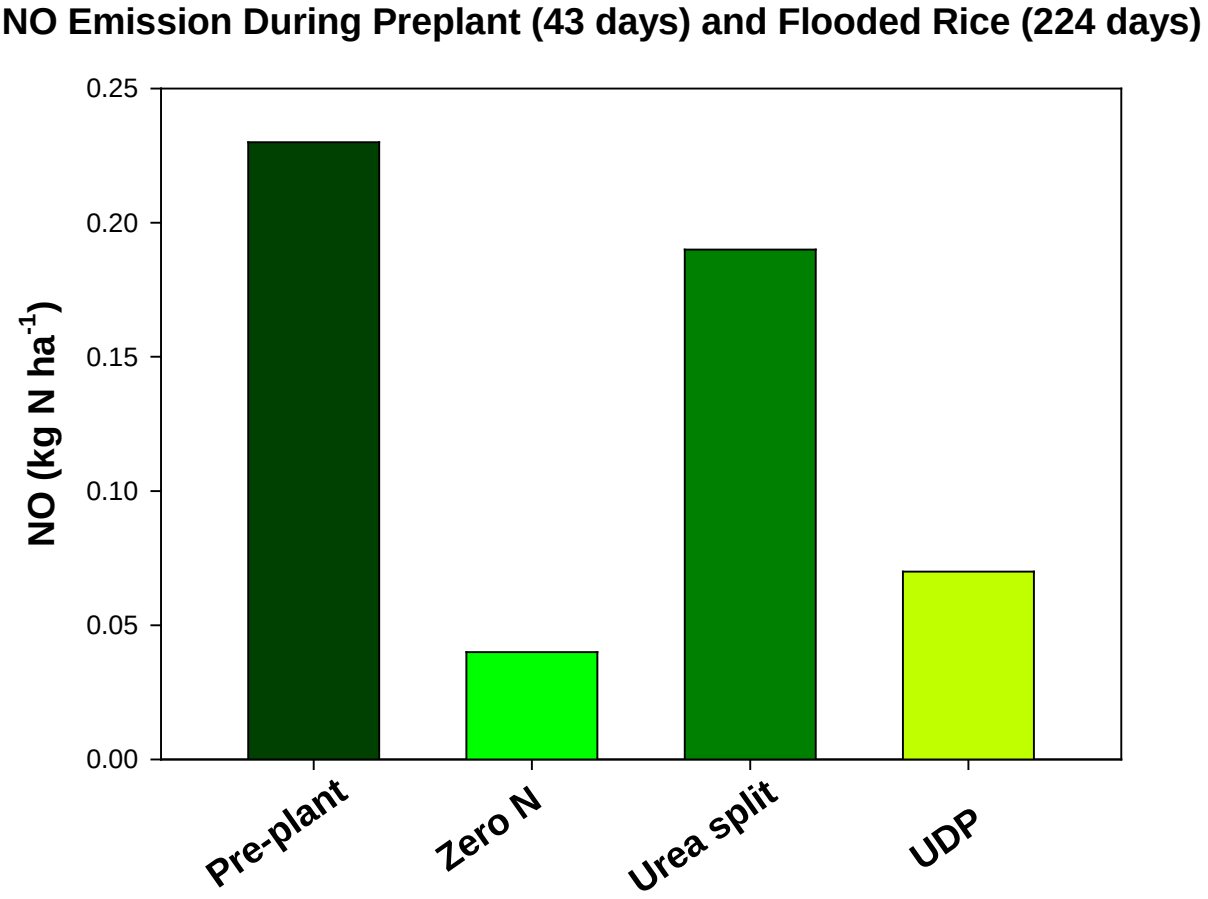


Nitrous Oxide (N_2O) Emission



N_2O emission prior to flooding, during lowland rice crop, and during post-harvest drying.

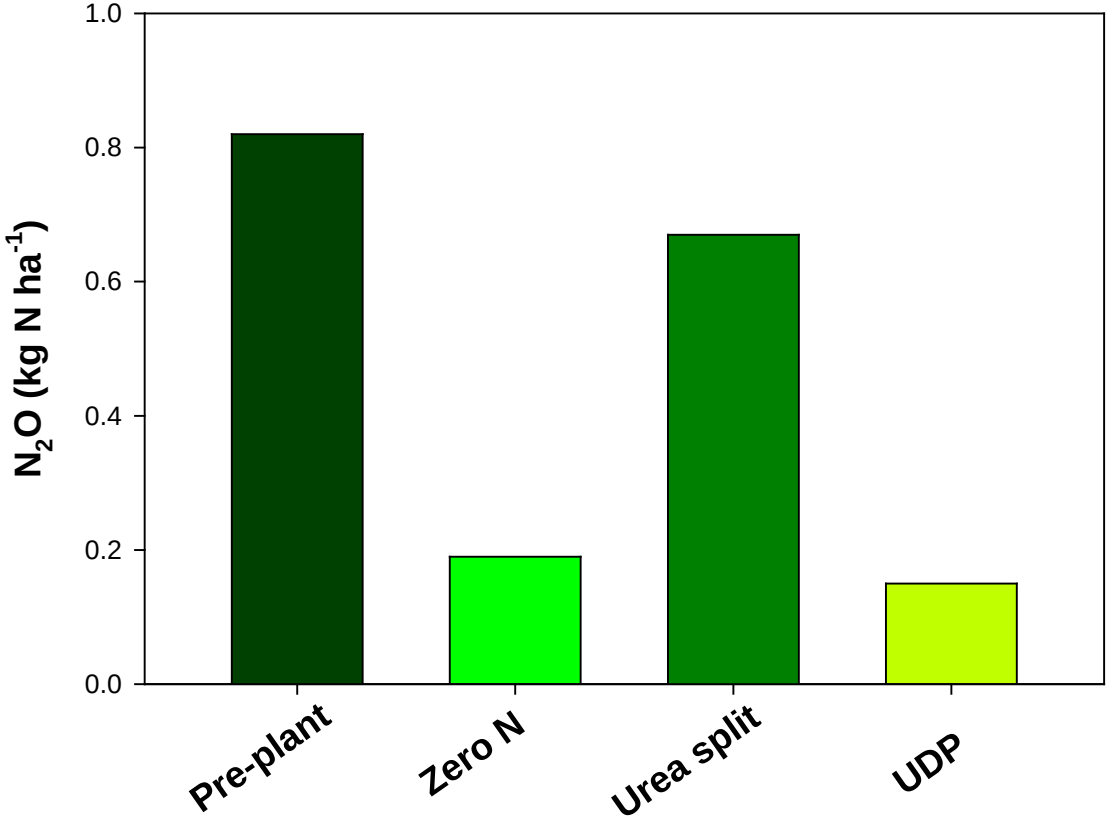
NO Emission During Cropping Cycle



NO emission during preplant stage is higher than during rice cropping. Urea application had higher emissions than zero N and UDP treatments.

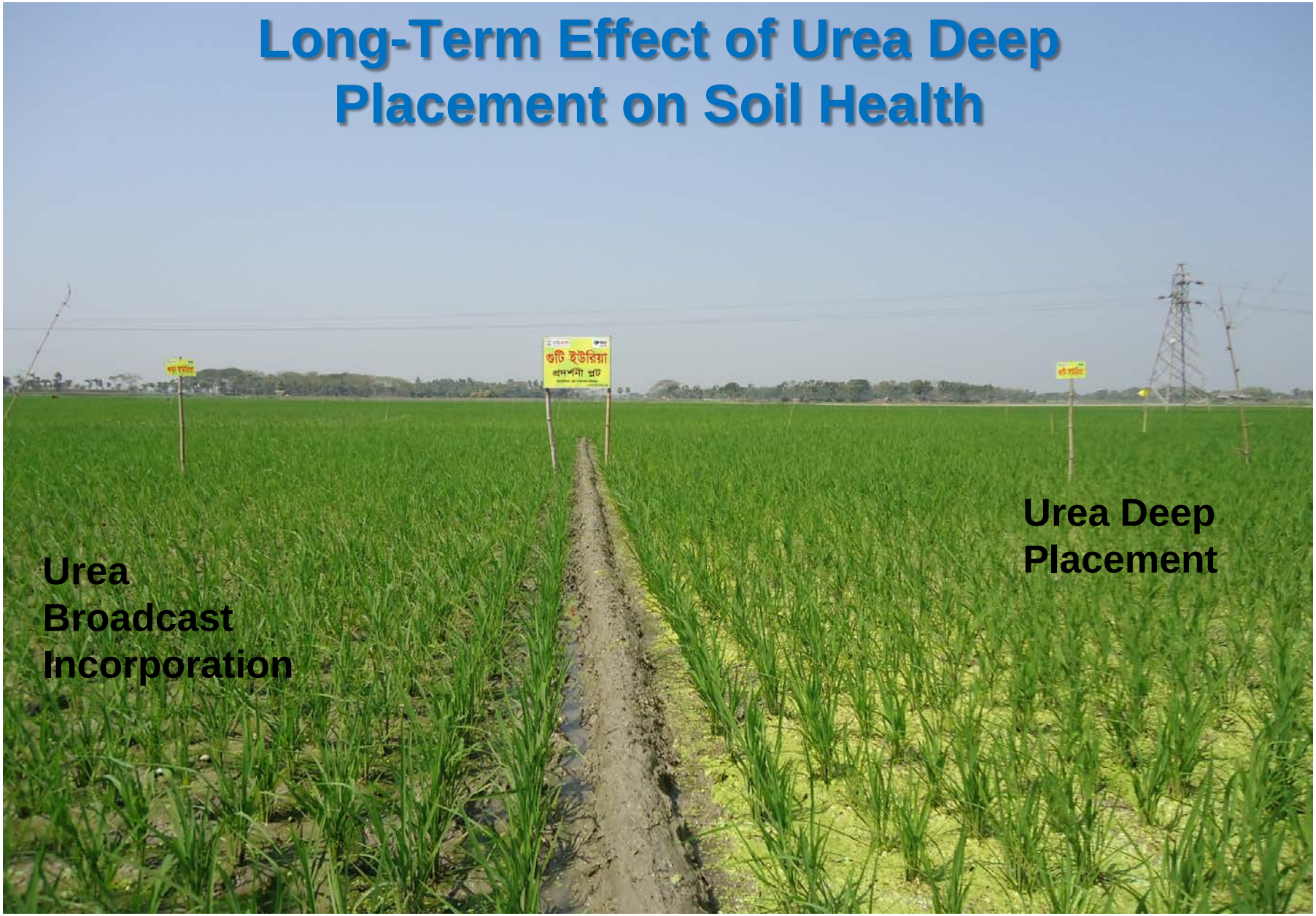
N_2O Emission During Cropping Cycle

N_2O Emission During Preplant (43 days) and Flooded Rice (224 days)

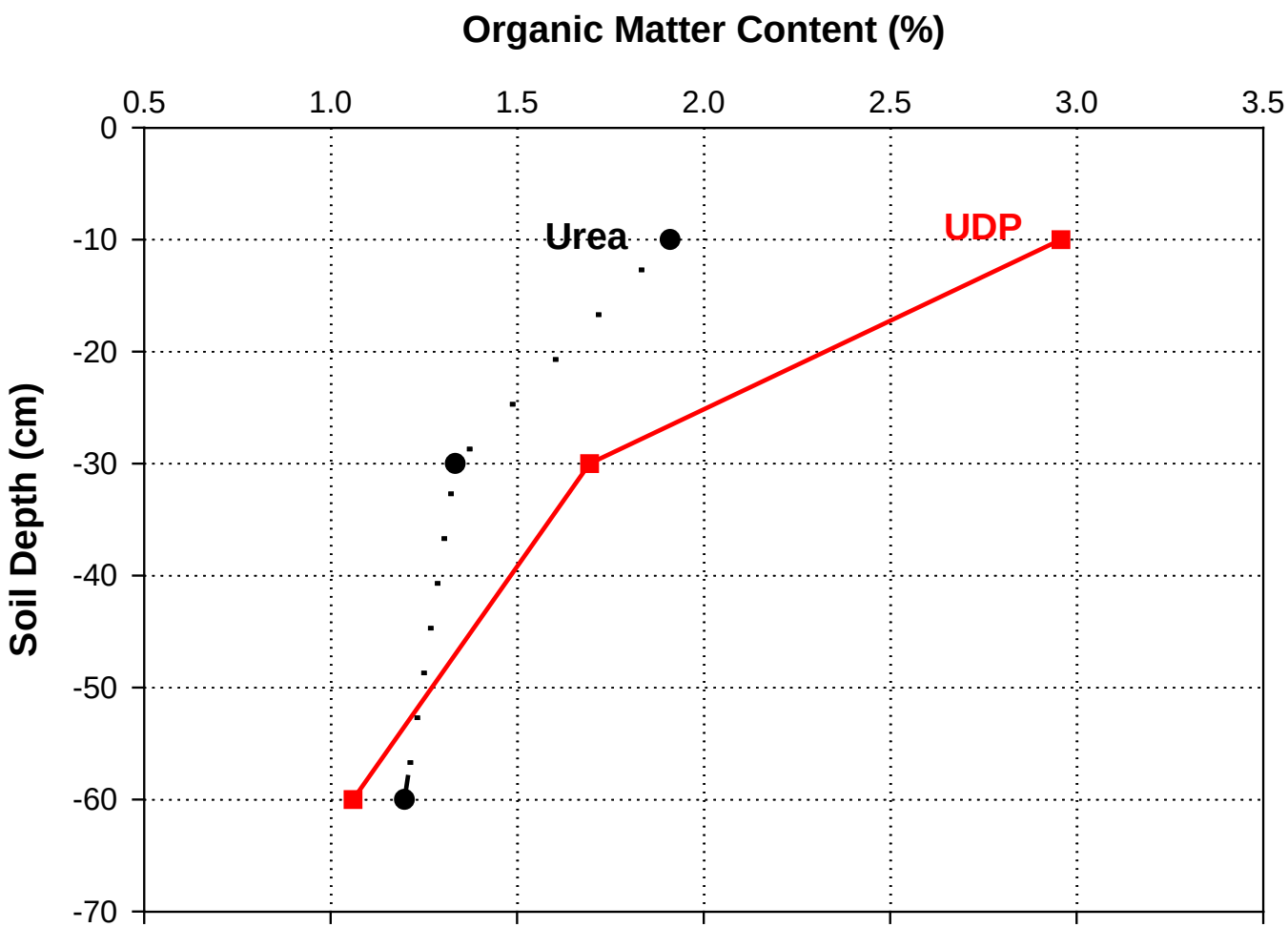


N_2O emission during preplant stage is higher than during rice cropping. Urea application had higher emissions than zero N and UDP treatments.

Long-Term Effect of Urea Deep Placement on Soil Health



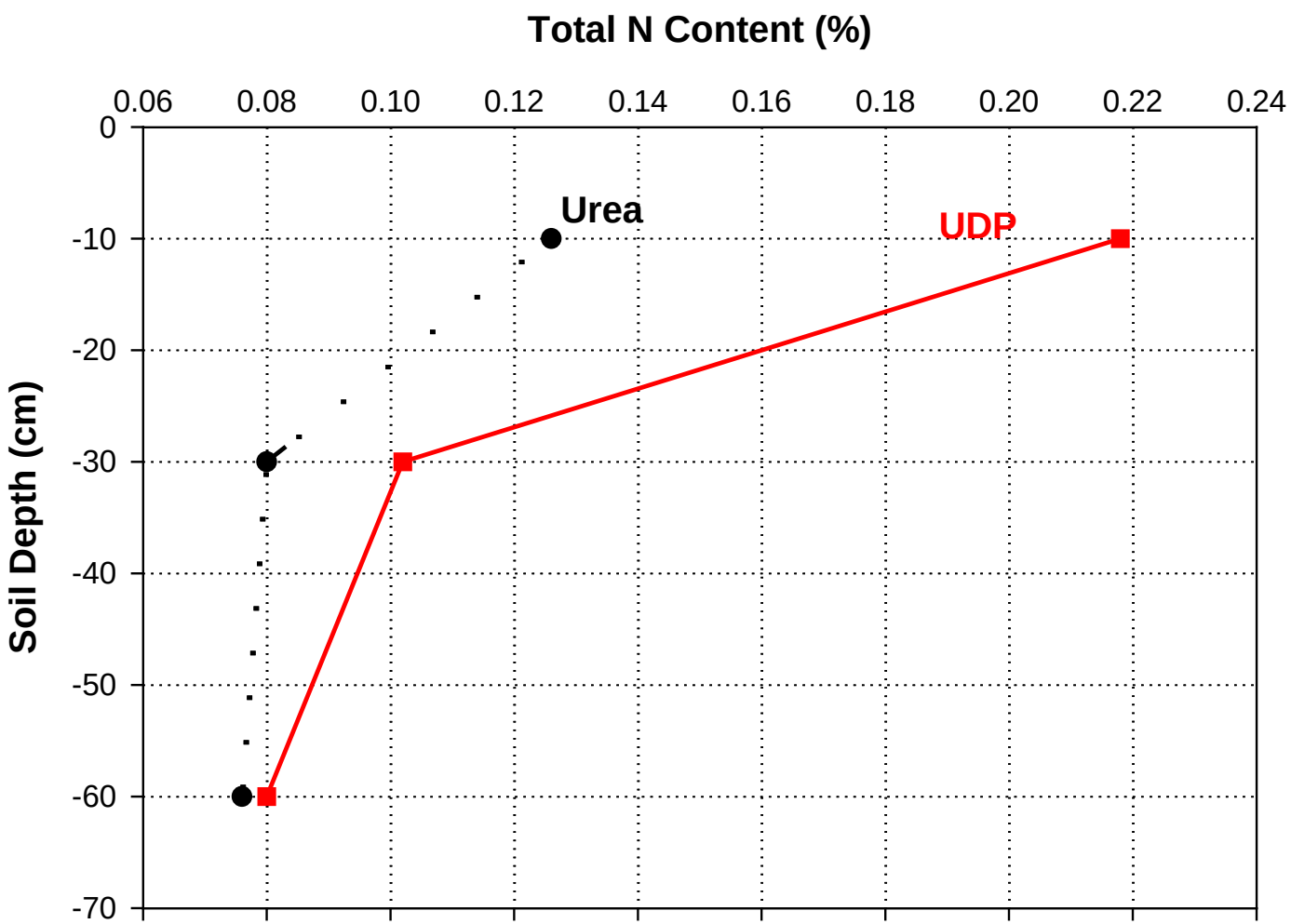
Long-Term Effect – C Sequestration



1% increase in C for 10 cm soil depth
= 10 t ha^{-1} C

Comparison of Organic Matter Content with UDP and Urea

Long-Term Effect – Total Soil N Content



Comparison of Soil Total Nitrogen with UDP and Urea

Summarizing - Deep Placement Resulted In:

- Reduced N loss (up to 50%)
- Improved rice grain yield (15-35%); also for upland crops
- Less N fertilizer use (25-40%)
- Up to 50 kg additional rice grain per kg N
- Significantly higher P recovery
- Increased C sequestration (roots, algae)
- Much of N_2O and NO emission occurred during the preplant stage when soil was saturated/flooded prior to rice transplanting
- Both N_2O and NO emissions were significantly lower with UDP compared to urea
- Less weeding with UDP

Implications for CDM: N fertilizer, N_2O-NOx, CO_2 fixed

Future Research

Urea application➔100 kg CO_2 Equiv GHG per ton rice

- ***Continuous field level quantification of N_2O-NOx emission in rice-based cropping. USAID supported project at two sites in Bangladesh by May 2013.***
- ***Quantify CO_2 capture from deep-placed urea briquette.***
- ***Quantify residual effect/revise recommendations.***
- ***Increased applicator options.***

Thank You

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Zachary Baquet,
USAID/BFS
zbaquet@usaid.gov

Upcoming Events

InnovATE
e-Consultation | May 7-8

Ag Sector Council
May 29 | Horticulture

KDMD

Agrilinks and the Agriculture Sector Council Seminar Series are products of the USAID Bureau for Food Security under the Knowledge-Driven Microenterprise Development (KDMD) project.