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Global Science Conference

March 16-18, 2015
Le Corum, Montpellier France

Reducing Nitrogen Run-off and Emission, and Increasing Rice Productivity in African Rice Production Environment

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Montpellier

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Sustainability of Yields under a Changing Climate

- Increased yields needed to meet production demands
  - Increased agricultural inputs (fertilizer and water) are needed to sustain high yields

- Challenges of Higher 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

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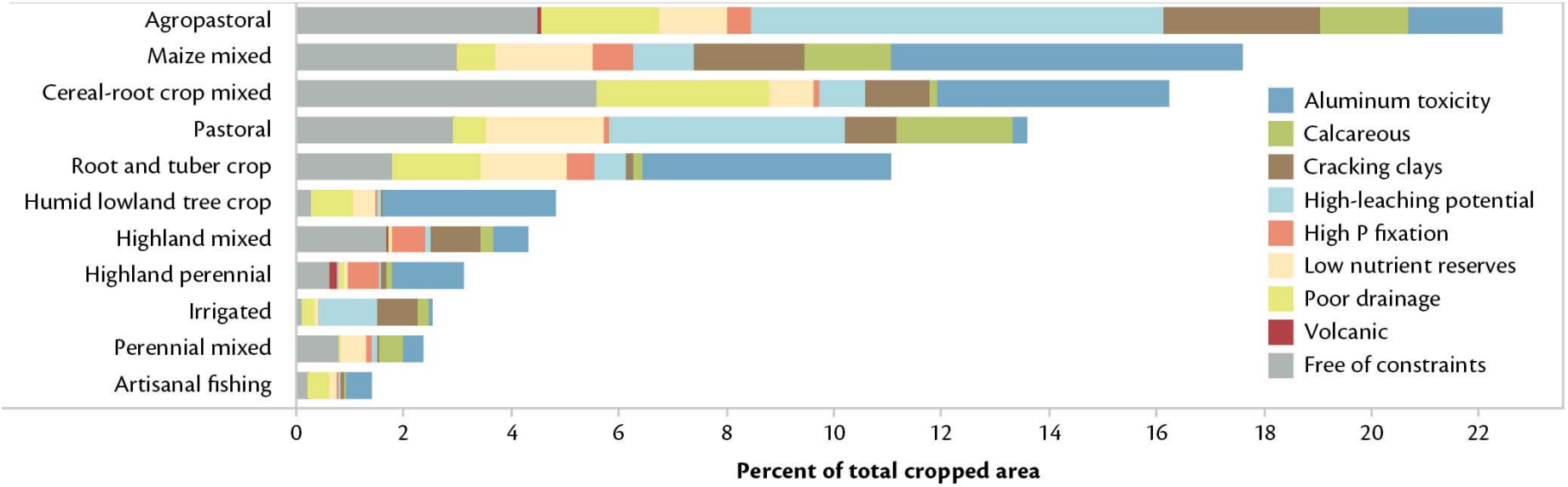
African Soil Constraints

FIGURE 1 Dominant soil constraint by farming system type in Africa south of the Sahara



Cox C., and Koo J. (2014). Soil Fertility. In K. Sebastian (Ed.), Atlas of African Agriculture Research & Development.

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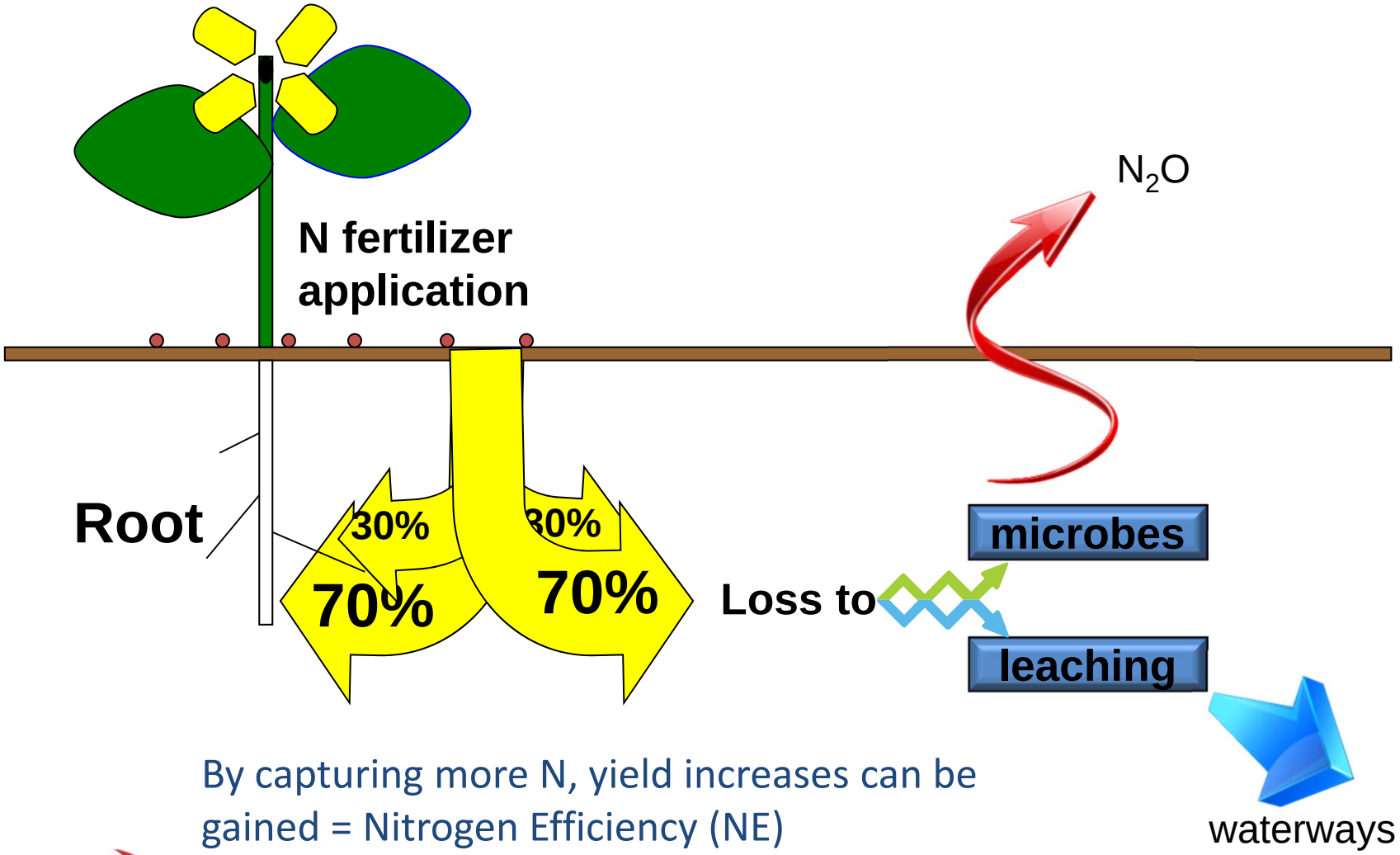
70% of Nitrogen Fertilizer is Lost



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

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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].

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AATF NEWEST Rice Goals

- Traits that mitigate causes of climate change
- Traits that harness against effects of climate change
- Traits that allow sustained yield under low input conditions

1. Improved Nitrogen Use Efficiency (NE)
2. Improved Water Use Efficiency (WE)
3. Improved Salt Tolerance (ST)

- Breeding material for Sub Saharan Africa, in the public domain
- Deliver a technology free of IP with humanitarian focus
- Use of germplasm with proven agricultural track record in SSA

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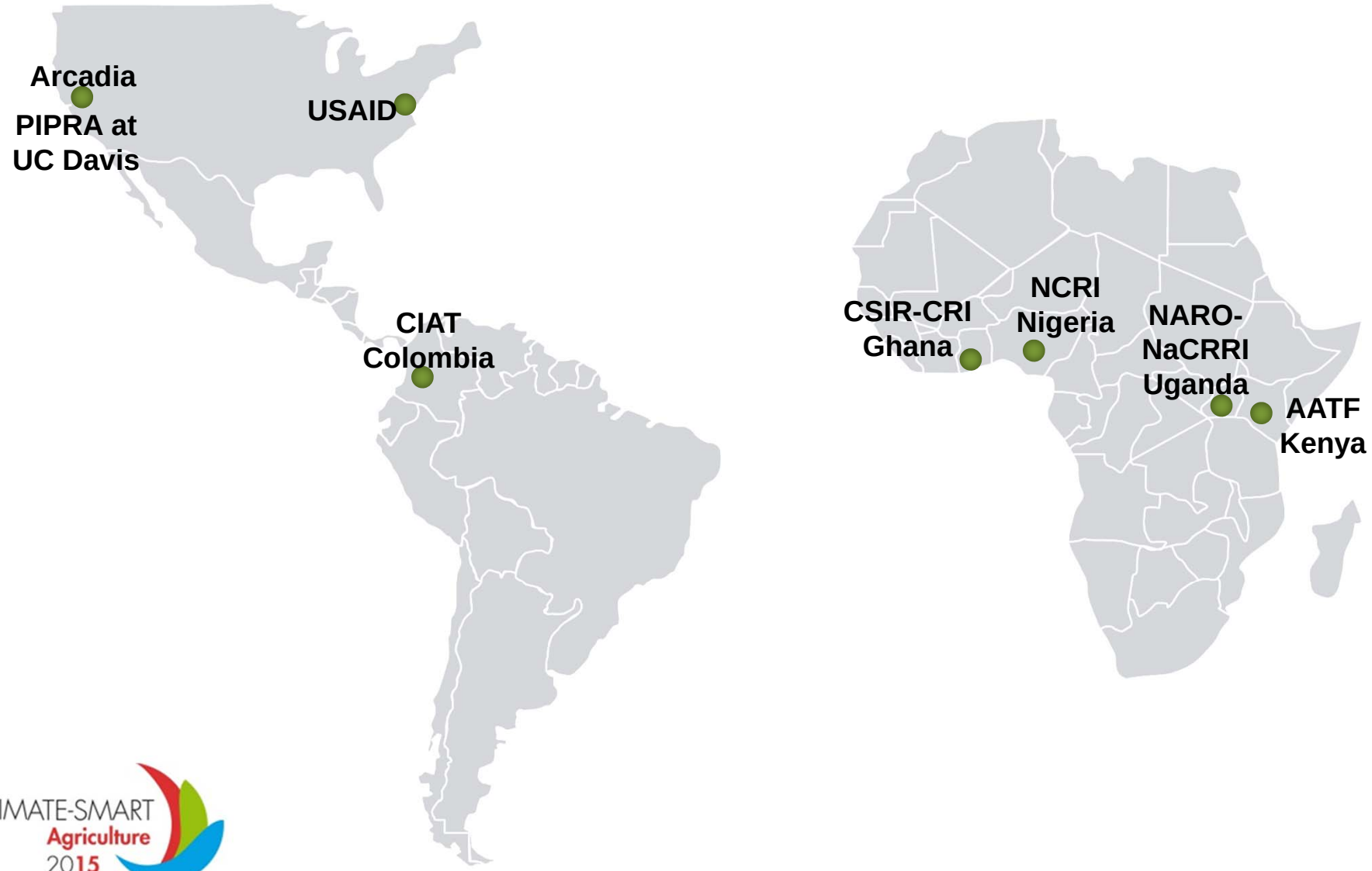
NEWEST Participants



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Choice of Germplasm

- NERICA (New Rice for Africa) varieties
- Wide spread throughout Africa
- Consumer-related acceptability
- Yield potential
- Amenable to genetic engineering

} NERICA-4

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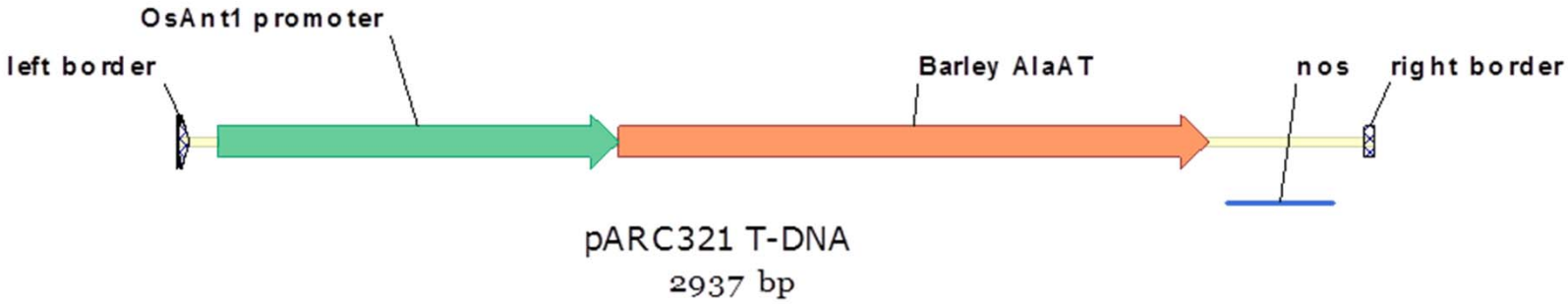
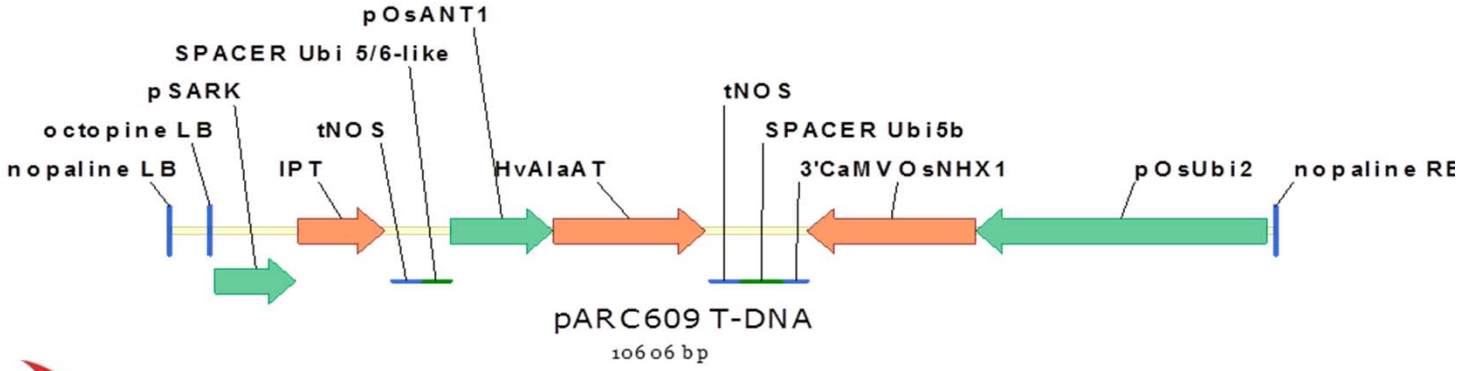
Deliverables 2008-2014

- **15 Nerica-4 NUE lines:**
  - All marker-free and vector backbone-free



- **20 Nerica-4 NEWEST lines:**
  - All vector backbone-free
  - 6 events marker-free, 16 single copy T-DNA insertions



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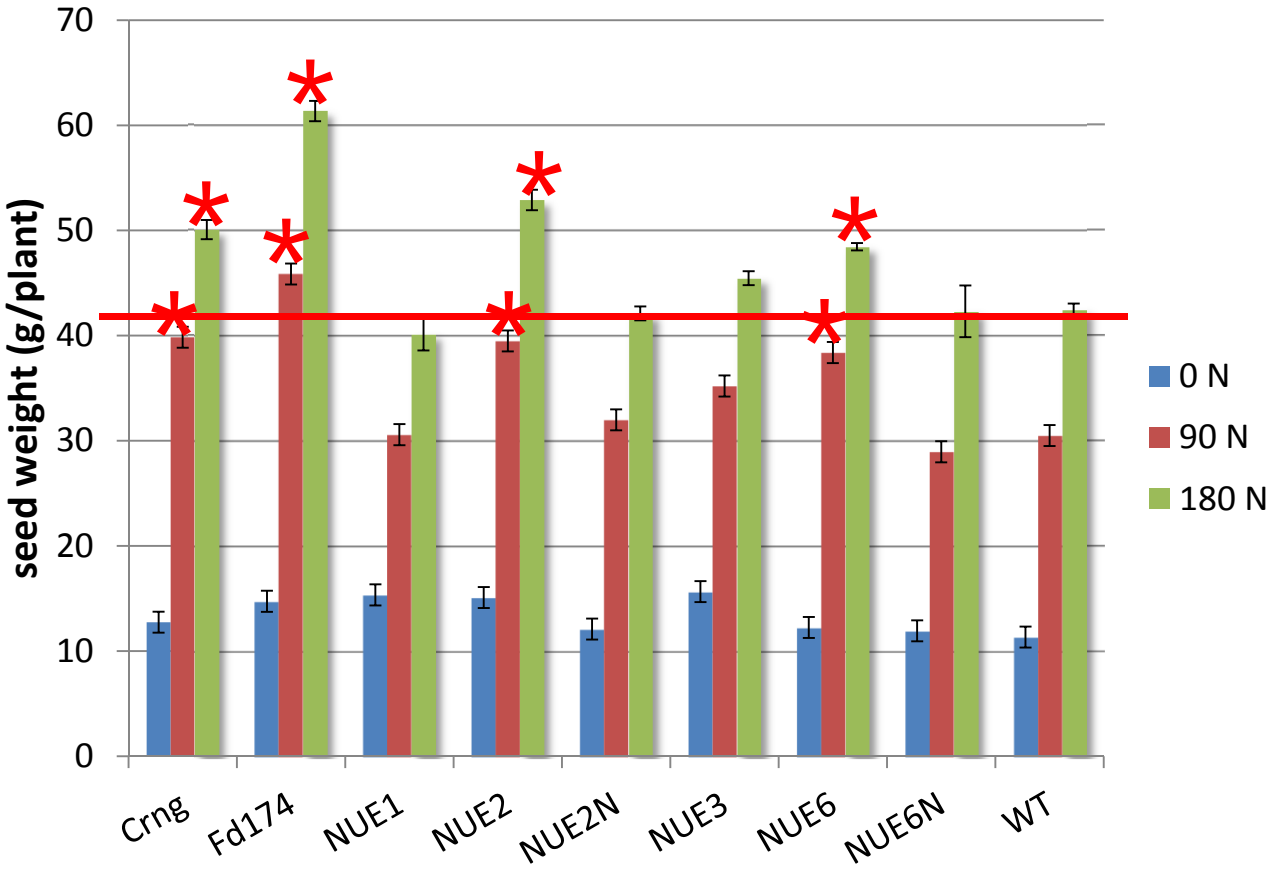
CIAT 2nd Lowland NUE Trial - 2013



ANOVA; P=0.05; $LSD_{0.05}$ = 4.72

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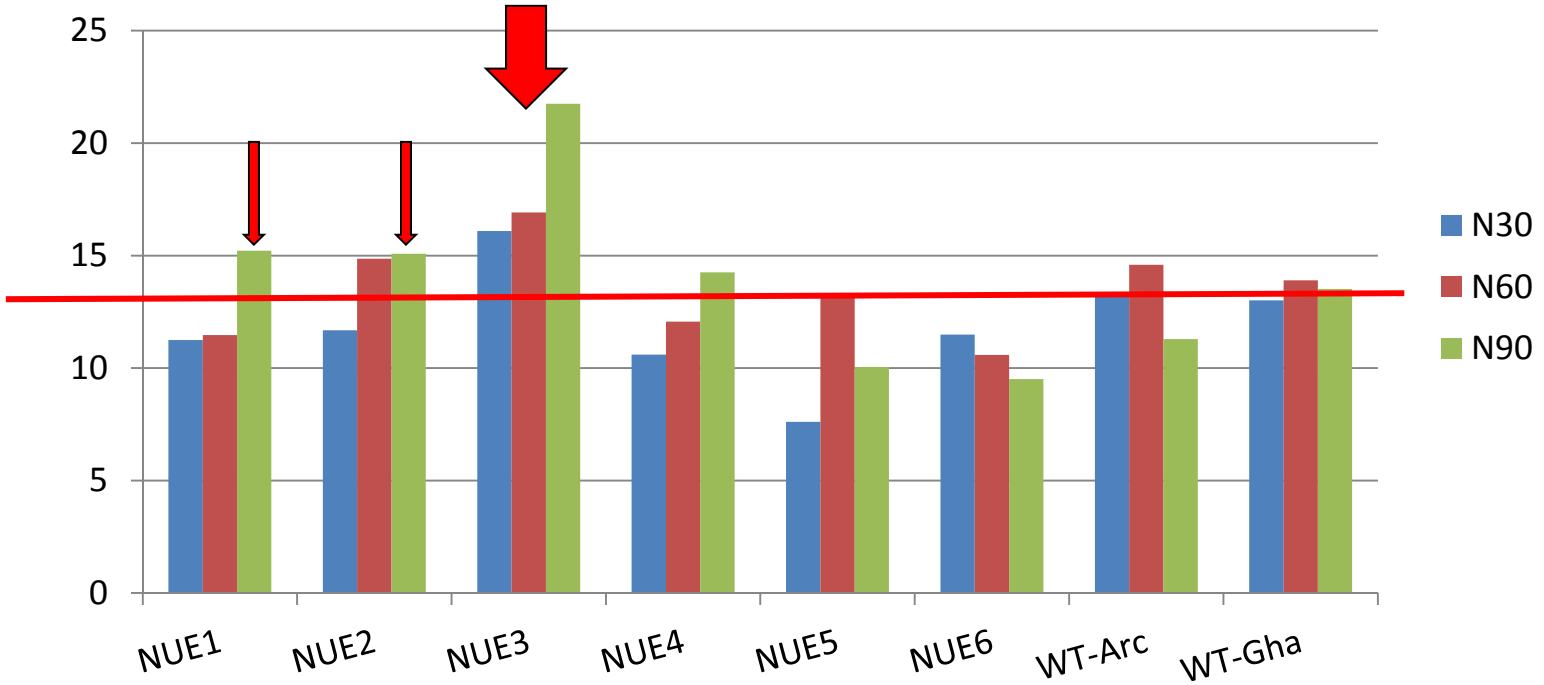
CRI-Ghana 1st Rainfed NUE Trial - 2013



- event **NUE-3** consistently outperforming WT;
- event NUE-1 and -2 outperforming at 90 kg/ha N

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Overall Best Performers
(% yield increase vs. control)

	Colombia							Ghana						Uganda		
	LL1			LL2			UL	1			2			1		
kg/ha N	0	90	180	0	90	180	90	30	60	90	30	60	90	30	60	90
NUE-1				35						35						
NUE-2	16	28	25	33	30	25	34			34			14			
NUE-3				38	15			21	16	93	52	35	11			
NUE-6	22				26	14	27									
NUE-7								39				4	12			
NUE-9								14			15		19			
NUE-11								16			22					
NUE-12									21		11					
NUE-13								20					24			
NUE-15															6	5

significantly outperforming control

outperforming control, but not significantly

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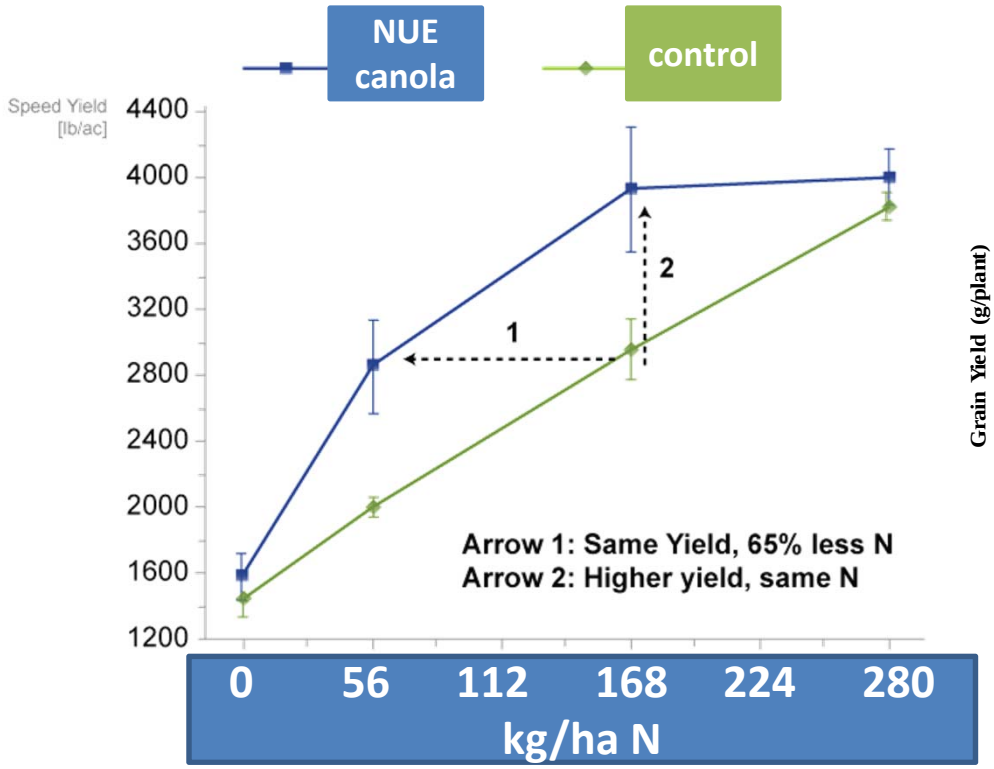
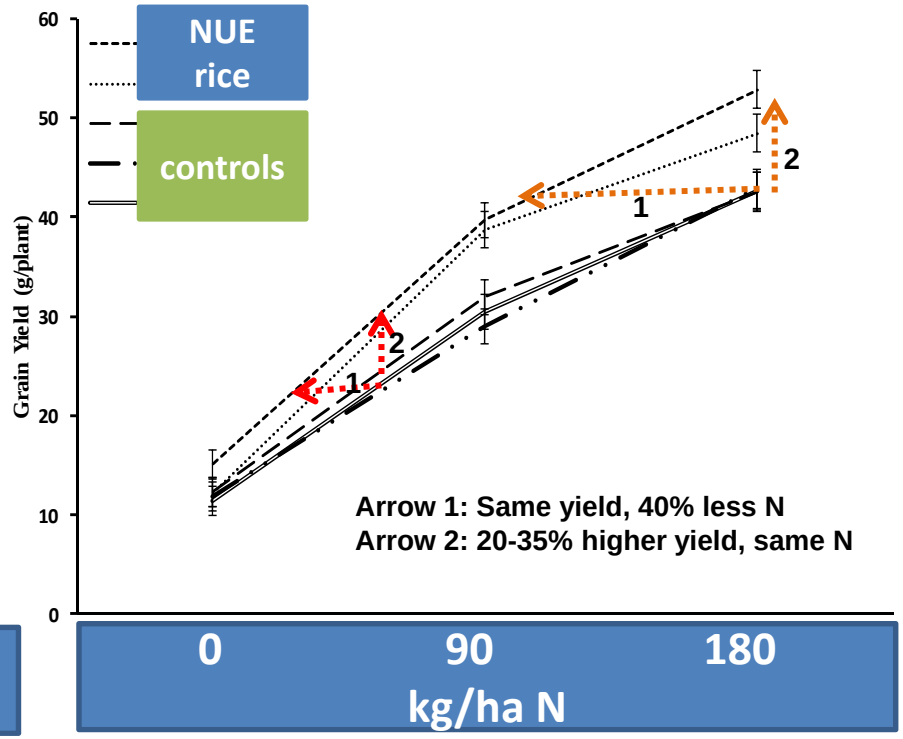
N Fertilization/Yield Management





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Methodology Development for Capturing N_2O Emissions, tied to carbon credit trade

- China (2007-2013)
- India (2009-2013)
- Indonesia (2014-2016)

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Gas Monitoring throughout the Crop Cycle

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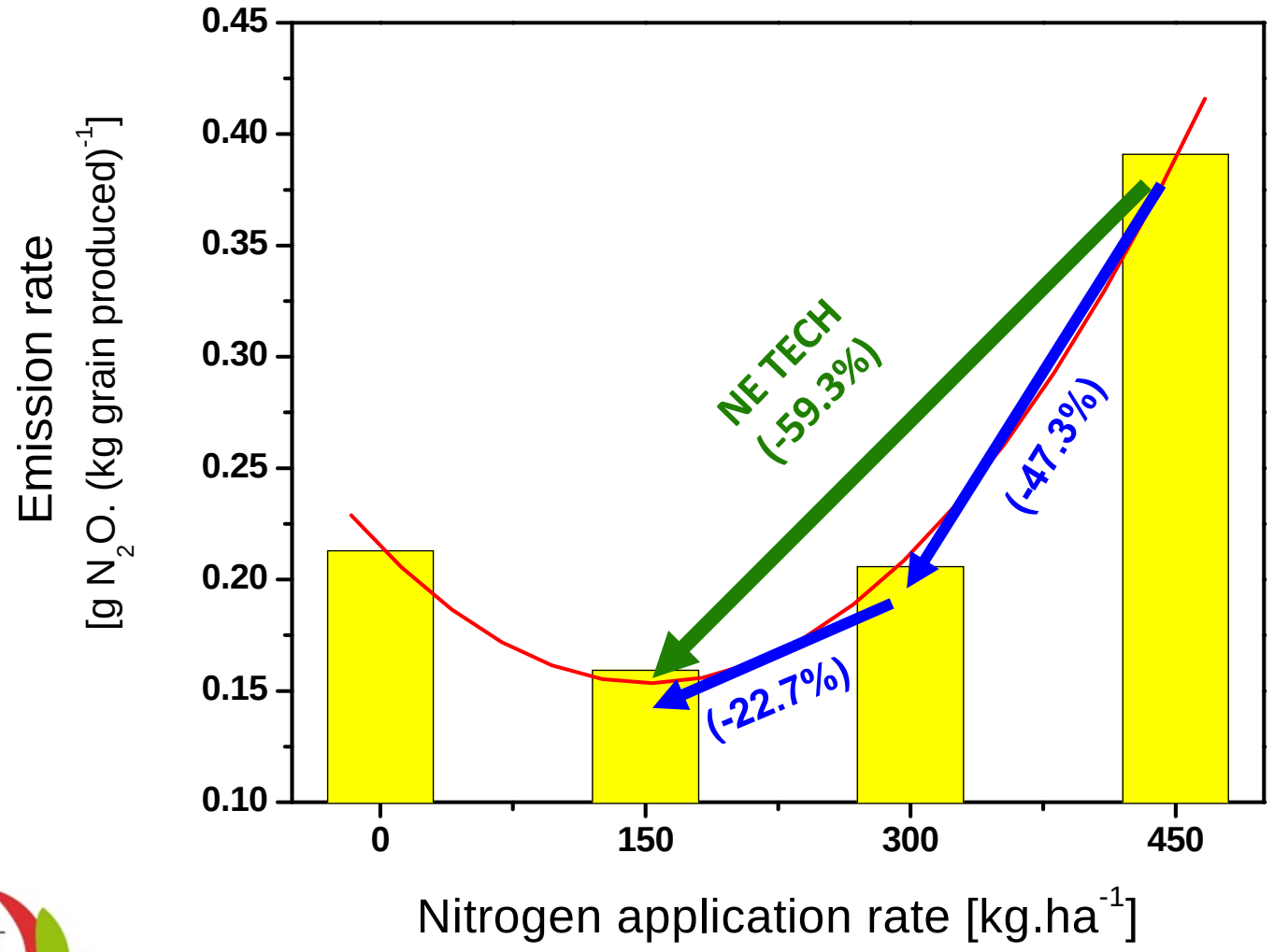
Rice N_2O Emission at Different N Rates



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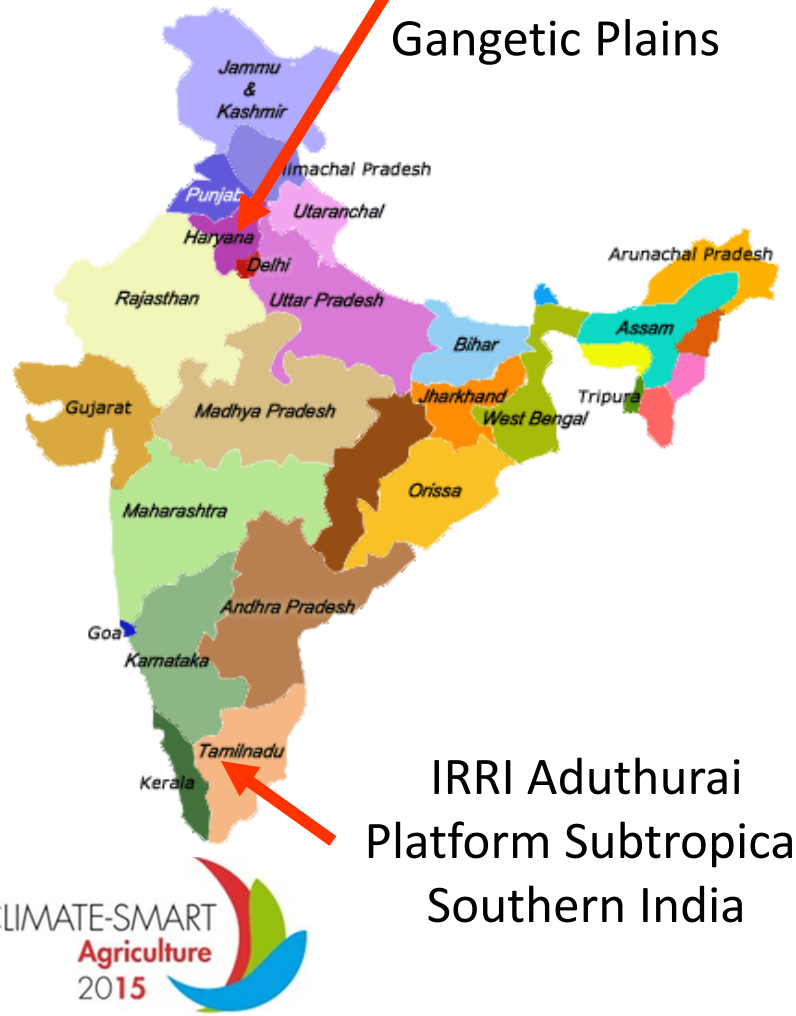
Greenhouse Gas Emissions from Rice Fields

IRRI Karnal Platform
Western Indo-
Gangetic Plains



IRRI Aduthurai
Platform Subtropical
Southern India

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Planned N_2O Emissions Capture

Indonesian Agricultural Environment Research Institute (IAERI), Pati, Central Java, Indonesia

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Establish Methodology to Capture (N_2O) Emissions from Rice

Development of New Methodology

- Collection of field data and submission of a new methodology to the UNFCCC/CDM (Clean Dev. Mechanism) Executive Board
- Worked with relevant CDM authorities and/or other experts within and outside China/India to achieve approval by Executive Board
- **Dec 2012**, Arcadia methodology was approved
- Farmers to earn carbon credits from reduced fertilizer use in conjunction with Nitrogen Efficient seed

Establishment of Agricultural Carbon Credit and Trading System

- The NAAFS/IRRI coordinates with the appropriate authorities in Ningxia/Haryana/Tamil Nadu 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

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Expected Outcomes

For high input farming systems, aiming at sustaining yield:

Lowering fertilizer input lowers production cost

Reducing nitrogen run-off and emission

Additional cost reduction through carbon credit trading

For low input farming systems, aiming at increasing yield:

Even with continued low fertilizer applications, 20% or more yield increase is expected

Reducing negative environmental impact is of lower magnitude

Further reducing cost by carbon credit trading may be achieved when carbon market in place

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Value of NUE Trait to Grower
"The Triple Win"

- Assumptions:
  - 10-15% improvement in yield
  - 30% N use reduction (high input farming system)
  - 15% decrease in total production cost
  - Carbon price of $10/metric ton of CO_2 eq. (current)

1. Food Security: Yield Increase: $700 / ha
2. Mitigation: a) Fertilizer Savings: $250 / ha
   b) Carbon trade: $53 / ha
3. Adaptation: additional WE and ST

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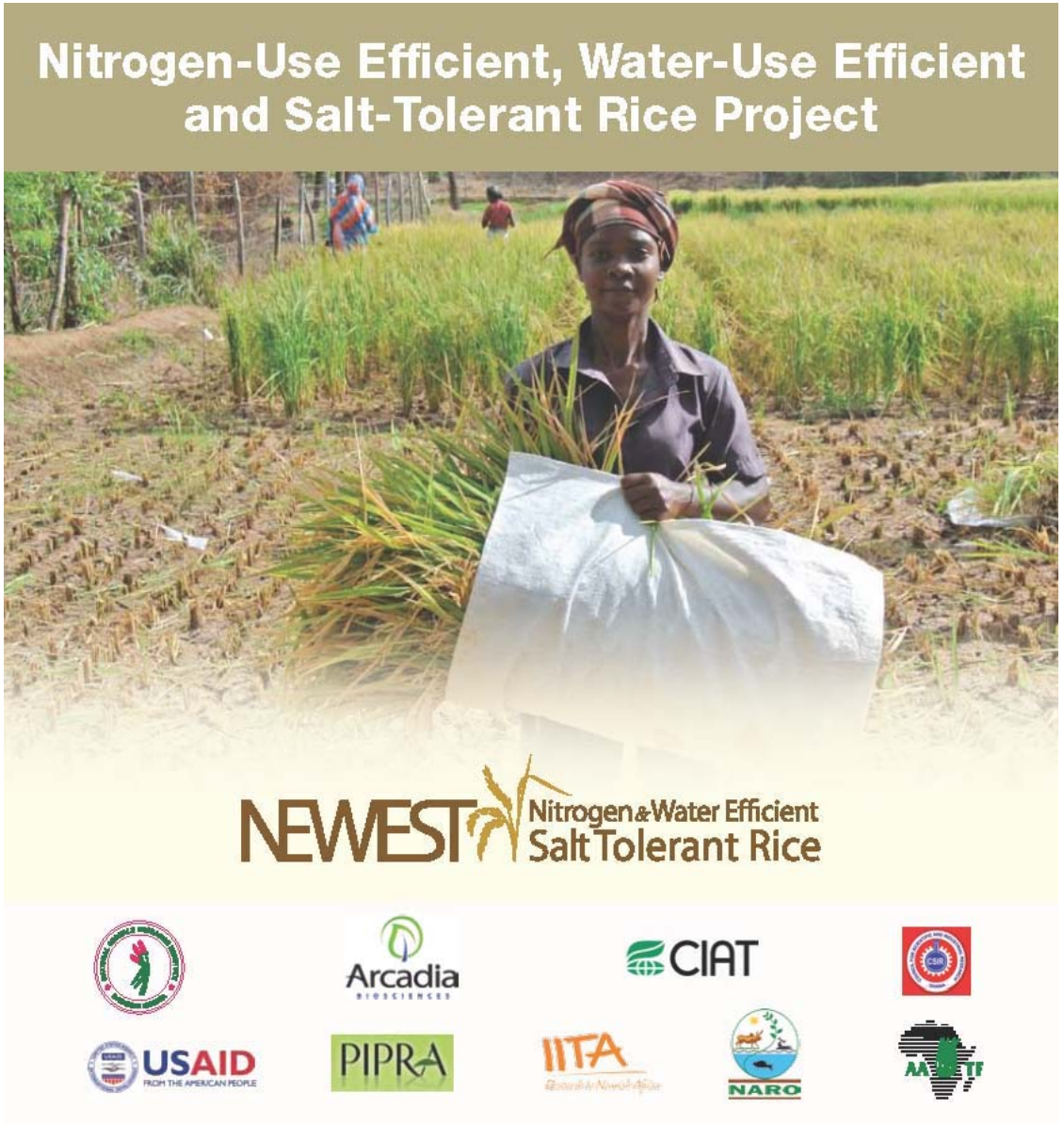
Merci!



Thank you!

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