

Global assessment of potassium limitation to crop yields

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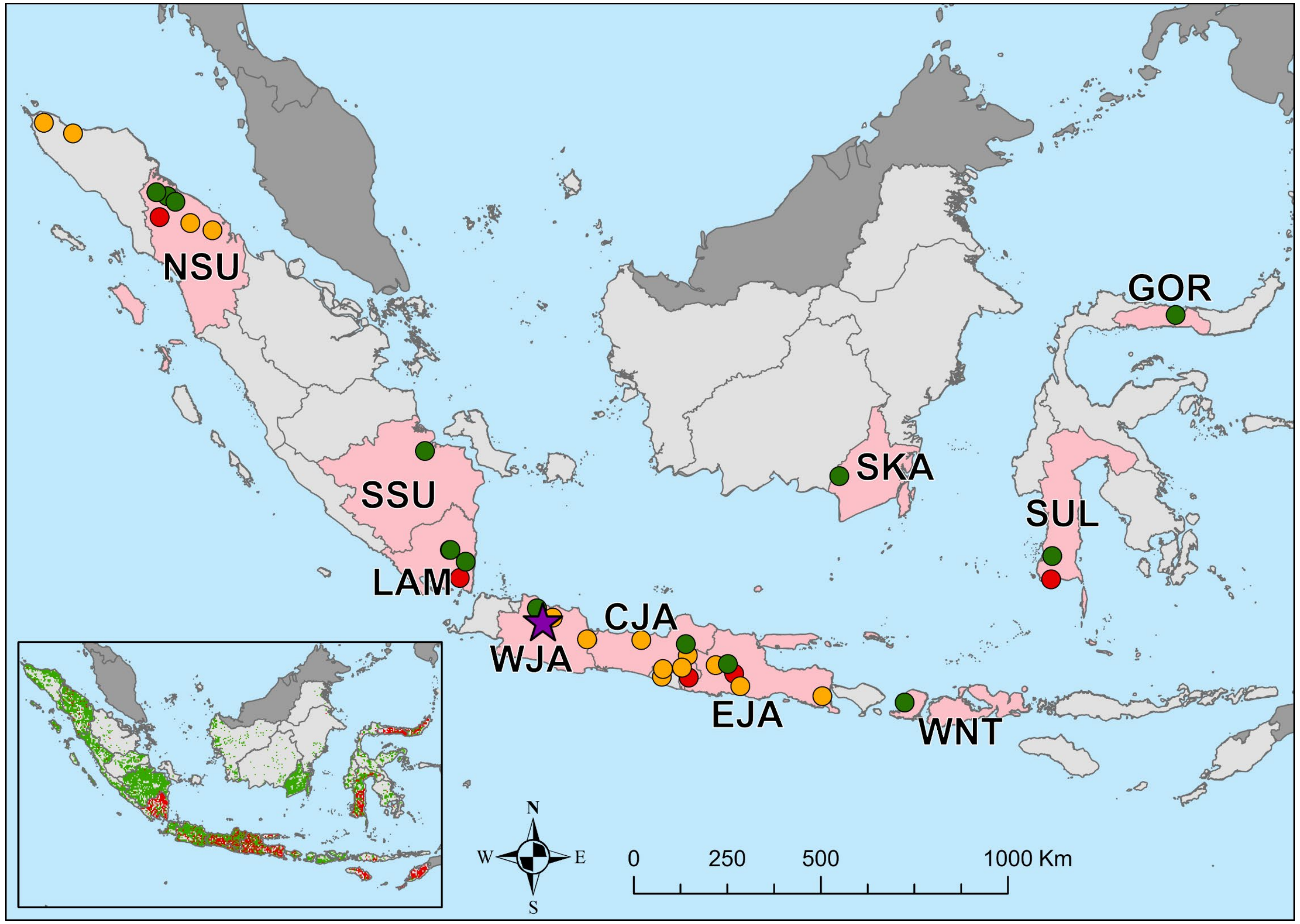
CASE STUDY: RICE & MAIZE IN INDONESIA

Our study area accounts for 70% and 50% of national rice and maize area



Databases:

- Farmer field survey data (n=1600) and leaf tissue analysis (n=480)
- Rice (n=172) — on-farm trials (IRRI, IPNI)
- Maize (n=39) — on-farm trials (IRRI, IPNI)
- Long-term rice experiment

North Sumatra (NSU), South Sumatra (SSU), Lampung (LAM), West Java (WJA), Central Java (CJA), East Java (EJA), West Nusa Tenggara (WNT), South Kalimantan (SKA), South Sulawesi (SUL), Gorontalo (GOR)

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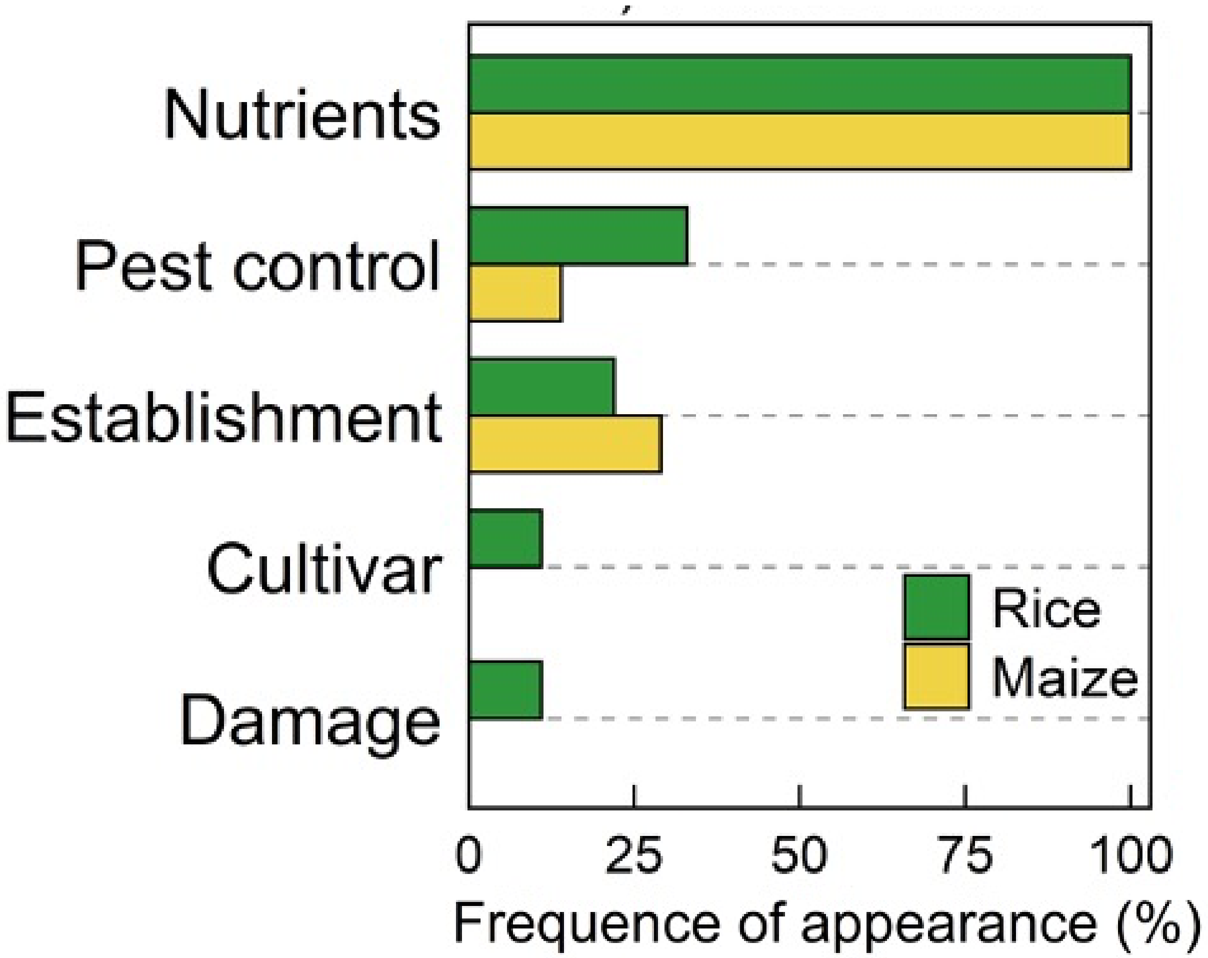
YIELD CONSTRAINTS FOR RICE & MAIZE

Analysis of farmer survey data suggest nutrients to be a key factor explaining yield gaps



Adapted from Rizzo *et al.* (Field Crops Research, 2023)

FOUR APPROACHES TO ASSESS NUTRIENT LIMITATION

Approach 1 — Calculation of nutrient balances based on farmer survey data

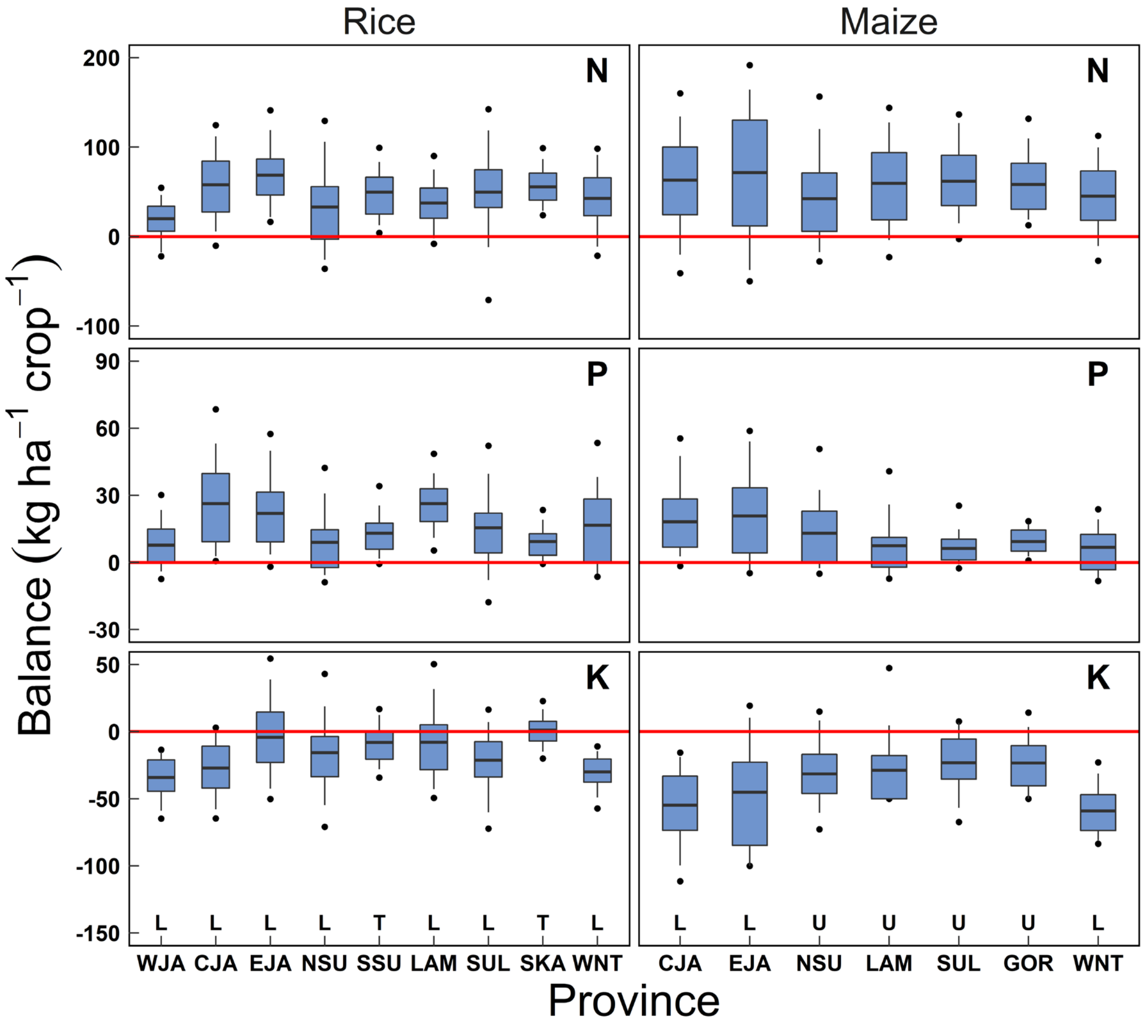
Approach 2 — In-situ nutrient status diagnosis based on leaf tissue analysis

Approach 3 — Analysis of data from long-term fertility experiments.

Approach 4 — Analysis of on-farm fertilizer trials.

Approach 1 ON-FARM CROP NUTRIENT BALANCES

Average N and P balances were positive, but negative for K.



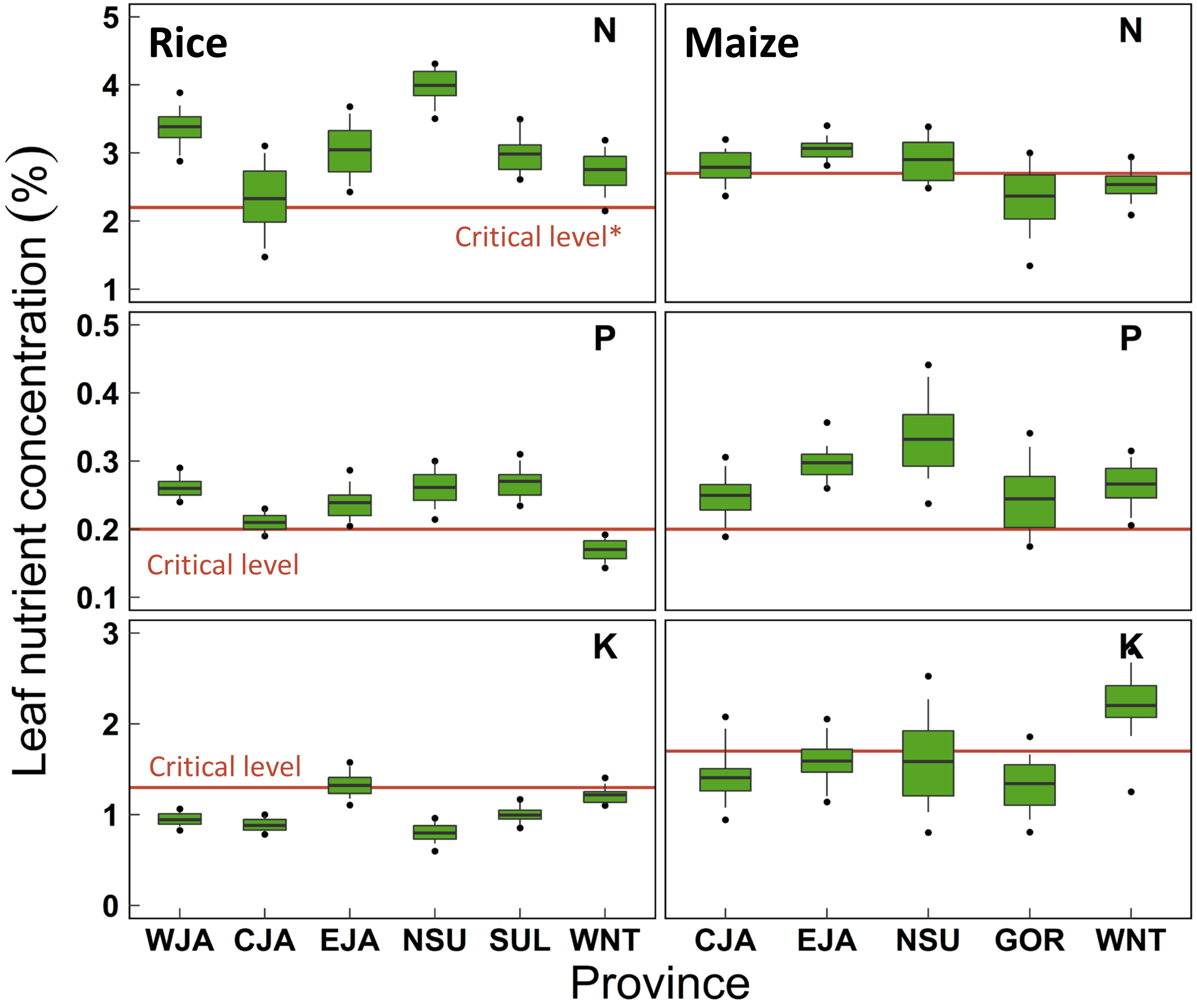
Rizzo *et al.* (submitted)

*Nutrient balance estimated as the difference between crop nutrient removal and nutrient inputs (including fertilizer, manure and N fixation in rice) based on survey data collected from 1,600 fields in North Sumatra (NSU), South Sumatra (SSU), Lampung (LAM), West Java (WJA), Central Java (CJA), East Java (EJA), West Nusa Tenggara (WNT), South Kalimantan (SKA), South Sulawesi (SUL), Gorontalo (GOR).

Approach 2

ON-FARM CROP NUTRIENT STATUS

Fields were generally sufficient in N&P but deficient in K



Rizzo *et al.* (submitted)

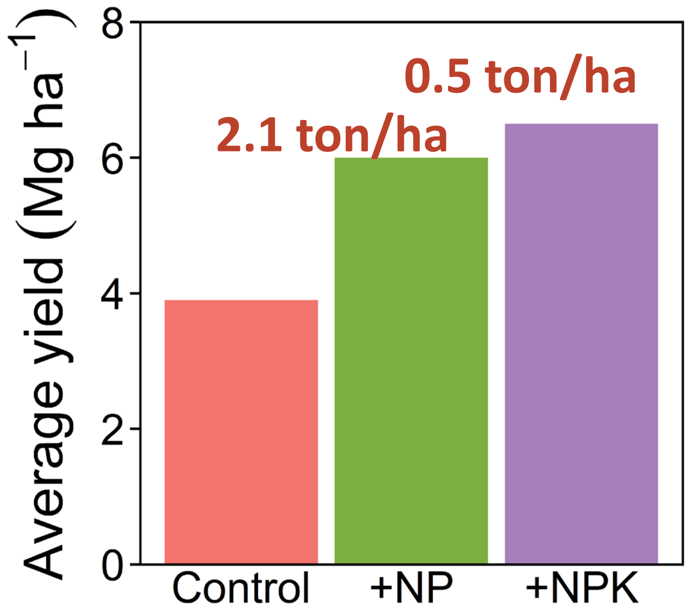
* Based on leaf tissue samples (flag leaf in rice & ear leaf in maize) collected at the beginning of flowering in 480 fields in Indonesia.
Critical level established based on our review of 86 articles reporting critical nutrient concentrations for rice and maize

Approach 3

LONG-TERM EXPERIMENTS

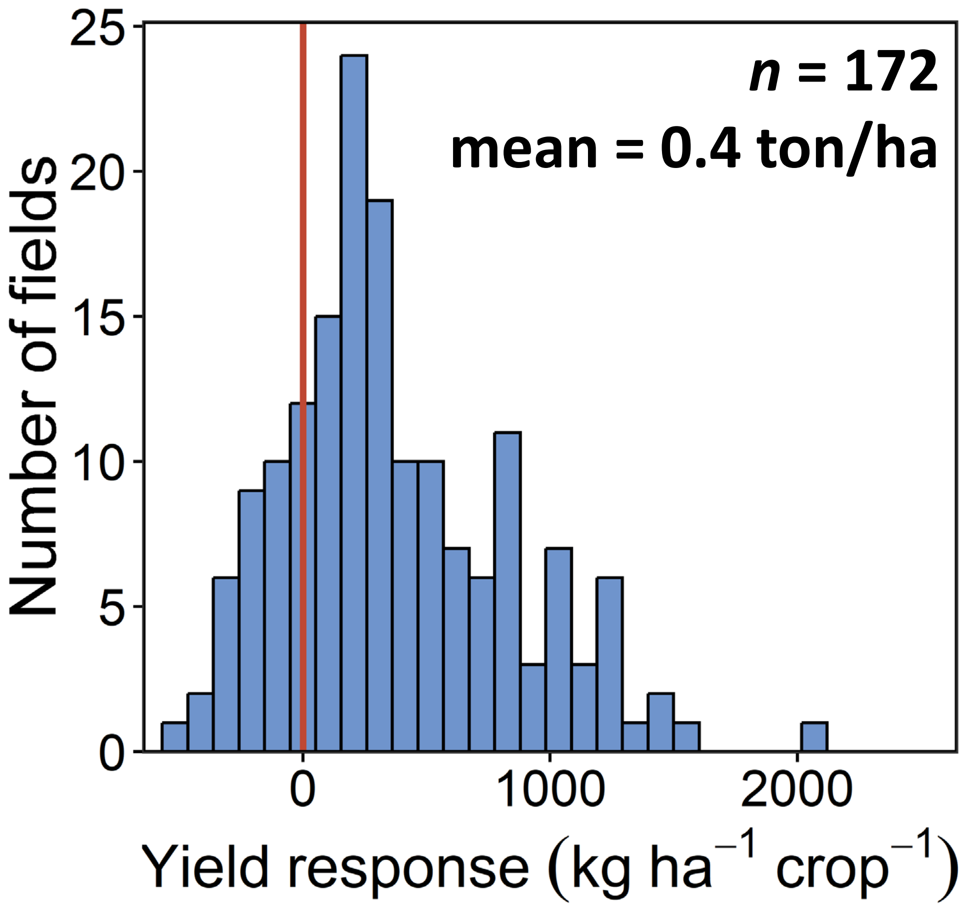
Long-term fertility experiment from 1994 to present.
A total of 29 consecutive rice crops.

Treatments: Control (0 – 0 – 0)
+NP (140 – 25 – 0)
+NPK (140 – 25 – 64)



ON-FARM RICE TRIALS

Consistent yield response to K fertilizer, but uncertain return on investment*.



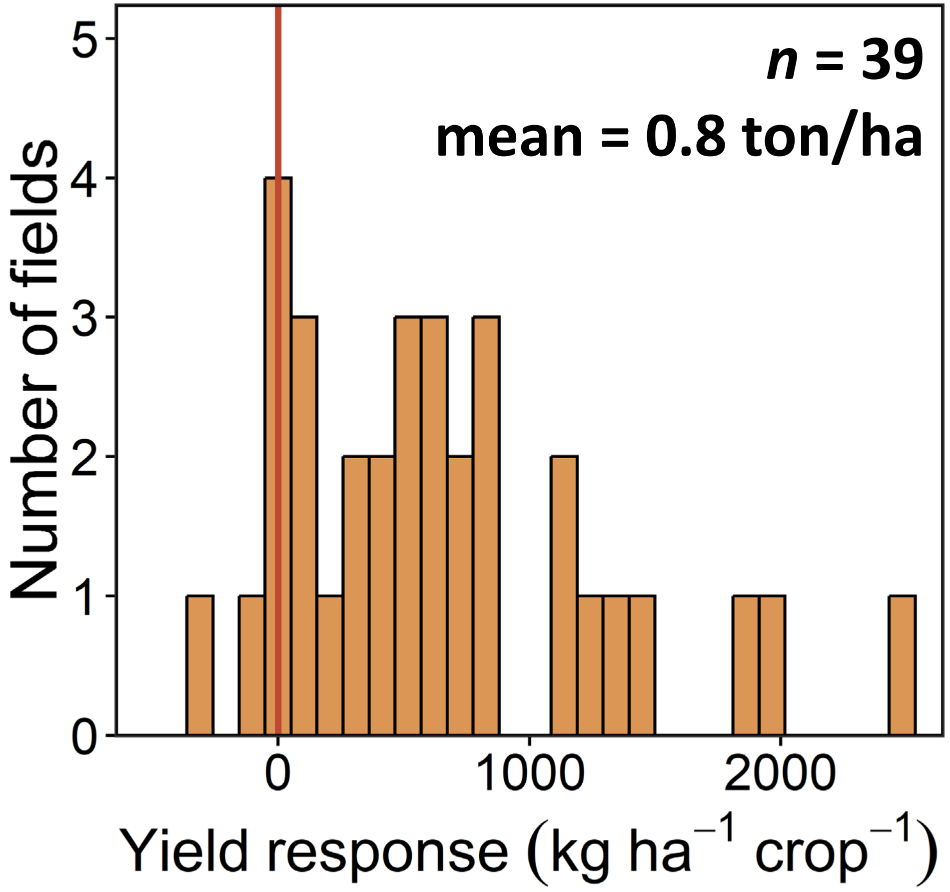
On farm trials for rice were conducted through 1997-2008. Treatments: +NP (147 – 40 – 0) and +NPK (147 – 40 – 60)

* Return on investment (ROI) was calculated as the ratio between net profit increase and K fertilizer cost, using historical average rice and MOP prices. A ROI > 1 is usually desirable to ensure widespread adoption of a technology

Approach 4

ON-FARM MAIZE TRIALS

Consistent yield response to K fertilizer, but uncertain return on investment*.



On farm trials for maize were conducted through 2004-2006. Treatments: +NP (175 – 45 – 0) and +NPK (175 – 45 – 88)

* Return on investment (ROI) was calculated as the ratio between net profit increase and K fertilizer cost, using historical average rice and MOP prices. A ROI > 1 is usually desirable to ensure widespread adoption of a technology

Global assessment of potassium limitation to crop yields

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UNIVERSITY OF Nebraska Lincoln

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OBJECTIVE

- Assess the **degree of K limitation in crop systems** to understand **where potassium is** (or will soon) **limiting crop yields.**

- Provide essential **input to national agricultural research and extension programs** on how to improve crop production through better **nutrient management and fertilizer recommendations.**

- Provide **information to orient policies and investments associated with fertilizers**, ultimately benefiting a wide range of stakeholders, including farmers, researchers, policy makers, and the private sector.

TARGET REGIONS AND CROPPING SYSTEMS

Region	Cereal-oilseed annual crops
Latin America	#1 Maize-wheat-soy-sunflower systems in Pampas (Argentina, Uruguay, and Brazil) #2 Double crop soy-maize system in Cerrado (Brazil & Paraguay)
US & Canada	#1. Maize-soybean systems with one crop per year in US Corn Belt (US and Canada) #2. South-east cotton & peanut (southeastern USA) #3. Potatoes & alfalfa (north-west USA)
South Asia	#1 Cereal-based systems (incl. rice, maize, wheat, pulses, mustard, peanuts, cotton, sugarcane, potatoes) in Indo-Gangetic (northern India, Pakistan, Nepal and Bangladesh)
East Asia	#1. Cereal (maize & wheat) systems in Northwest China, including Loess Plateau and Inner Mongolia, including irrigated cotton (north-western China)
Southeast Asia	#1. Lowland rice systems, with 2-3 crops per year (Mekong Delta, Red River delta, Myanmar, Luzon Island, and central Thailand)
SSA	#1. Maize-based systems in major producing areas in SSA (incl. south Africa).

APPROACH & DATA SOURCES

We are collecting **existing data** (published & unpublished – after 2000):

- **Estimate soil K supply**
  - Soil tests and data on K uptake from fertilizer omission plots
- **Diagnose plant K deficiencies**
  - Plant tissue analysis
- **Quantify the yield response to K fertilizer addition**
  - Short- or long-term fertility trials that include K treatments
- **Compute K balances**
  - Survey data (e.g., yield, K inputs, straw management)

All the information collected via this approach can be distilled through a 'traffic light' system indicating *where* K limitation is likely to occur

OUTPUTS

- Information to refine policies and investments on fertilizer management.
- A global database on potassium published and citable, with all contributors listed as co-authors
- Scientific publications
- Online workshops for all contributors to report and discuss project results
- Opportunities to develop further research collaborations between institutions



Thank you!

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