# Collaboration for Improved Soil and Water Management in Eastern and Southern Africa

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**Department of Agronomy and Horticulture Seminar**
**University of Nebraska, Lincoln**
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# Topics

- Issues and background
- INTSORMIL
- Collaborative activities
  - Objectives
  - Partners
  - Modes of operation
  - Results
- Opportunities for UNL

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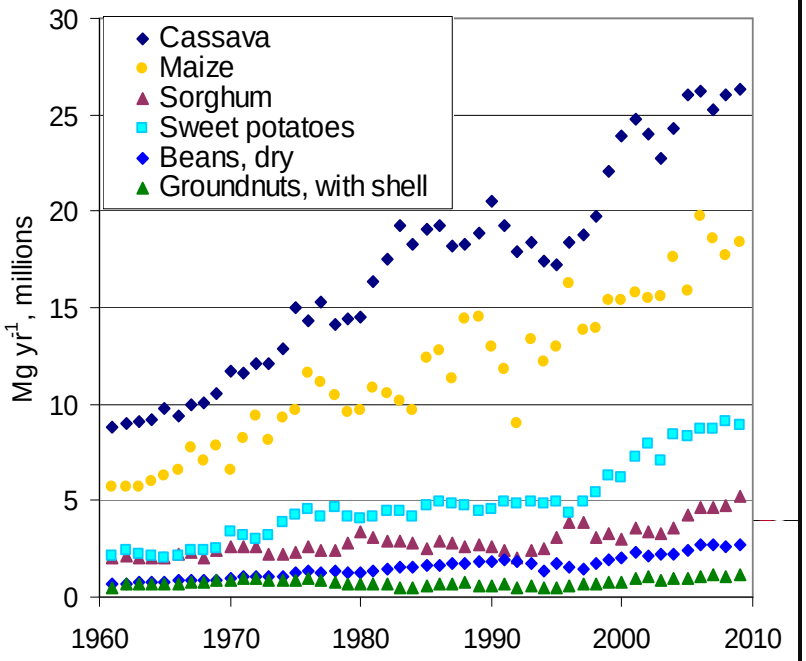
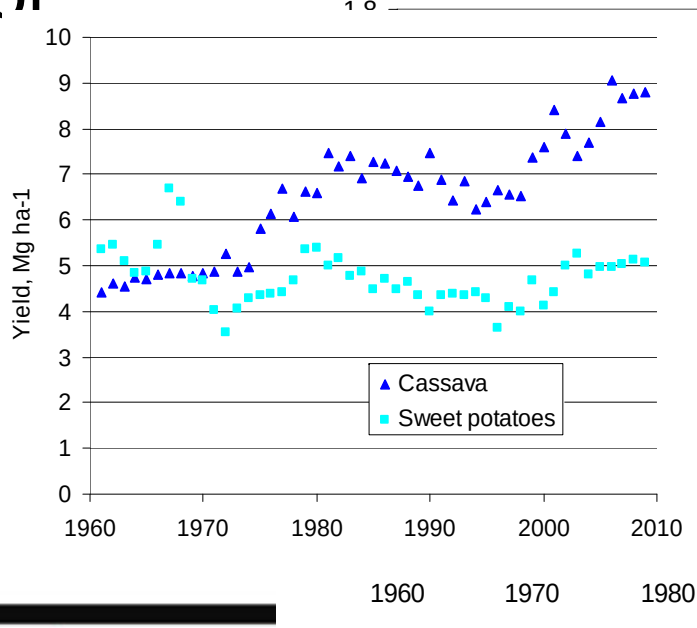
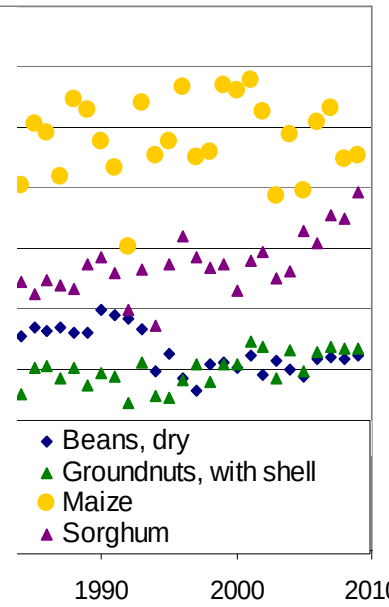
# Issues

- Production is increasing
  - Slight yield increase
  - Increased area
  - Per capita decline
  - Maintaining yield = achievement
- Mostly resource-poor smallholders
- Little input use
- Poor input supply & markets

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# Sorghum, Millet and Other Grains CRSP



USAID
FROM THE AMERICAN PEOPLE

# INTSORMIL focal crops

## Sorghum, Pearl Millet and Other Grains

- **Finger Millet (E. & Southern Africa)**

- **Tef (Ethiopia)**

- **Fonio (West Africa)**

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# INTSORMIL Technical Focal Areas

- Enhancing productivity and livelihood in marginal areas
- Soil and water management
- Integrated pest management
- Mitigating post-harvest losses
- Nutrition and health
- Food quality, processing and safety
- Broadening market access
- Increasing income
- Breeding, biotechnology, and biodiversity

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- Increase yield level and stability for sorghum through crop, soil, and water management while maintaining or improving the natural resource base

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# Grain sorghum (*Sorghum bicolor* (L.) Moench)

- An important crop in Africa
- genetically diverse and widely adapted
- primarily a crop of small-holder farmers
- typically produced under adverse conditions
  - low input use
  - marginal lands
  - numerous biotic and abiotic production constraints
- The grain and stover are used in many different ways with localized preferences.

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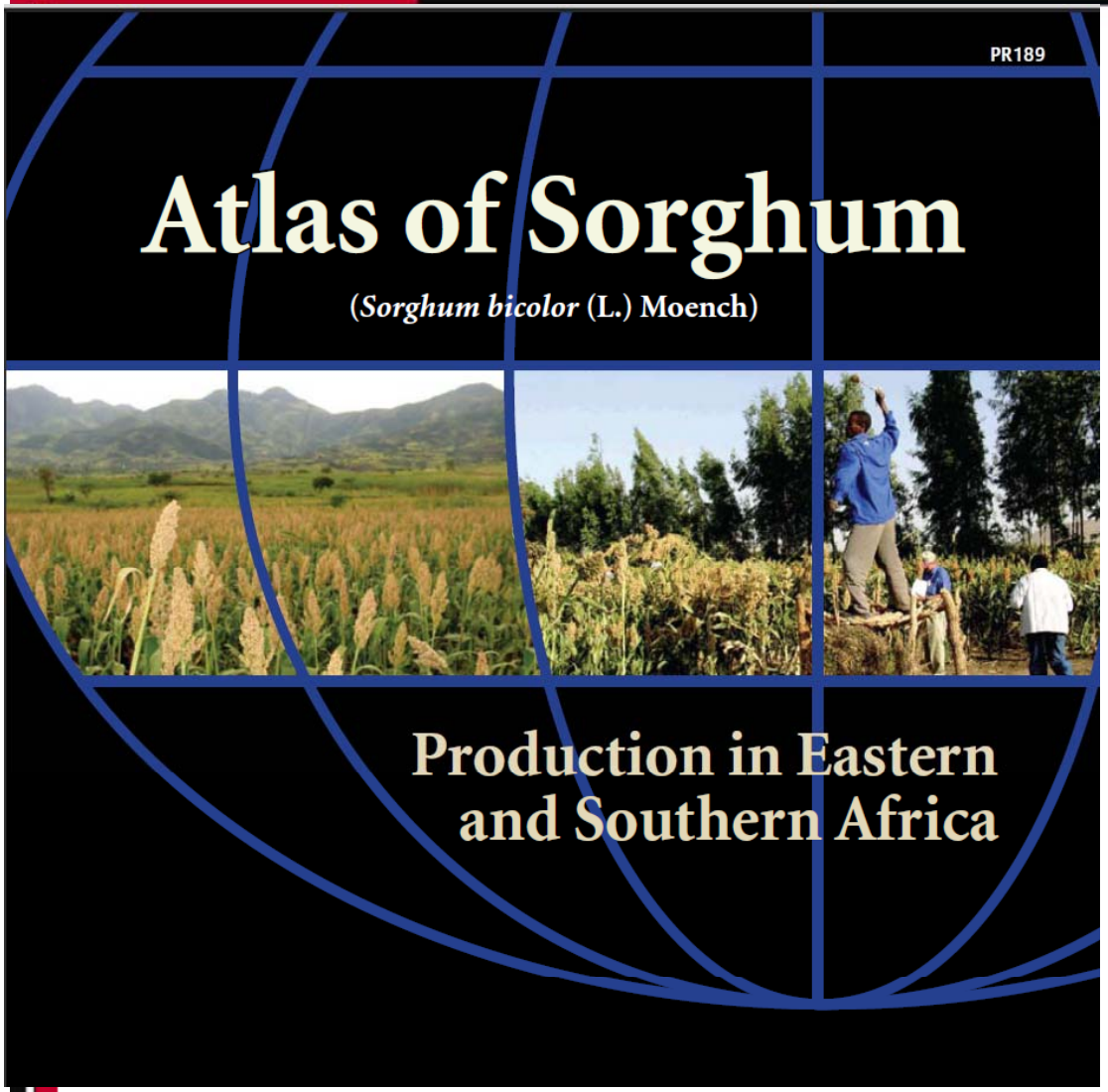


**Charles Wortmann* and Martha Mamo, UNL**

**Christopher Mburu, Kenya**

**Elias Letayo, Tanzania**

**Girma Abebe, Ethiopia**

**Kaizzi C. Kayuki, Uganda**

**Medson Chisi, Zambia**

**Munyaradzi Mativavarira, Zimbabwe**

**Soares Xerinda, Mozambique**

**Theophile Ndacyayisenga, Rwanda**

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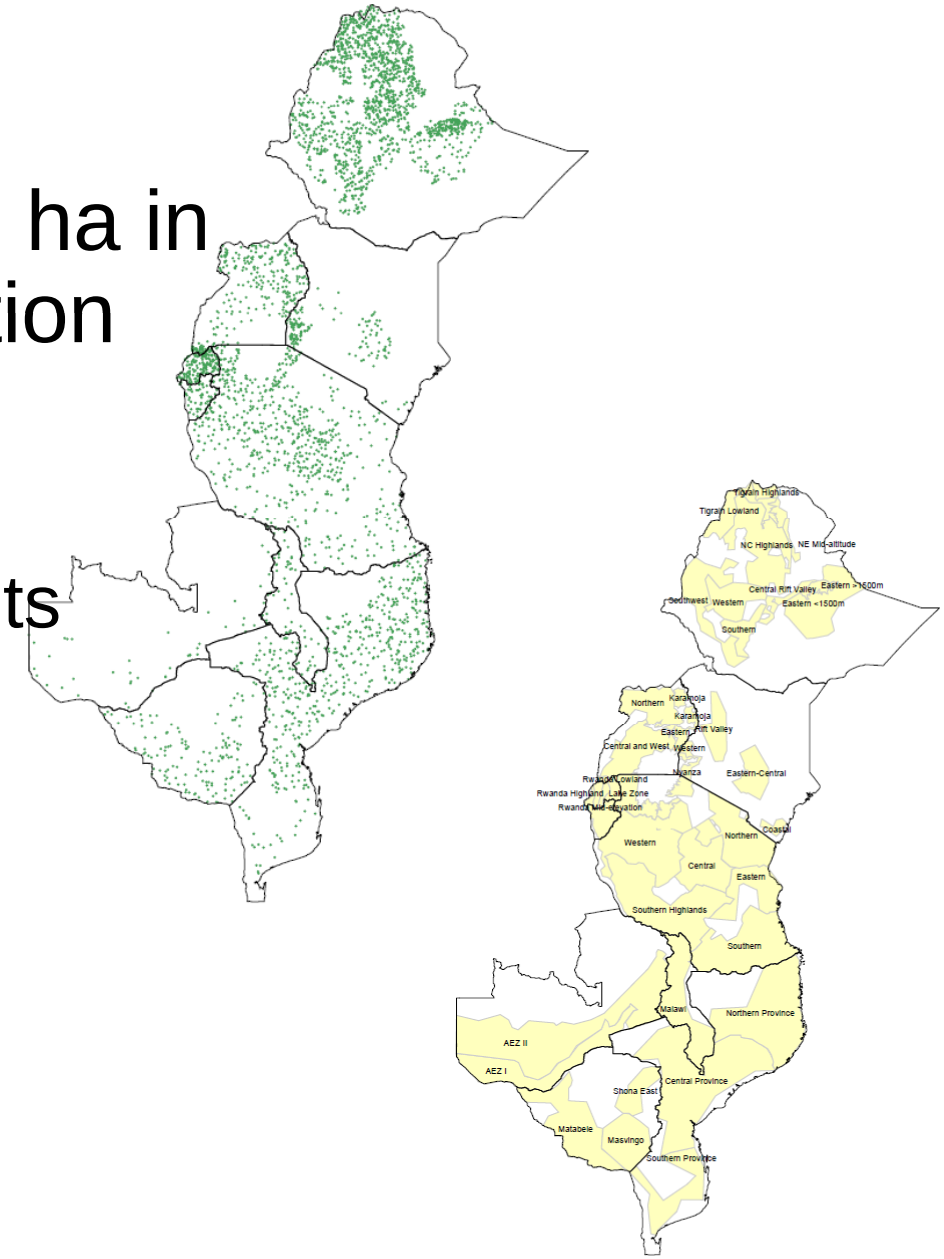
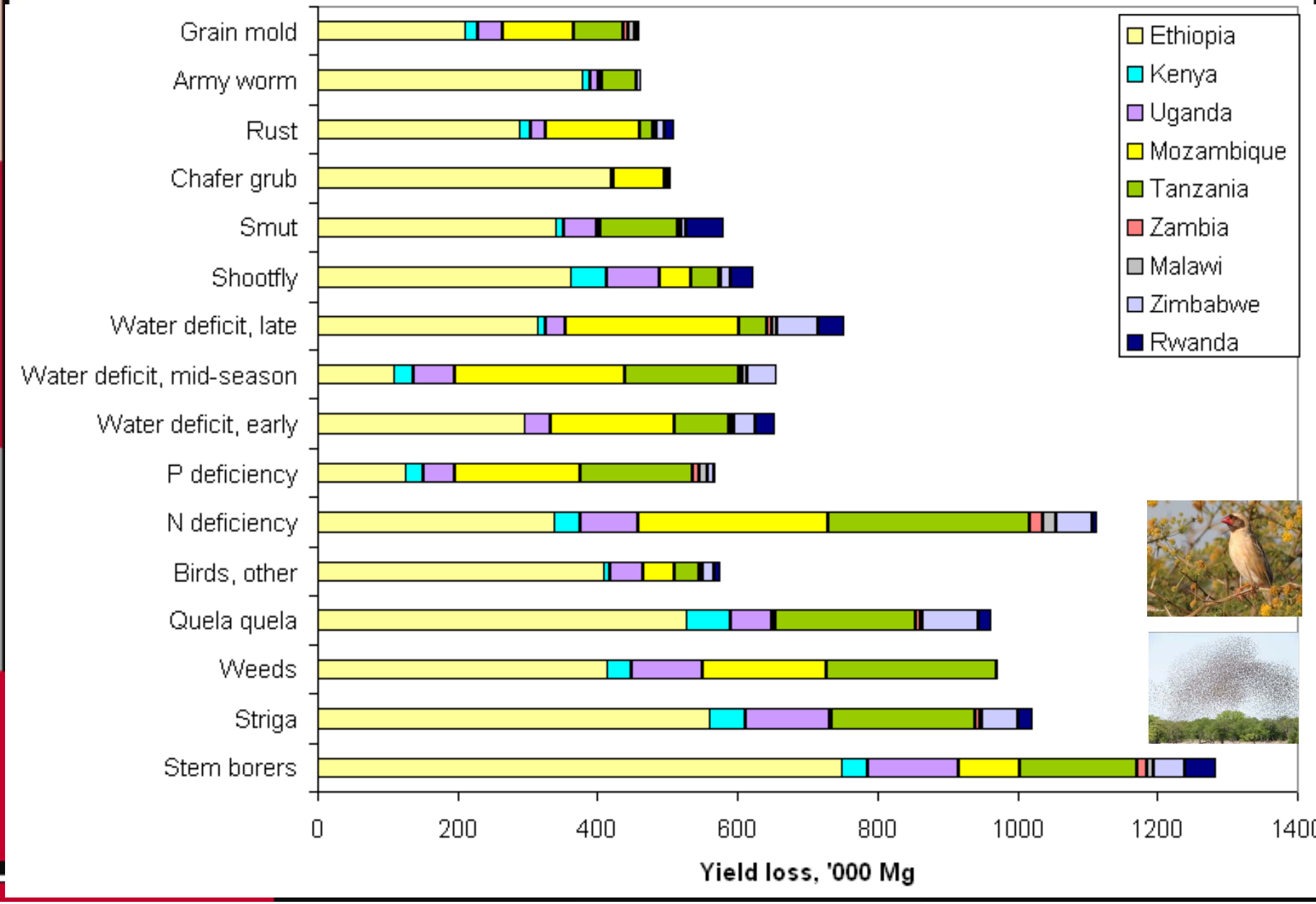
# The *Atlas*

- information for 3.4M ha in 39 sorghum production areas spanning 38º latitude
  - production constraints
  - cropping systems
  - management
  - uses
  - preferences
  - gender roles
  - marketing

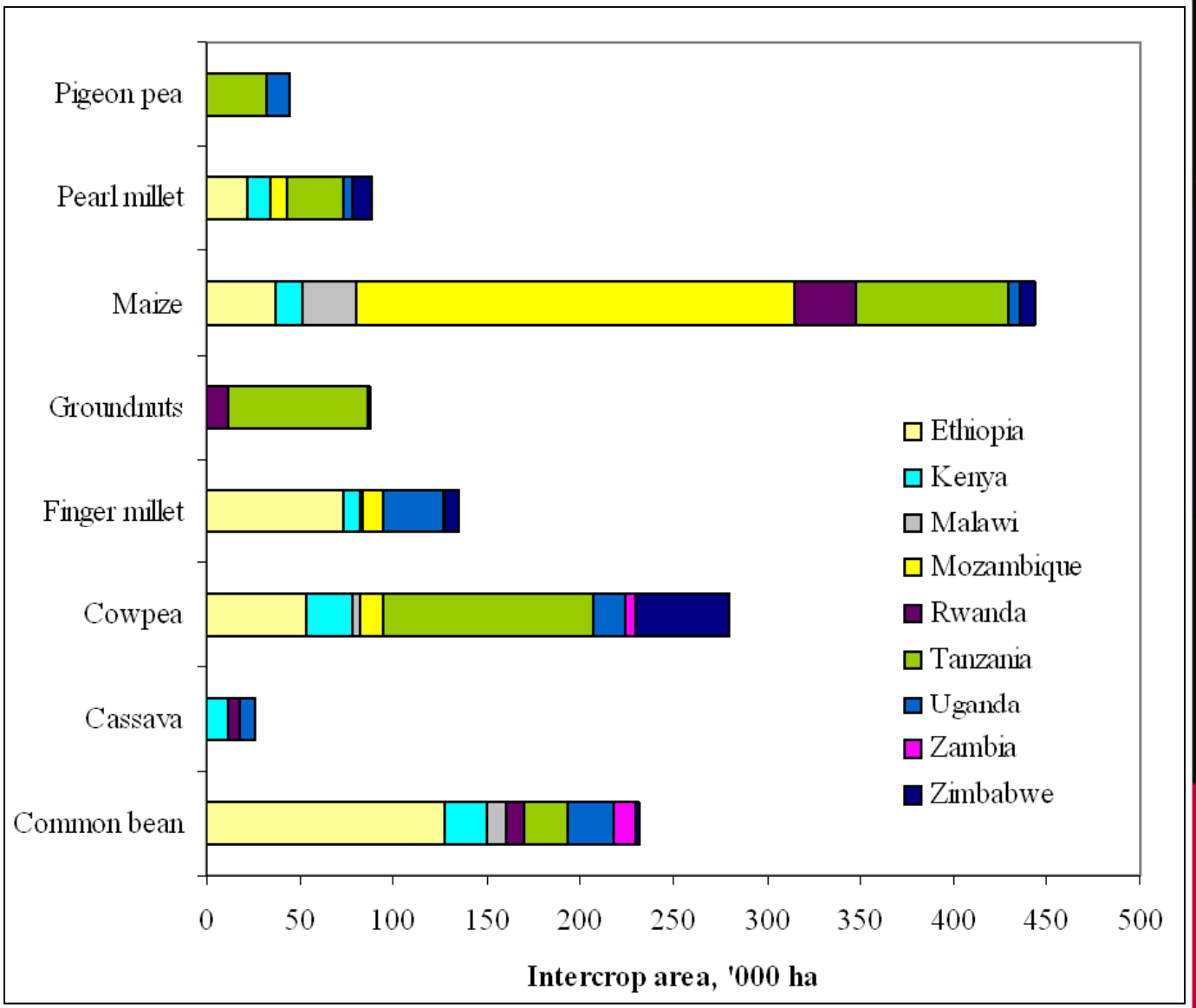


# 43 constraints were assessed; the top 16



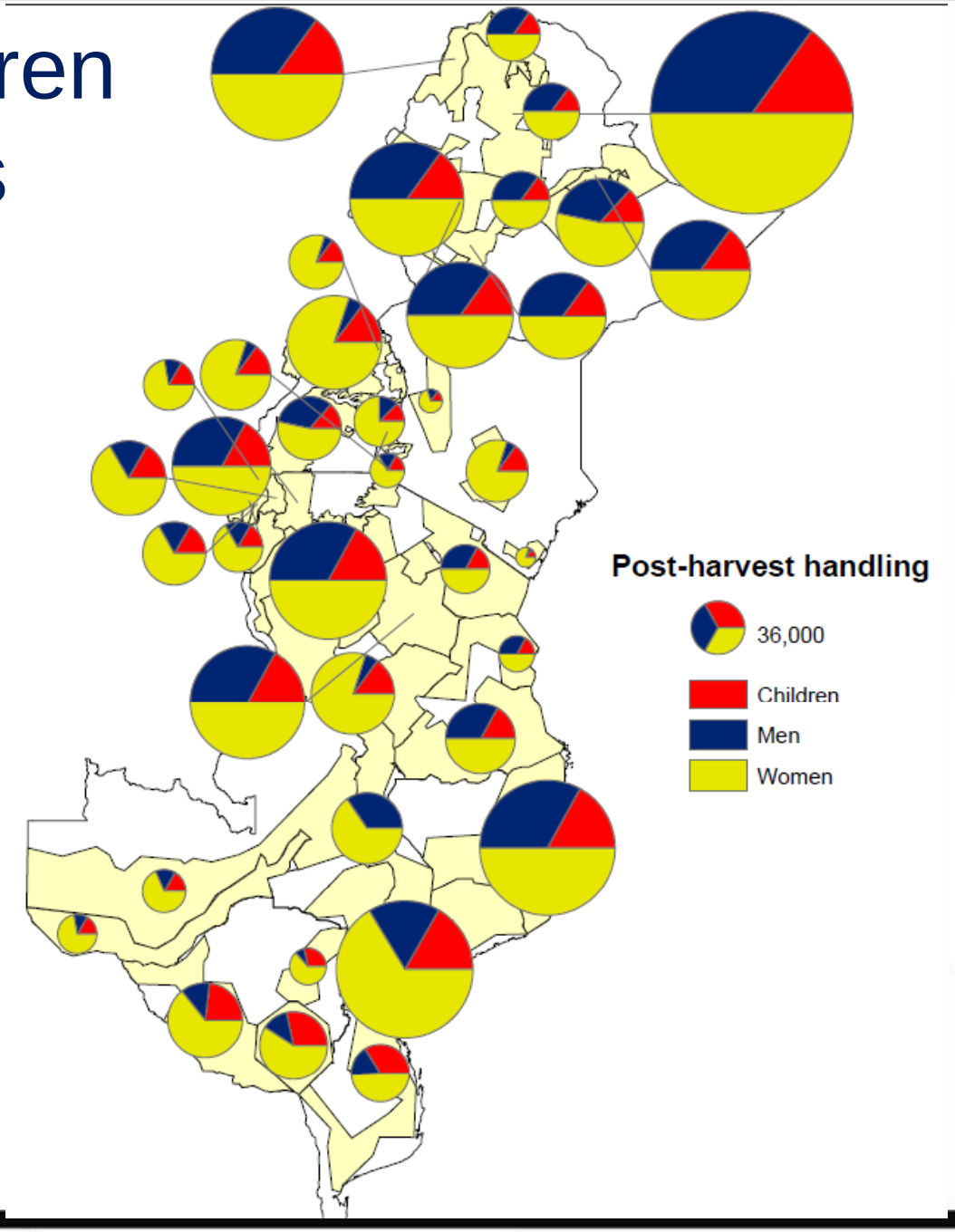
# Cropping systems

- 61% of sorghum is in sole crop in ESA
- Sorghum intercrops with maize, cowpea and common bean are most important



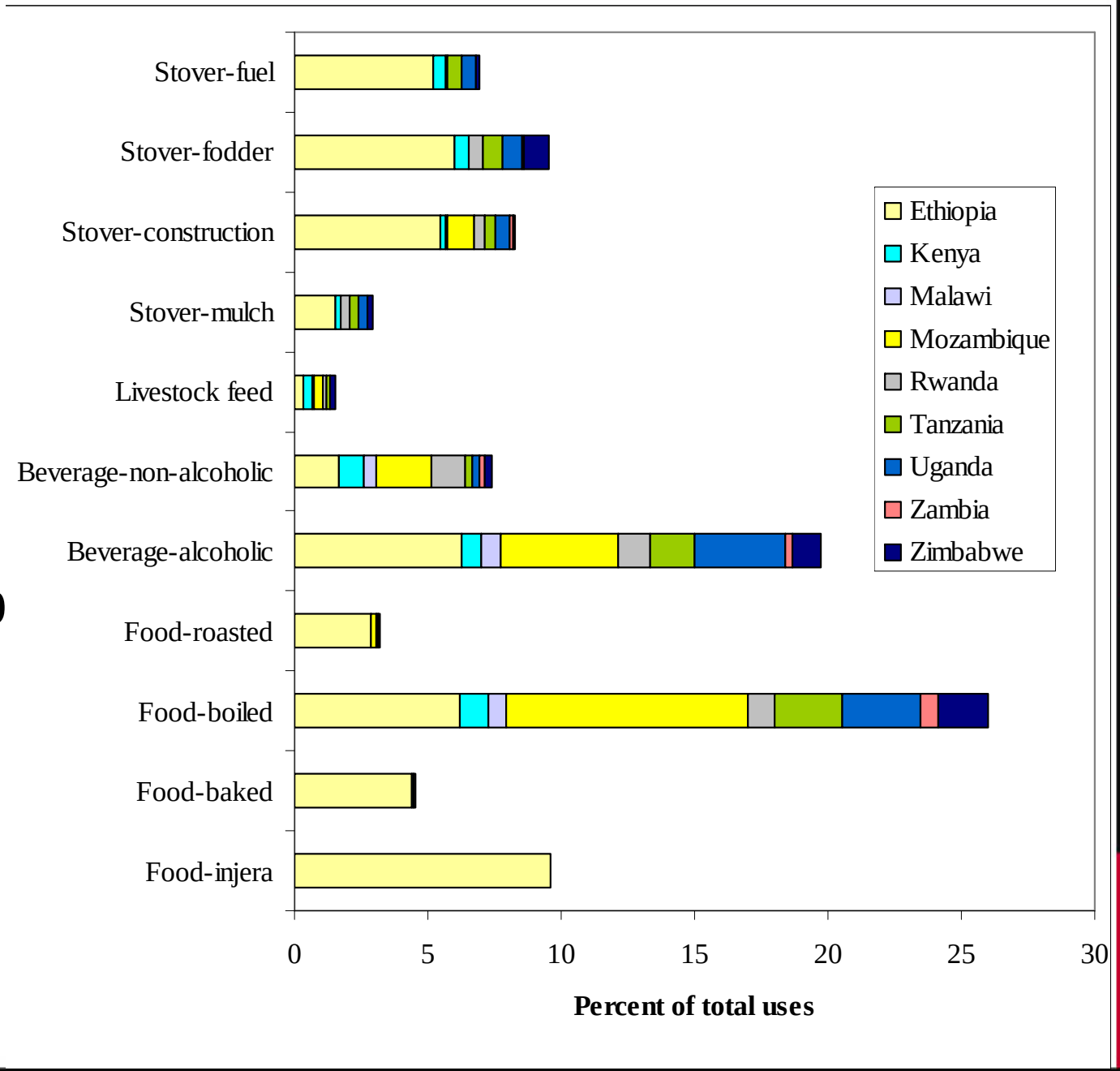
# Gender and children responsibilities

- Production
- Post-harvest
- Marketing



# Major uses of sorghum

Overall, stover = 26% of crop value; 37% in Ethiopia.



# Grain marketing

Production by small-scale farmers is primarily for home consumption. Overall, 34% is marketed.

The *Atlas of Sorghum Production in Eastern and Southern Africa*

- available at http://intsormil.org

| Country | % |
|---|---|
| Ethiopia | 29 |
| Kenya | 30 |
| Malawi | 28 |
| Mozambique | 24 |
| Rwanda | 67 |
| Tanzania | 40 |
| Uganda | 50 |
| Zambia | 28 |
| Zimbabwe | 23 |

# Collaboration in research and extension: Uganda and Ethiopia

- Collaborator is essential
  - Commonly working in difficult situations: low pay, poor facilities, little recognition
  - Little reason to be productive

Need to identify those who are capable and motivated

  - Recognition, technical support, funds, sponsorship

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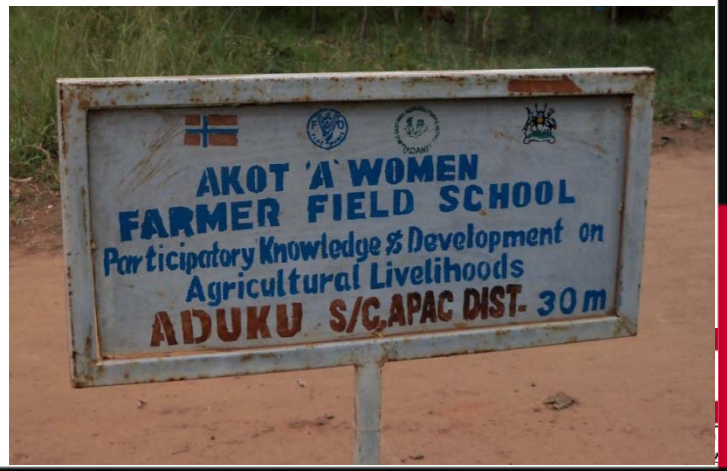
# Work with small-holder farmers

- Discussions to
  - Plan research
  - Convey information
  - Evaluate results

# Many sites and groups

- Local facilitators are key
  - Youth from the villages
  - Implement trials, organize field days and meetings
  - Advise farmers
  - Paid based on accomplishment
- Building on other accomplishments

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# Uganda: Dr. Kaizzi Kayuki, Kawanda Agricultural Research Institute, NARO

- Soil fertility management
- Reduced tillage
- Input supply and technology transfer

# Uganda: rotation, green manure and nitrogen

Yields and returns improved with crop rotation, mucuna, and N fertilizer.

| Previous crop and N rate, 36 OFTs | Grain yield | Returns above fertilizer cost |
|---|---|---|
| | Mg ha$^{-1}$ | '000 UgSh ha$^{-1}$ |
| Sorghum, no N | 1.21d | 374 |
| Cowpea, no N | 2.01c | 536 |
| Sorghum, 30 kg N | 2.33b | 472 |
| Mucuna, no N | 2.75a | 455 |

Kaizzi, C.K., J. Byalebeka, C.S. Wortmann, and M. Mamo. 2007. Low input approaches for soil fertility management in semi-arid eastern Uganda. Agron. J. 99: 847-853.

# Cover crops

***Tephrosia*, a leguminous shrub containing rotenone, used as a cover crop, controls mole rats**

# Uganda: N, P, manure

What is an acceptable B:C ratio for resource poor farmers who do not have good credit availability and who have alternative uses for their small amount of money?

1.5 or 1.75!!

| N, P and Manure, 61 OFTs | Yield increase | Net returns to input use | Benefit: cost ratio |
|---|---|---|---|
| | Mg $ha^{-1}$ | '000 UgSh $ha^{-1}$ | |
| 30N + 23$P_2O_5$ | 1.30 | 63.7 | 1.43 |
| 30N + 2.5 Mg manure | 1.47 | 41.2 | 1.21 |
| 30N | 0.77 | 38.6 | 1.45 |
| 2.5 Mg manure | 1.06 | 121.7 | 3.43 |

Kaizzi, C.K., J. Byalebeka, C.S. Wortmann, and M. Mamo. 2007. Low input approaches for soil fertility management in semi-arid eastern Uganda. Agron. J. 99: 847-853.

# Uganda: reduced tillage

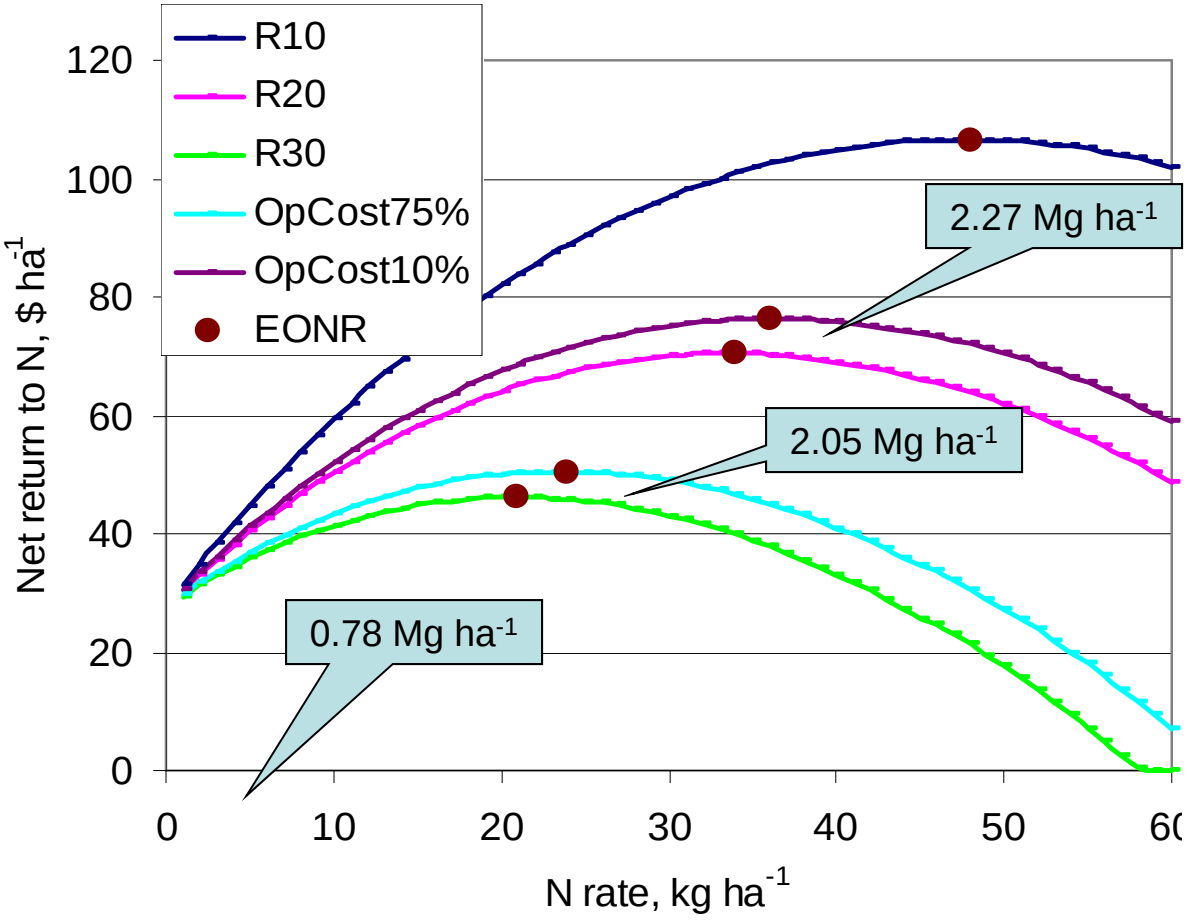
Replacing pre-plant tillage with glyphosate treatment increased yield and profitability.

| N, P and Manure, 61 OFTs | Grain yield | Net returns to input use |
|---|---|---|
| | Mg $ha^{-1}$ | '000 UgSh $ha^{-1}$ |
| Plowed | 1.56 | 23 |
| Glyphosate | 2.09 | 226 |
| Glyphosate + $30N + 23P_2O_5$ | 2.46 | 140 |

Kaizzi, C.K., J. Byalebeka, C.S. Wortmann, and M. Mamo. 2007. Low input approaches for soil fertility management in semi-arid eastern Uganda. Agron. J. 99: 847-853.

# Economics of Smallholder Use of fertilizer N for Sorghum in Uganda (AGRA supported)

- Nutrient cost relative to grain value is very high
  - e.g. ~17 kg grain to buy one kg N, R17




**Can we predict EONR?**

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## Best Fertilizer Options for Smallholders in Uganda?? (AGRA supported)

**Mean most profitable nutrient rate for an opportunity cost of 75%.**

| N, P | Nutrient rate, kg ha$^{-1}$ | Benefit: cost ratio |
|---|---|---|
| **MAIZE** | | |
| N | 24 | 3.0 |
| **SORGHUM** | | |
| N | 24 | 2.5 |
| P | 4 | 1.2 |
| **DRY BEAN** | | |
| N | 10 | 29.6 |
| P | 6 | 1.5 |
| **PEANUT** | | |
| P | 28 | 3.9 |

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# Uganda: technology dissemination

- Activities in 5 districts of eastern and northern Uganda currently; 7 districts in 2011; 2 locations each
  - Seed increase and dissemination for 3 new varieties
  - Enabling input supply: input supplier training
  - On-farm trials and field days
  - Baseline and adoption, and marketing, study
  - Many partners, e.g. Soroti Catholic Diocese Development Organisation (SOCADIDO), Teso Dioceses Development (TEDDO), government extension, Global 2000, Africa 2000, etc.

# Ethiopia

Tewodros Mesfin, EIAR/ Melkassa Research Center;
Gebreyesus Brhane, Axum University

- Tie-ridging for water conservation
- Skip-row planting for improved drought tolerance
- Soil fertility
- Climate change

# ETHIOPIA

Tied ridging, modification of traditional plow and planting attachment for the plow.

# Tied-ridging effects on sorghum yield

| Tillage treatment | Grain yield | Stover yield |
|---|---|---|
| **2003** | **Mg ha$^{-1}$** | |
| Flat planting | 1.48 | 5.92 |
| Shilshalo | 1.78 | 7.02 |
| Tied-ridge, in-furrow | 2.70 | 10.70 |
| Tied-ridge, on-ridge | 2.27 | 8.61 |
| **2004** | | |
| Flat planting | 0.79 | 3.87 |
| Shilshalo | 1.30 | 5.24 |
| Tied-ridge, in-furrow | 2.33 | 9.26 |
| Tied-ridge, on-ridge | 1.85 | 7.17 |

Brhane, G., C.S. Wortmann, M. Mamo, H. Gebrekidan, and A. Belay. 2006. Agron. J. 98:124-128.

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# **Buy-in:** tied-ridging research on highland pulses in northern Ethiopia

| Tillage treatment | Faba bean | Lentil | Field pea |
|---|---|---|---|
| | Grain yield | | |
| | Mg ha$^{-1}$ | | |
| Flat planting | 1.11 | 1.03 | 0.81 |
| Tied-ridging | 1.68 | 1.23 | 1.36 |

Brhane, G. and C.S. Wortmann. 2008. Tie-ridge tillage for high altitude pulse production in northern Ethiopia. Agron. J. 100:447-453.

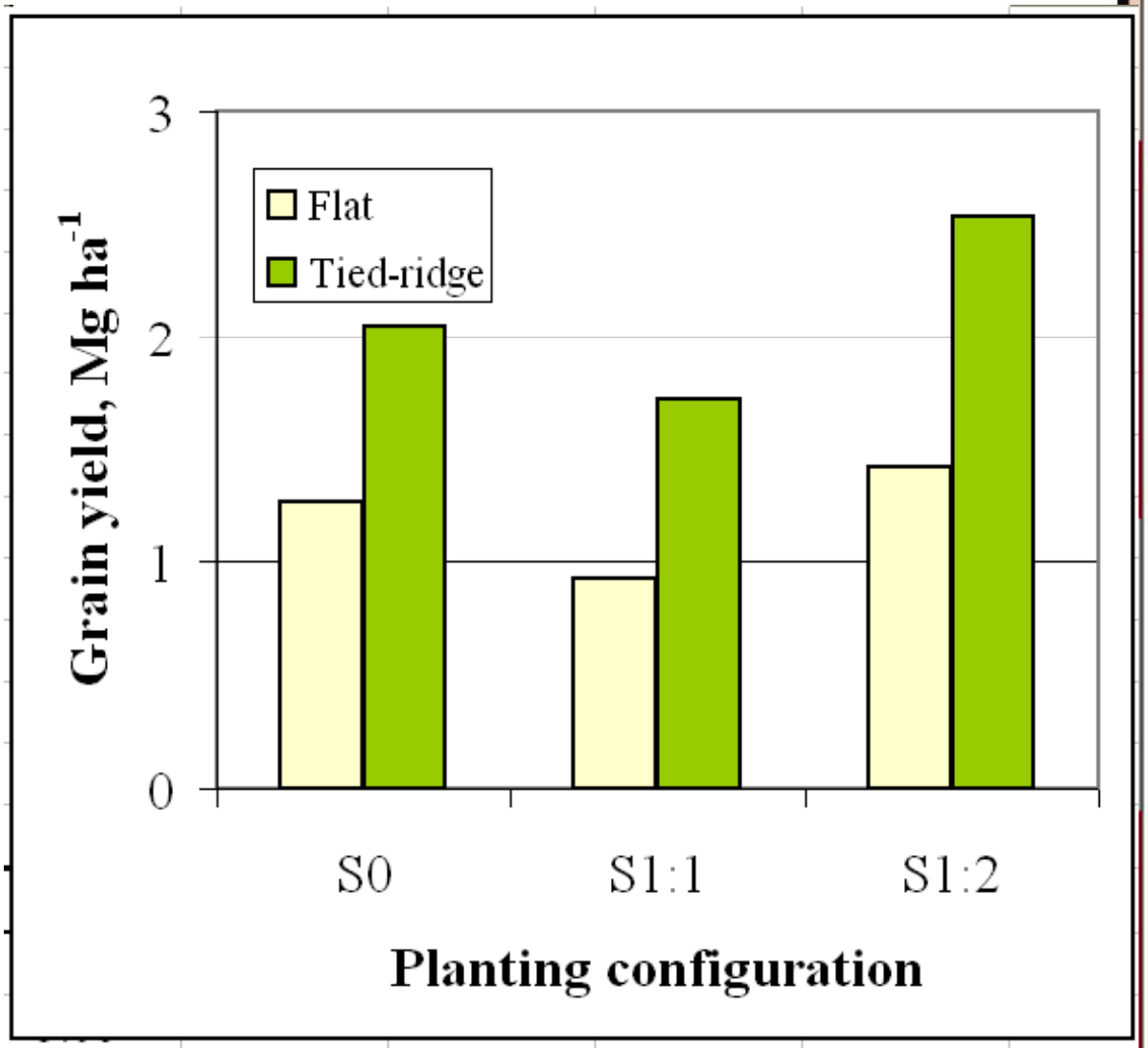
# Skip-row planting

- Common configurations while maintaining similar plant $ha^{-1}$
  - Plant 2 : skip 2
  - Plant 1 : skip 1
  - Plant 2 : skip 1
- A means of saving water for grain fill period: it takes time for roots to reach further soil water
- Most suited for
  - Severe water deficits during grain fill; <4.5 Mg $ha^{-1}$ grain yield
  - Deep soil with high water holding capacity
  - No-till and crop residue cover to reduce evaporation

Abunyewa et al. 2010. Agron J. 102:296-302.

# Skip-row planting x tied-ridging

- Small yield increase with S1:P2 but decrease with S1:P1
- Large response to tied-ridging




Mesfin et al. 2010. Agron J. 102:745-750.

# Skip-row and intercropping

- Farmers not likely to leave the skip-row area unplanted.
- Can an early maturing crop be planted in the skip area with increased productivity while saving some water for sorghum or maize grain fill?

# Climate variability

- Farmer decision system according to recent and anticipated weather conditions
  - Near bimodal rainfall pattern allows planting decisions over 4 month period
- Crop growth simulation models combined with experimentation
  - e.g. dry soil planting

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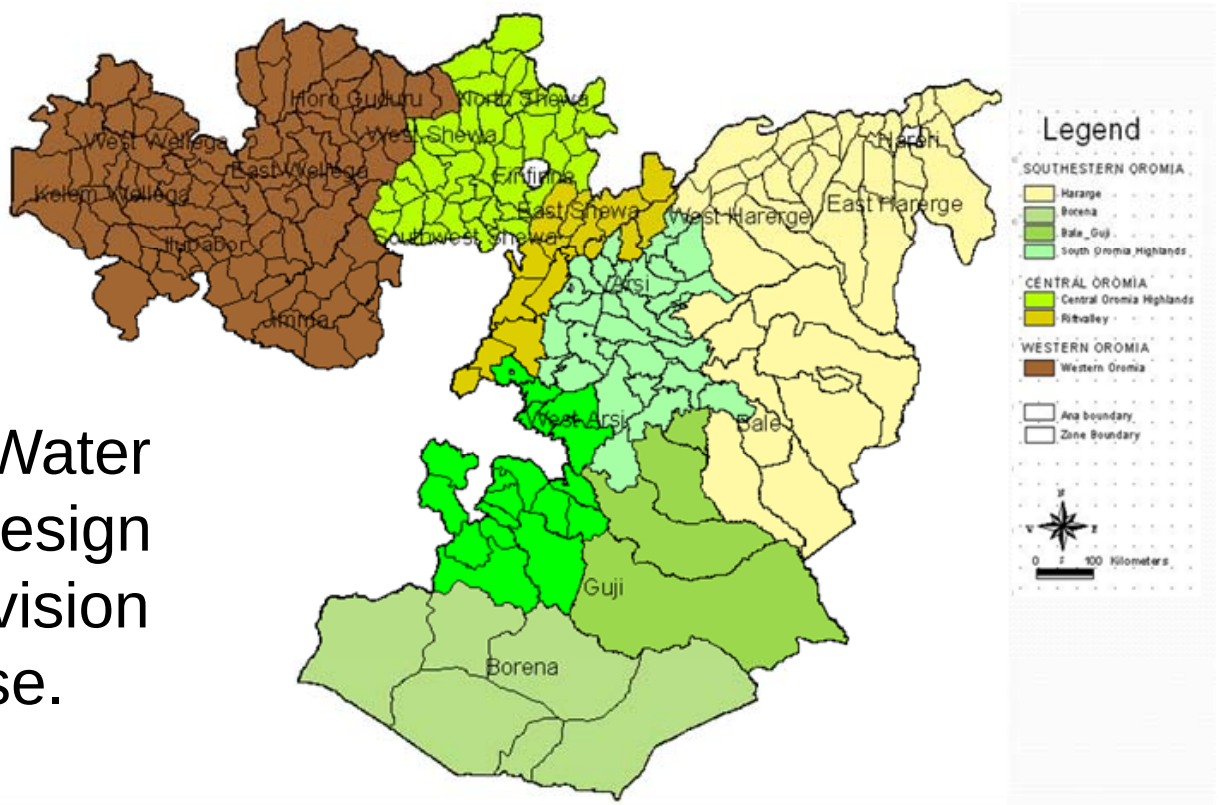
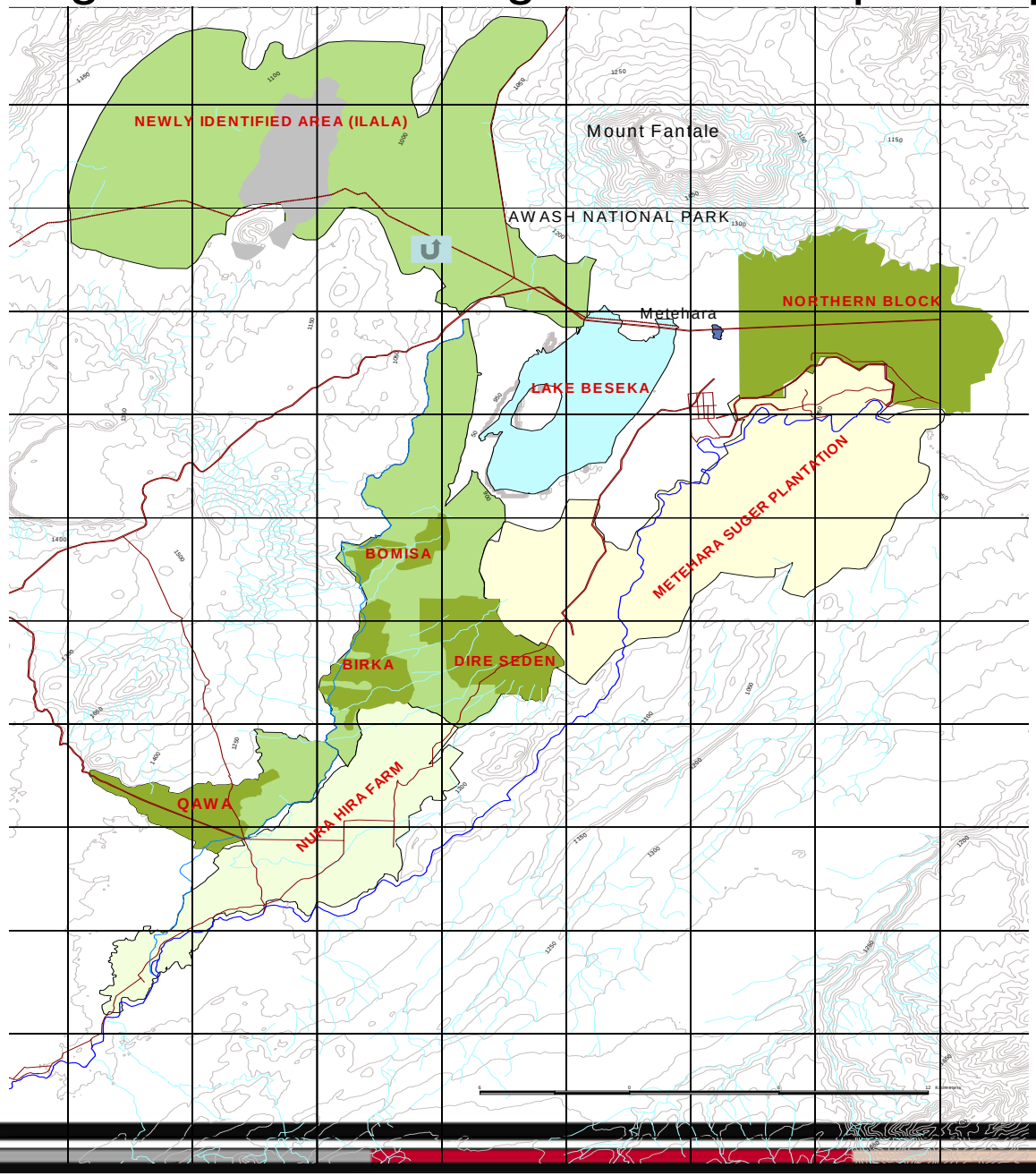
# Opportunities for UNL: Water for Food Program

- Technical and educational support to agricultural water management in Oromia region of Ethiopia

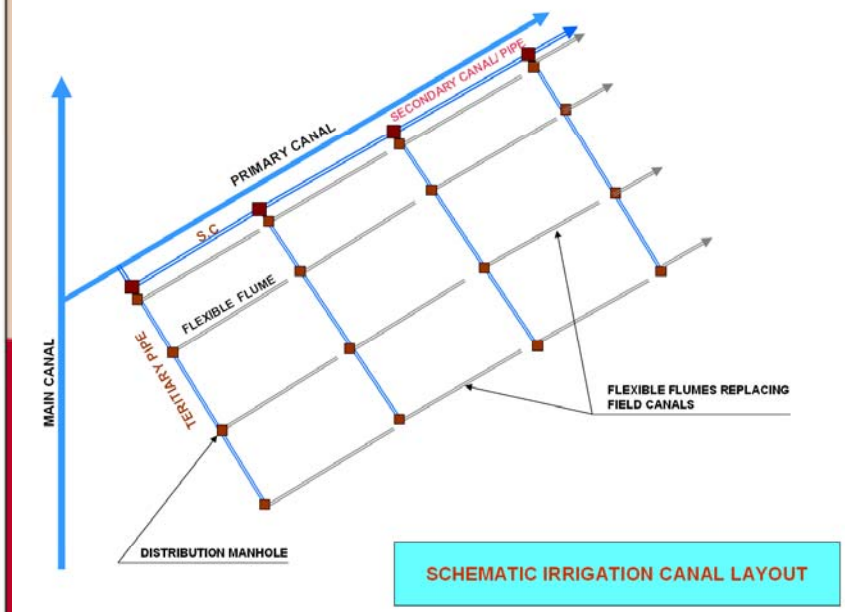



Oromia Water Works Design & Supervision Enterprise.

# Fentalle irrigation based integrated development project



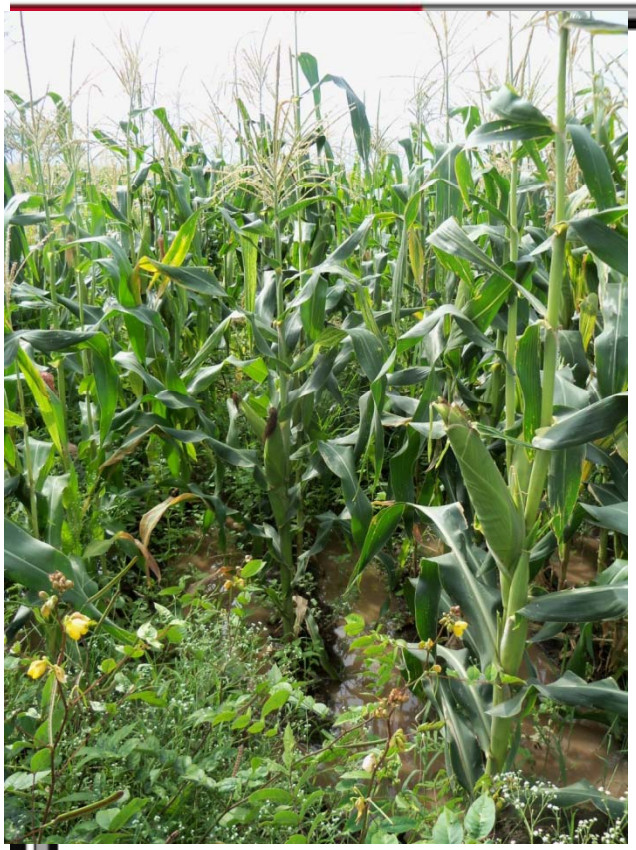
## *FENTALLE, CNT'D*




*Fentalle, cnt'd*

# Irrigation- Water from Awash River

# Irrigation



**Irrigated maize, harvest of irrigated maize and planting of a crop to be irrigated**

# COMBINING WITH LOCAL EXPERIENCE

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