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

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

Charles Wortmann
Department of Agronomy and Horticulture Seminar
University of Nebraska, Lincoln
September 24, 2010
Topics

• Issues and background
• INTSORMIL
• Collaborative activities
  ➢ Objectives
  ➢ Partners
  ➢ Modes of operation
  ➢ Results
• Opportunities for UNL
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
Sorghum, Millet and Other Grains CRSP
INTSORMIL focal crops

Sorghum, Pearl Millet and Other Grains

- Finger Millet (E. & Southern Africa)
- Tef (Ethiopia)
- Fonio (West Africa)
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
Increase yield level and stability for sorghum through crop, soil, and water management while maintaining or improving the natural resource base
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.
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

University of Nebraska-Lincoln
(cwortmann2@unl.edu)
The Atlas

- information for 3.4M ha in 39 sorghum production areas spanning 38° latitude
  - production constraints
  - cropping systems
  - management
  - uses
  - preferences
  - gender roles
  - marketing
43 constraints were assessed; the top 16

- Grain mold
- Army worm
- Rust
- Chafer grub
- Smut
- Shootfly
- Water deficit, late
- Water deficit, mid-season
- Water deficit, early
- P deficiency
- N deficiency
- Birds, other
- Quela quela
- Weeds
- Striga
- Stem borers

Yield loss, '000 Mg
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.
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](http://intsormil.org)

<table>
<thead>
<tr>
<th>Country</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethiopia</td>
<td>29</td>
</tr>
<tr>
<td>Kenya</td>
<td>30</td>
</tr>
<tr>
<td>Malawi</td>
<td>28</td>
</tr>
<tr>
<td>Mozambique</td>
<td>24</td>
</tr>
<tr>
<td>Rwanda</td>
<td>67</td>
</tr>
<tr>
<td>Tanzania</td>
<td>40</td>
</tr>
<tr>
<td>Uganda</td>
<td>50</td>
</tr>
<tr>
<td>Zambia</td>
<td>28</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>23</td>
</tr>
</tbody>
</table>
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
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
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.

<table>
<thead>
<tr>
<th>Previous crop and N rate, 36 OFTs</th>
<th>Grain yield Mg ha⁻¹</th>
<th>Returns above fertilizer cost 000 UgSh ha⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum, no N</td>
<td>1.21d</td>
<td>374</td>
</tr>
<tr>
<td>Cowpea, no N</td>
<td>2.01c</td>
<td>536</td>
</tr>
<tr>
<td>Sorghum, 30 kg N</td>
<td>2.33b</td>
<td>472</td>
</tr>
<tr>
<td>Mucuna, no N</td>
<td>2.75a</td>
<td>455</td>
</tr>
</tbody>
</table>

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!!

<table>
<thead>
<tr>
<th>N, P and Manure, 61 OFTs</th>
<th>Yield increase Mg ha⁻¹</th>
<th>Net returns to input use '000 UgSh ha⁻¹</th>
<th>Benefit: cost ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>30N + 23P₂O₅</td>
<td>1.30</td>
<td>63.7</td>
<td>1.43</td>
</tr>
<tr>
<td>30N + 2.5 Mg manure</td>
<td>1.47</td>
<td>41.2</td>
<td>1.21</td>
</tr>
<tr>
<td>30N</td>
<td>0.77</td>
<td>38.6</td>
<td>1.45</td>
</tr>
<tr>
<td>2.5 Mg manure</td>
<td>1.06</td>
<td>121.7</td>
<td>3.43</td>
</tr>
</tbody>
</table>

Uganda: reduced tillage

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

<table>
<thead>
<tr>
<th>N, P and Manure, 61 OFTs</th>
<th>Grain yield Mg ha(^{-1})</th>
<th>Net returns to input use ‘000 UgSh ha(^{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plowed</td>
<td>1.56</td>
<td>23</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>2.09</td>
<td>226</td>
</tr>
<tr>
<td>Glyphosate + 30N + 23P(_2)O(_5)</td>
<td>2.46</td>
<td>140</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>N, P</th>
<th>Nutrient rate, kg ha⁻¹</th>
<th>Benefit: cost ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIZE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>24</td>
<td>3.0</td>
</tr>
<tr>
<td>SORGHUM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>24</td>
<td>2.5</td>
</tr>
<tr>
<td>P</td>
<td>4</td>
<td>1.2</td>
</tr>
<tr>
<td>DRY BEAN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>10</td>
<td>29.6</td>
</tr>
<tr>
<td>P</td>
<td>6</td>
<td>1.5</td>
</tr>
<tr>
<td>PEANUT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>28</td>
<td>3.9</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Tillage treatment</th>
<th>Grain yield</th>
<th>Stover yield</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2003</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat planting</td>
<td>1.48</td>
<td>5.92</td>
</tr>
<tr>
<td>Shilshalo</td>
<td>1.78</td>
<td>7.02</td>
</tr>
<tr>
<td>Tied-ridge, in-furrow</td>
<td>2.70</td>
<td>10.70</td>
</tr>
<tr>
<td>Tied-ridge, on-ridge</td>
<td>2.27</td>
<td>8.61</td>
</tr>
<tr>
<td><strong>2004</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flat planting</td>
<td>0.79</td>
<td>3.87</td>
</tr>
<tr>
<td>Shilshalo</td>
<td>1.30</td>
<td>5.24</td>
</tr>
<tr>
<td>Tied-ridge, in-furrow</td>
<td>2.33</td>
<td>9.26</td>
</tr>
<tr>
<td>Tied-ridge, on-ridge</td>
<td>1.85</td>
<td>7.17</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Tillage treatment</th>
<th>Faba bean</th>
<th>Lentil</th>
<th>Field pea</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grain yield</td>
<td></td>
<td>Mg ha⁻¹</td>
</tr>
<tr>
<td>Flat planting</td>
<td>1.11</td>
<td>1.03</td>
<td>0.81</td>
</tr>
<tr>
<td>Tied-ridging</td>
<td>1.68</td>
<td>1.23</td>
<td>1.36</td>
</tr>
</tbody>
</table>

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

Skip-row planting x tied-ridging

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

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
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

Vast land resource (>18,000ha)
Fentalle, cnt’d

Irrigation - Water from Awash River
Irrigation
Irrigated maize, harvest of irrigated maize and planting of a crop to be irrigated