Progress in supporting sorghum farmers’ transition from subsistence to market orientation in West & Central Africa: Burkina Faso, Mali and Nigeria

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Product Line Description

- Monitoring crop production, use and market trends
- Access of farmers to information
- Research on user needs, especially women
- Strengthened private sector, especially in seed sector
- Partnerships for tangible impacts
- Informing policy makers

Crop Research

- Hybrid parent development
- Broaden genetic base; gene-to-trait analysis
- Efficient use of molecular and traditional tools
- Striga tolerance; low-P adaptation; Fe and Zn
- Crop management for sustainable intensification
- Pest and disease management
Objectives 2012-16

- Overarching Goal
  Over a ten-year period, an increase in sorghum production in Burkina Faso, Mali, Niger and Nigeria of 2.7 million tons

- Outcomes
  - Reduced rural poverty
    - Increased productivity and quality to meet market demands
  - Improving food security
    - Productive and more stable improved cultivars
  - Improving nutrition and health
    - Maintained threshold levels or increased iron and zinc in grain
RESULTS (2012 to mid-2016)

- **28** improved varieties and **7** hybrids released
- Important set of hybrids seed parents developed
- Increased yields from Integrated *Striga* management
- Micro-dosing reached >30,000 farmers in Mali, Burkina Faso and Nigeria
- Local motorized seeder developed in Mali for labor saving
- Improved capacity of farmer cooperatives in seed production and distribution
- Mini-packages developed for seed marketing
RESULTS:
Varieties and hybrids released

Improved farmer-preferred varieties and hybrids released

- Cultivars released and registered in the national/regional catalogue in Mali in 2016
  - 26 varieties
  - 7 hybrids

- Varieties released in Nigeria in 2016
  - 2 early varieties
RESULTS:
Tools & Technologies for Crop Improvement

Heterotic pools for main target group of hybrids

- 41 SSR markers to assess genetic diversity (Billot et al., 2013)
  - *Nigeria germplasm distinct from germplasm in Burkina Faso, Mali*
  - *Diversity assessment of 573 accessions across Nigeria in progress*

> 30 A/B pairs developed (different maturities and higher grain quality)

> 200 hybrids in testing for combining ability to establish heterotic groups
RESULTS:
Tools & Technologies for Crop Improvement

Efficient hybrid breeding with molecular tools

- 13 F3 segregating B populations (CK60B/Nigerian landraces) under selection; maintainers to be identified in 2016/2017
- 37 new B-lines and 43 best R-lines selected; assessed for genetic diversity using 20 SSRs
- 3 biparental populations developed; 600 F2 families phenotyped and genotyped for Rf gene mapping in WCA sorghum
- Plans to determine sterility inheritance and QTLs associated
RESULTS:
Tools & Technologies for Crop Improvement

Population Guinean Naine Diversified (PGND) developed

- Over 50 fixed lines (S5 generation) and over 200 S2 and S3 progenies selected and evaluated with farmers.

Sudan savannah zone: Phenotype and GBS data for 4740 BC1F5 families from 47 populations from BC-NAM

- QTLs linked to productivity, maturity, grain and stover quality, photoperiodism, and resistance to foliar diseases identified.

South-Sahelian zone: 16 drought-tolerant populations (BCNAM) with over 1700 BC1F3 families

- Association analyses will identify markers for drought tolerance, other adaptive traits (in 2017)
RESULTS:
Tools & Technologies for Crop Improvement

Grain and Stover quality, including grain micronutrient content

✓ Several varieties selected for high grain yield and high Stover quality:
  Av. grain yield = 2t/ha,
  Biomass = 15 t/ha and a
  Total sugar content = 10-16%Brix

✓ 15 high Fe and Zn sorghum varieties and 10 hybrid parents identified and tested for adaptation in Nigeria

✓ 110 local/improved varieties and 35 hybrid parents in assessment for Fe/Zn grain contain

✓ 3 Bi-parental populations for association mapping (BPAM) for Fe and Zn developed
**Near Infrared Reflectance Spectroscopy**

NIRS is an indirect, non-destructive and non-invasive approach for a rapid, low-cost and simultaneous estimation of multiple attributes of plant materials.

### Calibration development

- **Stem/stover**
  - Crude protein
  - Neutral detergent fiber
  - Acid detergent fiber
  - Acid detergent lignin
  - Sugars
  - In-vitro digestibility

- **Grain**
  - Amylose
  - Protein
  - Lipid
  - Starch
  - Fiber
  - Moisture

### Spectra transfer

To transfer calibrations across different NIRS instruments.

### Capacity building

- MPA operation: 02 technicians
- NIRS seminar: 60 participants

### Challenges

- Reference analyses for calibration development & quality checking
- Focal person to coordinate NIRS activities
- Shortage of funds for NIRS activities

### Sorghum database at ICRISAT/IER Mali

<table>
<thead>
<tr>
<th>Crop</th>
<th>Material</th>
<th>Sample details</th>
<th>Samples scanned</th>
<th>Reference analyses</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum</td>
<td>Stem</td>
<td>Hybrid Trial-2013-P5a-LowP</td>
<td>64</td>
<td>7^a</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Hybrid Trial-2013-P3c-High P</td>
<td>64</td>
<td>9^a</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>BCNAM-2013-P3a</td>
<td>505</td>
<td>46^a</td>
<td>1029</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SMK10GEN-Burkina Faso</td>
<td>369</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shared samples – CIRAD</td>
<td>27</td>
<td>27^a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stover</td>
<td>Sadoré</td>
<td>3</td>
<td>3^b</td>
<td>414</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feed the Future Innovation Lab, Niger</td>
<td>14</td>
<td>14^b</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maradi, Niger</td>
<td>6</td>
<td>6</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Bama 2015 (semis 1), Burkina Faso</td>
<td>242</td>
<td>-</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Bama 2015 (semis 3), Burkina Faso</td>
<td>149</td>
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<tr>
<td></td>
<td>Whole grain</td>
<td>BCNAM-2013-Low P, Samanko</td>
<td>908</td>
<td>-</td>
<td>5424</td>
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<tr>
<td></td>
<td></td>
<td>BCNAM-2014, Sotuba</td>
<td>469</td>
<td>-</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>BCNAM-2013, Sotuba</td>
<td>1562</td>
<td>-</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>BCNAM-2012, Sotuba</td>
<td>2453</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dual purpose Sorghum, IER</td>
<td>32</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

^a Samples subjected to reference analyses at CIRAD, France
^b Samples subjected to reference analyses at ILRI, India
RESULTS:
Tools & Technologies for Crop Improvement

Grain and Stover quality, including grain micronutrient content

Growth performance with chicks feed with sorghum in Niger and Nigeria

- 50% sorghum + 50% maize or 100% sorghum can be substituted to maize in poultry feeding.
- Sorghum without tannin has a nutritional value compared to that of maize.
- Poultry feed and broilers costs can be reduced significantly using sorghum as energy source in the feeding.
RESULTS: Integrated Crop Management

Integrated management of soil fertility and *Striga*

- 60% higher yields from **Integrated Striga management** over farmers’ practice, with marketable surplus of ~ 412 kg per ha
- > 20,000 **Fighting Striga** DVDs distributed, including 10 videos in 6 local languages, French and English
- **Micro-dosing** reached >30,000 farmers in Mali, Burkina Faso and Nigeria
RESULTS: Integrated Crop Management

Labor-efficient agricultural equipment

Seeding labor time reduced from 12 person days / ha (manual) > 1 person day / ha (animal traction) > ¼ person day /ha by motorized seeder in Mali.
## RESULTS: Seed Systems and Input Services

<table>
<thead>
<tr>
<th>Quality seed production and dissemination</th>
<th>Seed production</th>
<th>Trainings</th>
<th>Awareness creation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seed produced (Mt): ~ 1920</td>
<td>38 seed cooperatives trained from 2014 to 2016 in seed production techniques</td>
<td>Mini-packages (0.5kg, 1kg, 6kg), important tools for seed marketing</td>
</tr>
<tr>
<td></td>
<td>Seed distributed (Mt): ~ 1632</td>
<td>Rural radio staff trained in better communication on new variety and hybrid characteristics to increase seed dissemination</td>
<td>Rural radios: ~ 993, Demonstration plots: ~ 1100, Seed fares: ~ 26, Farmers at field days: ~ 4675 (1403)</td>
</tr>
</tbody>
</table>
## RESULTS: Seed Systems and Input Services

### Seed Production with farmer cooperatives in Mali (2012 - 2015)

<table>
<thead>
<tr>
<th>Type</th>
<th>Year 2012</th>
<th>Year 2013</th>
<th>Year 2014</th>
<th>Year 2015</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPVs (kg/ha)</td>
<td>38 958</td>
<td>22 196</td>
<td>27 014</td>
<td>26 162</td>
<td>114 330</td>
</tr>
<tr>
<td>Hybrids (kg/ha)</td>
<td>8 252</td>
<td>43 477</td>
<td>18 728</td>
<td>44 049</td>
<td>114 506</td>
</tr>
<tr>
<td>Total (kg/ha)</td>
<td>47 210</td>
<td>65 673</td>
<td>45 742</td>
<td>70 211</td>
<td>228 836</td>
</tr>
<tr>
<td>% Hybrid</td>
<td>17%</td>
<td>66%</td>
<td>41%</td>
<td>63%</td>
<td>50%</td>
</tr>
</tbody>
</table>
GENDER

Plant Available P (Bray1) in women’s and men’s sorghum fields in Mali

Frequency %

4 6 8 10 12 >12

Female  Male
High P(+12ppm); low P (7ppm). Several progenies of BCNAM-Lata populations show higher grain yield and better adaptation compared to Lata.

High_P Environment Grain Yield (g m⁻²)

Low_P Environment Grain Yield (g m⁻²)
## RESULTS: Capacity building

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students who completed PhD training</td>
<td>7 (2)</td>
</tr>
<tr>
<td>Students who completed Masters training</td>
<td>4 (1)</td>
</tr>
<tr>
<td>Technicians</td>
<td>80</td>
</tr>
<tr>
<td>Trainees in short-duration training programs</td>
<td>4618 (1293)</td>
</tr>
</tbody>
</table>
IMPACT

- 4,618 farmers (28% women) trained in seed production technique
- >1920 tons of certified seed produced
- 47% sorghum farmers in target countries exposed to new varieties
- Net benefits estimated at FCFA 23 813 (US$ 40) per hectare generated through Integrated *Striga* Management
- Micro-dosing reached more than 30,000 farmers in Mali, Burkina Faso and Nigeria
- 128 locally developed motorized seeders distributed in Mali
- Over 20,000 Fighting *Striga* DVDs distributed.
Lessons Learned

- Breeding of improved cultivars can be greatly accelerated through the use of genomic technologies and tools.
- BCNAM is a rapid method for useful population development and detection of QTLs associated to farmer-preferred traits.
- Community-based seed producers can play important roles in hybrid seed dissemination.
- Mini-packages with key information on the crop variety are important tools for seed marketing in the target zones.
- Addressing critical livestock-feeding challenges will require strategic use of crop residues.
Areas suggested for continued R4D

- Identification of gender-preferences for traits
- Maximization of heterosis through development of heterotic pools
- Efficient multi-trait selection using molecular and genetic tools
- Enhanced stover and grain quality through bio-fortified varieties
- Development and promotion of climate-smart varieties
- Continued creation of awareness of new technologies for adoption
- Training of seed producers’ cooperatives to produce quality seeds
- Food processing and product development
  - *Time saving and reduced drudgery for women*
  - *Training women for entrepreneurship in the sorghum value chain.*
# Contributing Bilateral Projects

<table>
<thead>
<tr>
<th>Donor Organization</th>
<th>Funding End Date</th>
</tr>
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<tbody>
<tr>
<td>GCP</td>
<td>Nov-15</td>
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<td>GCP</td>
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<tr>
<td>CORAF/WECARD (USAID funded)</td>
<td>May-15</td>
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<tr>
<td>BMZ/GIZ</td>
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<tr>
<td>McKnight Foundation</td>
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<td>USAID, Mali</td>
<td>Sep-16</td>
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<td>Michigan State University (BMGF)</td>
<td>Apr-16</td>
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<td>HarvestPlus</td>
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<td>Mar-17</td>
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<tr>
<td>McKnight Foundation</td>
<td>May-18</td>
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</table>
Summary

- Sorghum production, traditionally subsistence in WCA, is becoming more important in the market economy of the region.
- Persistent low yields of sorghum are primarily due to continued practice of traditional and minimum-input production techniques.
- Interventions needed:
  - Increase access to improved seeds and fertilizer.
  - Create awareness around appropriated input and demand.
  - Increase access to mechanization services.
List of Posters

1. Dual-purpose sorghum: an option to increase total crop value for smallholder farmers in West and Central Africa

2. Strategy for seed systems management in smallholder farming in West Africa

3. Adoption of improved varieties of millet and sorghum in WCA: current situation and perspectives

4. Research-development partnerships for large-scale utilization of priority proven technologies of Millet and Sorghum in Mali.
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Thank You

http://drylandcereals.cgiar.org

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