Towards Improved Field Water Management In Gash Agricultural Scheme, Eastern Sudan

(From Africa to Asia and Back Again Project)

Managing Soil moisture and field water management

by

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HRC - SUDAN
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Africa to Asia and Back Again: Testing Adaptation in Flood-Based Farming Systems

- The Project builds on an earlier grant of IFAD – Spate Irrigation for Poverty Alleviation and Rural Growth, implemented by UNESCO-IHE and MetaMeta (as conveyors of the spate irrigation network).

- Four country chapter of the Spate Irrigation Network, hosted respectively by Mekelle University (Ethiopia), HRC (Sudan), WEC (Yemen) and SPO (Pakistan).

- The area under FBFS in Africa and Asia is estimated at 20-35 million hectares.

- FBFSs are neglected in most countries, with most attention going to conventional perennial irrigation systems or alternatively to rain-fed agriculture.
The Gash Agricultural Scheme

- GAS consist of six blocks
- Total area 240,000 feddans
- Average irrigated area 80,000 feddans
Gash River

2/8/2015

15/7/2015

3/7/2015
Research Rationale

Rationale

- Improving field water management was a key research theme identified by stakeholders in the project Inception workshop in April 2015.

- Several previous policy and investment interventions focused on main and secondary systems while largely neglecting the field water management.
Objectives

- Evaluate the efficiency of field water management of the current irrigation practice and field layout
- Assess the impact of current field water management on productivity
- Identify and analyze, alternative practices for improving field water management and productivity
- Formulate improvement recommendations for interventions on the ground
Research Questions:

• To what extent the livelihood will be affected positively by developing the farmer network?

• What is the maximum achievable water and crop productivity from the soil moisture content after the interventions?

• What is the water and crop productivity from this remaining soil moisture content?

• What is the possibility the available water after the first crop?
Methodology
Research Approach and Methods

- WinSRFR programme: Simulation of field water application efficiency (%)
- Current meter & float: inflow (m³/s)
- Surveying:
  - Field topography (m/m or %)
  - Field dimensions (m²)
- Soil texture (silt to clay): Infiltration rate
Approach in years 2015-2019

**Phase I**
- Mesga selection in Kassala Block
- Pre-season investigation
- Field survey
- Flow measurements (Jul.-Aug.)
- SMC sampling
- Reporting/documentation

**Phase II**
- Analytical work
- Modeling

**Phase III**
- Mesga selection in Kassala Block
- Field survey
- Construction works
- Pre-season investigation
- Flow measurements (Jul.)
- SMC sampling
- Reporting

*Season 2019 Its Data is under process*
Field work

Season - 2015

- Collecting soil sample using hand-auger
- Installing gauge stuff
- Flow measurements
- Maintaining control structure D/s of Megra_2
- Stopwatch
- Float method
Surveying Work
Current situation

- Irrigation application: 23 Days
- Mesga (field/plot) size: 1000 Feddan (420 ha)
- Field layout: 0.00138 m/m uniform slope

Results

- 50% of mesga is dry
- 40% efficiency: 60% deep percolation: Some will recharge the groundwater
- Some will be available for crops by capillary rise
- In best soils (silt loam), vertical soil moisture movement will recover some of the dry area
### Scenarios formulation

**Sub-Dividing**

<table>
<thead>
<tr>
<th>1</th>
<th>1</th>
<th>2</th>
<th>1</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<td>3</td>
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<td>2</td>
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Interventions on farm level

• According to the results that was shown in the workshop which was held in Kassala state in December 2016, the Administration and leader farmers in GAS were being discussed to apply the proposed solution in cropping season in 2017

• based on what is addressed in the workshop and meetings the field preparation is being done so far to ensure the success of the experiment.
Season - 2017

SIDE VIEW OF MEETINGS AND FIELD VISIT
Outcomes
# Flow measurements

## I. WL measurements

<table>
<thead>
<tr>
<th>Year</th>
<th>Pilot farm</th>
<th>Area (Feddan)</th>
<th>Flow (Mm$^3$)</th>
<th>Water depth (mm)</th>
<th>No. of days</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Kassala Block: Mesga 1</td>
<td>2000</td>
<td>4.7 (2.86 m$^3$/s)</td>
<td>700</td>
<td>19</td>
</tr>
<tr>
<td>2017</td>
<td>Kassala Block: Mesga 14E</td>
<td>1000</td>
<td>3.00 (3.16 m$^3$/s)</td>
<td>715</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Practice</td>
<td>1000</td>
<td></td>
<td></td>
<td>15</td>
</tr>
</tbody>
</table>
Outcomes/discharge measurements

(4.7 Mm³ in 19 days)  2015

(3.0 Mm³ in 11 days)  2017
## SMC sampling

<table>
<thead>
<tr>
<th>Sampling Mesga</th>
<th>Pre-season</th>
<th>Batch 1</th>
<th>Batch 2</th>
<th>Batch 3</th>
<th>Batch 4</th>
<th>Batch 5</th>
<th>Batch 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesga 1</td>
<td>31/5-6/6</td>
<td>29/8-2/9</td>
<td>9/9-12/9</td>
<td>30/9-4/10</td>
<td>23-25/10</td>
<td>26-28/11</td>
<td>-</td>
</tr>
</tbody>
</table>

**Average soil moisture (%):**

<table>
<thead>
<tr>
<th>Time</th>
<th>Year 2017</th>
<th>Year 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-season</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd reading</td>
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<tr>
<td>3rd reading</td>
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<tr>
<td>4th reading</td>
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<tr>
<td>Harvesting</td>
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</table>
SMC% Monitoring Phase I:

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>Preseason</th>
<th>Batch-1</th>
<th>Batch-2</th>
<th>Batch-3</th>
<th>Batch-4</th>
<th>Batch-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.3</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
</tr>
<tr>
<td>0.3 - 0.6</td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
<td><img src="image9" alt="Image" /></td>
<td><img src="image10" alt="Image" /></td>
<td><img src="image11" alt="Image" /></td>
<td><img src="image12" alt="Image" /></td>
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<tr>
<td>0.6 - 0.9</td>
<td><img src="image13" alt="Image" /></td>
<td><img src="image14" alt="Image" /></td>
<td><img src="image15" alt="Image" /></td>
<td><img src="image16" alt="Image" /></td>
<td><img src="image17" alt="Image" /></td>
<td><img src="image18" alt="Image" /></td>
</tr>
</tbody>
</table>
### SMC% Monitoring Phase II:

<table>
<thead>
<tr>
<th>DEPTH (m)</th>
<th>Preseason</th>
<th>Batch-1</th>
<th>Batch-2</th>
<th>Batch-3</th>
<th>Batch-4</th>
<th>Batch-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.3</td>
<td><img src="image1" alt="Graph" /></td>
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<td><img src="image4" alt="Graph" /></td>
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<td>0.3 - 0.6</td>
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<td><img src="image18" alt="Graph" /></td>
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</tbody>
</table>
The situation after Modification

- Irrigation application:
  - 11 Days
- Mesga (field/plot) size:
  - 500 Feddan (210 ha)
- Field layout: 0.002 m/m uniform slope

Results

- 100% of the area is irrigated
- 86% efficiency: 14% Surface Runoff, 0% deep percolation
The situation after Modification

- **Irrigation application:**
  - 11 Days
- **Mesga (field/plot) size:**
  - 1000 Feddan (420 ha)
- **Field layout:** 0.002 m/m uniform slope

Results

- 86% of the area is irrigated
- 100% efficiency: 0% deep percolation
Yield Production

Season - 2015

- **Dry Yield Production:** 5.8 Sack / feddan
- **Biomass Production:** 0.6 ton / feddan
Yield Production
Season - 2017

- **Dry Yield Production:** 12.8 Sack / feddan

- **Biomass Production:** 2.1 ton / feddan
## Production

<table>
<thead>
<tr>
<th>Average Dry Yield Production in GAS</th>
<th>Dry Yield Production in Mesga 14 East</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tabat (Sack/Feddan)</td>
<td>Aklamoya (Sack/Feddan)</td>
</tr>
<tr>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>9</td>
</tr>
</tbody>
</table>

Rainfall !!!
Achievements

• The total number of irrigation days is decreased (from 15 to 11 days)
• The applied water depth in 2017 is 715 mm compared to 700 mm in 2015
• Performance indicators as adopted from WinSRFR are also enhanced
• Soil moisture distribution is enhanced.
**Limitations**

- The constructed mesga canal does not reach its design capacity during the irrigation period
- Sustainability of mesga canal for future use and its condition regarding siltation
- Levelling of the mesga before season also has obvious impacts on water distribution
THANK YOU