PROMOTING AGRICULTURAL TECHNOLOGY IN THE NILE BASIN

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Figure Source: FAO Statistical Pocketbook: World Food and Agriculture (2015), page 28, Figure 48
A New Path to African “Fertility”

Application of Agricultural Technologies to:

✧ Improve Yields
✧ Increase Water Use Efficiency
# Agricultural Characteristics

<table>
<thead>
<tr>
<th>Country</th>
<th>Dominant Holding Type</th>
<th>Main Advantages and Disadvantages</th>
<th>Agricultural Area (percent of total)</th>
<th>Cultivated Area (percent of total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>Small Holder (50% &lt; 0.42 ha)</td>
<td>✦ Encroaching Urbanization ✦ Highly Productive, gains available in water use efficiency</td>
<td>3,761,000 ha (4%) (FAO Aquastat, 2013)</td>
<td>3,761,000 ha (4%) (FAO Aquastat, 2013)</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Small Holder (Avg. &lt; 1 ha)</td>
<td>✦ Increasing productivity and fertilization ✦ Lacks storage and irrigation capacity</td>
<td>36,259,000 ha (33%) (FAO Aquastat, 2013)</td>
<td>16,259,000 ha (15%) (FAO Aquastat, 2013)</td>
</tr>
<tr>
<td>Sudan</td>
<td>Small Holder</td>
<td>✦ Poor Productivity ✦ Potential for horizontal Expansion</td>
<td>112,702,000 ha (60%) (FAO Aquastat, 2012)</td>
<td>21,252,000 ha (11%) (FAO Aquastat, 2012)</td>
</tr>
</tbody>
</table>
2014-2016 Avg. Rice (paddy) Yield (metric tonnes/ha)

- United States: 8.3
- EU: 6.8
- India: 3.6
- Morocco: 7.4
- World: 4.6
- China: 6.9
- Vietnam: 5.7
- Thailand: 2.9
- South Africa: 2.7
- Egypt: 9.4
- Ethiopia: 2.9
- Sudan: 3.1

Source: FAOSTAT
2014-2016 Avg. Wheat Yield (metric tonnes/ha)

- United States: 3.1
- EU: 5.7
- India: 3
- Morocco: 1.8
- World: 3.3
- China: 5.3
- Vietnam: 1
- Thailand: 3.5
- South Africa: 3.5
- Egypt: 6.6
- Ethiopia: 2.7
- Sudan: 2.6

Source: FAOSTAT
2014-2016 Avg. Seed Cotton Yield (metric tonnes/ha)

- United States: 2.6
- EU: 3.7
- India: 1.4
- Morocco: 2.1
- World: 2.2
- China: 4.5
- Vietnam: 1.1
- Thailand: 0.2
- South Africa: 3.3
- Egypt: 3.2
- Ethiopia: 0.8
- Sudan: 1.6

Source: FAOSTAT
IRRIGATED YIELDS

<table>
<thead>
<tr>
<th>Crop</th>
<th>U.S.</th>
<th>Egypt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat (tonnes/ha)</td>
<td>5.98</td>
<td>6.56</td>
</tr>
<tr>
<td>Corn (tonnes/ha)</td>
<td>13.5</td>
<td>7.37</td>
</tr>
<tr>
<td>Sorghum (tonnes/ha)</td>
<td>5.06</td>
<td>5.63</td>
</tr>
<tr>
<td>Cotton (100 kg/ha)</td>
<td>12.9</td>
<td>7.37</td>
</tr>
<tr>
<td>Rice (tonnes/ha)</td>
<td>8.32</td>
<td>8.8</td>
</tr>
</tbody>
</table>

YIELDS OVER TIME

Cereal Yields kg/ha


Egypt
Ethiopia
Sudan

Doubling of Fertilizer Consumption

Nitrogen use per area of cropland (kg/ha)

- Egypt: 430.7
- Ethiopia: 11.7
- Sudan: 7.2

Phosphate use per area of cropland (kg/ha)

- Egypt: 133.2
- Ethiopia: 12
- Sudan: 3.3

Potash use per area of cropland (kg/ha)

- Egypt: 11.5
- Ethiopia: 0
- Sudan: 0.1

Pesticide Use

- Egypt: 11,363
- Ethiopia: 5,976
- Sudan: 1,667.73

Data Source: FAO Statistical Pocketbook (2015), Data for 2014
FERTILIZER V. YIELD RELATIONSHIP

2010 Cereal Yield (thousand hg/ha)

2009 Nitrogen Fertilizer Consumption kg/ha (arable land + permanent crops)

FERTILIZER V. YIELD RELATIONSHIP

FERTILIZER TRADE

Nitrogenous Fertilizer Trade

Value in 1000 US$

700000

525000

350000

175000

0

Egypt

Ethiopia

Sudan

Import Value

Export Value

62% of Egyptian Exports of Nitrogen Fertilizer go to Europe: France (21%), Italy (13%), Spain (10%)

1.8% of Egyptian Exports of Nitrogen Fertilizer are to African nations

Source: FAOSTAT, 2014 data for Egypt and Ethiopia, 2012 data for Sudan
(Source: OEC)
## Irrigation Area

<table>
<thead>
<tr>
<th>Country</th>
<th>Cultivated Area:</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>3.7 million ha</td>
<td>- 3.6 million ha equipped for full control in 2010 (2.7 million ha (76%) in Old Lands). - 100% of equipped area irrigated in 2002.</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>16.2 million ha</td>
<td>- Estimates range widely from 91,000 ha equipped (NBI 2016) to 658,000 ha equipped for full control in 2014/2015. (1.9 million ha water managed) (FAO Aquastat)</td>
</tr>
<tr>
<td>Sudan</td>
<td>21.3 million ha</td>
<td>- 1.9 million ha equipped for full control irrigation in 2014 - 50-60% of equipped area irrigated in 2011. 43% in 2000</td>
</tr>
</tbody>
</table>

IRRIGATION TECHNOLOGY USED

(Egypt)
- 16 km$^3$ of drainage water, 6 km$^3$ reused (2011 Est.). 88% of irrigation area is drained
- Rainwater harvesting in North Sinai and Northwest Coast (133,500 ha)
- Field efficiency estimated at 50% in 2007 (FAO Egypt CPF, 2013)

(Ethiopia)
- Gravity drainage, but not widely implemented except in irrigated lands
- Well-developed rainwater harvesting (128,000 ha)

(Sudan)
- Estimate of 500,000 ha drained in pre-2011 Sudan
- Surface gravity method and canals.

*Assumed based on lack of specific data
WATER USE

Cubic meters of Agricultural Water Withdrawals per ha Harvested Irrigated Crop Area

Virtual Water (Cascao, 2017; Zeitoun et al., 2010)

- Egypt imports 32-34 bcm of Virtual Water, mostly through food ~ this is equivalent to about 40% of their water consumption figure.
- Ethiopia is a net VW exporter, and most of the exports (coffee) are grown through “green” water. However these exports total roughly 1 bcm (Zeitoun et al., 2010).
- Approximately 2% of VWT occurs within the Nile Basin region (Zeitoun et al., 2010).
- Potential for increasing regional trade and cooperation! (Cascao, 2017)
METHODS FOR INCREASING AGRICULTURAL PRODUCTIVITY AND WATER USE EFFICIENCY

https://commons.wikimedia.org/wiki/File:Palissage_et_irrigation_du_vignoble_de_Paarl.jpg
IRRIGATION

- Irrigation not only increases **yield**, but reduces **inter-annual variability**. (Otsuka and Larson, 2013; Kucharik and Ramankutty, 2005)

- **Lining canals** and switching to **drip and other localized irrigation systems** ensure that more water is transpired rather than going to drainage (Brouwer et al., 1989)
  
  • However increased efficiency does not automatically translate to water savings without controls on overall consumption (Perry & Steduto, 2017)

- Institutional supports such as **guaranteeing water delivery and cost sharing** of upgrades can incentivize investment (FAO RNE)

- Potential for **“supplemental irrigation”** and the expanded management of rainwater for this purpose. Can increase cropping cycles and smooth out variability (Oweis and Hachum, 2006; Hengsdijk et al., 2014; Rockstrom et al., 2009)

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Earthen canals</th>
<th>Lined canals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sand</td>
<td>Loam</td>
</tr>
<tr>
<td>Canal length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long (&gt; 2000m)</td>
<td>60%</td>
<td>70%</td>
</tr>
<tr>
<td>Medium (200-2000m)</td>
<td>70%</td>
<td>75%</td>
</tr>
<tr>
<td>Short (&lt; 200m)</td>
<td>80%</td>
<td>85%</td>
</tr>
</tbody>
</table>

Field Application Efficiency (Brouwer et al., 1989a)

<table>
<thead>
<tr>
<th>Irrigation methods</th>
<th>Field application efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface irrigation (border, furrow, basin)</td>
<td>60%</td>
</tr>
<tr>
<td>Sprinkler irrigation</td>
<td>75%</td>
</tr>
<tr>
<td>Drip irrigation</td>
<td>90%</td>
</tr>
</tbody>
</table>
Asia’s Green Revolution was seed driven and occurred in a similar small-holder dominated setting. (Otsuka and Larson, 2013)

Maize hybrids have already shown great promise in Africa (Gabre-Madhin et al., 2004)

Seed development needs to focus on and local partnerships with small/medium seed corporations due to the multitude of agro-climate systems and crops grown in the Basin and Africa as a whole (AGRA)

Improved seed varieties are not only higher yielding but more drought and pest tolerant (AGRA)
Inorganic fertilizers must be used to restore soil nutrients, and will be spurred by farmer education and training, increased local availability, and reduced prices. (Nziguheba et al., 2010)

More data on soil type and chemical properties would aid in the appropriate application of inputs (Nziguheba et al., 2010; Berazneva et al., 2016)

Successful techniques for erosion reduction and soil moisture retention include terracing, grass buffers, contour bunds, and conservation tillage to reduce erosion and downstream sedimentation (Mati, 2005)
# The Current Situation

<table>
<thead>
<tr>
<th></th>
<th>Productivity</th>
<th>Fertilizer</th>
<th>Water Use Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>High</td>
<td>Excessive</td>
<td>Deficient</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>Below Average</td>
<td>Low</td>
<td>Deficient</td>
</tr>
<tr>
<td>Sudan</td>
<td>Low</td>
<td>Very Low</td>
<td>Deficient</td>
</tr>
</tbody>
</table>
LOOKING AHEAD

Egypt:

❖ Expand adoption of efficient irrigation technologies
❖ Export production knowledge and inputs (fertilizer) to other basin countries
❖ Reduce cultivation of water intensive crops such as rice, wheat, and sugarcane and increase cultivation of more drought resistant crops such as groundnuts and sorghum (Davis et al., 2017, FAO Egypt CPF, Brouwer et al., 1989b, Brouwer and Heibloem, 1986)

Ethiopia:

❖ Continue to increase fertilizer consumption as well as introducing new seed varieties
❖ Implement storage and supplemental irrigation

Sudan:

❖ Expand irrigation and improve efficiency in large schemes
❖ Introduce fertilizer and new seed varieties
REFERENCES


REFERENCES CONTINUED


