ArcGIS Online

As a Tool for International Agricultural Research

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Ethiopian population...

96,633,458

- Median age: 17.6
- Life expectancy: 60.75
- Growth: 2.89%
- Urban: 17%
- Obesity, adult: 1.1%
- Underweight children under age 5: 29%
- Unemployed, age 15-24: 29.4%
- Literacy, age 15 and up: 39%

CIA World Fact Book – Ethiopia
Ethiopian economy...

**GDP $118.2 billion** (2013 est.)

- $1,300 per capita
- Sector of origin:
  - agriculture: 47%
  - industry: 10.8%
  - services: 42.2%

CIA World Fact Book – Ethiopia
Ethiopian agriculture…

Dominated by smallholder farms

– Most less than 2 ha
– Predominantly animal & hand labor
– 89% of labor force
– Many fields in use for 5,000+ years
  • severe erosion
  • depleted fertility
Ethiopian agriculture... 

Dominated by smallholder farms

– 87.4 % of rural households operate <2 hectares
– 64.5 % of them cultivated <1 hectare;
– 40.6 % operated 0.5 hectare or less
– Such small farms are fragmented on average into 2.3 plots
Ethiopian agriculture...

Dominated by smallholder farms

– The average farm size can generate only about 50% of the minimum income required for the average farm household to lead a life out of poverty, if current levels of farm productivity and price structures remain constant. Such farmers have little or no surplus for investment and for input purchase.
Ethiopian agriculture...

- Elevations up to 3,400+ m (11,000+ feet)
- Slopes up to 50 percent or greater
Ethiopian agriculture...

Area in production 2007/08

- Smallholders 12,000,000 ha
- Commercial farms 461,000 ha

Crop production 2007/08

- Smallholders 95% of production
- Commercial farms 5% of production
  2.6% of ceral production

Crop Production in Ethiopia: Regional Patterns and Trends
**Ethiopian agriculture...**

### Table 1. Crop area and production (smallholder farms, Meher season); averaged over 2004/05–2007/08

<table>
<thead>
<tr>
<th>Crop</th>
<th>Number of holders</th>
<th>Area cultivated</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Share in total</td>
<td>Level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(%)</td>
<td>(ha)</td>
</tr>
<tr>
<td>Grain</td>
<td>11,519,148</td>
<td>92.7</td>
<td>10,382,365</td>
</tr>
<tr>
<td>Cereals</td>
<td>11,156,837</td>
<td>73.4</td>
<td>8,230,211</td>
</tr>
<tr>
<td>Teff</td>
<td>5,462,782</td>
<td>20.9</td>
<td>2,337,850</td>
</tr>
<tr>
<td>Maize</td>
<td>7,287,931</td>
<td>14.2</td>
<td>1,595,238</td>
</tr>
<tr>
<td>Wheat</td>
<td>4,118,164</td>
<td>12.8</td>
<td>1,439,098</td>
</tr>
<tr>
<td>Sorghum</td>
<td>4,253,534</td>
<td>12.8</td>
<td>1,429,886</td>
</tr>
<tr>
<td>Barley</td>
<td>3,842,462</td>
<td>9.1</td>
<td>1,024,390</td>
</tr>
<tr>
<td>Pulses</td>
<td>6,377,027</td>
<td>12.4</td>
<td>1,384,499</td>
</tr>
<tr>
<td>Oilseeds</td>
<td>3,127,131</td>
<td>6.9</td>
<td>767,655</td>
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<tr>
<td>Vegetables</td>
<td>4,936,741</td>
<td>1.0</td>
<td>106,585</td>
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<tr>
<td>Root crops</td>
<td>4,757,733</td>
<td>1.6</td>
<td>174,826</td>
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<tr>
<td>Fruit crops</td>
<td>2,658,415</td>
<td>0.5</td>
<td>51,078</td>
</tr>
<tr>
<td>Chat</td>
<td>2,068,262</td>
<td>1.3</td>
<td>141,881</td>
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<tr>
<td>Coffee</td>
<td>3,049,120</td>
<td>2.7</td>
<td>305,940</td>
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<tr>
<td>Hops</td>
<td>1,685,422</td>
<td>0.2</td>
<td>23,457</td>
</tr>
</tbody>
</table>

Source: Authors’ calculations using CSA data

Crop Production in Ethiopia: Regional Patterns and Trends
Plowing...
Plowing...
Plowing...
Climate zones...

Hot: <1500m
Temperate: 1500-2400m
Cool: >2400m

JJAS rainfall...
JJAS rainfall - percent of total

http://journals.ametsoc.org/doi/pdf/10.1175/MWR3304.1
Opportunities...

Crops and yields can be improved
  – grain quantity and quality
  – straw quantity and quality

Profitability can be improved
  – Individuals and communities
  – Country and region

Food security can be improved
The situation...

**Significant annual nutrient losses are occurring**

- prolonged lack of fertilization in continuous cropping,
- high proportions of cereals in the cropping system, and
- application of suboptimal levels or imbalanced blends of mineral fertilizers.
The situation...

Many smallholder farmers in Ethiopia

– are aware of the potential positive contribution of mineral fertilizers to crop production,
– yet only 35% of farmers apply fertilizer
– on about 40% of area under crop production.
The situation...

**Fertilizer use in Ethiopia**

- increased about 10% per year 1989 - 2004,
- but the growth rate of total cereal production was below 2 percent per year for the same period
The situation...

Current fertilizer recommendations in Ethiopia

– are based on very general crop-specific guidelines
– or more often, a single recommendation for all crops
The plan...

This project will conduct **fertilizer response studies** for barely-wheat production systems in **four regions** of Ethiopia representing major tef, wheat, maize growing areas in the country. Five Ethiopian research centers will be involved in site selection, and the test sites will be ground truthed with the aid of the **new soil map**.
The plan...

Test plots and soil test sites will be mapping into a GIS and all relevant site data will be recorded, including site characteristics, soil analysis results, crop inputs (fertilizer, seeds, rain/irrigation, etc) and harvest data. The GIS allow integration of diverse data sets, and enable us to extrapolate area-specific fertilizer recommendations from a limited number of empirical fertilizer trials.
An integral part of this work will be to train local workers to map and collect all of the needed data to complete the project. The majority of this training by the University of Tennessee will be hands-on and on-site during the startup phase of the project, with additional training via online collaborations (Skype, Blackboard Collaborate, etc.) on an as-needed basis.
Sustainable Intensification

Practices that sustainably intensify farming system productivity, allowing more to be produced on less land, while:

• Improving soil quality,

• **while reducing erosion**, salinization, and other forms of degradation

• **achieve greater resilience** to drought, 

• **better fertilizer efficiency**, and

• reduced greenhouse gas emissions

Sustainable Intensification

• **Minimizing** the use of pesticides and herbicides by applying **integrated pest management, crop rotation, and crop diversification.**

• Employing **environmental management systems** to ensure proper treatment of solid waste, manure, and waste water.

• **Ensuring** the safe storage, application, and disposal of agricultural chemicals.

• **Maintaining** habitats to support wildlife and conserve biodiversity.

Sustainable Intensification

It helps reduce the risks of complex problems like climate change and water scarcity – important because agriculture constitutes approximately 70 percent of water consumption in the developing world, increasingly competing with demand for domestic, industrial, and ecosystem services.

The project...

**Partners in Ethiopia**

- Ethiopian Agricultural Transformation Agency
- Hawassa University
- Debre Birhan Ag Res
- Shinai Ag Res
- Tigray Ag Res
Project team...

Ethiopian ATA and partners...

– designed study with UTIA input
– selected locations in various ecoregions
– established plots
Project team...

UTIA Ag Research & Extension...

– collaboration during design phase
– participated in crop evaluations
– mapped sites
Goals...

Develop appropriate fertilizer recommendations meeting the principles of Sustainable Intensification based on

– Crop
– Ecoregion
– Soils
– Producers’ goals
Goals...

**Develop educational / outreach products** to communicate results and teach Sustainable Intensification concepts
The GIS challenge...

Collaboration of specialists from University of Tennessee (UT) and Ethiopian Agricultural Transformation Agency (ATA)

Sustainable Intensification fertilization trials

- 65 field locations
- 1,500+ test plots

- How to share information and communicate results?
The challenge...

Sharing project data and content

– across 7 time zones

– communication barriers
  • language
  • network outages

Technical issues

– sporadic Internet outages at ATA
– no data services in field locations
Sites...

65 field locations, 24+ plots per field

- N, P, K
- Cu
- S
Evaluations...

Each plot evaluated in-field
  – Grain volume and quality
  – Straw quantity and quality

At harvest
  – Yields of grain and straw

Lab analysis
  – Quality and nutritional value
Pre-existing data...

- Populations
- Cropping areas
- Ecoregions
- Precipitation
- Soil maps (FAO)
- LANDSAT derived products
- SRTM elevation data
Data in progress...

• Updated soil maps
• Socioeconomic surveys
• Fertility trials data
  – yields
  – nutritional value
  – input costs
  – profits
Data to be generated...

Maps of results

– Summary data
– Links to
  • photographic records
  • case studies
Data to be generated...

Predictive maps

- Extrapolate based on similar
  - ecoregion
  - elevations
  - crops
  - soils
ArcGIS Online opportunities...

As ArcGIS Online (AGO) matures...

- Easier feature service publication
- Better geoprocessing options
- Easier integration with ArcGIS Desktop
ArcGIS Online options...

Varying levels of AGO accounts:

- Public, no sign-in
  - view maps shared to public
- Public accounts
  - create personal maps using own and public data
- Organizational account
  - publish feature services (layers) and maps
  - data enrichment
  - deoprocessing
ArcGIS Online issues...

Varying levels of AGO accounts:

- Public, no sign-in
- Public accounts
- Organizational account
  - Cost
  - Computing credits
  - IT department misunderstandings
What we have now...

UT knoxville has AGO organization account

– Controlled by IT department
  • Limited understanding of GIS opportunities
  • Restrictive interpretation of who can use the product
  • Cannot add users without University ID#
  • Concerned someone will use too many credits
What’s next...

Adapt project plan to IT policies

– Share databases via other Clouds
– Geoprocessing to be accomplished in ArcGIS Desktop
– Publish resulting feature services and map tiles
– Create ‘Story Maps’ to share results with public and other stakeholders
– Create online and print educational materials appropriate for Ethiopian smallholders
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