

ArcGIS Online

As a Tool for International Agricultural Research

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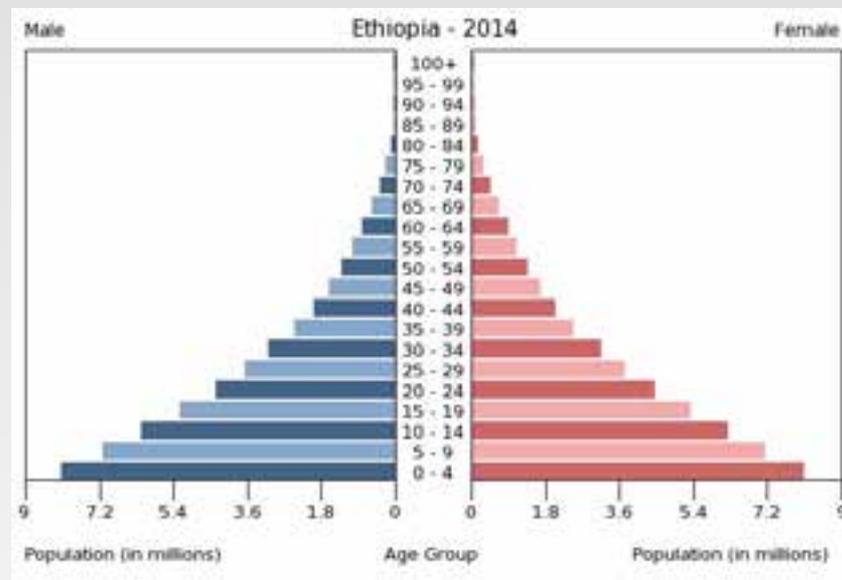
Debre Birhan Agricultural Research Station
Beza Shewangzaw



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

<https://www.cia.gov/library/publications/the-world-factbook/geos/et.html>

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
<https://www.cia.gov/library/publications/the-world-factbook/geos/et.html>

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

Land, Land Policy and Smallholder Agriculture in Ethiopia, by Samuel Gebrelassie
<http://www.future-agricultures.org/component/content/article/74-policy-briefs/83-land-land-policy-and-smallholder-agriculture-in-ethiopia#.U63OwrGrG9E>

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.

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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 cereal production

Crop Production in Ethiopia: Regional Patterns and Trends
<http://www.ifpri.org/sites/default/files/publications/essprn11.pdf>

Ethiopian agriculture...

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

Crop	Number of holders	Area cultivated		Production	
		Share in total (%)	Level (ha)	Share in total (%)	Level (metric tons)
Grain	11,519,148	92.7	10,382,365	79.8	14,090,273
Cereals	11,156,837	73.4	8,230,211	68.3	12,062,972
Teff	5,462,782	20.9	2,337,850	13.6	2,407,948
Maize	7,287,931	14.2	1,595,238	18.8	3,314,286
Wheat	4,118,164	12.8	1,439,098	13.0	2,293,308
Sorghum	4,253,534	12.8	1,429,886	12.5	2,216,181
Barley	3,842,462	9.1	1,024,390	7.5	1,326,422
Pulses	6,377,027	12.4	1,384,499	8.5	1,495,547
Oilseeds	3,127,131	6.9	767,655	3.0	531,754
Vegetables	4,936,741	1.0	106,585	2.4	424,825
Root crops	4,757,733	1.6	174,826	8.3	1,473,292
Fruit crops	2,658,415	0.5	51,078	2.3	403,459
Chat	2,068,262	1.3	141,881	0.7	126,427
Coffee	3,049,120	2.7	305,940	1.2	210,671
Hops	1,685,422	0.2	23,457	0.1	26,311

Source: Authors' calculations using CSA data

Crop Production in Ethiopia: Regional Patterns and Trends
<http://www.ifpri.org/sites/default/files/publications/essprn11.pdf>

Plowing...



Plowing...



Plowing...



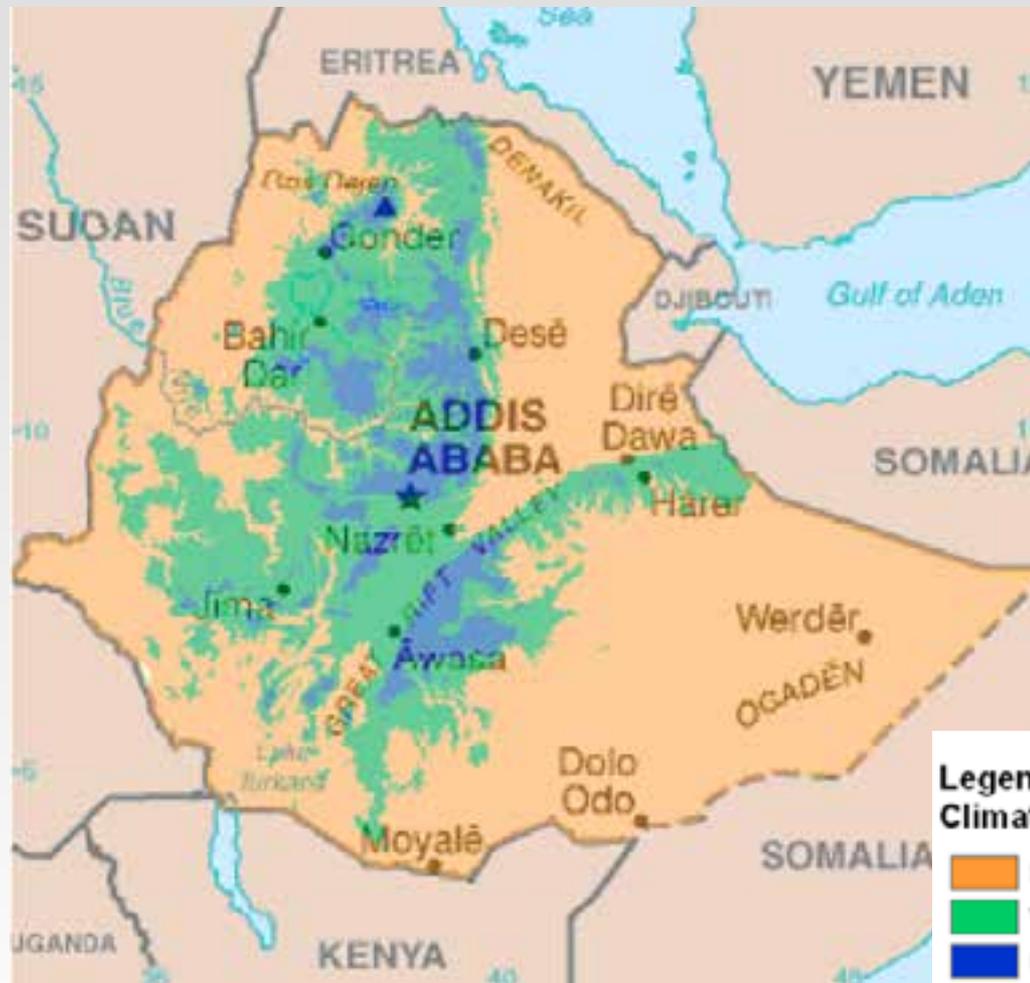
Plowing...



Plowing...

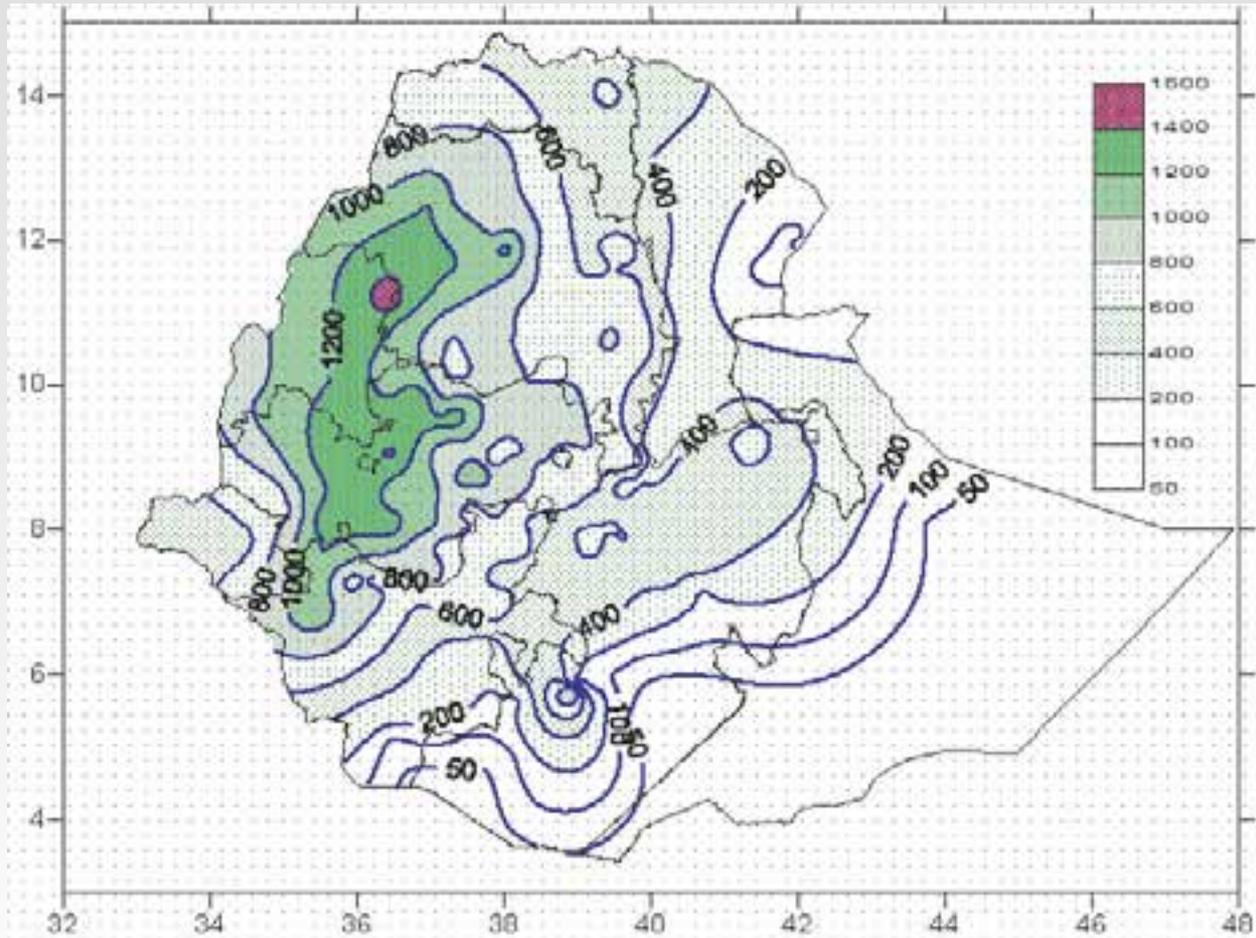


Climate zones...



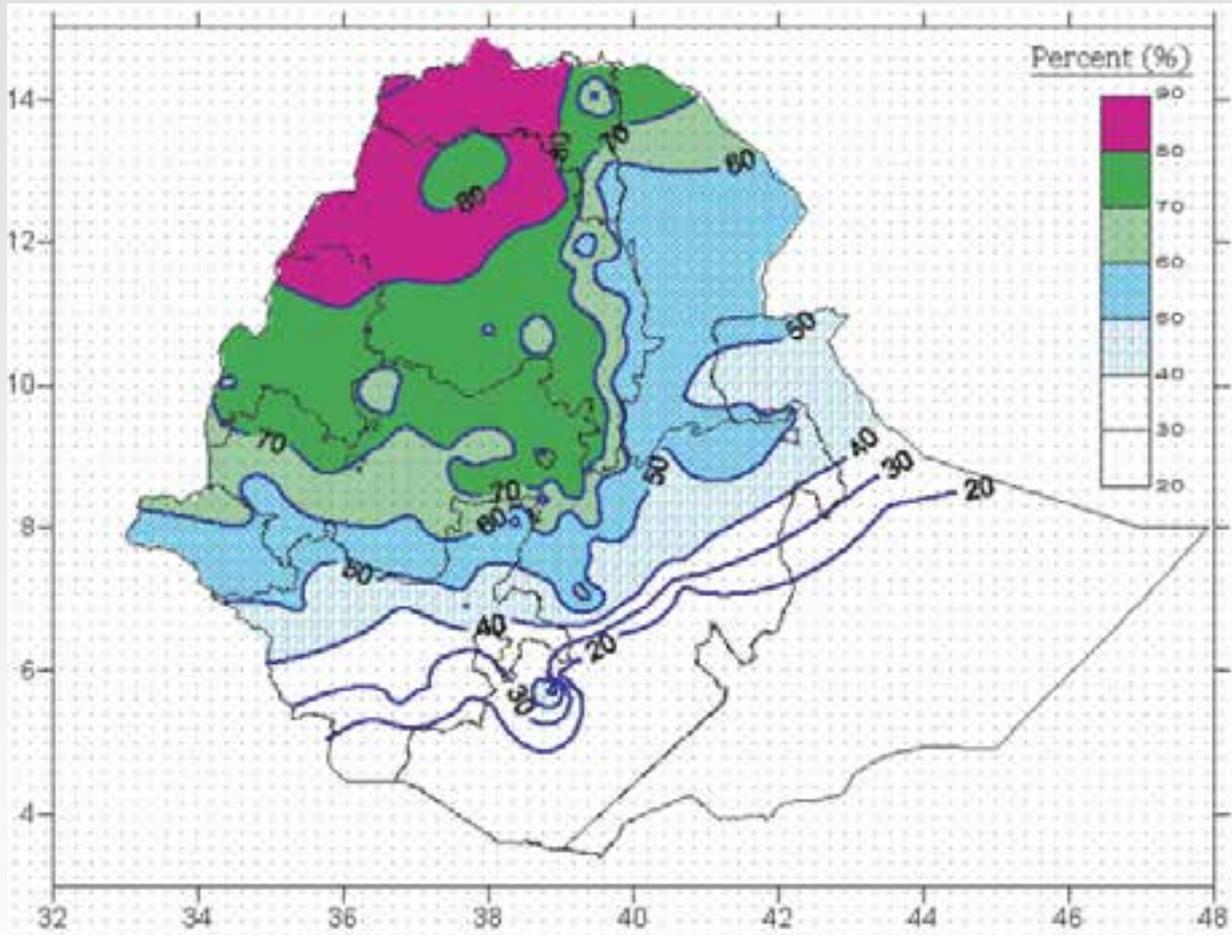
2008 Royal Meteorological Society. *Int. J. Climatol.* 28: 1723 – 1734 (2008) DOI: 10.1002/joc
<http://onlinelibrary.wiley.com/doi/10.1002/joc.1623/pdf>

JJAS rainfall...



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

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...

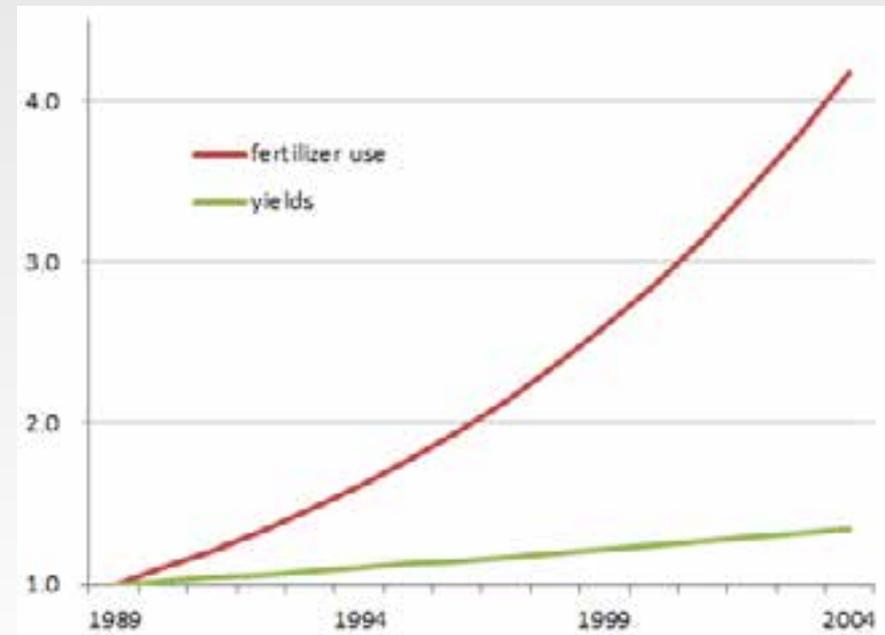
Many smallholder farmers in Ethiopia

- 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.

The plan...

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
- to **achieve greater resilience** to drought, **better fertilizer efficiency**, and
- reduced greenhouse gas emissions

<http://www.usaid.gov/what-we-do/agriculture-and-food-security/investing-sustainable-agriculture>

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.

<http://www.usaid.gov/what-we-do/agriculture-and-food-security/investing-sustainable-agriculture>

Sustainable Intensification

It **helps reduce the risks** in developing countries **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.

<http://www.usaid.gov/what-we-do/agriculture-and-food-security/investing-sustainable-agriculture>

The project...

Partners in Ethiopia

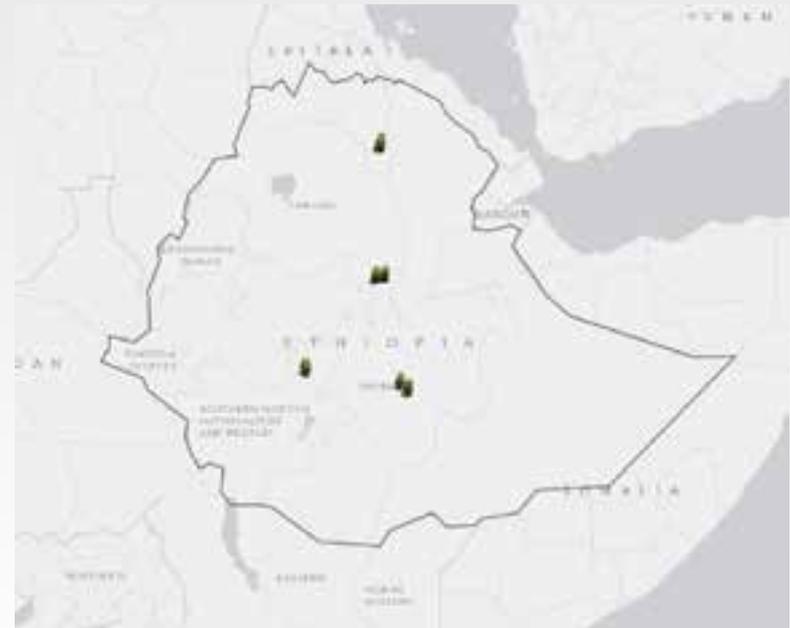
- Ethiopian Agricultural Transformation Agency
- Hawassa University
- Debre Birhan Ag Res
- Shinai Ag Res
- Tigray Ag Res



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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