Spatially Explicit Analysis of Agriculture, Poverty and Economic Development in sub-Saharan Africa

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Senior Research Fellow - Environment and Production Technology Division, IFPRI
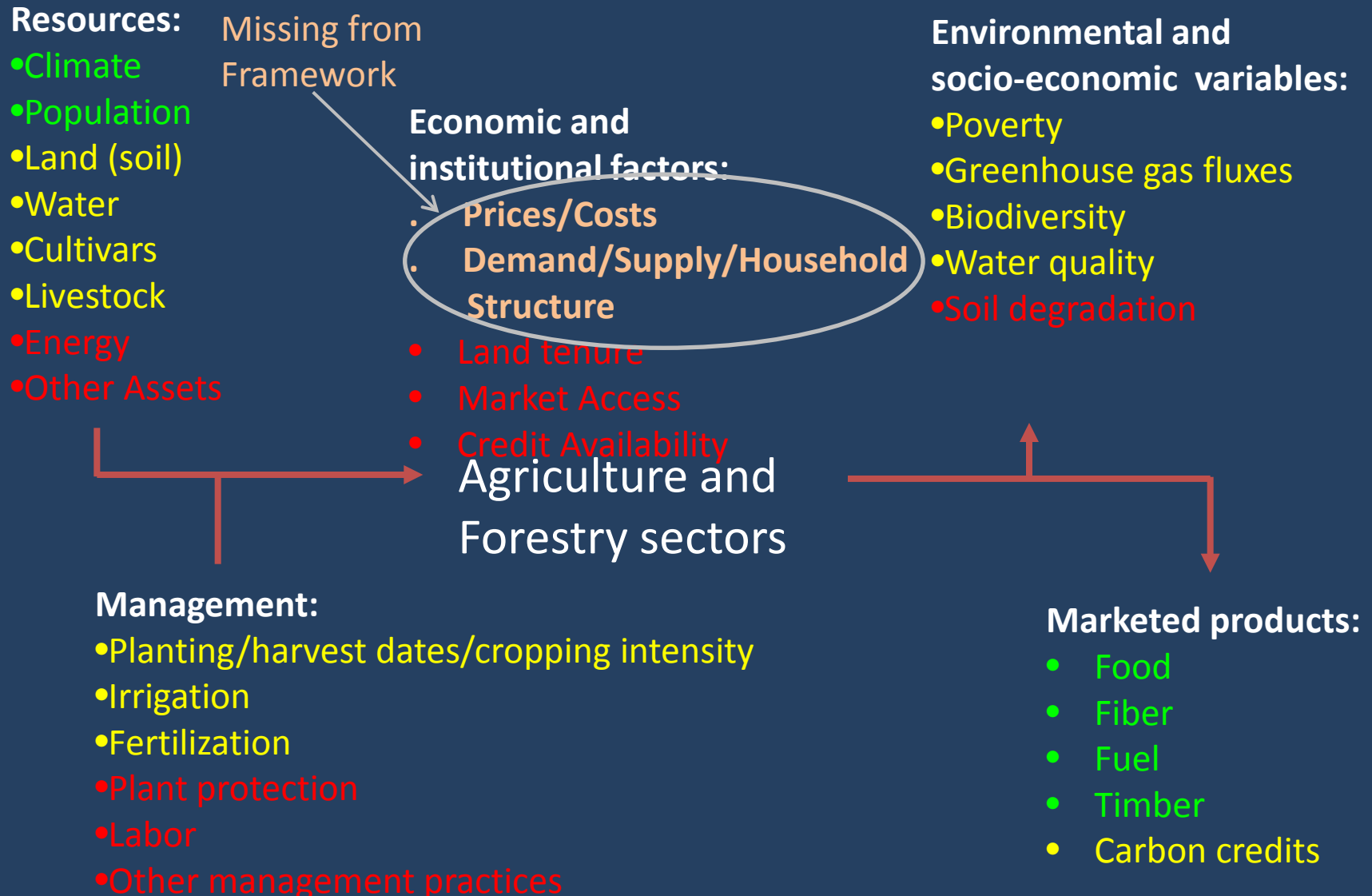*Co-PI -* HarvestChoice
Coordinator - CGIAR Consortium on Spatial Information (CGIAR/CSI)

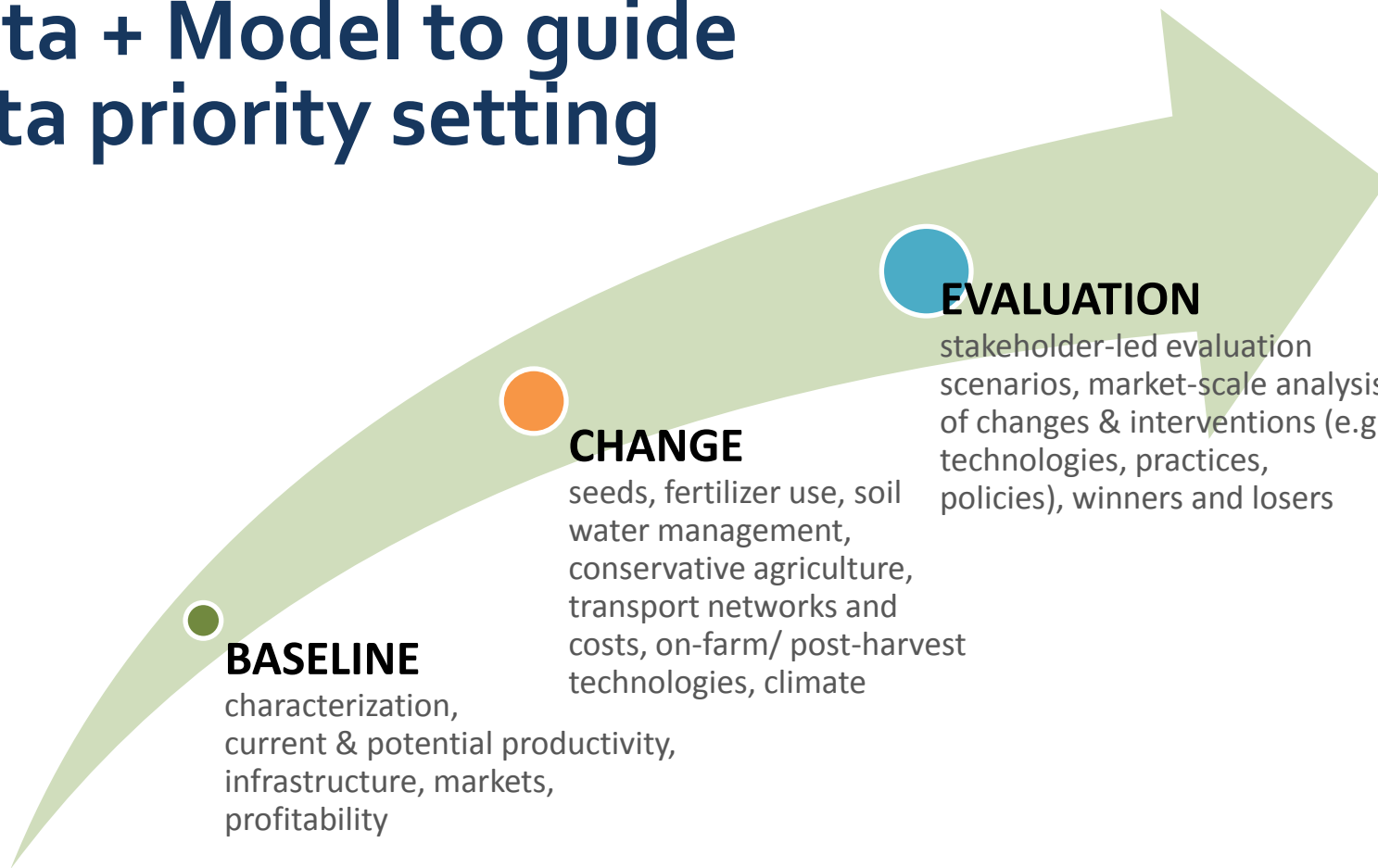**GEOSHARE Kickoff Workshop** | **Purdue University**

23-24 May 2011

Data needed to understand tradeoffs between agriculture and the environment

Resources:
- Climate
- Population
- Land (soil)
- Water
- Cultivars
- Livestock
- Energy
- Other Assets

Missing from Framework

Economic and institutional factors:
- Prices/Costs
- Demand/Supply/Household Structure
- Land tenure
- Market Access
- Credit Availability

Environmental and socio-economic variables:
- Poverty
- Greenhouse gas fluxes
- Biodiversity
- Water quality
- Soil degradation

Agriculture and Forestry sectors

Management:
- Planting/harvest dates/cropping intensity
- Irrigation
- Fertilization
- Plant protection
- Labor
- Other management practices

Marketed products:
- Food
- Fiber
- Fuel
- Timber
- Carbon credits

We also need an analytical framework of Data + Model to guide data priority setting

BASELINE
characterization, current & potential productivity, infrastructure, markets, profitability

CHANGE
seeds, fertilizer use, soil water management, conservative agriculture, transport networks and costs, on-farm/ post-harvest technologies, climate

EVALUATION
stakeholder-led evaluation scenarios, market-scale analysis of changes & interventions (e.g. technologies, practices, policies), winners and losers

Harvest Choice

Hunger, Poverty & Productivity:
Spatial Covariates/Proxies & Analytical Flow

Terrain, Demography, Infrastructure, Admin Units

Production Environment & Constraints

Production Systems & Performance

Interventions/ Responses

Linkage to Macro Models
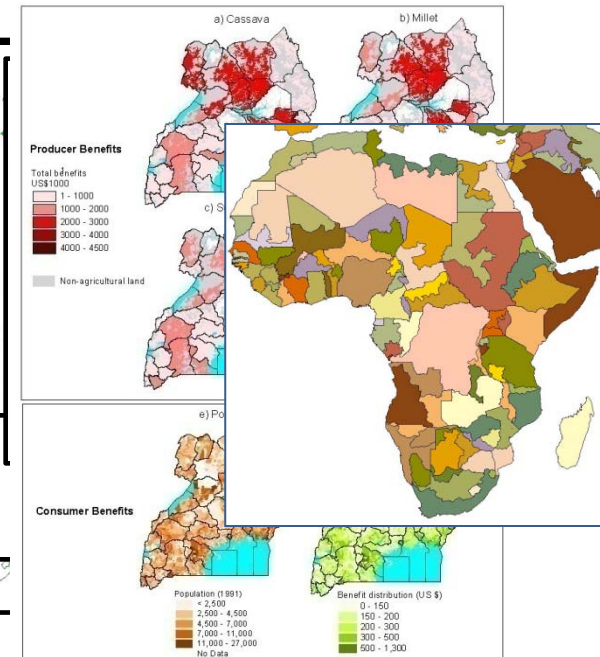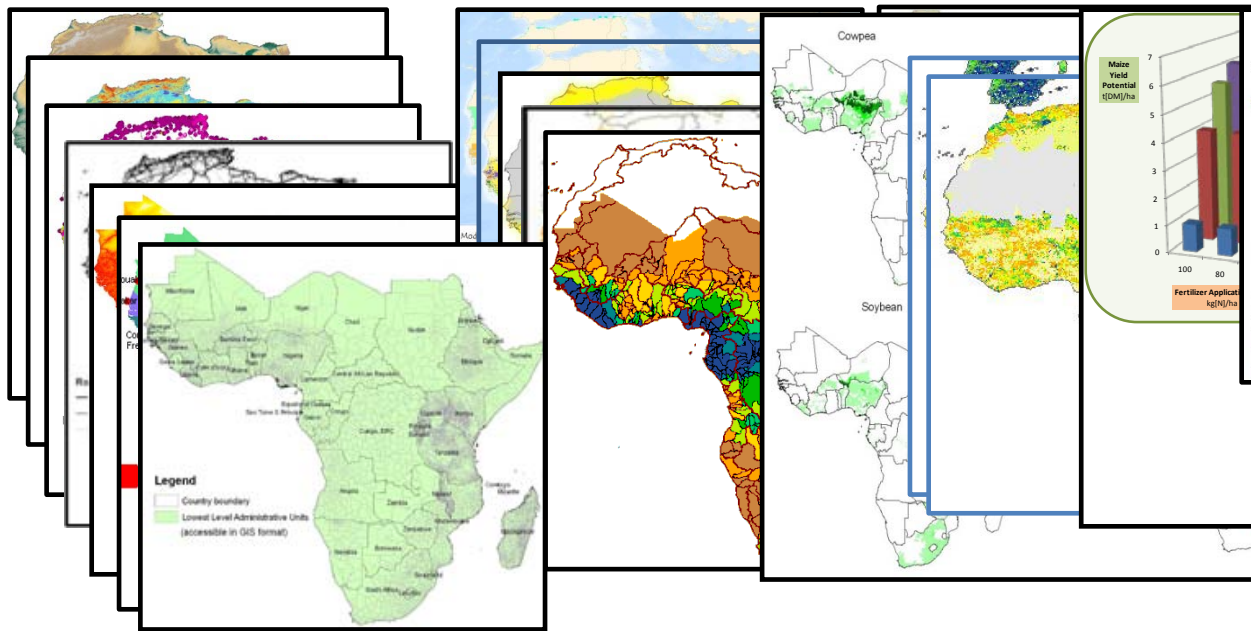
Administ

Aggregate to FPUs

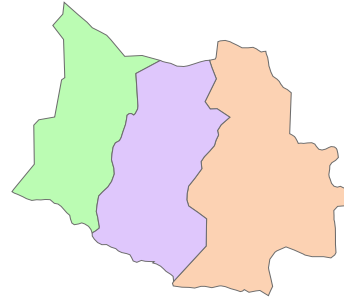**More analysis, interpretation, behavioral responses and outcomes**

Hierarchical Data and Analytical Frameworks

Fixed
Geographies of Analysis

Flexible
Geographies of Analysis

MACRO
Policy/Market Context & Impact
Macro-scale. Usually geo-political/
admin units (policies, institutions) as
the unifying concept and object of analysis.
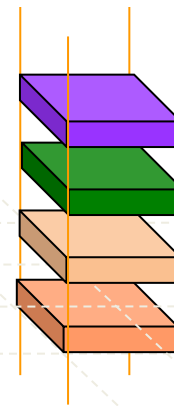Commodity focus

e.g., IMPACT/WATER,
GTAP & derivatives
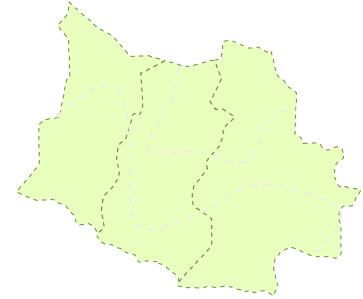
e.g., DREAM,
MM models

MESO
Production/Market Context & Impact
Meso-scale. Gridcells/pixels as units of analysis.
Natural/Human landscape patterns as unifying
concept and object of analysis. Systems focus.

Infrastructure/Market Access

Production Systems

Ecosystems & ES Services

Demographics/Human Welfare

MICRO
Household/ Community Characterization
Cross-country

HH Attributes	Urban/ Rural	Income/ Exp	Consumption Patterns	Production Systems Inputs, Tech Adoption	Market Participation

Data Theme: Resources

Climate:

- ✓ **Spatial/temporal downscaling** - CRU monthly (0.5deg) & NASA Power daily (1 deg) to derive **daily historic climate for crop models**
  http://labs.harvestchoice.org/2010/08/cru-mashup/

- ✓ **Spatio-temporal analysis** of patterns & trends in **climate constraints and risks**.
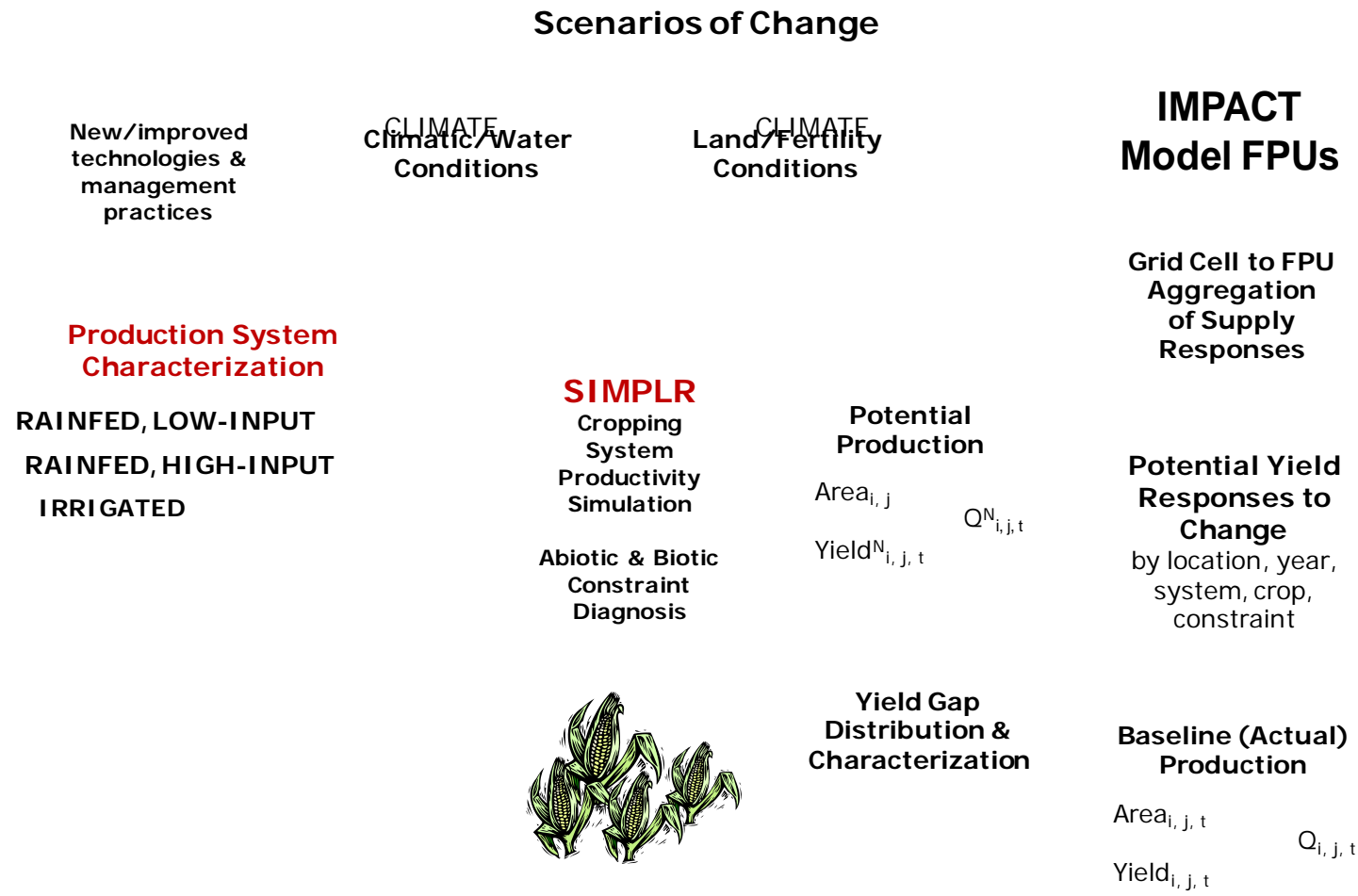
- ✓ **CCAFS Spatial downscaling** of **GCM outputs**

Data Theme: Resources

Soils:

✓ **Global:** Converting **WISE soil profile data** (ISRIC) into crop model input formats (DSSAT, APSIM). (With Columbia/EI, U. Georgia, ISRIC)

✓ **Global:** Update of **Fertility Capability Classification** (FCC) soil fertility indicators (Columbia/EI, based on Harmonized World Soil Database (HWSD – FAO, ISRIC, IIASA)
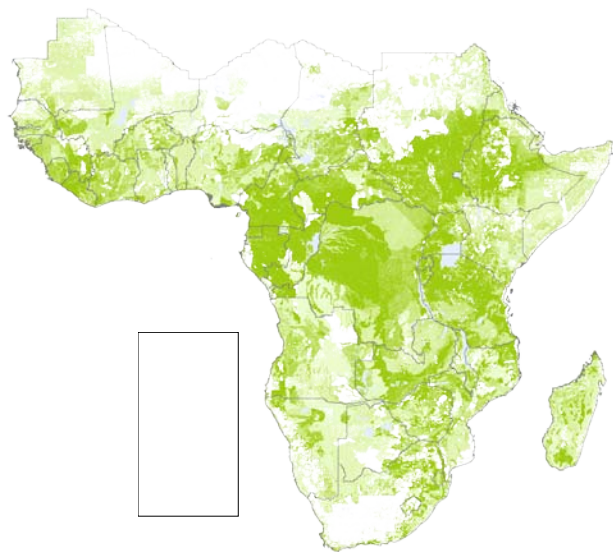
http://labs.harvestchoice.org/2010/12/updating-soil-functional-capacity-classification-system/

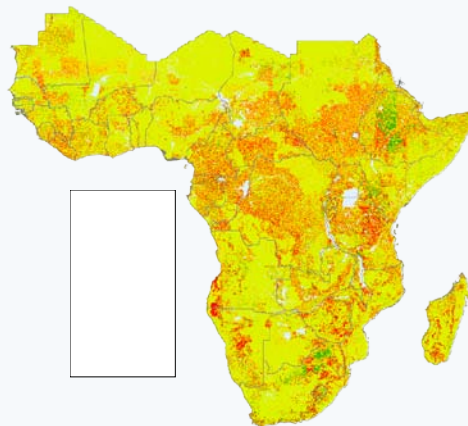# Data Theme: Management (Production System Characterization & Modeling)

Scenarios of Change

New/improved technologies & management practices	CLIMATE Climatic/Water Conditions	CLIMATE Land/Fertility Conditions	IMPACT Model FPUs

Production System Characterization

RAINFED, LOW-INPUT

RAINFED, HIGH-INPUT

IRRIGATED

SIMPLR
Cropping System Productivity Simulation

Abiotic & Biotic Constraint Diagnosis

Potential Production

$Area_{i,j}$

$Yield^N_{i,j,t}$

$Q^N_{i,j,t}$

Grid Cell to FPU Aggregation of Supply Responses

Potential Yield Responses to Change
by location, year, system, crop, constraint

Yield Gap Distribution & Characterization

Baseline (Actual) Production

$Area_{i,j,t}$

$Yield_{i,j,t}$

$Q_{i,j,t}$

SPAM (Baseline Patterns of Crop Distribution and Performance)

Climate Change Vulnerability

Scenario A2A (2050-2000) MAIZE
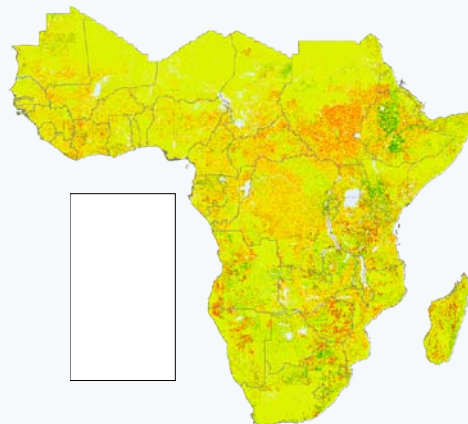
Scenario A2A (2050-2000) SORGHUM
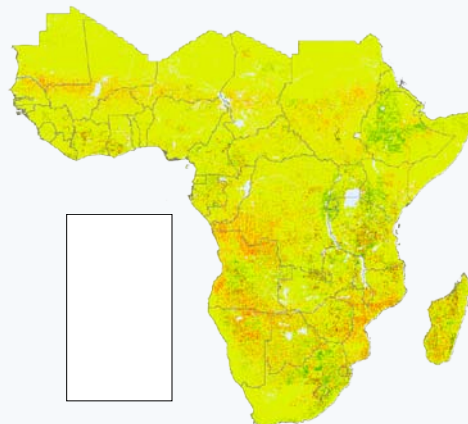
Scenario A2A (2050-2000) GROUNDNUT

Simulated maize yield potential (current climate)

Global Modeling of Potential Pest Prevalence (UMN)

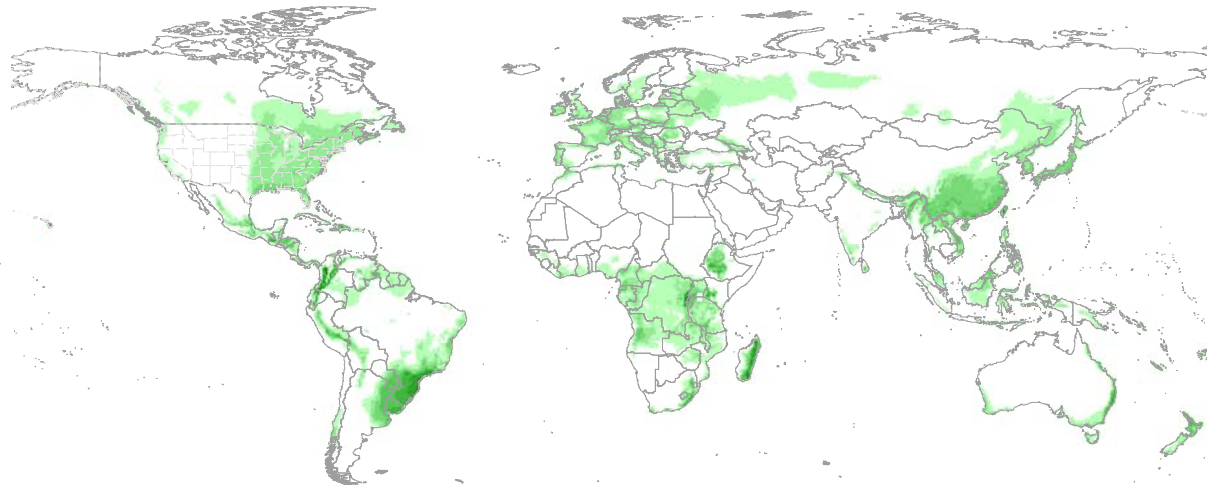*Magnaporthe grisea* (Wheat Blast)

Septoria tritici (Leaf Blotch)

Cochliobolus sativus (Spot Blotch)

Puccinia striiformis (Stripe Rust)

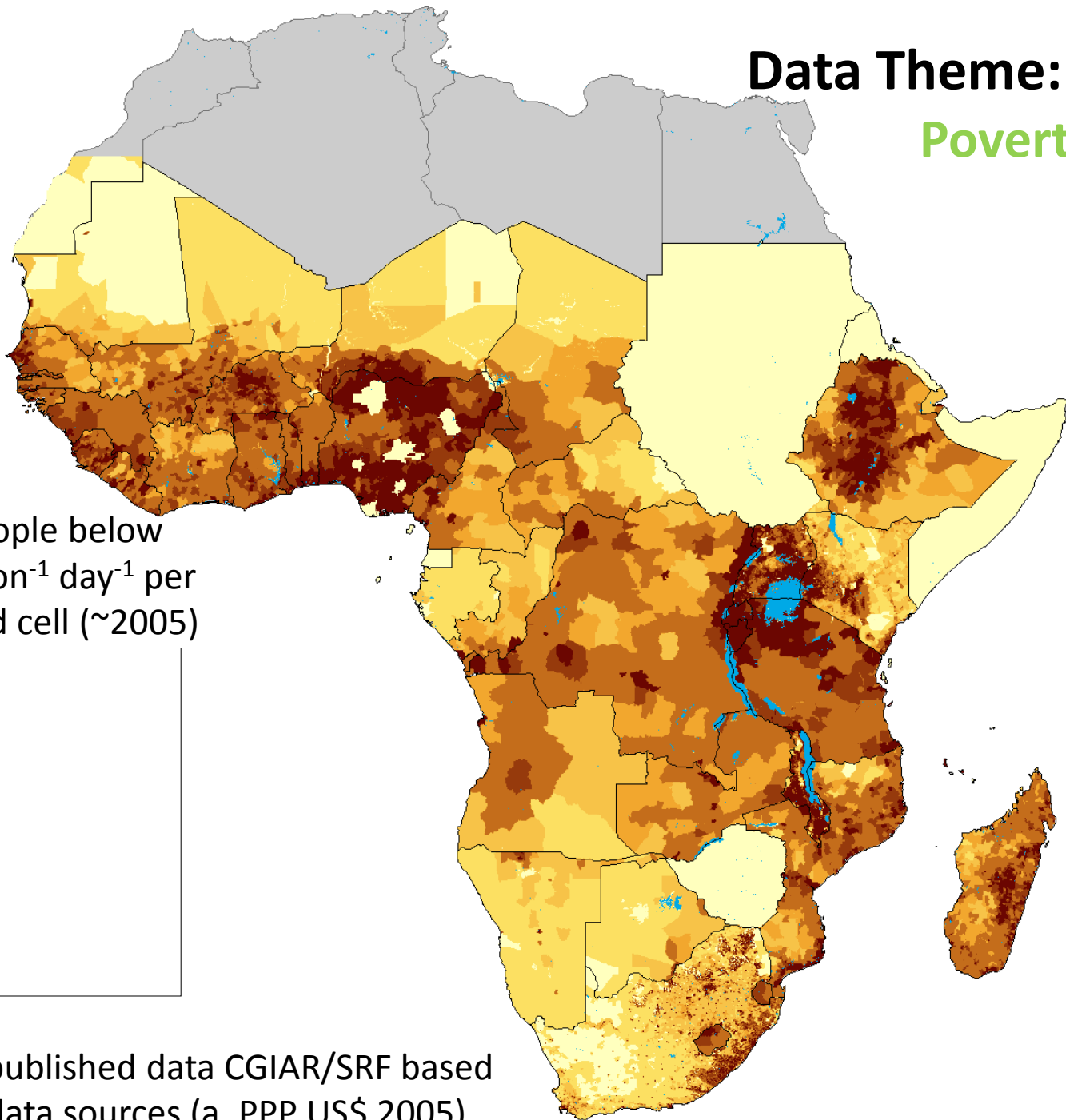*Puccinia triticina* (Leaf Rust)

Puccinia graminis (Stem Rust)

Data Theme: Welfare
Poverty

No. of people below
1.25^a person^{-1} day^{-1} per
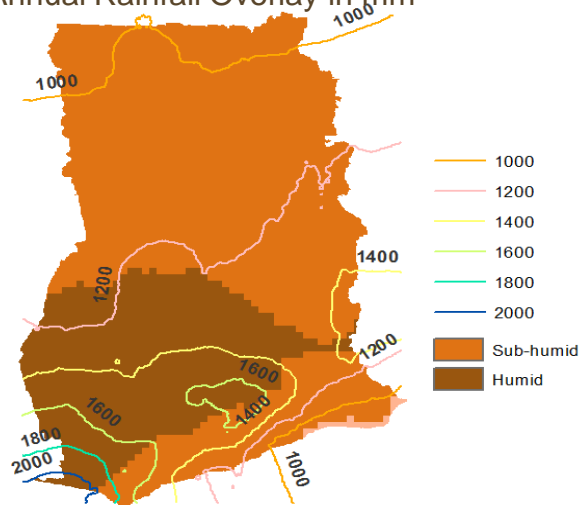100 km^2 grid cell (~2005)

Source: Unpublished data CGIAR/SRF based
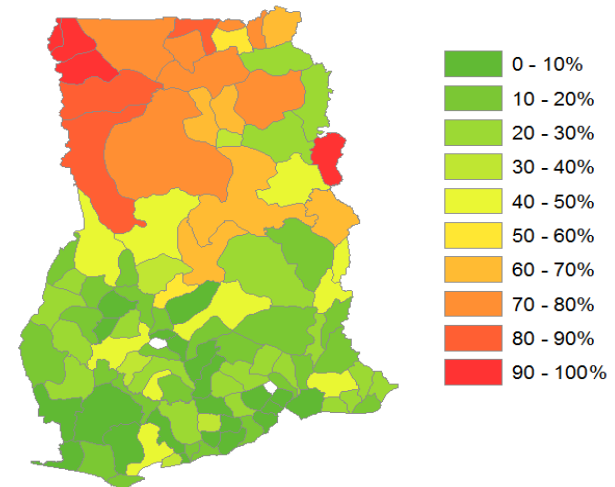on various data sources (a. PPP US$ 2005)

Poverty prevalence is higher in more marginal environments

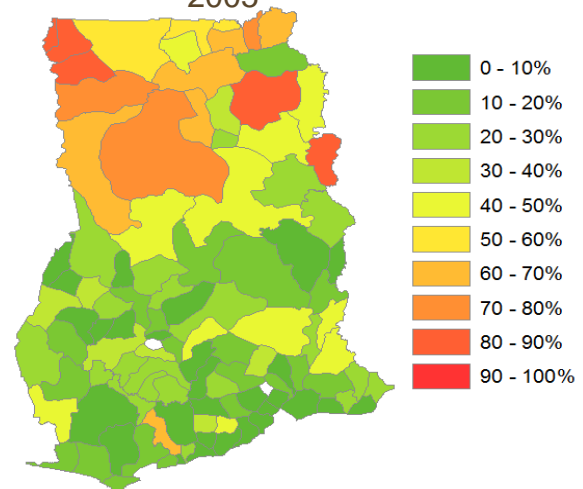Agro-Ecological Zones with Annual Rainfall Overlay in mm
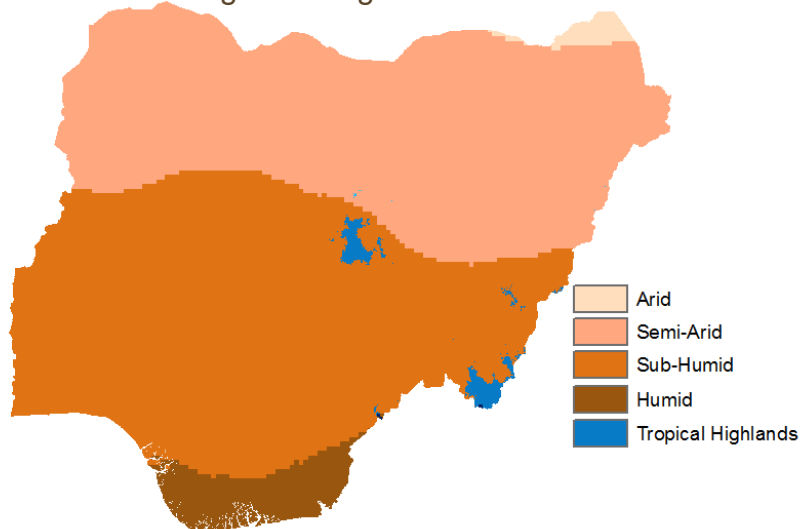

Rural Poverty Prevalence 2005
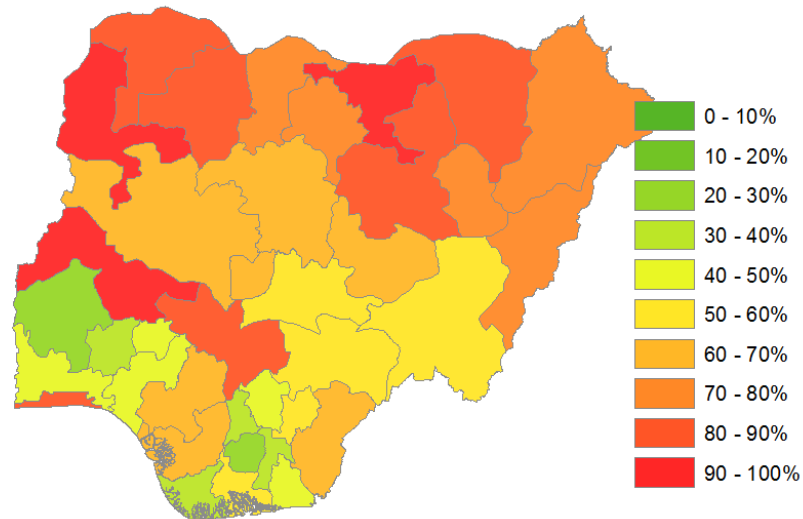

Ghana Districts
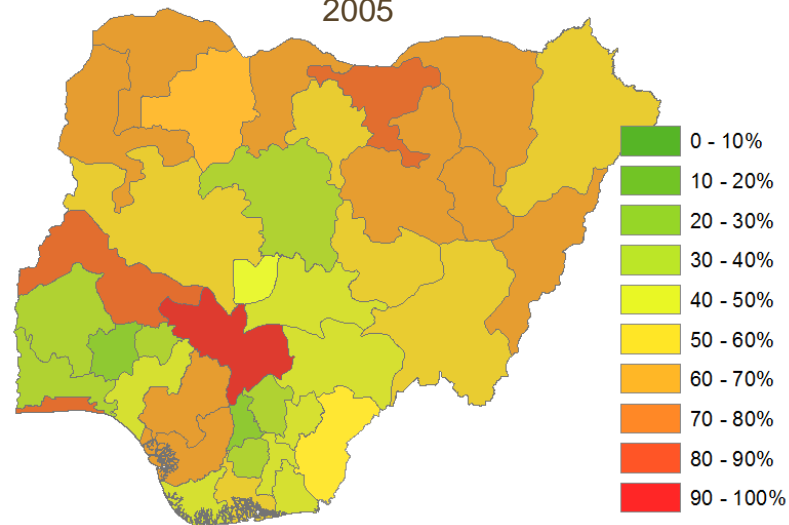

Ultra – Poor Share of Rural Poor 2005

Poverty line set at $1.25 /person/day, Ultra-Poor is < $.75 /person/day (2005 PPP US$).
Calculated from Ghana Living Standards Survey 2005 (GLSS5) and World Bank Povcalnet
(HarvestChoice 2010)

Agro-Ecological Zones

Legend:
- Arid
- Semi-Arid
- Sub-Humid
- Humid
- Tropical Highlands

Rural Poverty Prevalence 2005

Legend:
- 0 - 10%
- 10 - 20%
- 20 - 30%
- 30 - 40%
- 40 - 50%
- 50 - 60%
- 60 - 70%
- 70 - 80%
- 80 - 90%
- 90 - 100%

Nigeria States

Sokoto, Katsina, Jigawa, Yobe, Borno, Kebbi, Zanfara, Kano, Water body, Kaduna, Bauchi, Gombe, Niger, Plateau, Adamawa, Kwara, FCT, Nassarawa, Taraba, Oyo, Ekiti, Kogi, Benue, Osun, Ondo, Ogun, Edo, Enugu, Ebonyi, Lagos, Anambra, Cross-Rivers, Delta, Imo, Abia, Rivers, Akwa Ibom, Bayelsa

Ultra – Poor Share of Rural Poor 2005

Legend:
- 0 - 10%
- 10 - 20%
- 20 - 30%
- 30 - 40%
- 40 - 50%
- 50 - 60%
- 60 - 70%
- 70 - 80%
- 80 - 90%
- 90 - 100%

Poverty line set at $1.25 /person/day, Ultra-Poor is < $.75 /person/day (2005 PPP US$).
Calculated from Ghana Living Standards Survey 2005 (GLSS5) and World Bank Povcalnet
(HarvestChoice 2010)

Data Theme: Market Access
Portsheds/Trade Corridors

http://labs.harvestchoice.org/2010/08/port-sheds/
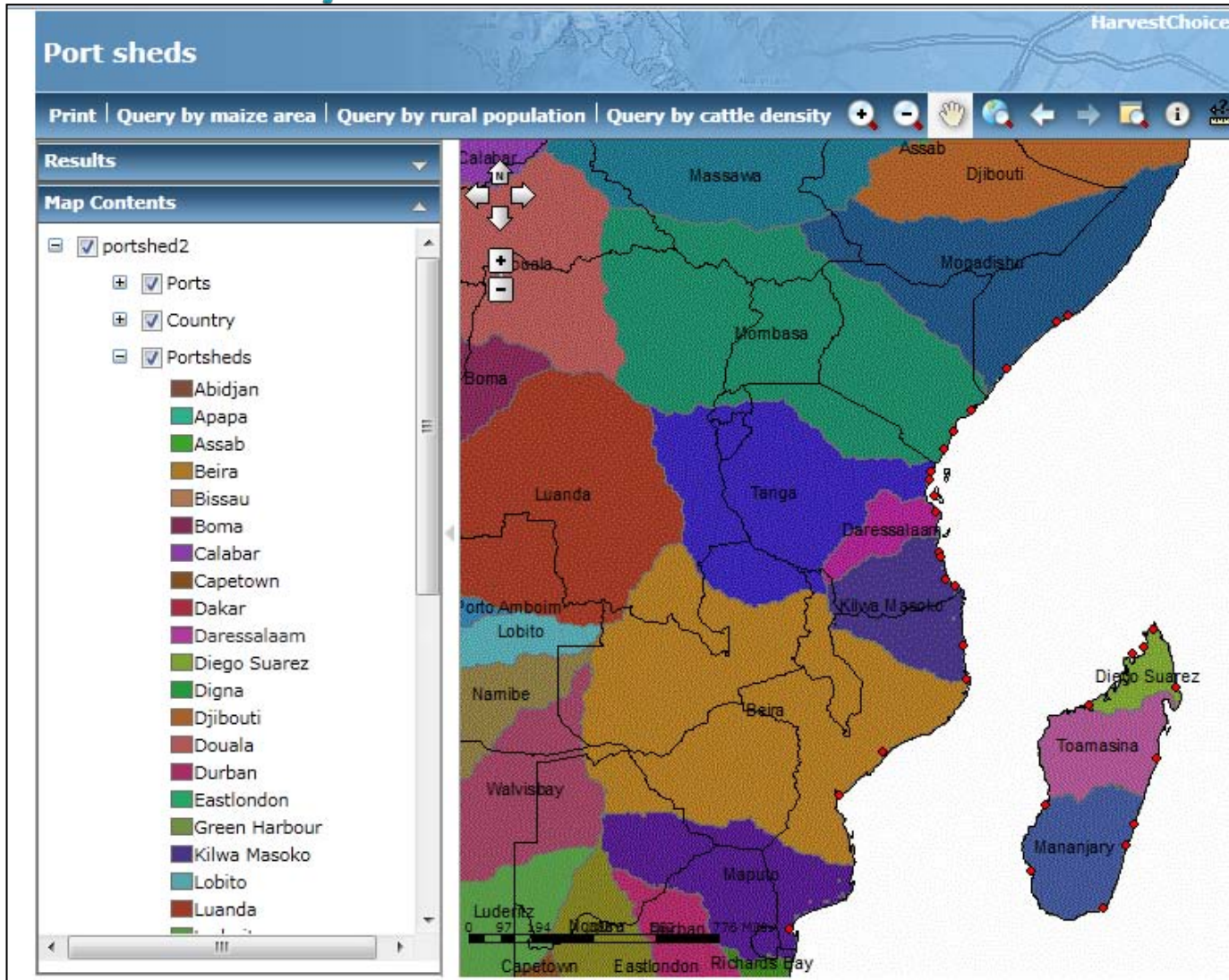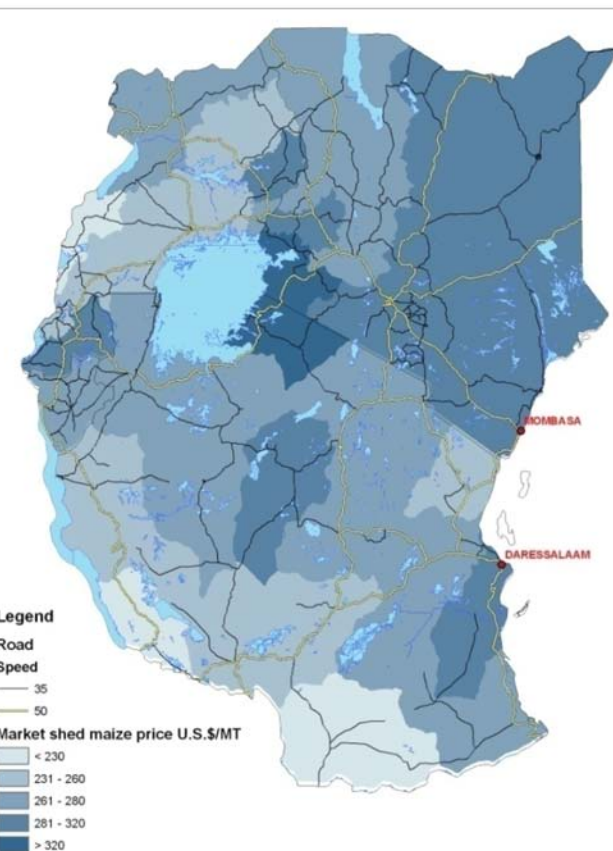
Data Theme: Market Access/Prices
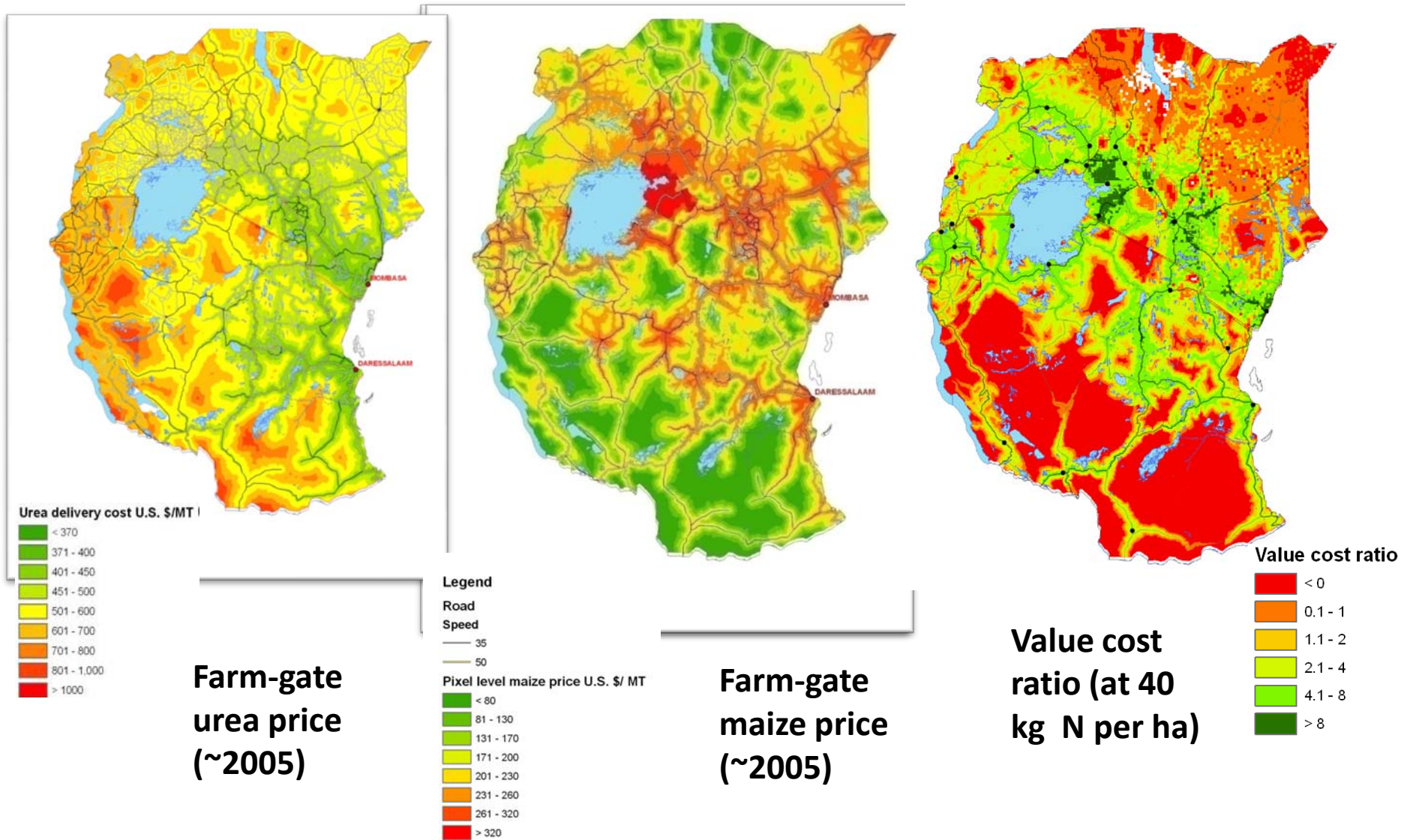## Maize Markets and Market Prices
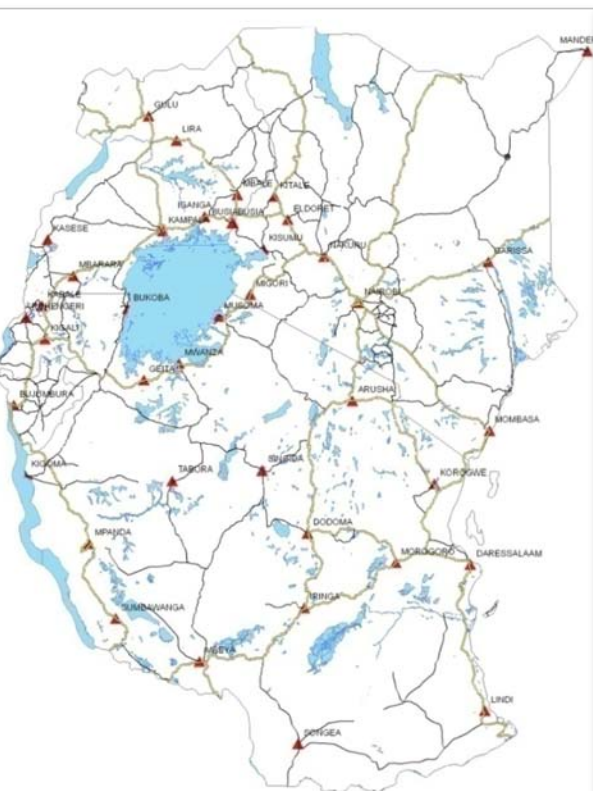
40 towns & cities reporting maize prices
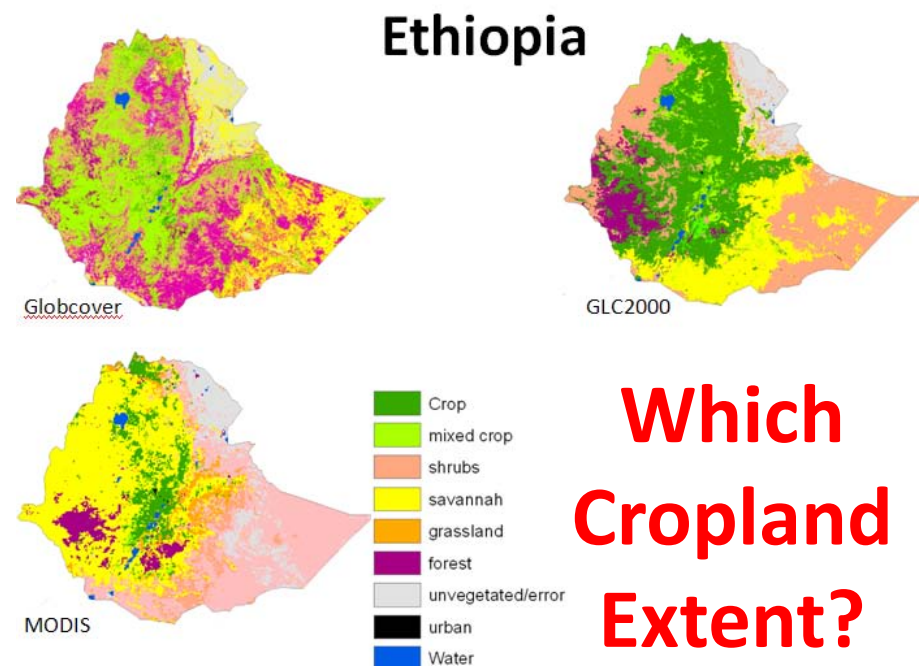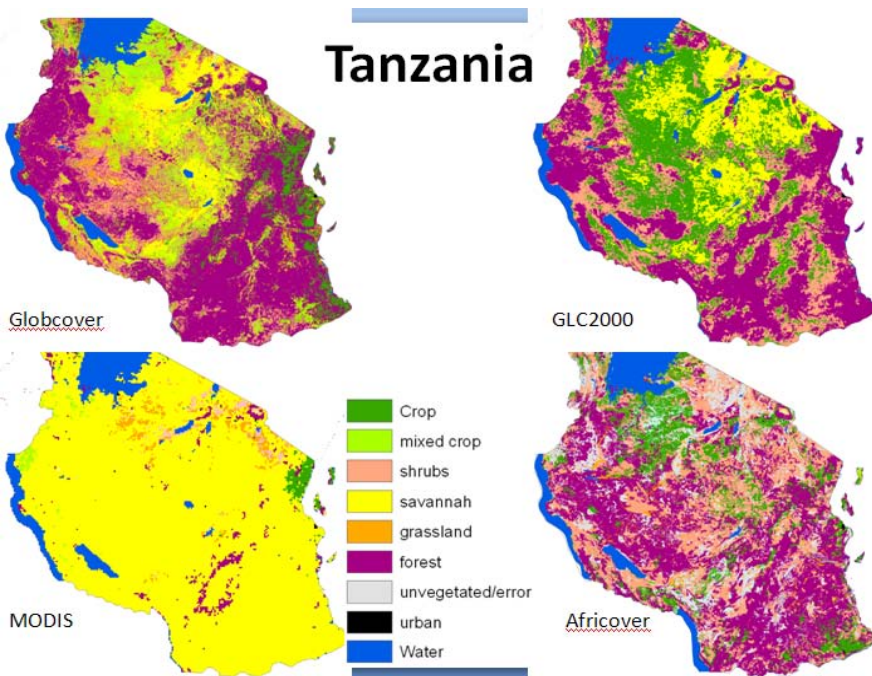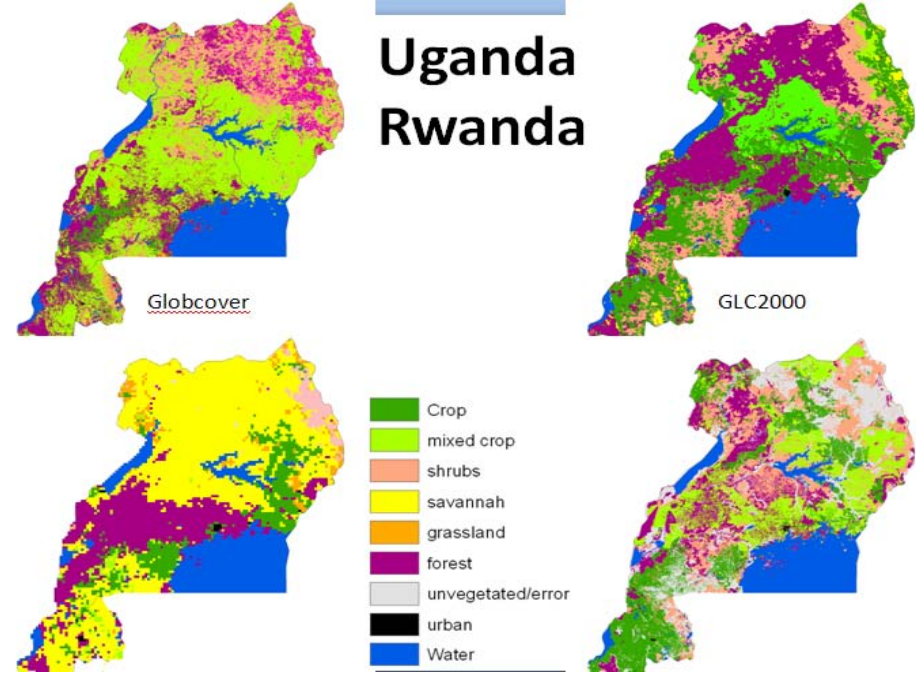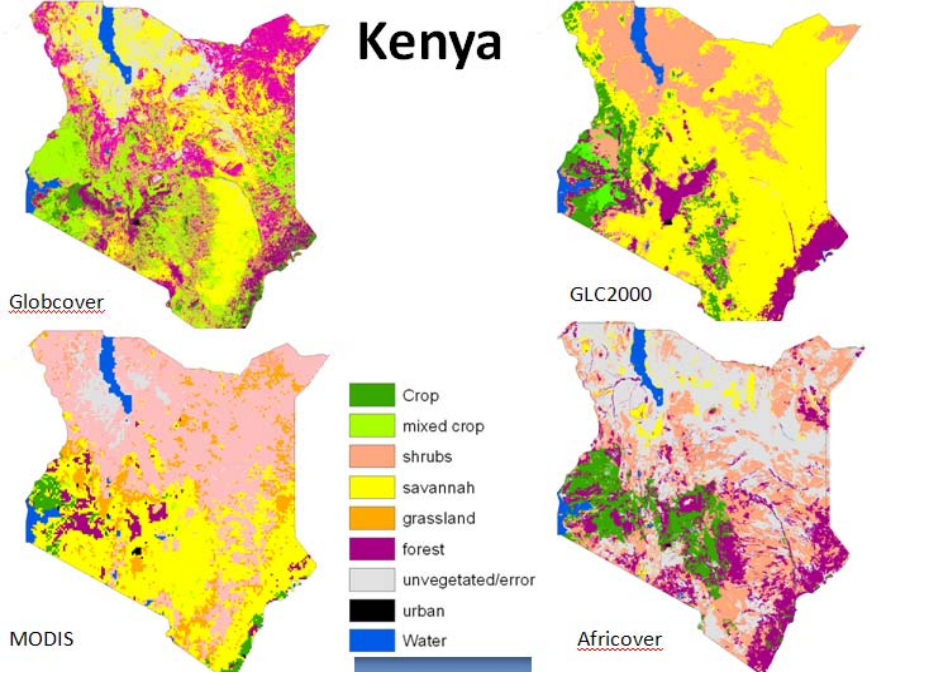
40 maize "marketsheds"

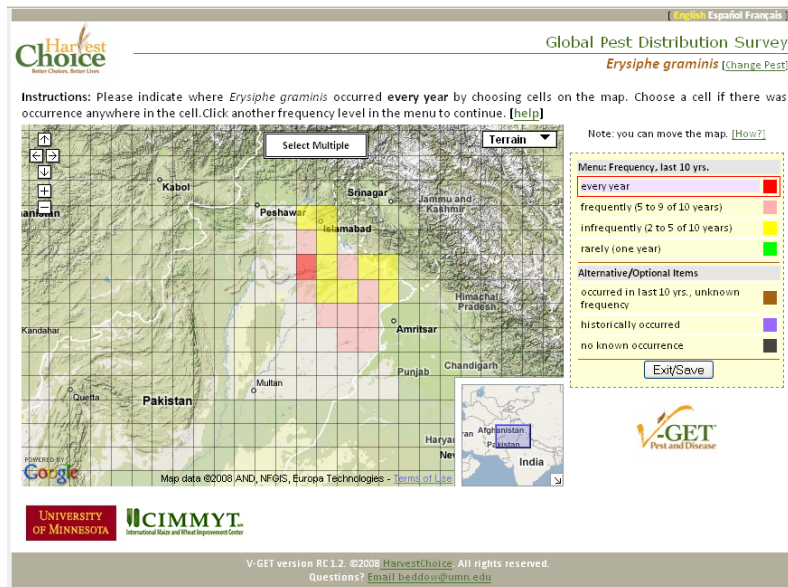**2005 av. maize prices in each marketshed**

Data Theme: Market Access/Prices
Input Use Profitability: Spatial Policy Analysis

Urea delivery cost U.S. $/MT
- < 370
- 371 - 400
- 401 - 450
- 451 - 500
- 501 - 600
- 601 - 700
- 701 - 800
- 801 - 1,000
- > 1000

Farm-gate urea price (~2005)

Legend
Road Speed
- —— 35
- —— 50

Pixel level maize price U.S. $/ MT
- < 80
- 81 - 130
- 131 - 170
- 171 - 200
- 201 - 230
- 231 - 260
- 261 - 320
- > 320

Farm-gate maize price (~2005)

Value cost ratio (at 40 kg N per ha)

Value cost ratio
- < 0
- 0.1 - 1
- 1.1 - 2
- 2.1 - 4
- 4.1 - 8
- > 8

Kenya

Globcover — GLC2000 — MODIS — Africover

Uganda Rwanda

Globcover — GLC2000

Legend:
- Crop
- mixed crop
- shrubs
- savannah
- grassland
- forest
- unvegetated/error
- urban
- Water

Tanzania

Globcover — GLC2000 — MODIS — Africover

Ethiopia

Globcover — GLC2000 — MODIS

Which Cropland Extent?
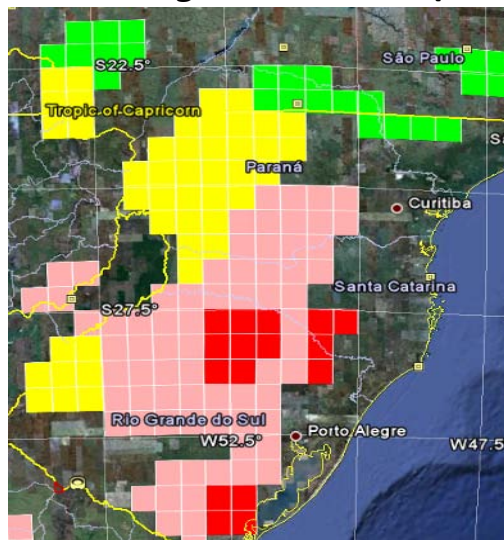
Validation: Web Enabled Survey Tool – V-GET ™

A web enabled, interactive survey tool which automatically geo-codes respondent information on pest occurrence.
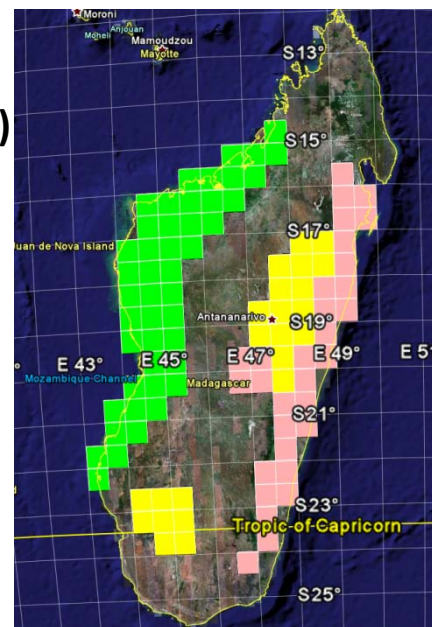
Magnaporthe oryzae (rice blast)

Fusarium graminearum (scab)

Puccinia striiformis (stripe rust)

Survey Distribution Partners: CIMMYT, CIAT, USDA, IRRI, UMN, Syngenta (more to come)

GEOSHARE: Concluding Observations

- Importance of analytical framework for focusing/ prioritizing data efforts

- Role in data advocacy & maintaining a prioritized data investment agenda

- Acknowledge and account for multiplicity of data sources, sets & methods (new taxonomies?)

- Role in documenting and adopting best practices & in routine inter-comparison of data products

- Leadership role in applying best practices for communicating data reliability and utilization criteria (e.g., user guidance on fitness for specific purposes for specific datasets)