ISABELA – Imagery for Smallholders: Activating Business Enterprises, Leveraging Agriculture

STARS – Spurring a Transformation for Agriculture through Remote Sensing

District and village authorities and producers in Kofa (Bebeji, Kano, Nigeria) Sukumba (Koutiala, Sikasso, Mali)
How can remote sensing data be used most effectively in smallholder and commercial farming?

P.C.S. Traore et al.

But first: **why** could remote sensing help achieve agricultural intensification targets? (sub-Saharan Africa, and beyond)

<table>
<thead>
<tr>
<th>Fertilizer use:</th>
<th>Cultivated land:</th>
<th>Demand growth:</th>
<th>Mutations: land, credit, inputs</th>
<th>Heterogeneity: unequalled</th>
<th>Yield gaps: enormous</th>
<th>Info. technology: nimbler cheaper</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 kg/ha</td>
<td>20% of arable</td>
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Yesterday
Sukumba, Mali, 2014
50-70 cm pan time series
multispectral (4-8 bands)
$0.25/ha

Today
30 cm pan time series
superspectral (29 bands)
$0.23/ha (ms: $0.15/ha)

Tomorrow?
20 cm pan time series
hyperspectral (50+ bands)
$0.17/ha
Never before have coordinated ground-air-space data been generated at such spatial, temporal densities.

Mali example (2014) - plant growth

Variables measured

- Biweekly:
  - light interception / LAI
  - f-cover
  - plant height
  - chlorophyll content
  - BBCH devpt. stage

- End-of-season:
  - FW, DW for veg. & repr.

ground measurements

- 48 fields over 30km²
- 5/6 fertility plots
- 5 quadrats
- 5 plants
- 3 variables
- 3 visits
- 59,400 records
Then: **what** can remote sensing tell us about small holder crops response to environment, management?

**Landscape scale (inter-field variability)**

- Fertilization and genotype effects dwarfed by other management factors
- **Equifinality problems** ensue in attributing crop response to particular practices
- VHR imagery akin to mechanistic models in data-scarce environments ("GIGO")
- Mobile sensor networks more efficient at capturing particular management data

**Parcel scale (intra-field variability)**

- Yield positively correlates with **light interception** (leaf area index)
- Yield negatively correlates with **canopy heterogeneity**
- Diverging views on heterogeneity management substantiate opportunity for participatory **precision agriculture**
- Source: SenseFly eBee data mosaics, Sukumba (Mali), 2014
- ([www.stars-project.org](http://www.stars-project.org))
RS of smallholder crop response to fertilization at scale is thus possible if and only if stratified at a landscape level (across household endowment and soil fertility classes).

**intra-field variability: lowlands - midslope - plateau** (sorghum example)
So: **how** can remote sensing data be used most effectively in smallholder and commercial farming?

Example: soil fertility management

- Environment: soils (WHC, fertility, ...)
- Management: labor, equipment, agronomy (sow, weed, ...)
- Biophysical typologies
- Hybrid stratification
- Socio-economic typologies
- farmer practices
- soil samples

Input supplier

R&D team

Beycat™ franchisees

Sentinel1-2-3 Worldview2-3

raw observation data

raw imagery

calibrated knowledge content

\[ \delta y = f(E, M) \]

[Example: soil fertility management]

Imaging technologies

farmer feedback loops

‘Next-gen’ advisory services

So: **how** can remote sensing data be used most effectively in smallholder and commercial farming?
From a business / sustainability perspective, what did we learn from STARS in West Africa?

ISABELA results were sufficiently compelling to trigger a **unique space for public-private joint-ventures** now ‘reverse-engineering’ the STARS project from the demand side.

**ISABELA Value Proposition 1:** provide a sustainable, subscription-based rural land tenure information service supported by very high-resolution satellite imagery.

**ISABELA Value Proposition 2:** develop digital libraries and algorithms for smallholder crop recognition at scale.