
AIARD Conference, Hilton Garden Inn, Washington, D.C.  
5th June, 2018.

J. Adewopo, I. Mohammed, A. Kamara, P. Craufurd, B. Vanlauwe | Associate Scientist
### Frequency of consumption of Staple Food Crops at the National level.

<table>
<thead>
<tr>
<th>Staple Food Crops</th>
<th>Overall Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>20.1</td>
</tr>
<tr>
<td>Cassava</td>
<td>16.5</td>
</tr>
<tr>
<td>Rice</td>
<td>14.9</td>
</tr>
<tr>
<td>Cowpea grain</td>
<td>11.8</td>
</tr>
<tr>
<td>Groundnut</td>
<td>11.1</td>
</tr>
<tr>
<td>Yam</td>
<td>10.4</td>
</tr>
<tr>
<td>Sorghum</td>
<td>6.6</td>
</tr>
<tr>
<td>Plantain</td>
<td>5.9</td>
</tr>
<tr>
<td>Soybean</td>
<td>2.6</td>
</tr>
</tbody>
</table>

*Source: IITA Nigeria Food Consumption and Nutrition Survey, 2003*
Old Problem – The Challenge

US Maize Yield vs. Sub-Saharan African Maize Yields

- **United States**: USDA NASS (2016) 10.3 t/ha
- **Côte d’Ivoire**: USDA PS&D (2016) 0.71 t/ha
- **Ethiopia**: USDA PS&D (2016) 0.96 t/ha
- **Kenya**: USDA PS&D (2016) 1.09 t/ha
- **Nigeria**: USDA PS&D (2016) 0.91 t/ha
- **South Africa**: USDA PS&D (2016) 4.06 t/ha
- **Tanzania**: USDA PS&D (2016) 1.38 t/ha
- **Uganda**: USDA PS&D (2016) 3.43 t/ha

Data: USDA PS&D, USDA NASS, Gro Intelligence

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What does Agronomy at Scale Involve?

“agronomy” = “the science of soil management and crop production”

“at scale” = “at the required spatial extent and granularity to solve the problem”

What would this transformed landscape look like?

- Weak/No integration of spatial data
- Limited reach & Monitoring systems (adoption/yields)
- Limited Tech Availability

Developing solutions that contribute to the shift

- Extensive integration of spatial data
- Reaching millions & efficient monitoring systems (adoption, yields)
- Developing, Adapting, and Deploying Techs

How to move towards this vision
How far to move?
Who to engage?
Old Problem – The Challenge

1. No georeferencing of reported yield locations
2. Full reliance on unvalidated/unverified farmer reported yield data
3. Unknown/inaccurate area of farmlands surveyed

Collaborative Workshop on Crop Yield Estimation in Nigeria: Advancing Methods through Partnership

NAERLS- TAMASA -BUK-NASRDA

Date: Thursday 19th April 2018
Venue: Training Hall, NAERLS-ABU, Zaria
Advancing Maize-based Systems

Old Problem – The Challenge
Old Problem – The Intervention

- Develop and promote innovative tools/methods for assessing and optimizing yield in smallholder maize-based systems.

Target Countries for Maize-based system Agronomy Intervention

**BMGF ($12 Million)**

Taking Maize Agronomy to Scale in Africa (TAMASA)

www.tamasa.cimmyt.org
Old Problem – The Goal

Potential Yield

- Develop and promote innovative tools/methods for optimizing and assessing yield in smallholder maize-based systems.

Yield Gap (>50%*)

- Non- (or minimally - ) invasive

Realized Yield

- Scalable (Space & Time)

- Spatially explicit
#1. Can farmers’ reported yield be trusted for national yield estimation?

![Image of farmers in a field]

**New Possibilities – Smartphones**

**Farmers’ Managed Field - FMF**

[Diagram showing the integration of smartphones and farmers managed fields]

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www.iita.org
#1. Can farmers’ reported yield be trusted for national yield estimation?

**Grain Yield (t.ha⁻¹)**

- **BK** – Bunkure
- **DG** – Doguwa
- **FT** – Funtua
- **IK** – Ikara
- **SB** – Soba

**Box Plots**

- **Farmer Reported**
- **Field Estimated**

**Scatter Plot**

- **R² = 0.1 (weak)**

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**New Possibilities – Smartphones**

- **New Possibilities**
  - Smartphones
#2. How can we rapidly and accurately assess smallholder farm area?

**Drone:** Sensefly eBee-1 UAV (Fixed Wing)
**Sensor:** Multi-spectral 4C Camera Sensor + RGB
**Mission Planning:** e-Motion and ArcGIS
#2. How can we rapidly and accurately assess smallholder farm area?

### Summary Statistics (ha)

- **Mean**: 0.329744
- **Median**: 0.239938
- **Mode**: 0.279963
- **Range**: 1.860254
- **Minimum**: 0.042927
- **Maximum**: 1.903182

### Freq

- Farm Area (ha)
  - 0: 60
  - 0.5: 40
  - 1: 20
  - 1.5: 2
  - 2: 0

### Bunkure, Kano
#3. Can yield-targeting technologies be reliably tested at fewer locations?
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- **Stepwise stratified spatial sampling**
  
  - Determine relevant variables
  - Assess gridded data on variables and subset by AOI mask
  - Generate random $k$-points as clusters within $j$-quadrats (10 x 10 km)
  - Reclassify into strata ($m$-classes)
  - New layer from non-weighted compositing of variables
  - Conduct stratified-random sampling of $n$-points from $k$-points and based on $m$-classes
  - Calculate sample size per strata ($n$-points) based on relative proportion of each $m$-class
  - Final selected point locations for trials
  
  $n = 3000$ (1321 Consented)
  
  $n = 449$
  
  $n = 30$
#3. Can yield-targeting technologies be reliably tested at fewer locations?
#3. Can yield-targeting technologies be reliably tested at fewer locations?

- Optimizing sample size for nutrient response trials

- Similar understanding of nutrient response with fewer sampling locations!
#4. Can we assess yield variability with remotely-sensed agronomic variables?

- **Trimble GreenSeeker (NDVI)**

\[
\text{NDVI} = \frac{\rho_{NIR} - \rho_{Red}}{\rho_{NIR} + \rho_{Red}}
\]
• Rapid assessment of yield variability

- UAV-derived in NOT plots
- Greenseeker-measured in NOT plots

- UAV-borne and Proximal Sensors can be used to estimate yield estimation in controlled conditions
**Conclusion – Framework**

**Designated Sentinel Sites**
- Multicriteria selection
- Stakeholders co-managed
- [Bi-] Annual Crop Cuts
- ICT Tools and Techs (Pilot, Deploy)

**Integrate Data from Existing Regional or Country-wide Projects**
- Curate and Adapt SOPs
- Synthesize Data
- Adopt proven techs

**Ground-operations Domain**

**Database/Repository**

**Remote Sensing Analytics**
- Imagery Analytics
- Cropland Mapping Analytics
- Yield Prediction Analytics
- Uncertainty Assessment

**Governments /Institutions**

**Research**

**Markets**
Thank you.

Julius B. Adewopo | j.adewopo@cgiar.org

TAMASA
Taking Maize Agronomy to Scale in Africa