Mapping Crop Types and Cropping Systems in Nigeria with Sentinel-2 Imagery

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59
fields
93
fields
50 m

Background - Population and Food Security

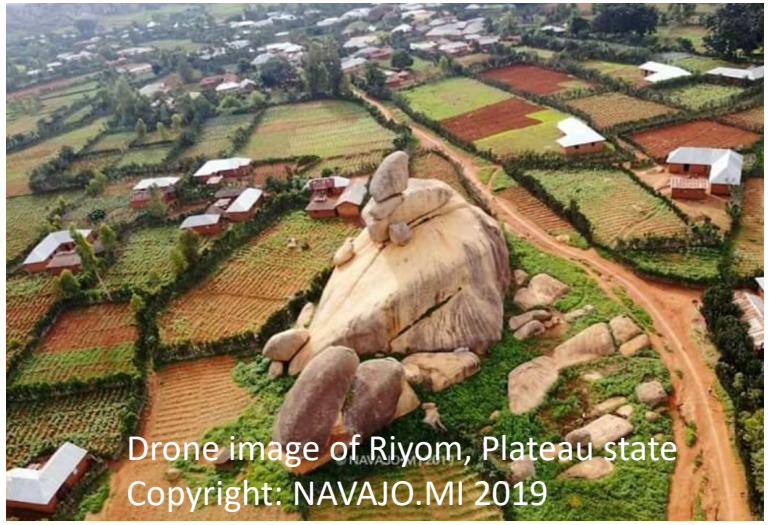
- Smallholder - 1/3 of the world's food production
- Nigeria's - over 200 mil people
- 79.5 mil farmers - smallholder and poor
- Maize - 2nd largest producer in Africa (FAO 2020)
- Potato - 4th largest producer in Africa (FAO 2020)

2050

www.geoba.se/population

No crop maps - why?

Small farm sizes



Drone image of Riyom, Plateau state
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Intercropping

Trees in farms

Lacking reference data, why?

i. Free data policies (Landsat, **Sentinel**,etc)
ii. Data storage capabilities
iii. Advance machine learning capabilities
iv. Computational tools (e.g. **FORCE**, GEE)

Research gap

Previous studies – **Sentinel 2** – crop types mapping –complex systems in Africa – often focused on;

- focused on **yield estimates** (Burke and Lobel 2017; Jin et al. 2019) — Crop types mapping
- on **indices** and regression models (Jin et al. 2017;Karlson et al 2020) — Spectral bands
- combine **satellite data** (Kpienbaareh et al. 2021; Prins et al. 2021) — Sentinel 2
- tested for **small** areas (Lambert et al 2018; Rustowicz et al 2020) — Regional scale
- monocropping or **sole crops** (Abubakar et al. 2020; Mazarire et al. 2020) — **Intercropping**

Our study

Research Aim

…to create a workflow for isolating **phenological features** and mapping the most relevant crops in the complex agricultural setting of Nigeria using **S2 spectral bands**

1) Map **maize**, **potato**, and **mixed cropping** systems using all available S2 data

2) Assess crop types distributed across gradients of **field sizes**

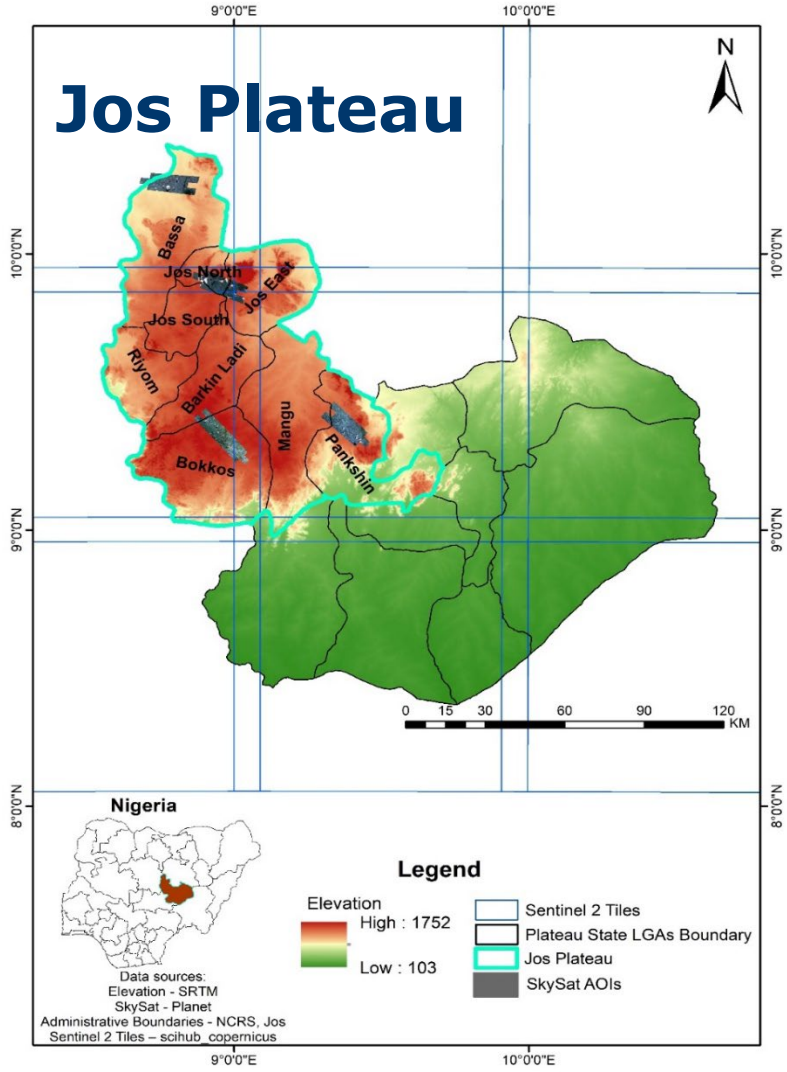
Study Area- Data

- Average temperature: 22°C
- Average annual rainfall: 1,317mm
- Produces 85% potato in Nigeria
- 4th largest maize producer in Nigeria
- Very heterogeneous terrain

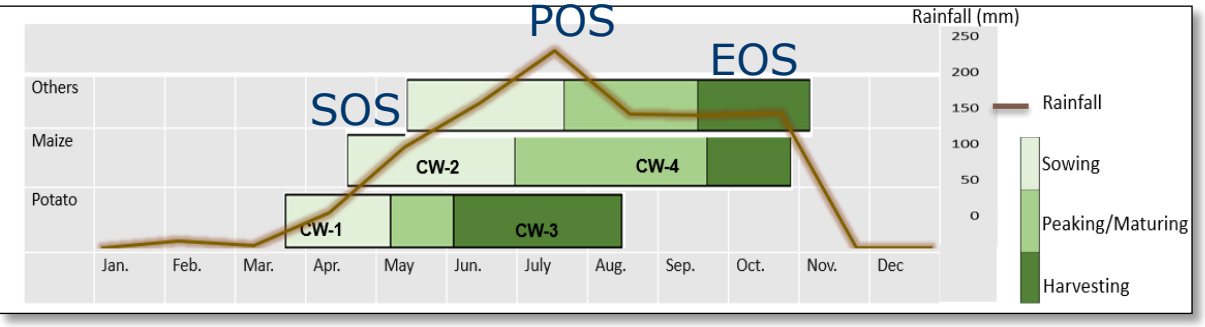

Natural savanna vegetation


Mountainous terrain

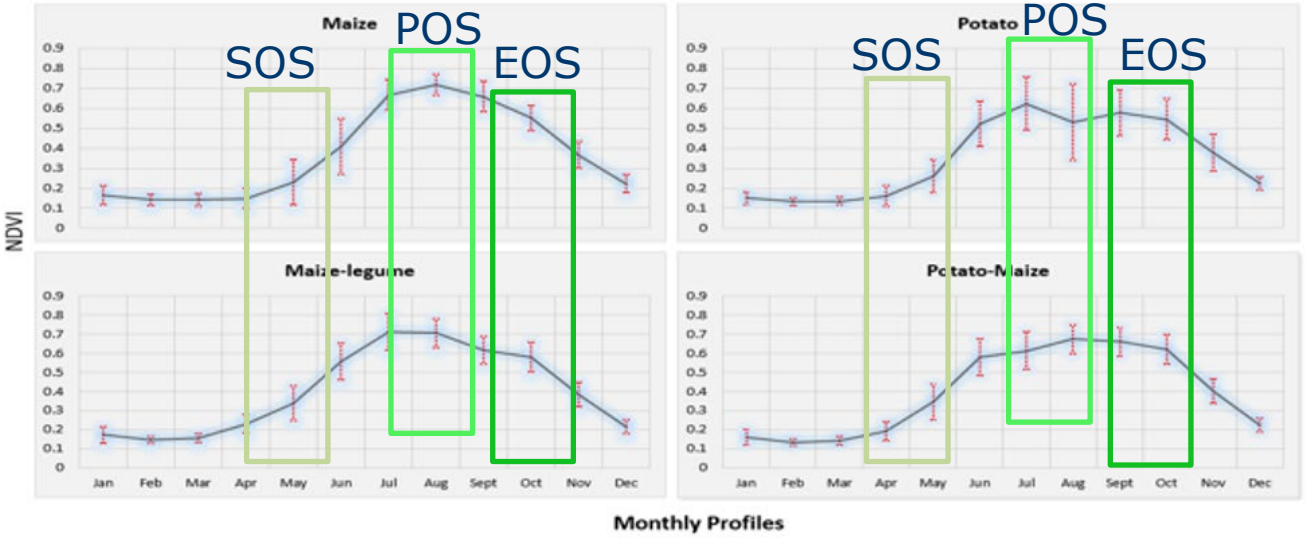

Mining devastations



Cropping Calander



Phenology



Narrow critical windows (Griffiths et al,2019)

Spectral Temporal Metrics **(STMs)**

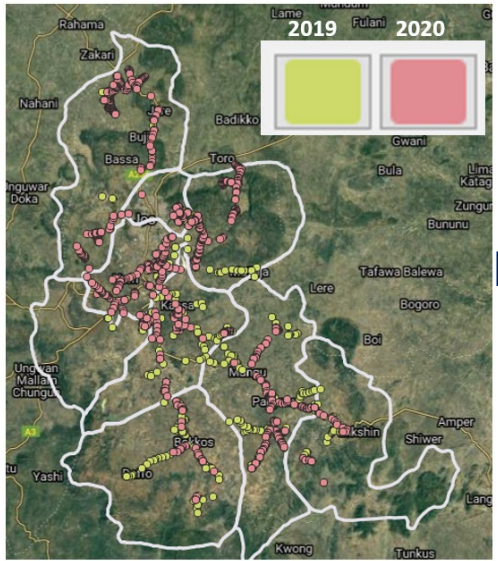
Critical Windows (**CW**)

CW-1 = sowing **potatoes**

CW-2 =**maize** sown and **potato** canopy has reached full cover

CW-3 = harvesting **potato**, **legumes** are introduced and **maize** is at maximum biomass

CW-4 = **maize** is at senescence and l**egumes** are maturing



Field data

Methodology

Processes
Results
Data

Data Preparation and Pre-processing

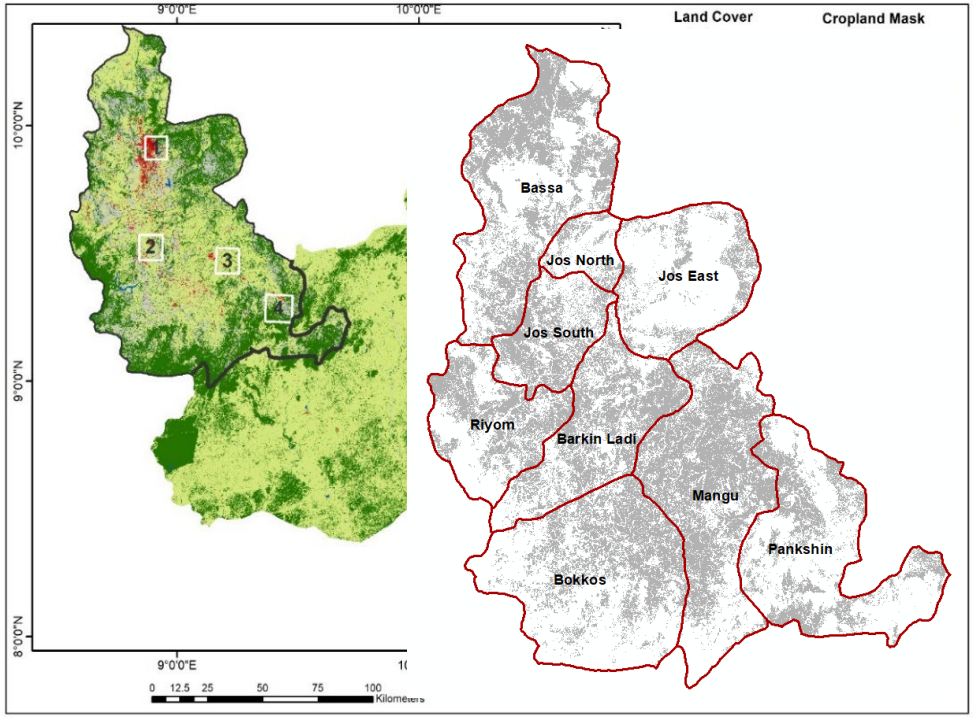
11 **Sentinel 2 STMs** (770 image features) **+ DEM**

Landcover mapping → Cropland mask → **Crop Type Mapping** → **Field Level Analysis**

Sentinel 2

SkySat

SRTM



Validations

Results

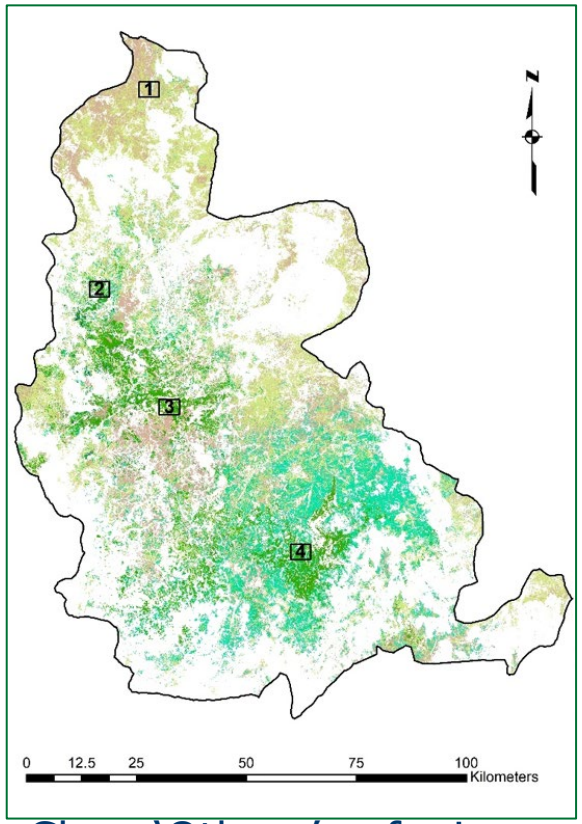
Landcover
Cropland
Crop type
Field sizes

Results – Crop Type Map

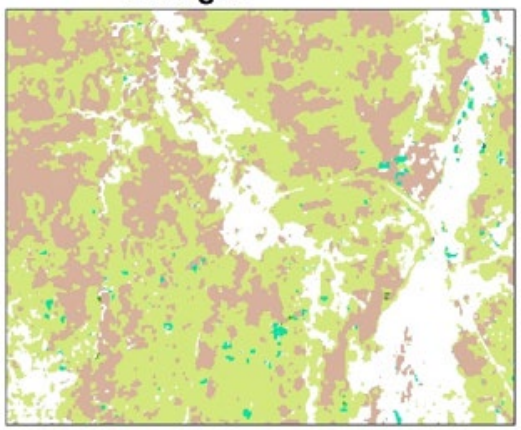
Maize	51.2%
Potato	1%
Potato-Maize	17.5%
Maize-Legumes	30.3%
Others	

} 48% (intercropped)

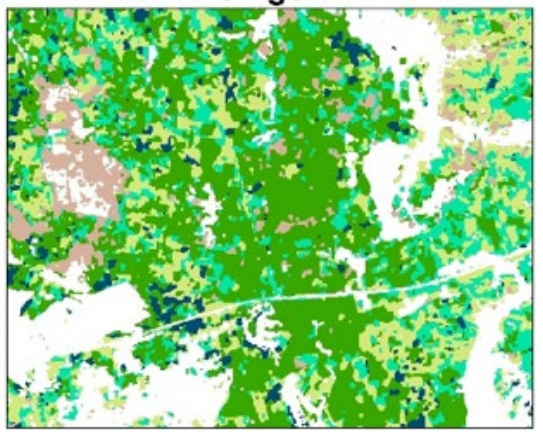
Find data here



1:Jengre

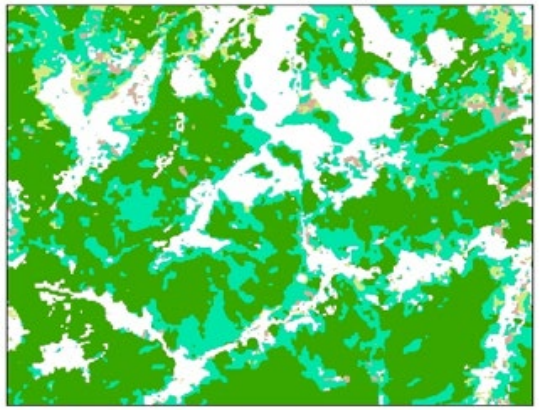


2:Maingo



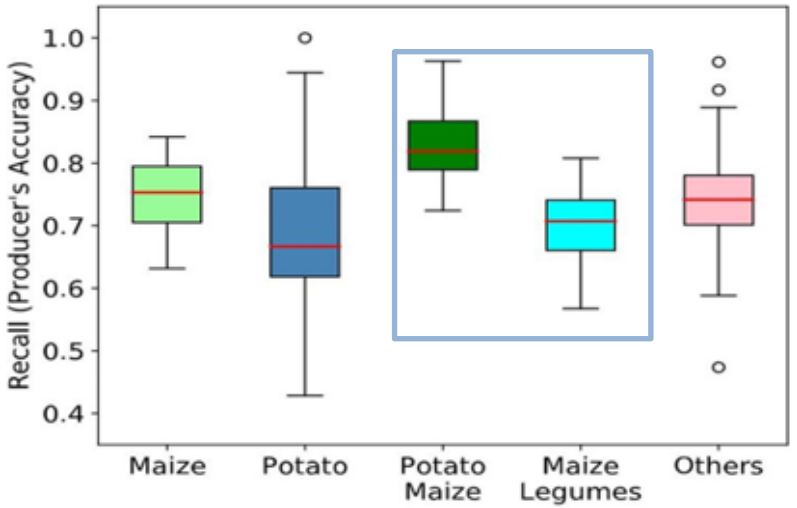
3:Hiegpang - Barkin Kwi

4:Kurra- Ampang west

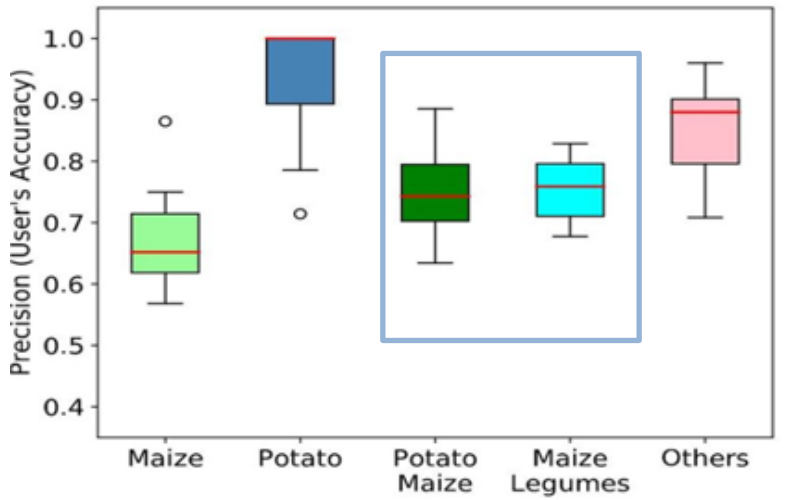


Class 'Others' = fonio, vegetables, grasses, rice and yam

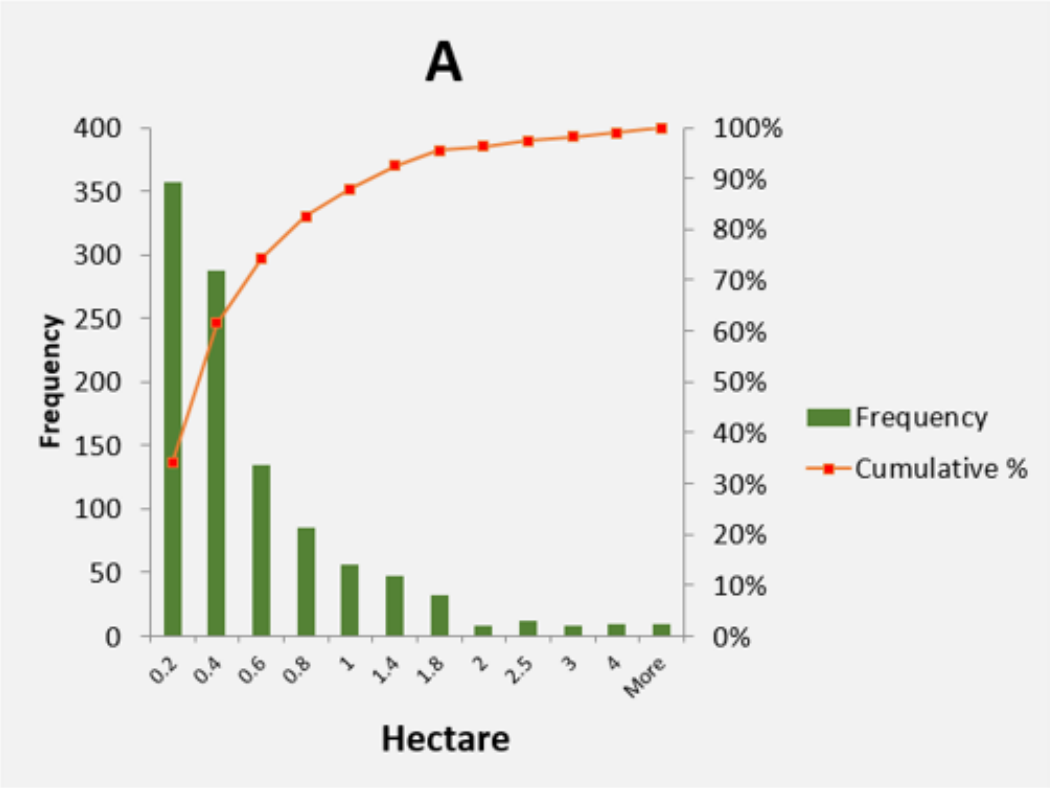
Producer's Accuracies

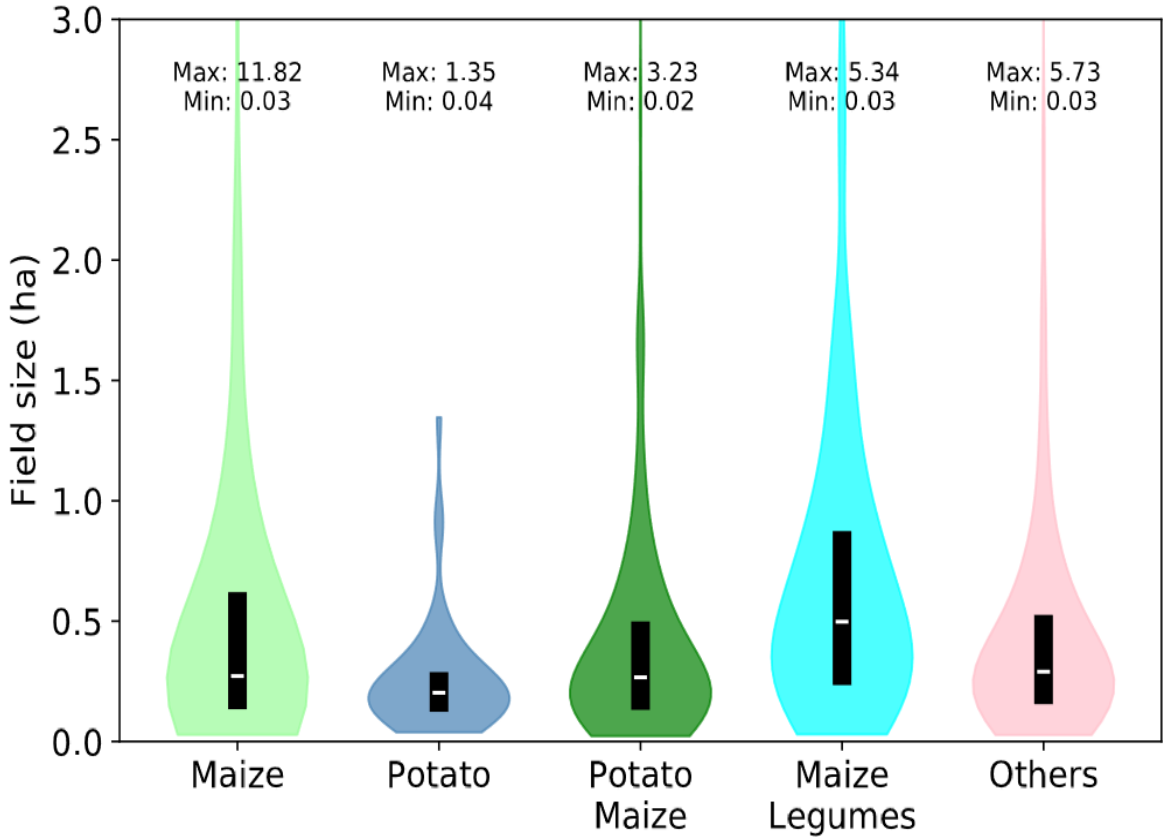


User's Accuracies



Results- Field sizes





~50% of the fields in Africa are smaller than **0.4 ha**
~25% are smaller than **0.2** ha (Carletto et al., 2015)

- Potato fields are the smallest
- Economic reasons (seeds are expensive)

Summaries

- Mapping intercropped classes is feasible with Sentinel data

- Factors affecting the accuracies;

- ✓ quantity and spatial distribution of reference data
- ✓ spectral similarity
- ✓ pests, diseases, and poor management practices
- ✓ the frequency and quality of available satellite data
- ✓ **cloud cover** - Critical narrow windows

Conclusion

- Our crop maps can guide informed policies, pest and disease **early warning systems**, **yield estimations**, bioenergy estimates, etc

What can we improve?

- Field Level classification

What do we recommend?

- Multi- sensor compositing - Landsat (spatial resolution) or very high-resolution data (cost) or Sentinel 1 data (Griffiths et al,2019, Jin et al 2019 RSE)

Find Article here

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THANK YOU FOR LISTENING!