A Tool to Explore Spectral, Spatial and Temporal Features of Smallholder Crops

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STARS
SPURRING A TRANSFORMATION FOR AGRICULTURE THROUGH REMOTE SENSING

Central questions of this learning grant

STARS

ITC, ICRISAT, University Maryland, CIMMYT, CSIRO

How can current *remote sensing systems* (space/air/ground) feed the often data-poor *smallholder food production systems* in sub-Saharan Africa and southern Asia with actionable information?

ARSIS

CIP

How to develop and use *low-cost UAV technology & methodology* to improve smallholder field monitoring?

Smallholder farming

High-income agriculture is a *data-intensive* business in a *homogeneous* landscape.

Most systems are stressed out and cannot yield much more than present.

Low-income agriculture takes place in *heterogeneous* landscapes, and we have *no reliable data* on it.

World's future breadbaskets are in Africa and Asia.

Central dimensions

Shared learning

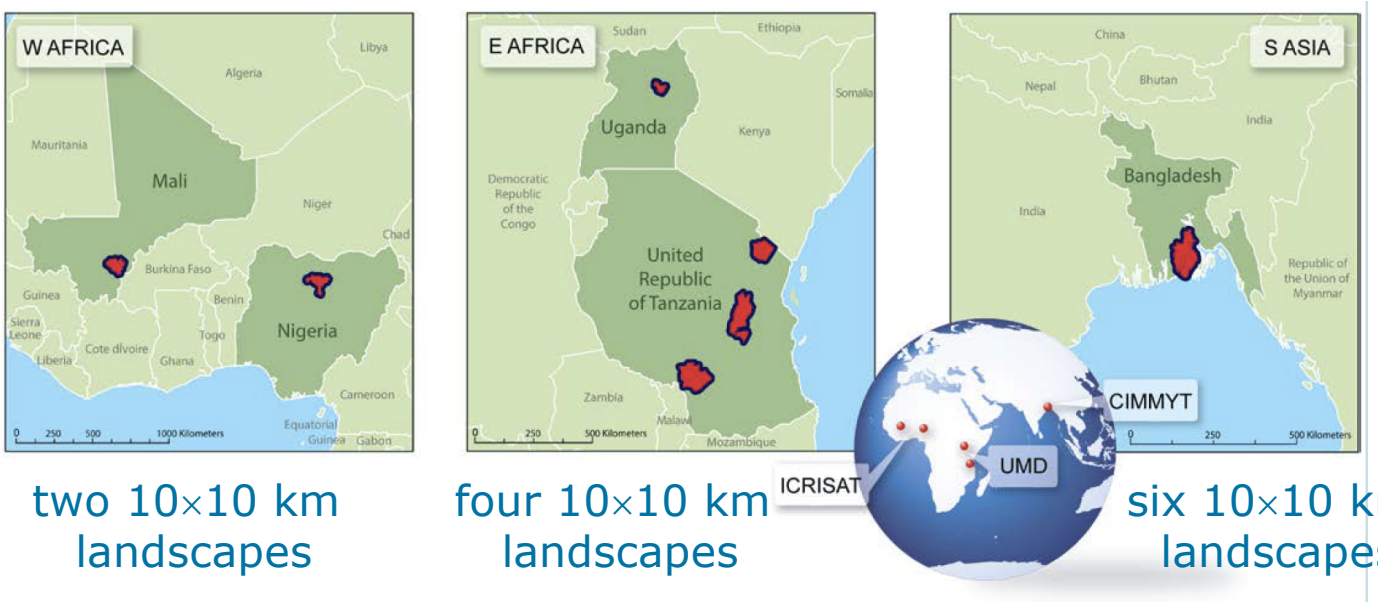
End-user engagement

Business models for sustained use

Technological integration

Global public goods

Where we work



two 10×10 km landscapes

four 10×10 km landscapes

six 10×10 km landscapes

Stakeholder approaches:

grass roots **government** **small enterprises**

STARS Image data stack

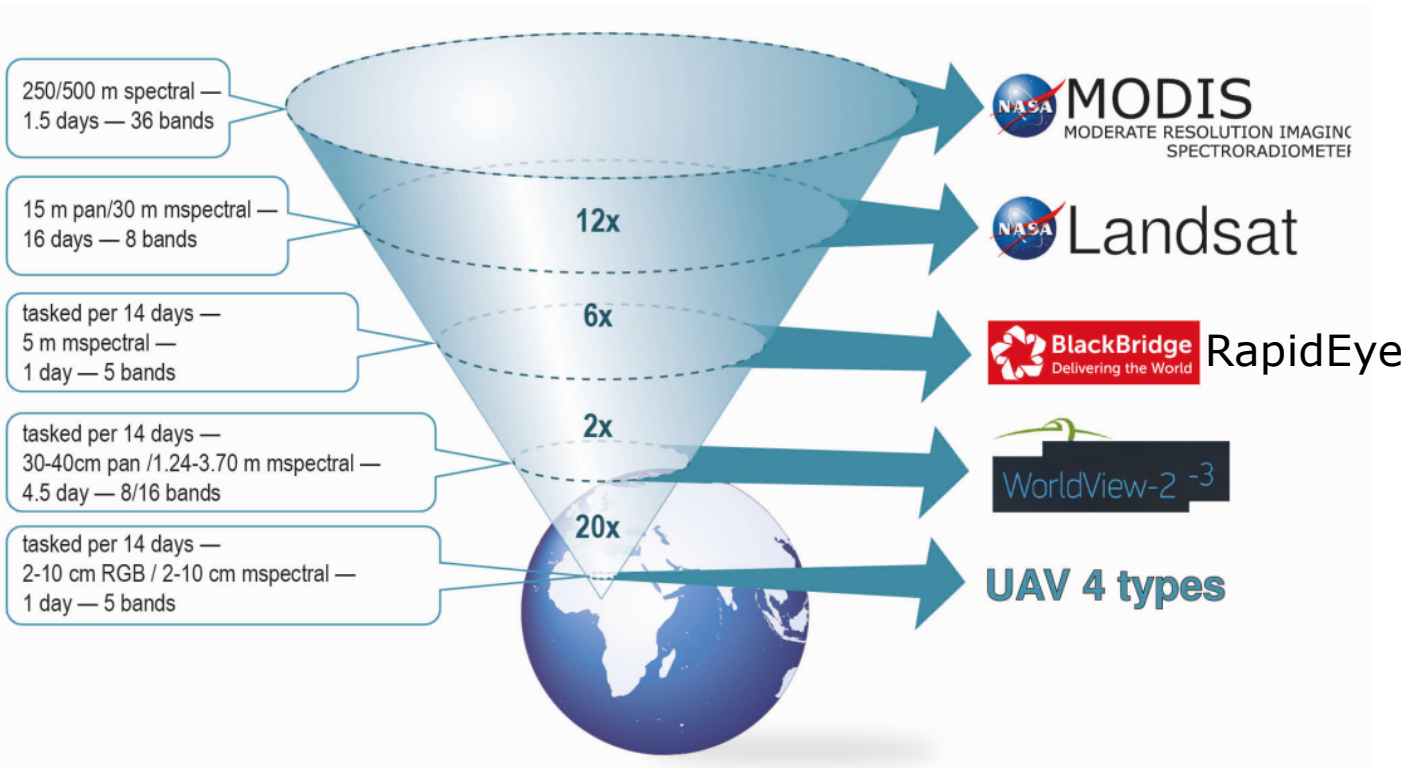
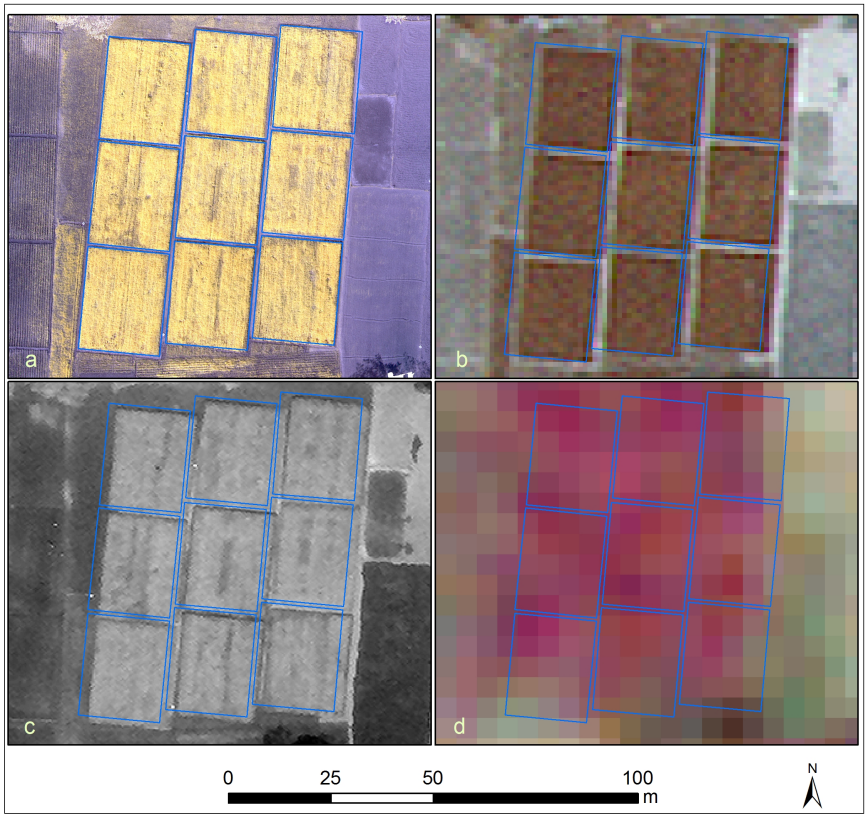


Image data

UAV
Tetracam
multispectral



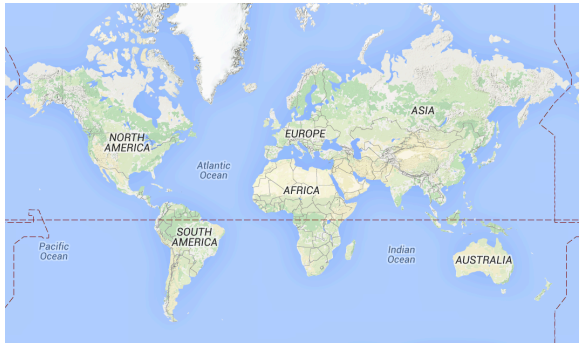
WorldView-2/3
multispectral

WorldView-2/3
panchromatic

Planet RapidEye
multispectral

ITC, CSIRO, and partners

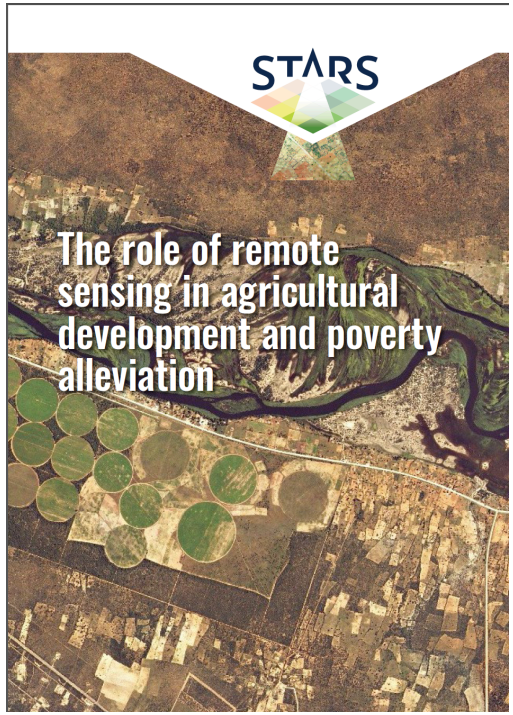
GLOBAL PUBLIC GOODS



STARS Landscaping Study

Ten investment opportunities

OPPORTUNITY 1: Produce a cartographic baseline and digital elevation model for Sub-Saharan Africa
OPPORTUNITY 2: Establish online remote-sensing data services for Africa
OPPORTUNITY 3: Improve soil and land resource assessment and monitoring
OPPORTUNITY 4: Improve rainfall data for famine early warning
OPPORTUNITY 5: Develop more effective administrative systems for land tenure
OPPORTUNITY 6: Provide timely information on agricultural production for national decision-making
OPPORTUNITY 7: Support the revolution in micro-scale irrigation
OPPORTUNITY 8: Optimise large-scale irrigation
OPPORTUNITY 9: Close the yield-gap in market-oriented family farming
OPPORTUNITY 10: Support the development of index-based insurance



www.stars-project.org/en/knowledgeportal/landscaping-study/

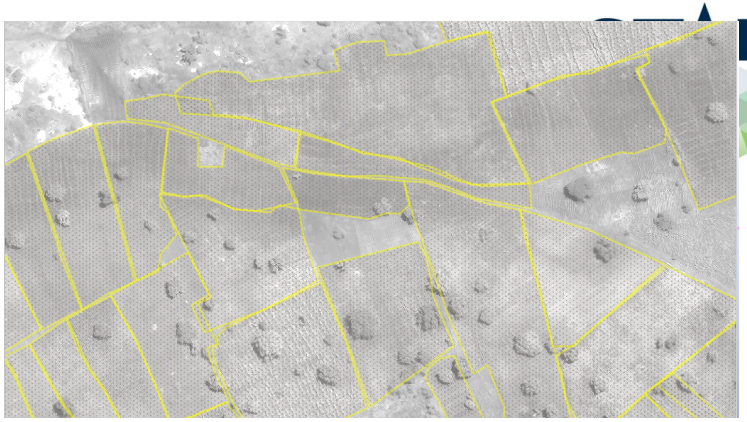
Open domain data sets and related methods & software

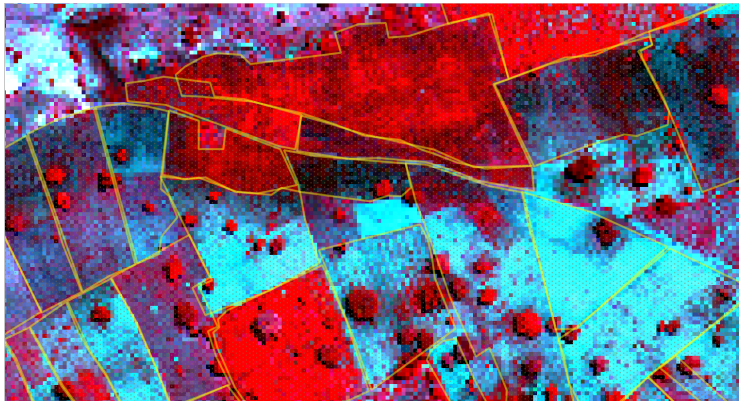
- Will go into *shared mode* soon
- Watch both

www.stars-project.org and
github.com/GIP-ITC-UniversityTwente/

- Or register with contact@stars-project.org

Many upcoming examples here are based on ICRISAT team fieldwork led by Sibiry Traore in Mali and Nigeria.

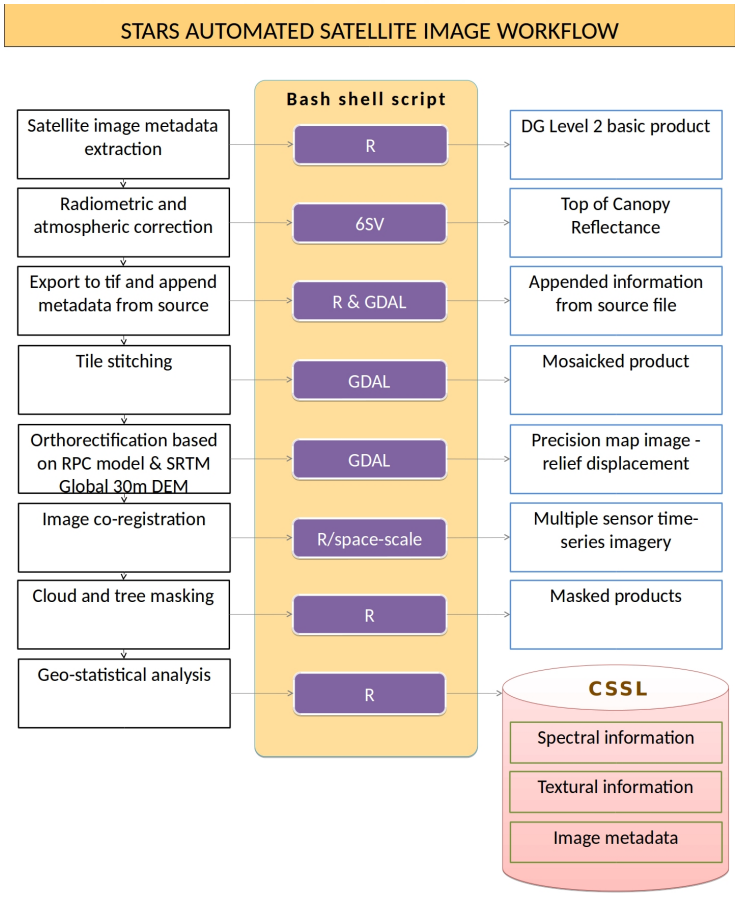




Automated Satellite Image Workflow

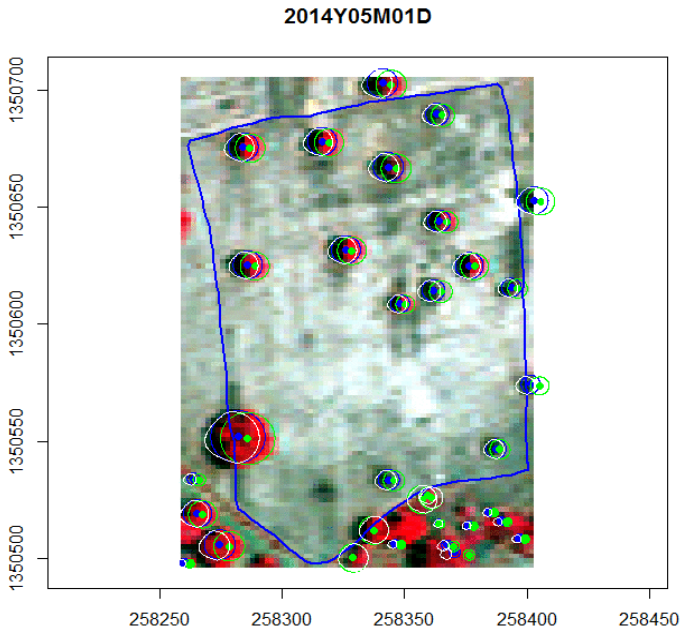
Open-source and **free** software

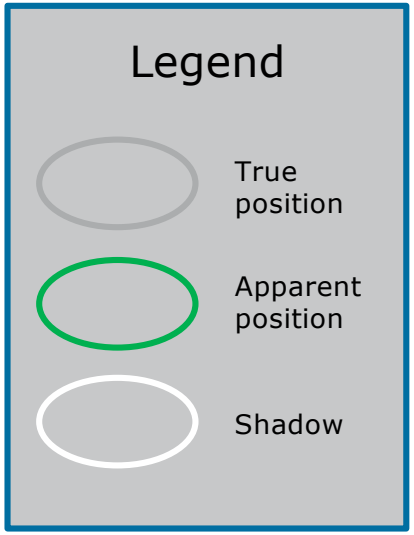
- Linux (base platform; makefiles)
- R (most operations)
- GDAL (I/O raster and vector)
- STARS scripts in Fortran/Python (radiometric calibration)



Accurate image co-registration and tree (shadow) masks

- Satellite images are not co-registered
- Main interest: crop pixels; foreign objects have to be masked
- Tracking crop pixels in space/time requires accurate geo-location and co-registration



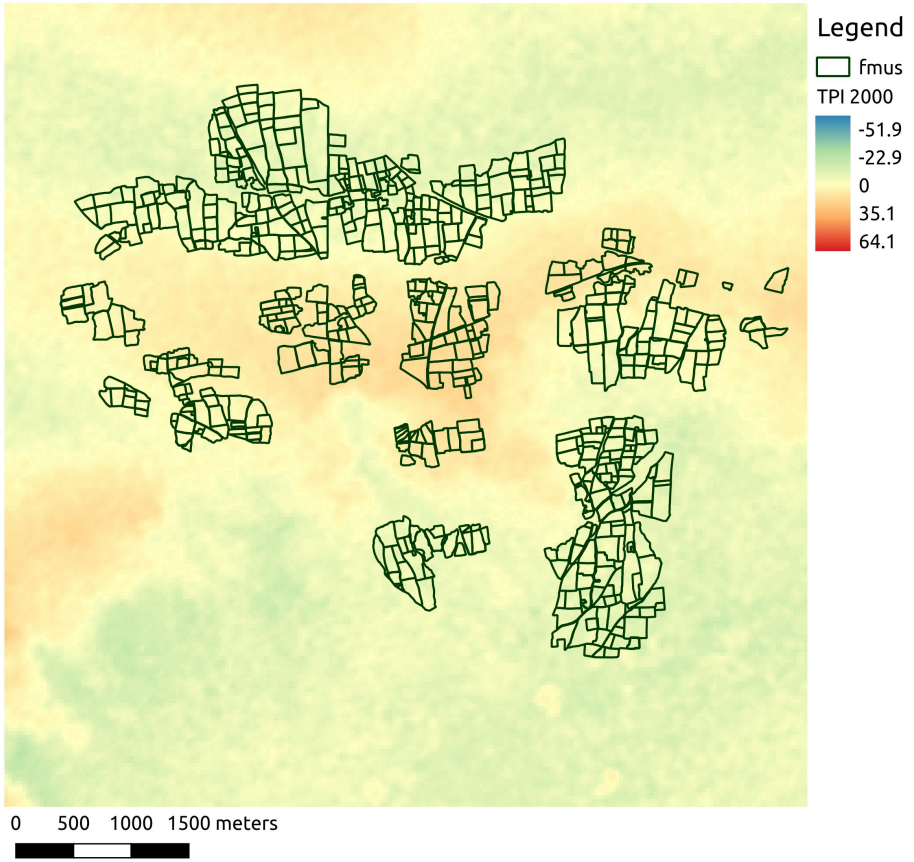


Public Good Outcomes

Crop Spectrotemporal Signature Library

- Spectral & textural statistics for all our crop fields followed over time
- Accompanying farm field data from field surveys
- Field-specific data derived from ancillary sources: elevation and topographic position, later also soils
- Eventually: Image-derived field management data (pure/mixed, rows, orientation)
- Basis for many crop analysis routines (type, stress, yield studies)
- No image pixel data is held

Topographic Position Index



Public Good Outcomes

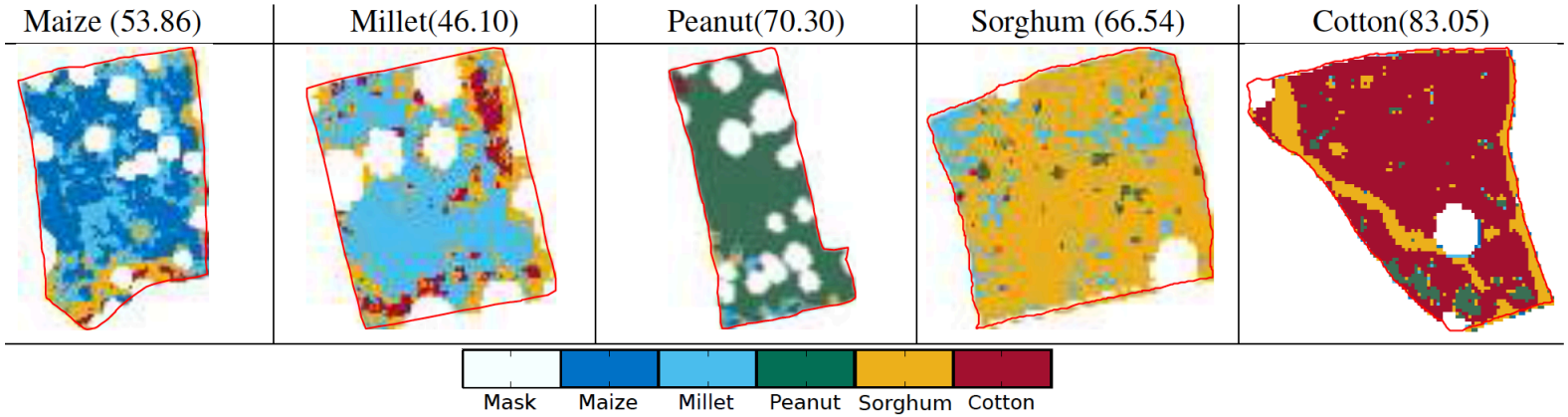


Image Analysis Algorithm Repository

- Data ingestion workflows
- Analytical workflows
    - Landcover mapping and Crop type identification
    - (Field delineation …)

Using Guided Regularized Random Forests in Google Earth Engine.

Multitemporal data analysis

The use of **satellite image time series** facilitates the identification of crops in RS images

- Capture differences in crop phenology
- Classifiers can find dates (pairs of images) where the class separability is maximal.

- Time series of WorldView-2 and -3 images
  - Mali (*Sukumba*)
  - 7 dates in 2014 (May to Nov but unevenly distributed in time due to clouds)
  - Panchromatic: broad spectral band with high spatial resolution (~0.45m)
  - Multispectral: narrow(er) spectral bands but with lower spatial resolution (~2m)

Crop identification with WorldView time series

Co-registered images, tree (shadow) masked (STARS image workflow)

- **Images stacked to create multitemporal cubes**
- **GLCM textures** (18 metrics) calculated in 4 angles using 256 gray levels and various sliding window sizes
- Classifiers using Random Forest techniques with feature space defined on right.

- Field constants
- Image spectral metrics
- Image textural metrics (GLCM)
- Image directional texture metrics
- VI metrics
- VI textural metrics
- To be done: truly dynamic features

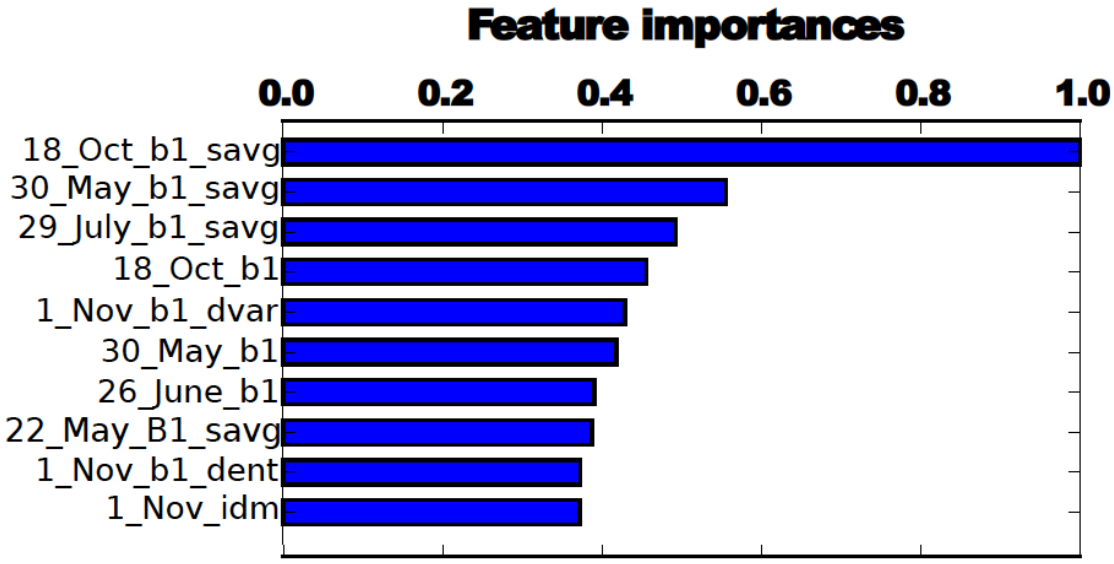
Rationalizing classifier results

Happy to find out which are the most discriminatory image features, but

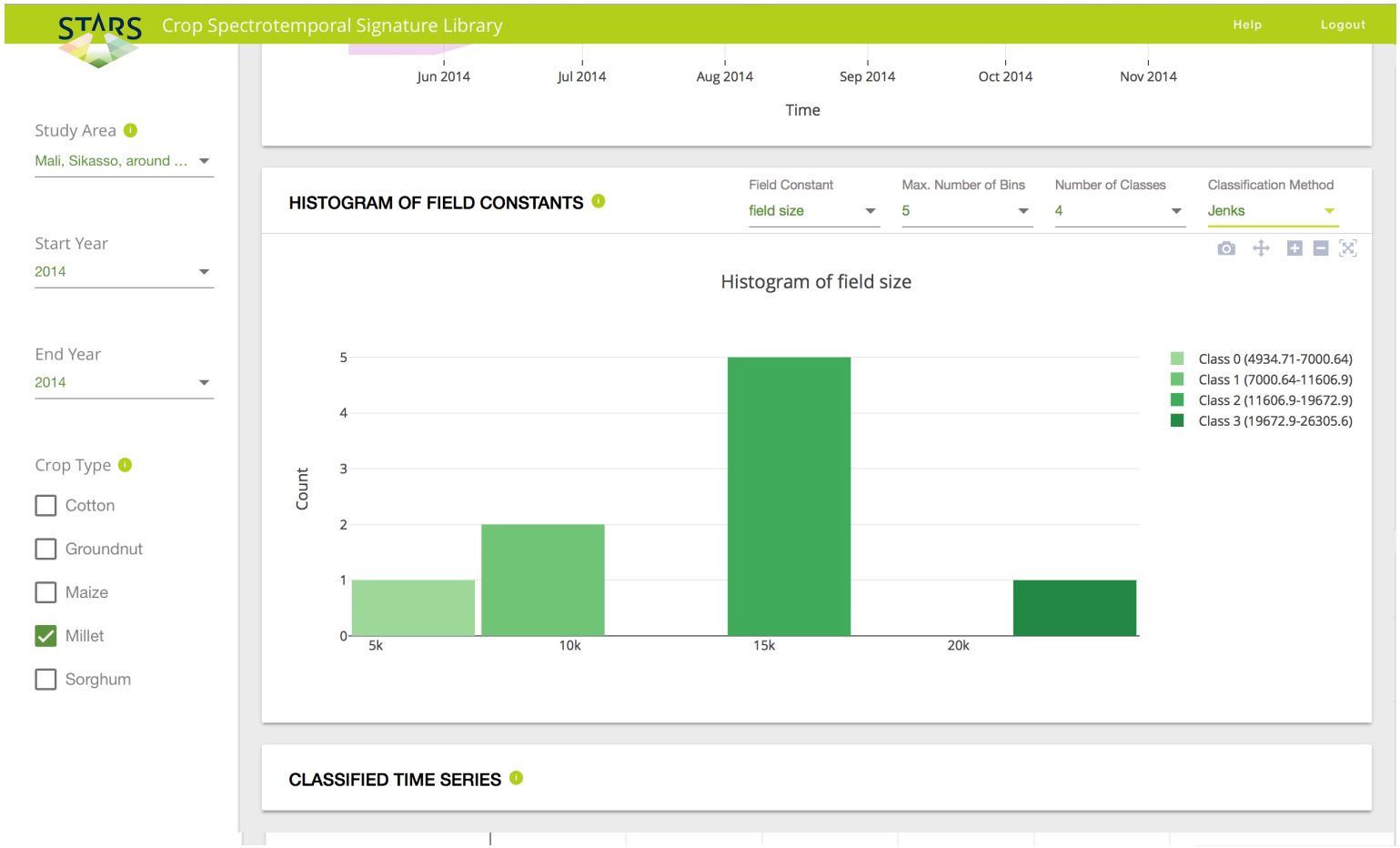
- Why these?
- What do they represent?
- Why in this combination?

Need for a

Data Exploration tool.



Online data exploration tool



Standing invitation

Smallholder ag researchers:

Many projects target SHA.

Where these surveys include at least:

- *Crop-labeled farm field geometries*
- *Timing of the crop season*

My team at ITC has interest to develop and deliver EO-based multitemporal field statistics, to help grow the open access STARS CSSL. At no or low cost.

Our group is advertising two positions, initially for 4 yrs resp. 6 yrs:

Assistant professor in GIS and RS

Tenure-track professor in Geodata Science

Deadline October 1, 2017.

Please refer to

www.utwente.nl/en/organization/careers
and follow path to > ITC > GIP

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