Remote sensing as a monitoring tool for cropping area determination in smallholder agriculture in Tanzania and Uganda

SPHI
Sweetpotato for Profit and Health Initiative

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Unmanned Aerial Vehicle (UAV)-based remote sensing technology is a game changer in the gathering of agricultural statistics data. Relatively low-cost platforms, coupled with high quality sensors and sophisticated-yet-user-friendly processing techniques allows gathering of accurate crop statistics data at large scale with minimal effect of clouds.

Fig. 1 **UAV flies in one of the fields** in Misungwi, Tanzania (credit E.Cheruiyot)

CENTRO INTERNACIONAL DE LA PAPA
CIP
A member of the CGIAR Consortium

What is the problem?

Crop statistics are important tools for planning, policy making and timely interventions to address food insecurity. Therefore, many countries go to great lengths to gather crop statistics data from all farmers. The most common conventional source of data for crop statistics is Agriculture Sample Census carried out at regular intervals (for example, every five years in Tanzania). However, this method is costly and the information is not frequently updated. It also relies on farmers' recollection of the crops they grew, the area that they grew in and their yields, which is often inaccurate. Many smallholder farmers, especially in developing countries, do not keep written records of their farming activities or plot sizes. The potential of satellite remote sensing in gathering accurate crop statistics data has been demonstrated, but associated costs are prohibitively expensive and the data are often negatively affected by clouds.

What do we want to achieve?

Using sweetpotato as a pilot crop, CIP is leading efforts to develop cost-effective methods that utilize UAV as a platform to collect accurate and timely data for agricultural statistics. Beyond the platforms, we also develop low-cost and high quality sensors for specific agricultural applications, as well as the software required to process and analyze the acquired data. All these products are considered to be in the public domain.

The project seeks to achieve the following specific objectives:

- Obtain a baseline of crop reflectance at different stages of growth in the crop;
- Develop, test and ground-truth products generated by a remote sensing platform for surveying crops in sampling areas;
- Adapt algorithms and software for the data fusion combining very high resolution data with data from coarse resolution satellite images;
- Validate the technology by comparing results with information provided by the sampling framework used by the National Agricultural Bureaus in Tanzania and Uganda and ground-truthing;
- Elaborate an upscaling plan, impact pathway, and theory of change for this innovation.

Where are we working?

The current phase of the project is being implemented in Misungwi district, Tanzania and Kumi district, Uganda, with sweetpotato as a pilot crop. With the partnerships and collaborations we are building, we plan to out-scale the project to include other crops and cover wider regions.

Fig. 2 **An aerial image** taken with a regular digital camera

How are we making it happen?

We realized the importance of involving the stakeholders early in the project, and in October 2014, we conducted an inception workshop with participation of national, regional and international organizations largely drawn from Kenya, Tanzania and Uganda. These stakeholders highlighted the challenges they expected the technology to solve, and their feedback helped us to shape the approach of the project in a manner that will bring greater impact to communities. We started assembling the UAV in Nairobi in January 2015. Special cameras are attached to the UAV, which a pilot remotely flies over farmers' fields to take images (Fig. 1 & 2). Different crops reflect light in unique ways, and the optical characteristics of the crops are recorded by the camera. An analysis of these optical characteristics allows scientists to identify the crops in the images (Fig. 3 & 4).

The approach under investigation falls under the following protocol: (i) Locally assemble and test UAVs; (ii) Construct a spectral library of crops and other land cover types in the target region; (iii) Acquire aerial images and process them to identify crops and estimate cropping areas; (iv) Upscale the results to cover wider regions by fusion with satellite data.

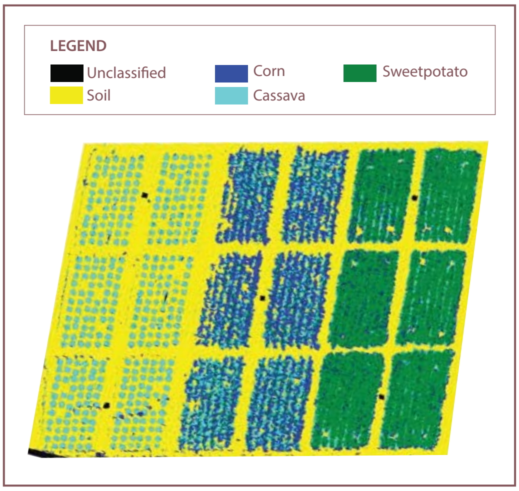

Fig. 3 **Identification of crops** from an image taken using a multispectral camera

What have we achieved so far?

During the first half of 2015, we have assembled and tested one UAV. We conducted the first data collection field mission in Misungwi district in April 2015. Aerial images of crops were taken and a team of CIP scientists are processing the data to differentiate the crops in the images and estimate the area covered by each crop. So far, we have found that sweetpotato is one of the major crops grown in the lowlands that partly border Lake Victoria; the other crops include cassava, maize, sorghum, rice and cotton.

We are in the process of assembling the second UAV. We are also making significant progress in processing the generated data. To promote learning exchange, we established a Community of Practice on UAVs for agriculture in three countries (Tanzania, Uganda and Kenya) and a web-based platform has been created to facilitate discussions (refer to https://dgroups.org/groups/uav4ag to join).

What´s next?

Plans are underway to carry out another field mission in Uganda's Kumi district. The next major step is upscaling of the crop statistics data collection to larger areas by fusing UAV-based data with satellite data. Our approach will involve non-conventional techniques like non-linear methods to upscale the data. We also plan to use multi-fractal statistical scaling methods which we have previously applied to precipitation.

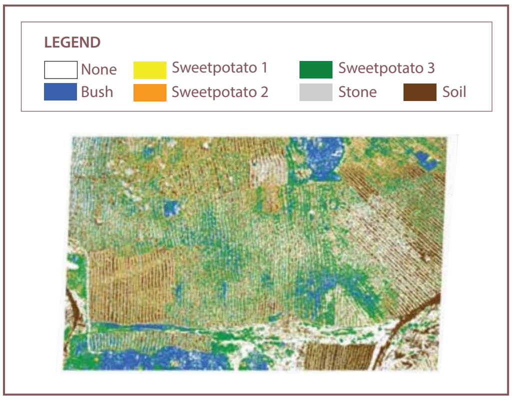

Fig. 4 **Identification of crops** from an image taken using a regular camera

Key Partners:

- University of Missouri;
- World Agroforestry Centre (ICRAF);
- University of Nairobi, Kenya;
- Civil Aviation Authority;
- Agricultural Research Institute (ARI – Ukiriguru);
- Tanzania National Bureau of Statistics (NBS);
- Uganda Bureau of Statistics (UBOS);
- National Semi-Arid Resources Research Institute (NaSARRI) – Uganda;
- Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA);
- Food and Agriculture Organization (FAO) Kenya.

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