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

SPHI Sweetpotato for Profit and Health Initiative

SEP 2016

Fig 1. Participants of the final ARSIS Stakeholders Workshop held in Nairobi on 6-7 June, 2016. There were 44 participants from over 29 national, regional and international institutions.

CIP INTERNATIONAL POTATO CENTER A CGIAR RESEARCH CENTER

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 extent, with minimal effect of clouds.

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 the 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' often inaccurate recollection of the crops they grew, the area that they planted and their yields. 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. Freely available satellite imageries, on the other hand, have a coarse resolution and require extensive ground-truthing.

What do we want to achieve?

CIP and partners are developing cost-effective methods that utilize UAV-RS platforms to collect accurate and timely data for agricultural statistics, complementing information registered with satellite imageries. 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. Best of all, these products are 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 UAV-based extremely high resolution data with data from coarse resolution satellite imageries;
- 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?

Limited by the difficulty in getting permits to fly UAVs in Kenya, Uganda and Rwanda, the field missions in 2016 were conducted in Kilosa, Tanzania, together with the district statisticians.

Key Partners:

- University of Missouri
- Ecole Polytechnique, France
- University of Twente, The Netherlands
- University of Nairobi, Kenya
- Civil Aviation Authorities
- Agricultural Research Institute (ARI – Ukiriguru)
- Tanzania National Bureau of Statistics (NBS)
- Uganda Bureau of Statistics (UBOS)
- National Semi-Arid Resources Research Institute (NaSARRI) – Uganda
- CGIAR CENTERS
- District Offices in Tanzania and Uganda
- Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA)
- Food and Agriculture Organization (FAO) Kenya.

How are we making it happen?

The theory of change for the innovation was based on the creation of a community of practice, involving stakeholders from research organizations (international, national and universities); public institutions in agriculture, extension, and statistics; the private sector; and farmer organizations, all contributing with multiple perspectives that could inform and shape the development and delivery of the products for smallholder agriculture in Africa. Inception and final workshops (Fig. 1) were organized to learn from the diversity of stakeholder groups, their perspectives on the usefulness of the innovation, their concerns and expectations, as well as how each envisioned change happening to enable UAV-based remote sensing system (RS) as a tool in support of smallholding farming in Africa. The latter included a technology fair, organized for hands-on learning on UAV-RS technology and to share communication products developed in response to identified needs such as training videos. During the project period, the regulatory framework for UAVs emerged as a key factor enabling or hindering the testing and use of the innovation. The majority of countries do not have a regulatory framework in place. Some countries have regulations that differentiate use for research from use for commercial purposes. Other countries have banned use of UAVs because of security concerns in the country.

What have we achieved so far?

The first achievement was to build the capacity of young professionals in East Africa to assemble, modify, and repair drones and multispectral cameras; and to use them with other field equipment such as radiometers as well as for processing field data. The second accomplishment was the formation of an active community of practice. The third was the completion of the reflectance library for most important crops and conducting of several field missions in Tanzania - guided by district statisticians; the most comprehensive being the monitoring of 100 ha of agricultural fields in Kilosa. The pixel resolution of the mosaic registered with the UAV-RS system was around 5 cm (Fig. 2). The complementarity between imageries taken with UAV-based sensors and 10-m resolution Sentinel 2 imageries are shown in Fig. 3. We demonstrated that images from the UAV determine area under specific crops with an error of <2%. Given this low error, the actual error is fully dependent on the classification error- i.e. confusion among crops with similar reflectance properties - that ranged from 5-15%. Crop statistics in over 1.5 ha in Morogoro showed that sweetpotato comprised 6% of the cropped area.

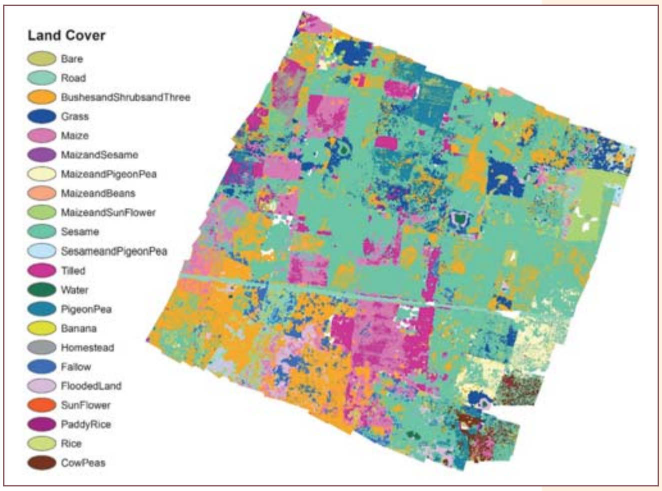

Fig 2. Classification obtained from a mosaic of UAV images covering 100 ha in Kilosa district, Tanzania. The images were taken at 120 m above ground with a spatial resolution of less than 5 cm.

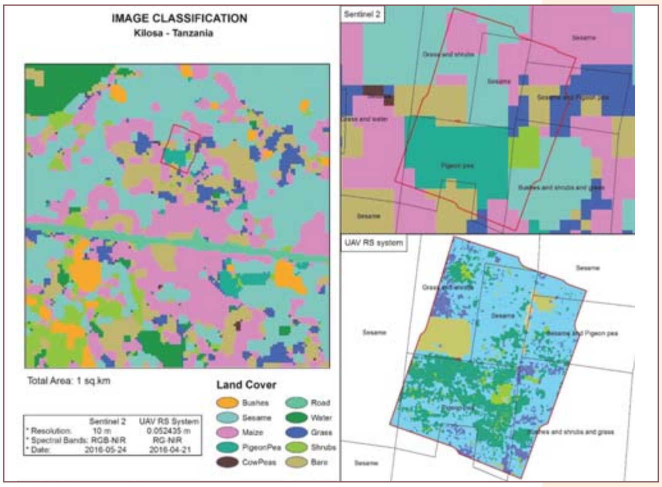

Fig 3. Classification obtained from a satellite image in Kilosa district, Tanzania (Left) and comparison of classifications obtained with satellite (Sentinel-2) and UAV-based imageries at resolutions of 10 m and 5 cm, respectively (Right).

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). The membership has grown exponentially.

What´s next?

We are seeking funding to transfer the developed technology to Bureaus of Statistics in the Region and other interested institutions. Clearly, in the next phase, advocacy among policy makers and a concerted effort to inform and facilitate the development of regulations that permit full use of the technol- ogy for agricultural purposes is of high priority.

CONTACT

Roberto Quiroz (CIP),
r.quiroz@cgiar.org