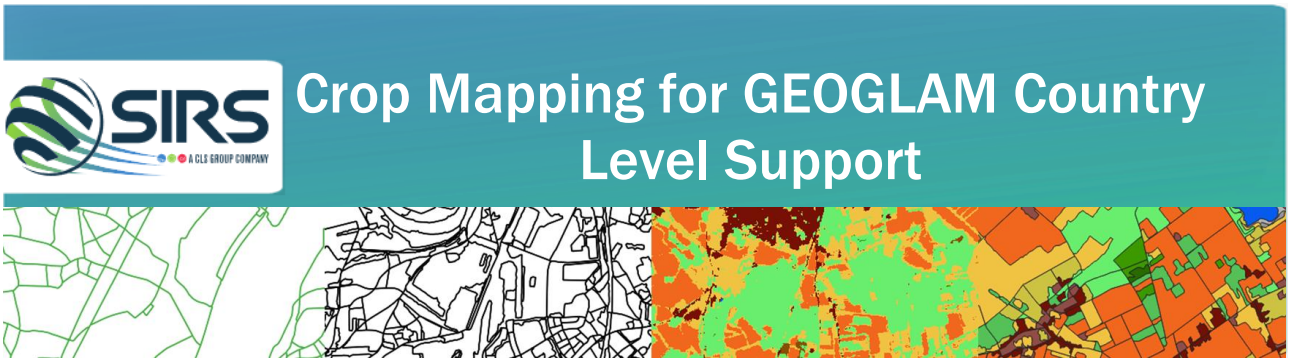
Service contract for the Copernicus Land monitoring services



Framework Contract N°939708-2020-IPR

First Specific Contract

D2.4 Field Campaign for Uganda – Short Rains season – Methodology applied

Prepared by:

CLS
COLLECTE LOCALISATION SATELLITES

TerraSphere

with support from:

Upande

Reference: COPERNICUS4GEOGLAM_ShortRains_Field_Campaign_Uganda

Issue 1.0 - 03/03/2022

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AEZ	Agro-Ecological zones
AOI	Area of Interest
DRDPM	Department of Relief, Disaster Preparedness and Management
FAO	Food and Agriculture Organization
GeoODK	Geographical Open Data Kit
GPS	Global Positioning System
JRC	Joint Research Centre of the European Commission
NGO	Non-Governmental Organization
OSM	Open Street Map
RGB	Red Green Blue
VHR	Very High spatial Resolution

1 Introduction

CLS (Collecte Localisation Satellites) and **TerraSphere** were selected in response to the Call for Tender for a Framework service contract in relation to Crop Mapping for Group on Earth Observations Global Agricultural Monitoring Initiative (**GEOGLAM**) Country Level Support as part of the Copernicus Global Land component.

The present document covers the D2.4 Deliverable focusing on summarizing the workflow and the changes between the actual field sampling and the planned one (as of the feasibility study) and the description of the impact of the changes in the following tasks.

Upande Ltd as a subcontractor to CLS was in charge of the field campaigns in Uganda for the short rains season. They subcontracted the field data collection to **OpenStreetMap Uganda** a local Non-Governmental Organization (NGO) taking full profit of experience from the long rains season and local knowledge regarding regulations, logistics and resources.

2 Objectives of the field campaign

The objective of the survey is to collect in the field harmonized training data (also called ground truth data) for 1) the classification of crop mask and crop types for the short rains season and 2) the provision of unbiased crop area estimates and the validation of the crop type maps and crop mask.

So, 75% of the data collected in the field will be used as a training dataset. The image classification will involve Sentinel-2 at 10-meters resolution (with support of Landsat-8), and Sentinel-1 time series. Sentinel-1 will only be used in case of prolonged cloudiness. The remaining 25% of the data collected in the field will be used to evaluate the accuracy of the results (distinction between crop types mainly) and to obtain information on unbiased crop area estimates.

3 Specification of the Area Of Interest (AOI)

There were no changes in the definition of the AOI for the short rains season as described in the feasibility study for Uganda (D1.1). Nevertheless, a change should be noticed compared to the field campaign for the long rains season; but anticipated as described in the D1.1.

Indeed, the second field campaign took place over the three administrative regions of Acholi, Teso and West Nile that experience two crop seasons (bimodal rainfall distribution). The region of Karamoja showing one growing season (unimodal rainfall) was excluded from the second field campaign as described in the feasibility study for Uganda (D1.1). The areas are located in the Northern and North-Eastern parts of Uganda as shown in Figure 1. The total area occupied by the AOI is covering approximately 58,800 km² representing 24% of the country.

The Teso region lies in the Eastern part of the country and along the cattle corridor making the region highly prone to drought. West Nile and Acholi regions are some of the regions that host a high number of refugees in the country, yet refugee influx keeps fluctuating with porous borders.

The three regions usually act as swing regions for food security and availability of data from these areas will be an important step towards food security forecast in the country.

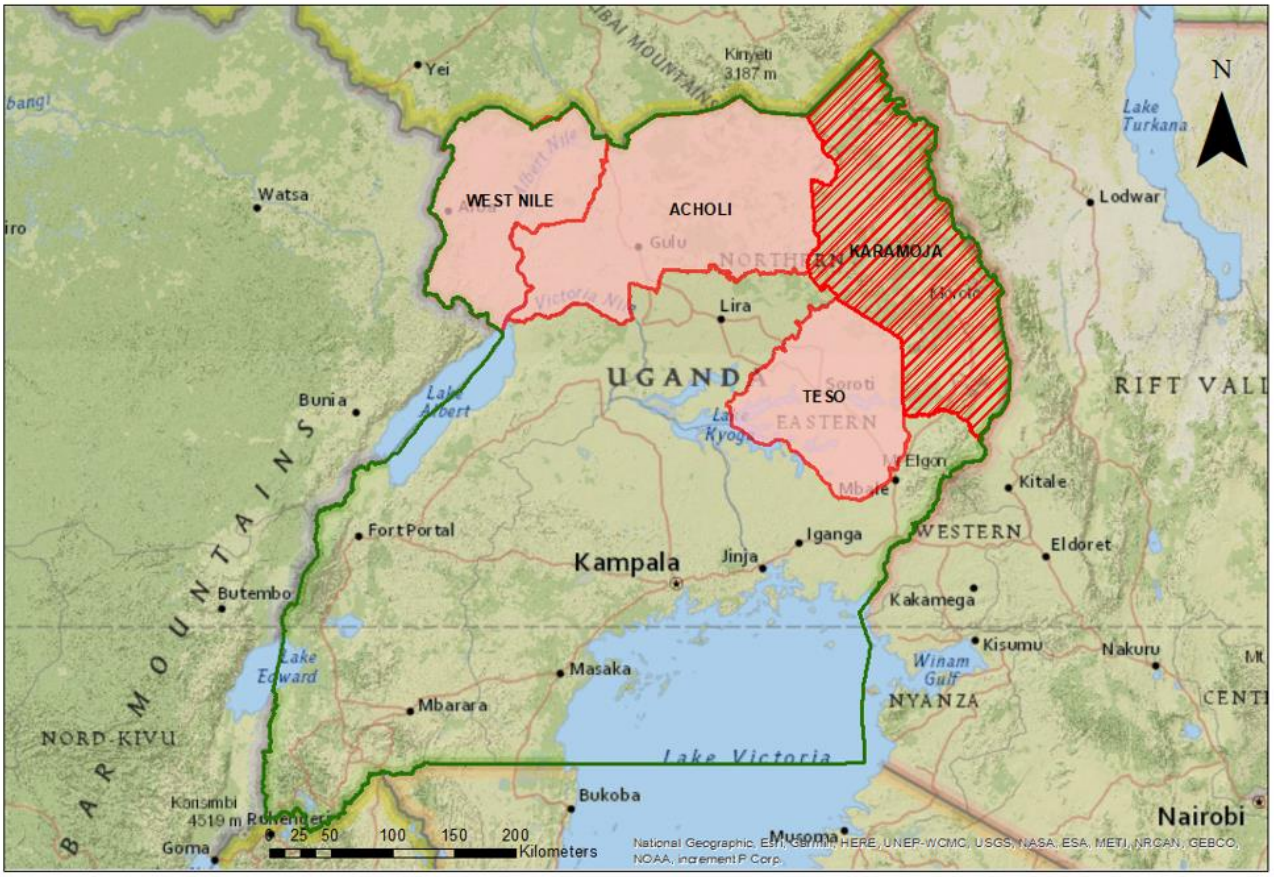


Figure 1: Area Of Interest (in red) in Uganda

4 Review of the Stratification and Sampling Design implemented in the feasibility study

4.1 Stratification

The stratification applied was unchanged from what was proposed in the feasibility study (D1.1) and is summarised as follows based on a series of 6 strata and defined as follows (see Figure 2):

1. Cropland Lowlands Humid;
2. Cropland Lowlands Sub-Humid;
3. Cropland Tropical Lands;
4. Cropland Highlands Humid;
5. Cropland Highlands Sub-Humid;
6. Other areas (including areas ≥ 1,800m and land cover classes different from cropland areas).

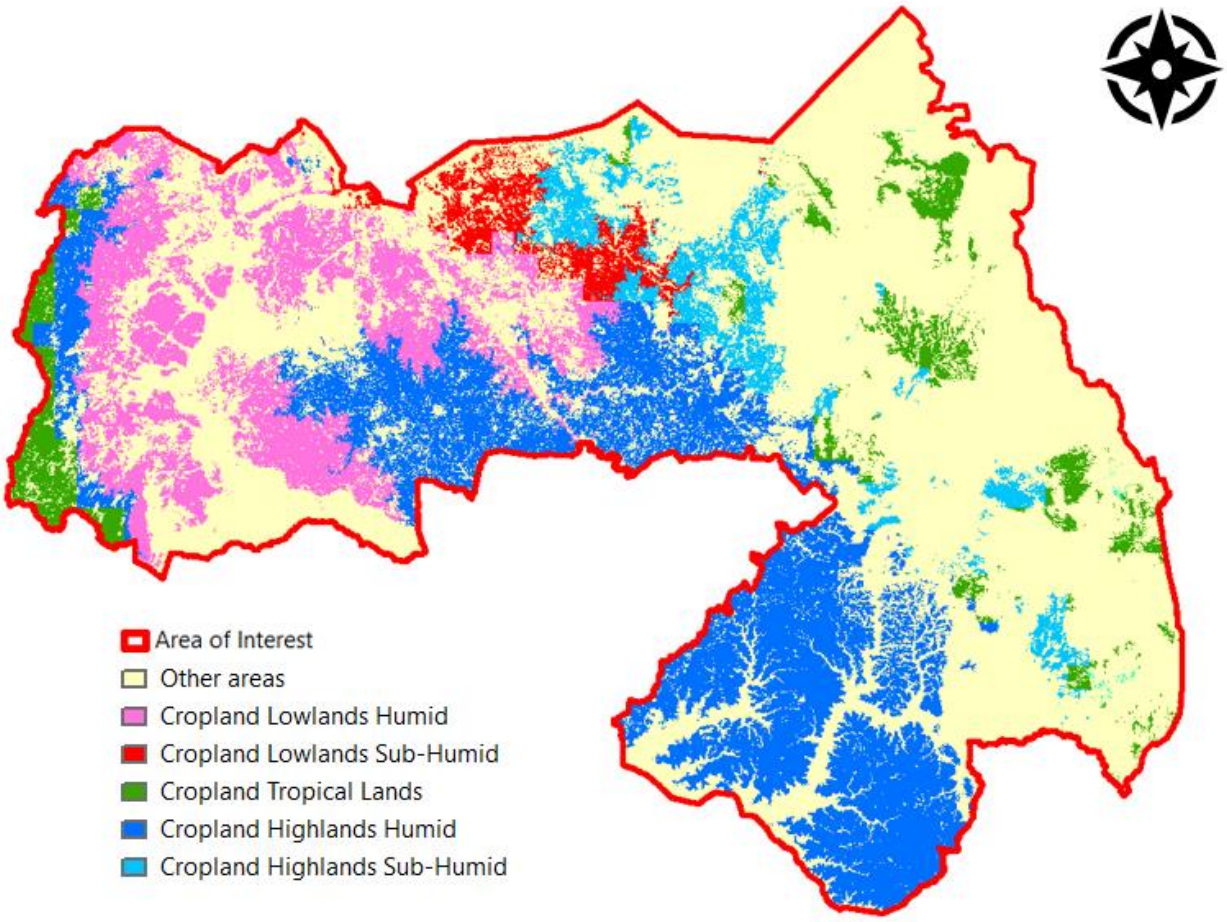


Figure 2: Derived AOI stratification

These strata are based on a combination of physical information (like the Copernicus Digital Elevation Model (DEM) at 30-meter spatial resolution[1] and the national land cover dataset provided by the Department of Relief, Disaster Preparedness and Management (DRDPM) from Uganda or the agro-climatic conditions (Agro-Ecological zones (AEZ) for Africa South of the Sahara at 10 km for the reference year 2015), so the resulting strata are homogeneous regarding both climate and agro-ecological conditions (relief, soil, etc.), and agricultural practices.

Short rains season field campaign

The stratification applied was unchanged from what was proposed in the feasibility study. No new stratification was applied for the second field campaign.

4.2 Sampling Design

The sample design applied was unchanged from what was proposed in the feasibility study (D1.1) and delivered in D1.2 as a as a georeferenced vector file. The approach is summarised as follows.

The selection of sample units was based on a stratified systematic and random sampling selection (two stage approach). The first stage was implemented by applying a 20 x 20 km grid over the overall area of the

1 https://spacedata.copernicus.eu/web/cscda/dataset-details?articleId=394198

AOI. In a second stage, multiple sample units were randomly selected in sequence for each grid cell based on the 500 x 500 m sub-grid as illustrated in Figure 3; resulting with 338 segments selected.

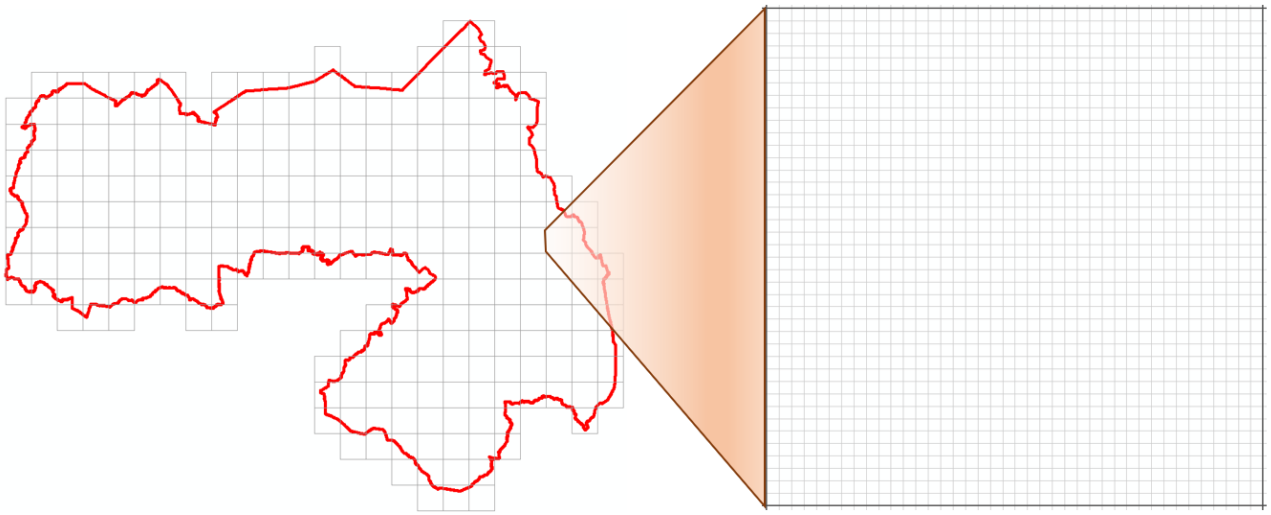


Figure 3: Two-stage stratified random sampling design: 1) 20 x 20 km grid applied on the AOI and 2) 500 x 500 m sub-grid used for the random selection of square segments as sample units

The spatial distribution of the sample units over the crop and non-crop strata are shown in Figure 4

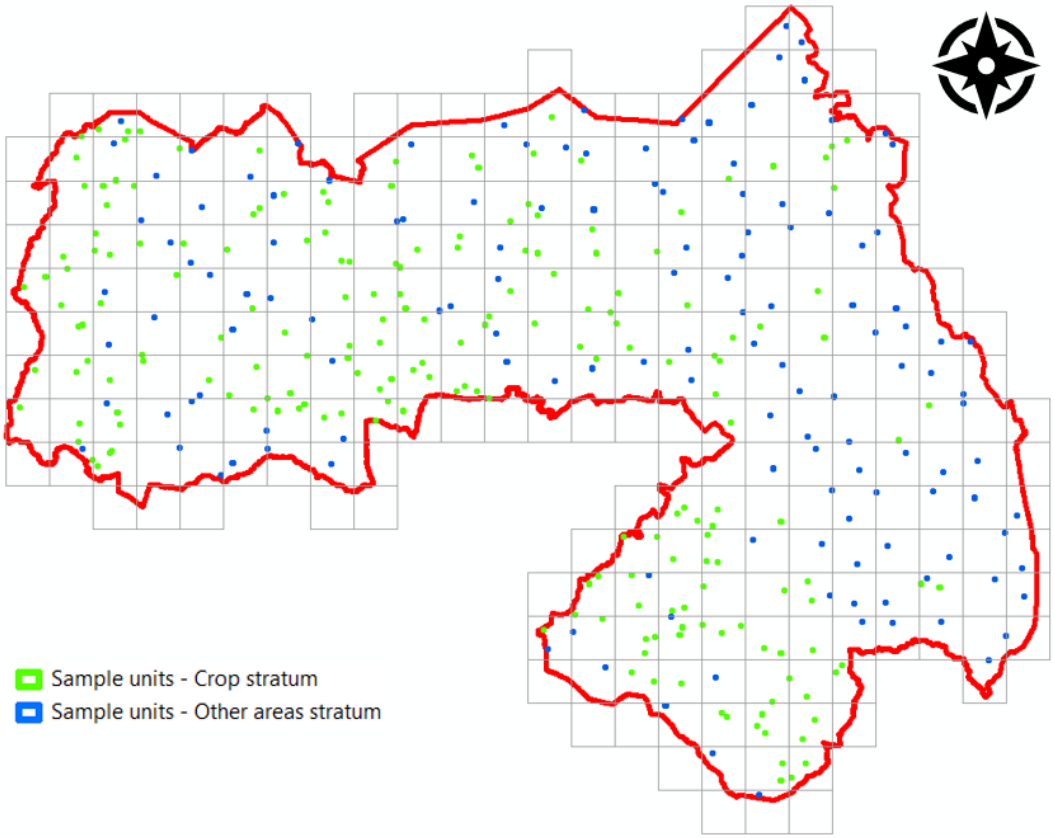


Figure 4: Spatial distribution of the sample units per aggregated stratum

However, a visual assessment of some of the selected segments was made during the feasibility study and showed that some crops were also sometimes present in the other areas stratum. Therefore, this assessment was conducted based on available imagery from Google Earth / Bing Maps over all segments to identify, from the overall samples, the segments without any crops present. This information was used to determine the number and location of the segment to be surveyed as an input to the contract for Upande Ltd. In total out of the overall sample of 338 segments, 259 segments were identified to contain field parcels and therefore were to be surveyed.

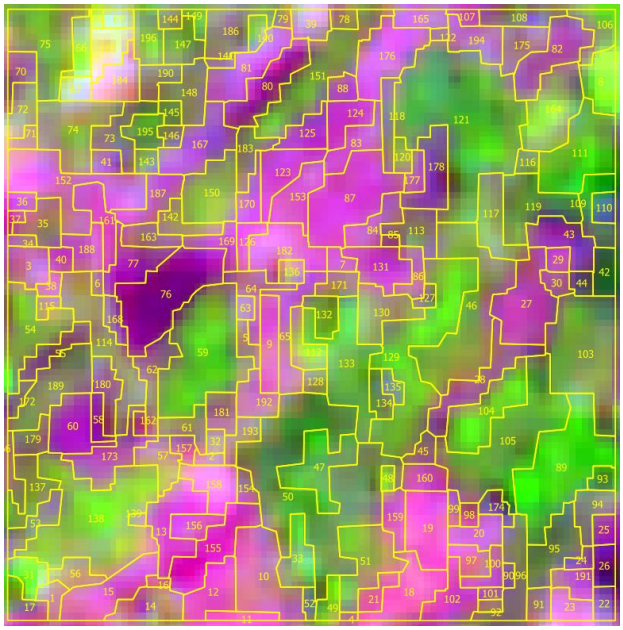
Short rains season field campaign

The sampling design applied was unchanged from what was proposed in the feasibility study. No new sampling design was implemented for the second field campaign; the same sample units/segments drawn were used but only focussing on the three regions of Acholi, Teso and West Nile.

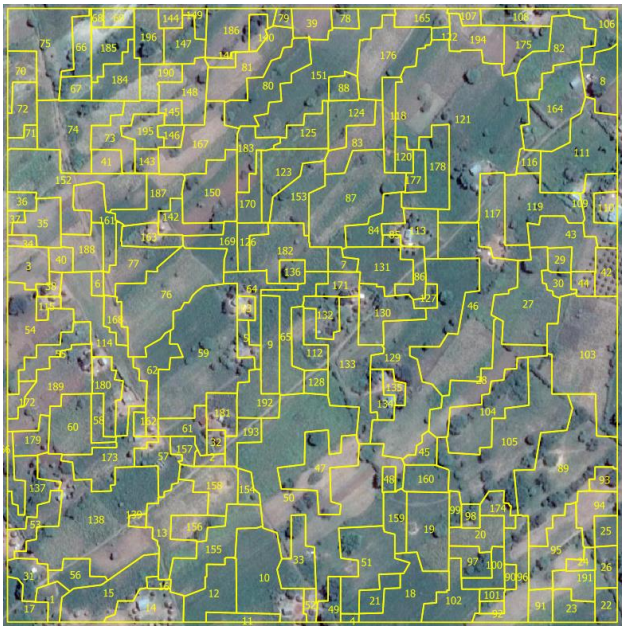
5 Field campaign

5.1 Segment survey protocol

Prior to the first long rains season field campaign, each segment has been visually interpreted by CLS using a combination of the most recent available Very High Resolution (VHR) imagery from Google Earth/Bing Maps, Yandex, Planet and Sentinel-2 imagery from the current season. All field boundaries (including cropland parcels) were digitalised, resulting in polygons that constitute the segment. Figure 5 shows an example of a square segment interpreted and digitalized overlaid on a Sentinel-2 image (9 April 2021) and a VHR Google satellite image (Actual date unknown). Both the square segments and the associated fields are numbered with unique identifiers. These identifiers correspond with the form to be filled by the enumerators. The hardware and software tools used by the enumerators to collect the information in each sample is described in the following section.



Sentinel-2 imagery from 09/04/2021 (False color composite B11/B8/B4)



VHR Google imagery (date unknow)

Figure 5: Example of samples digitalized prior to the fieldwork

After digitalising the fields, the land cover is determined. Based on the VHR and Sentinel-2 imagery a land cover is assigned following the "Main Land Cover" nomenclature presented in Table 1.

Table 1: Main Land Cover nomenclature

1	Forest
2	Grassland
3	Cropland
4	Bare soil
5	Urban
6	Shrubland
7	Water
8	Wetland

Standard definitions for Land Cover are applicable such as:

- Forest: areas covered by woody species capable of exceeding 5m height tree crown and area > 10%
- Grassland: areas where the vegetation is dominated by grasses with a maximum of 10% of tree cover
- Cropland: land devoted usually to agriculture (temporary or permanent) in case of doubt if there was not a clear distinction between e.g. grassland or cropland, the parcel was classified as cropland
- Bare soil: areas with a minimum of 50% bare ground
- Urban: human settlement with high population density and infrastructure of built environment
- Shrubland or bushes: where the vegetation is dominated by shrubs (small to medium sized perennial woody plant) >20% cover of woody plants < 5m high
- Water: areas covered with permanent water surfaces (canal, rivers, water bodies, etc.)
- Wetland: a distinct ecosystem that is flooded by water, either permanently or seasonally, may include vegetation.

Only segments for which cropland is detected were surveyed. In cases of doubt, the segment was included in the survey. As a result, 259 cropland segments were identified (out of 338) from which cropland parcels have been detected and potentially to be surveyed**.**

Short rains season field campaign

Prior to the second rainy season field campaign, it was decided not to update the visual interpretation (both geometry and thematic information). Indeed, the data collected during the short rains season field campaign showed that the fields was mostly correctly delineated.

The field campaign for the second rainy season taking place over the three regions of Acholi, Teso and West Nile, a total of 229 segments where cropland have been identified have to be surveyed as is shown in Figure 6.

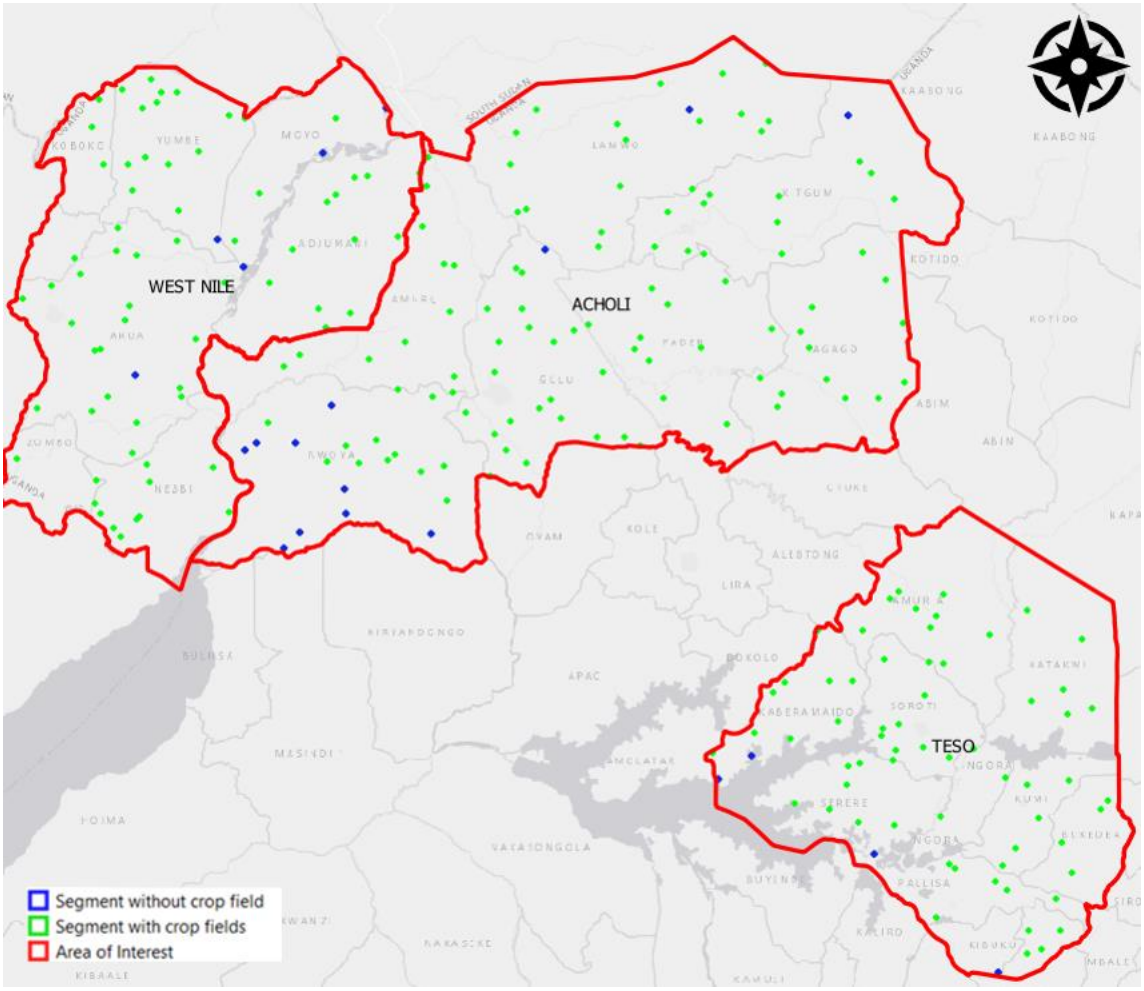


Figure 6: Spatial distribution of the 229 segments where crops have been identified

5.2 Adaptation of the field protocol and description of the impact of the resulting changes

5.2.1 Surveyed segments

Not all the 229 segments where crops have been identified were surveyed in the field. In fact, the second field campaign were interrupted during the process of collecting the data. The Ministry of Agriculture Animal Industry and Fisheries requested Uganda Crime Intelligence Agency (CI) to run background checks on the company and project. The Uganda fieldwork team were summoned to meet the CI Team and present all the requested documents including the EU-Letter about the project. Nevertheless, OpenStreetMap Uganda never received the authorization to resume the field campaign and surveyed the last missing segments.

Moreover, during the field campaign, the enumerators faced some difficulties accessing the segments due to multiple causes such as:

- Local people/farmers denying the access to their private land, getting even sometimes violent and despite the supporting letter from the government (see Figure 7). The country faces severe land grabbing issues, and some segments were located in disputed land under court review so the access was denied by the community.

Figure 7: Enumerator in Agago district working with the army for protection against hostile community

- Segments located in districts (Kitgum, Kaberamaido, Pader and Amoro) where the government authorities and officials didn't allow activities due to Covid-19 lockdown restrictions implementation (without inter-district movements).
- Segments located in areas affected by insecurity. Two days after the start of the field campaign, Uganda experienced attacks when there was twin suicide bombing in Kampala which were followed by others suicide bombing in some rural areas. Some areas were put under very high security alert and this delayed some of the enumerators. Clearances from the ministry of the presidency and RDCs committee were requested to start the field campaign (see Figure 8).

Figure 8: Enumerators being supported by the army and RDCs in Kumi district

- Segments not accessible due to the landscape (e.g. located in national reserve, swamp areas without road/track network)

So, for the safety of the enumerators, it was decided not to survey those segments. Finally, only 160 cropland segments were visited as shown in Figure 9.

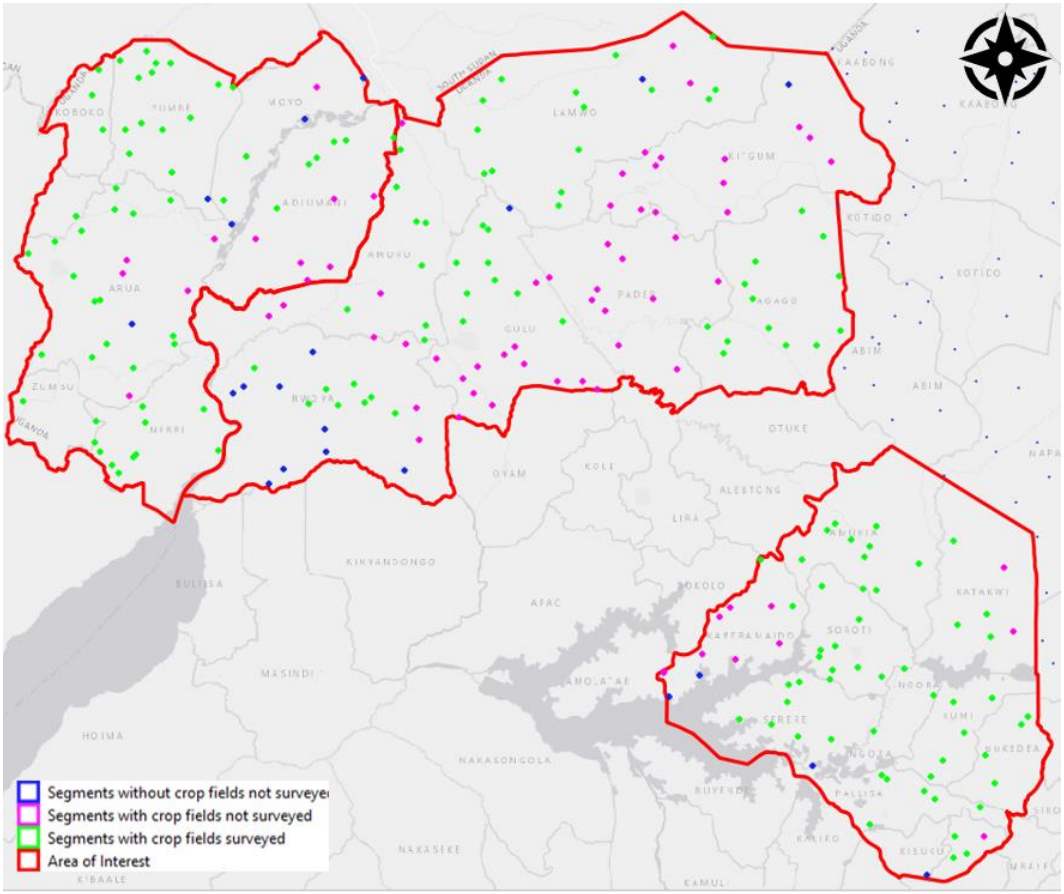


Figure 9: Final Spatial distribution of the surveyed segments

The 69 cropland segments that were not visited are mostly located located in the Acholi region (Kitgum, Pader, Gulu districts). The West Nile and Teso show a good coverage (except for Adjumani and Kaberamaido districts).

Nevertheless, Table 2 shows that the field campaign permits to have sufficient data for the image classification for the West Nile (80% covered) and Teso (84% covered) regions. Acholi is more problematic (52% covered), but impacted districts are mostly non-crop areas based on the long rains season mapping. Therefore, the surveyed samples should be representative of the overall AOI for those 3 regions and the resulting crop area estimates should not suffer from any substantial bias.

Table 2: Final distribution of the surveyed segments per region

Region	Segments surveyed	Segments not surveyed	Segments not to be surveyed	Total
Acholi	53	48	12	113
Teso	53	10	4	67
West Nile	54	12	5	71
Total	160	70	21	251

Moreover, all the parcels where crops were identified within a segment were not surveyed. This was due to the fact that it had been agreed that a maximum of 50 crop parcels within a segment were to be surveyed to avoid spending too much time on one segment. Indeed, as described in the feasibility study (D1.1), most of the farmers in the AOI are small holder farmers with land sizes ranging from 1 to 2.5 hectares often resulting in more than 50 crop fields per segment in some cases. In addition, to save time during the survey and considering the spectral heterogeneity of field parcel less than 1,000 m², it was also decided not to survey the crop parcels less than 1,000 m² with a maximum of 50 fields to be survey inside a segment.

5.2.2 Use of Drones

As stated in the D1.1 document for the feasibility study, the use of drones was envisaged to survey agricultural parcels that could not be reached on foot by the enumerators. However, overall access to the segment was more problematic than reaching individual parcels as described in section 5.2.1. Therefore, drones were not used for that purpose in Uganda for the short rains season.

5.3 Information collected in the field

The information collected was performed as planned in D1.1 with some minor adjustment as detailed below.

For each field id the enumerators have to collect data grouped in two categories:

1. First, the context of the sample with **field characteristics.** The geolocation of the position where the enumerators collect the data, and the time of visit were collected. The field characteristics to be collected in the field and to be reported in the form are shown in Table 3.
2. Secondly, the **crop characteristics** were be captured including especially the identification of the crop type for each field that is identified as cropland. The crop characteristics to be collected in the field are shown in Table 3.

Table 3: Information to be collected and documented in the application.

Additional information	Definition	Possibilities
Cropland presence	Presence of crop fields	Yes / No
Crop identifiable	Is a crop identifiable in the field?	Yes / No
Irrigation type	Identification of the irrigation type	Rainfed / Irrigated / Unidentified
Cropping pattern	Identification of the cropping pattern	Mono-culture / Mixed cropping / Agroforestry
Crop in monoculture	Identification of the name of the crop	Maize / Beans / Potatoes / see Figure 27
Crop field status	Identification of the crop field status	bare soil / crops in ridges / ridges closed / field covered
Overview photo of the field	Photo indicating the field	
Detail photo of the field	Photo indicating details like crop stage or field preparation	Text

Especially, the enumerators identified the correct crop type for each field identified as cropland using a predetermined nomenclature shown in ANNEX I – Description of form used for segment survey.

Short rains season field campaign

To improve the crop areas estimates and the classification results, it has been asked to the surveyors to indicate during the second rainy season field campaign:

1. if a dominant crop was visible for crops in mixed cropping pattern.
2. if the whole field was fully harvested or not.

5.4 Survey logistic and implementation

The survey logistics was performed as anticipated in D1.1 with some minor adjustments as detailed in the following sections.

5.4.1 Equipment in the field

Before performing the fieldwork, the team installed all the equipment and software tools mentioned below.

5.4.1.1 Mobile devices and software tools

The fieldwork was carried out predominantly with **mobile devices** (e.g., an android smartphone or a tablet) using a dedicated **Open Data Kit (ODK) Collect** application to store the collected information in a uniform way using a smart form. ODK Collect is an open-source application which is usable offline but can communicate with a central database to retrieve forms and upload information. The information was stored in the form as numeric fields, text fields, photographs, and geolocation. Figure 10 presents an earlier example of a smart form which was used to test the fieldwork procedures in December 2020.

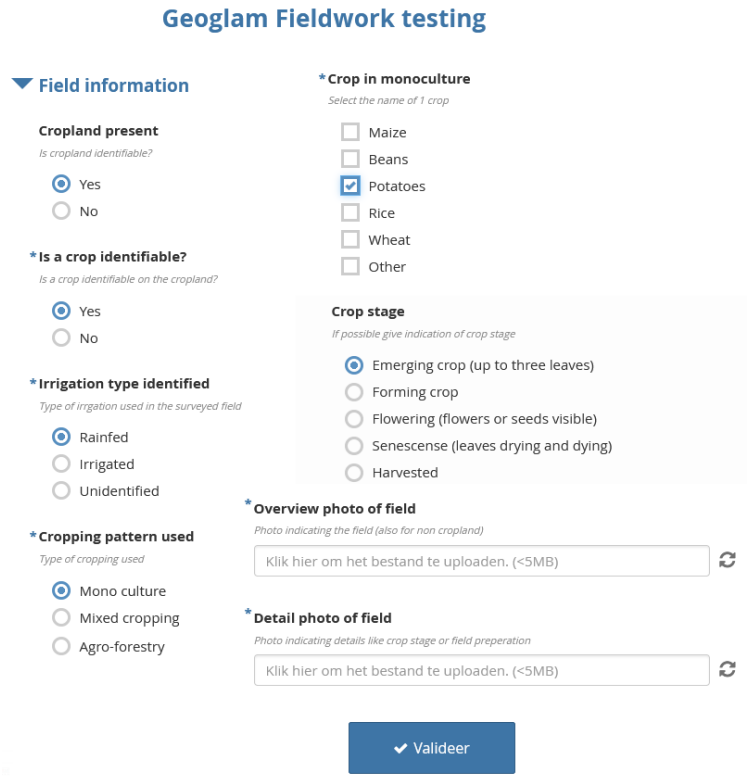


Figure 10: Screenshot of the GEOGLAM fieldwork data form for Uganda.

Data was captured locally and transmitted to secure cloud servers once internet connectivity became available.

Because the capture of geolocation is dependent on the Global Navigation Satellite System (GNSS) available on the mobile device like smartphone or tablet), it is important that the device is capable of getting an accurate measurement and quick fix of available satellites during sampling. The most ideal situation is when the chip of the device is capable of receiving multiple constellations such as GPS and GLONASS.

Beside the application needed for data collection, the application **Avenza maps** were installed on mobile device and used for convenient navigation from one sample unit to the next one. Avenza Maps allows the display of basemaps like Open Street Map (OSM). To facilitate navigation from one sample to the next one, custom maps were provided in MBtiles format as shown in Figure 11. These maps combine Red Green Blue (RGB) or False Color mosaicked Sentinel-2 images with vector overlays of the square samples and a selection of OSM elements (roads and waterways). Each team of enumerators were provided with an indicative optimal route.

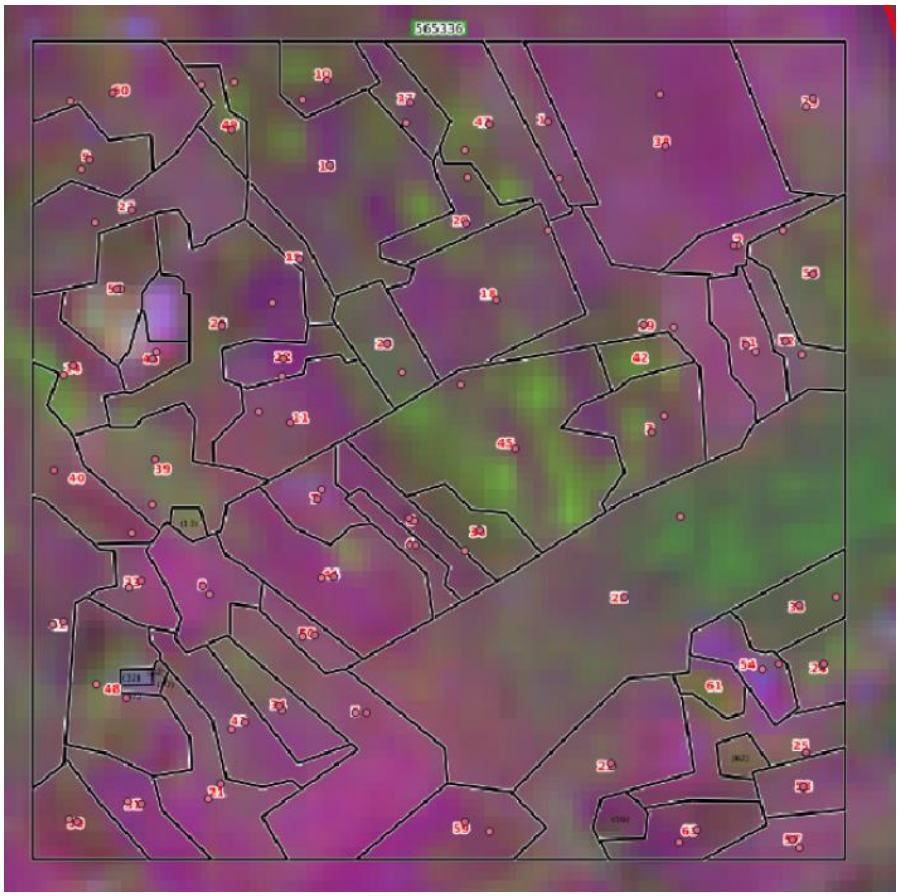


Figure 11: MBTiles and Satellite imagery used to guide the enumerator in the field

Figure 12 shows a general example of visualization possibilities with Avenza Maps.

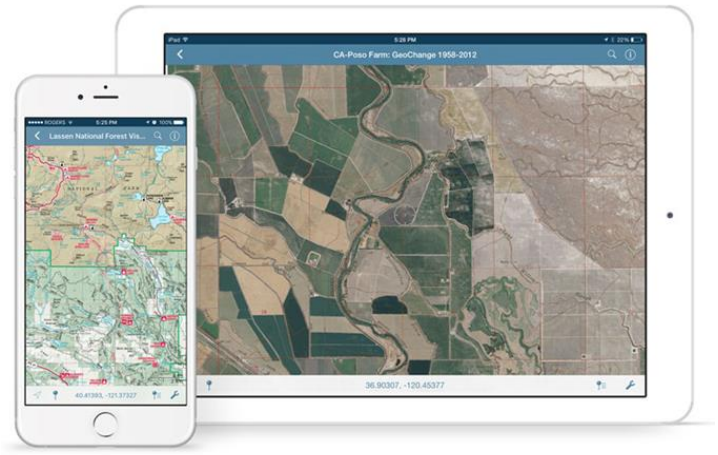


Figure 12: Avenza Map mobile app examples

5.4.1.2 Additional instruments and equipment

Although fieldwork can be performed with the mobile devices and tools mentioned above, additional equipment can be used during fieldwork. Especially to mitigate failure of the mobile devices or provide a cross-check. Enumerators were advised to equip themselves with hardware to mitigate problems with the mobile devices like spare memory cards, sufficient cables, chargers and power banks.

To cross-check the accuracy and mitigate errors with capturing geolocations on the mobile device an additional navigational device like a GPS receiver can be used in the field. An additional photo camera can be used to mitigate failures of the camera in the mobile device. It also helps to collect additional pictures during sampling to provide more context for those processing the fieldwork data.

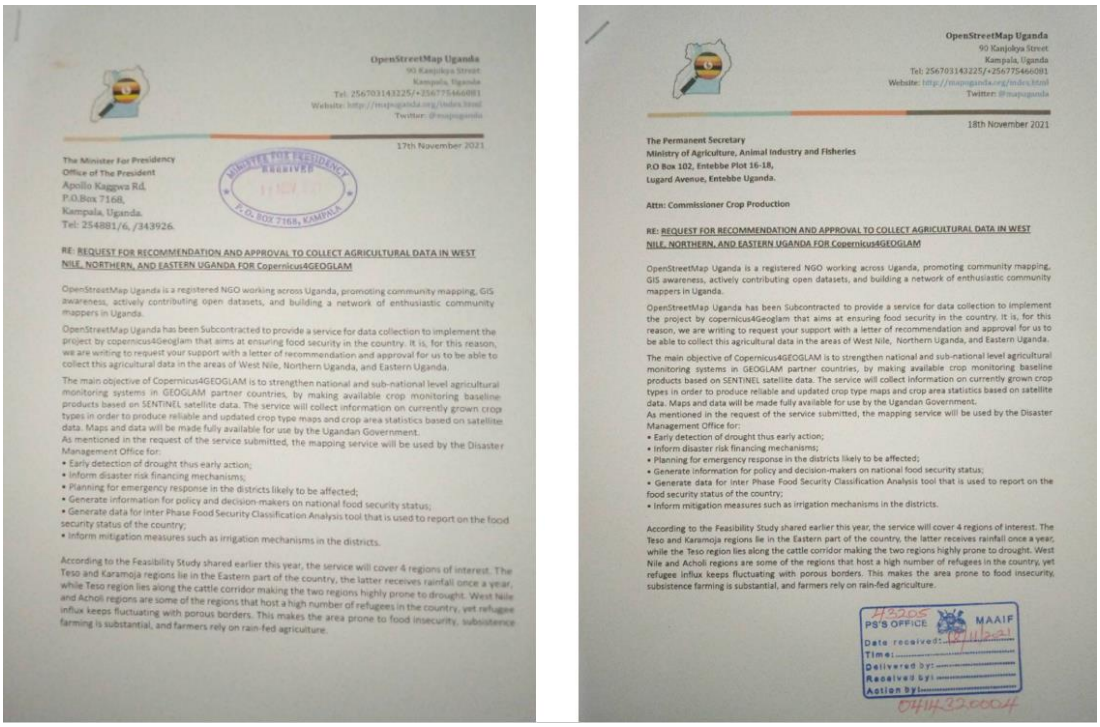
5.4.2 Field work methodology and orientation in the field

5.4.2.1 Guidelines

Every evening, the team prepared the routing to reach samples that they plan to do the day after. Each team of enumerators prepared an indicative optimal route to reach the segments to visit.

The following guidelines were applied:

- Maximize the use of public rights of way;
- Visit the local community leader office to ask permission where possible to get permission of carrying out the field visit in those areas
- Do not damage;
- If challenged, explain mission (show the official support letter from the country contact – see Figure 13), be polite, and apologise if necessary.



OpenStreetMap Uganda
90 Kanjokya Street
Kampala, Uganda
Tel: 256703143225/+256775466081
Website: http://mapuganda.org/index.html
Twitter: @mapuganda

17th November 2021

The Minister For Presidency
Office of The President
Apollo Kaggwa Rd,
P.O.Box 7168,
Kampala, Uganda.
Tel: 254881/6, /343926.

MINISTER FOR PRESIDENCY RECEIVED P.O. BOX 7168, KAMPALA

RE: REQUEST FOR RECOMMENDATION AND APPROVAL TO COLLECT AGRICULTURAL DATA IN WEST NILE, NORTHERN, AND EASTERN UGANDA FOR Copernicus4GEOGLAM

OpenStreetMap Uganda is a registered NGO working across Uganda, promoting community mapping, GIS awareness, actively contributing open datasets, and building a network of enthusiastic community mappers in Uganda.

OpenStreetMap Uganda has been Subcontracted to provide a service for data collection to implement the project by copernicus4Geoglam that aims at ensuring food security in the country. It is, for this reason, we are writing to request your support with a letter of recommendation and approval for us to be able to collect this agricultural data in the areas of West Nile, Northern Uganda, and Eastern Uganda.

The main objective of Copernicus4GEOGLAM is to strengthen national and sub-national level agricultural monitoring systems in GEOGLAM partner countries, by making available crop monitoring baseline products based on SENTINEL satellite data. The service will collect information on currently grown crop types in order to produce reliable and updated crop type maps and crop area statistics based on satellite data. Maps and data will be made fully available for use by the Ugandan Government.
As mentioned in the request of the service submitted, the mapping service will be used by the Disaster Management Office for:
- Early detection of drought thus early action;
- Inform disaster risk financing mechanisms;
- Planning for emergency response in the districts likely to be affected;
- Generate information for policy and decision-makers on national food security status;
- Generate data for Inter Phase Food Security Classification Analysis tool that is used to report on the food security status of the country;
- Inform mitigation measures such as irrigation mechanisms in the districts.

According to the Feasibility Study shared earlier this year, the service will cover 4 regions of interest. The Teso and Karamoja regions lie in the Eastern part of the country, the latter receives rainfall once a year, while Teso region lies along the cattle corridor making the two regions highly prone to drought. West Nile and Acholi regions are some of the regions that host a high number of refugees in the country, yet refugee influx keeps fluctuating with porous borders. This makes the area prone to food insecurity, subsistence farming is substantial, and farmers rely on rain-fed agriculture.

OpenStreetMap Uganda
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Website: http://mapuganda.org/index.html
Twitter: @mapuganda

18th November 2021

The Permanent Secretary
Ministry of Agriculture, Animal Industry and Fisheries
P.O Box 102, Entebbe Plot 16-18,
Lugard Avenue, Entebbe Uganda.

Attn: Commissioner Crop Production

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PS'S OFFICE MAAIF
Date received:
Time:
Delivered by:
Received by:
Action by:

Figure 13: Government supporting letter

5.4.2.2 Orientation

As mentioned, the software Avenza maps were used for navigation from one sample to the next one. Within the application distinct types can be used to navigate and orientate. Both OSM basemaps and custom made RGB or false color satellite imagery (see Figure 14) were provided. Overlays were available of the digitalized samples and fields in combination with OSM vector networks like roads and waterways. This routing was advised to be planned at least one day before visiting the sample.

Figure 14: Recent satellite imagery in natural colours to guide the enumerators in the field

Within the ODK Collect the same maps were made available through MBtiles. When taking a geolocation the enumerators could see a point on top of the selected basemaps with vector overlays. This helps 1) to visualize the geolocation is currently correctly measured and as such reduces the errors that might result of a lower quality satellite fix and 2) to capture locations in the app from a distance. This is possible because the location can be selected by tapping a location on the map and confirm the pinpoint. This type of orientation in the ODK collect app will be used when the enumerators are in the field.

5.4.2.3 Field survey protocol and data collection

When the team reaches the segment, enumerators filled in the smart form stored on the mobile device with ODK Collect. This form ensures a quick, intuitive and uniform collection of field data. The enumerator is asked to identify field information on crop type and crop stage, as well as meta information on the country, the surveyed sample unit, and the field_id.

Short rains season filed campaign

Based on the experience of the first field campaign for the long rains season, the smart form from ODK Collect has been updated allowing the field data collection process being more efficient and intuitive for the enumerators. The updates also facilitate the post-processing of the fieldwork data prior to the classification procedure. A detailed description of the new form and procedure are presented in ANNEX I – Description of form used for segment survey.

Figure 15: Illustration of the field data collection process (training session of the enumerators, field data collection)

5.4.2.4 Photography

In order to cross-check the results, geolocated pictures of the crops (close-up for crop phenology and more distant for crop type and condition) were captured to assess the quality of the collected fieldwork. If needed it will help to augment the results with the help of a trained agronomist.

So, enumerators were requested to take 1) an overview picture of each field present in the segment from their selected vantage location and 2) a close-up picture of the present crop.

Overview pictures provide an overview of the fields with clear features of the visible landscape. These pictures will support spatial orientation at a later stage, using *e.g.,* Google Earth.

5.5 Specification of the local fieldwork partner and organization

The Kenyan company Upande Ltd has been selected as partner of the consortium to conduct the fieldwork for both growing seasons in 2021. Upande Limited is a private Kenyan social enterprise founded in 2009 in order to provide Internet, web mapping and Geographical Information Systems (GIS) services to a variety of clients including private sector, governments, multilateral and bilateral agencies. Customers are primarily based in Kenya, but they serve several other clients across Africa and beyond. During the last few years Upande has moved from a services provider to developing its own products. All products share that they facilitate data centric decision-making and have sensor data integration. The Upande team consists of a group of experts in GIS, Internet mapping, environmental and social academics, software developers and business practitioners.

Upande Ltd subcontracted the field data collection to the local OpenStreetMap Uganda team a local NGO specialised in field data collection across Uganda and the promotion of the community mapping to generate map awareness. OpenStreetMap Uganda was founded in 2012 and was registered as an NGO and registered as a company in April 2017. They provide cartographic training, web mapping and Geographical Information Systems (GIS) services to a variety of clients including private sector, universities, government agencies and NGOs.

5.6 Summary of the field campaign

Starting date: 2021-11-16

Ending date: 2022-01-05

OpenStreetMap Uganda was responsible for all practical local fieldwork and data acquisition. The team was made up of experienced field enumerators who were also involved in the first campaign and a dedicated team took in charge the overall management of the campaign.

The project activities were delayed due to the impact of covid-19 and other challenges experienced during the field campaign such as:

- Access denied to privately owned lands even after being presented with the introductory letter supporting the exercise from the National government. The region is known to be subject to land wrangles and land grabbing. Enumerators were supported by the army in some districts (Kumi/Agago).
- Segments not accessible due to the landscape (e.g. located in national reserve, swamp areas, without road/track network)
- Segments located in districts where the government authorities didn't allow activities due to covid-19 lockdown restrictions implementation (especially the Teso and the districts of Kitgum, Pader, and Omoro) following the President’s guidelines (no inter-district movement allowed).
- Interruption of the field campaign by the Ministry of Agriculture Animal Industry and Fisheries and the Uganda Crime Intelligence Agency (CI)

6 Conclusion and recommendations

Overall, the field data collection in Uganda was performed as planned regarding the implementation and methodology but the field campaign was severely impacted by the interruption of the field campaign by the Ministry of Agriculture Animal Industry and Fisheries and the Uganda Crime Intelligence Agency, the current situation in the country primarily due to the impact of covid-19 pandemic, the hostile reception of the local community chiefs and members.

Thus, all the segments where crops had been identified were not surveyed in the field (69 cropland segments not visited out of 229). However, as presented in 5.2.1, the surveyed samples should be representative of the overall AOI for the 3 regions (West Nile, Teso and Acholi) and the resulting crop area estimates should not suffer from any substantial bias.

Moreover, due to all the reasons previously described, there was a delay 2-3 week which could have an impact since most of the crops were not in their vegetative state as shown in the field campaign preliminary results (D2.1) with most of the cropland characterized with bare soil.

Interaction with local team was good and the quality of the work was satisfying despite the current situation in the country, but adjustments were required.

Some recommendations based on feedback from OpenStreetMap Uganda can be made in case of a future campaign:

- Having a project focal participant from the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) as part of the field team to help shield us from resistance from the district officials. During the handover meeting, the presence of an official from MAAIF should be invited and a budget be considered to add production of maps and field reports for them for their future reference.
- Deploying Agricultural officer assistants to move with the enumerators to facilitate interactions with the farmers.
- Sharing the reports of the in-season field campaign results and crop mask/type mapping to the communities visited to support further activities and clearing some misconceptions of the project being sometimes associated with the land grabbing in the country.
- Involvement of all implementing parties early from the start of the project.
- Community engagement and involvement in the data collection.
- Materials such as T-Shirts, Baseball caps or umbrellas with logos from the European Union (EU) worn by enumerators during the field campaign to facilitate contacts with local farmers would be useful and essential. This will help prevent misunderstandings by the communities and uniquely differentiate them from the rest of the community members.
- Ensuring community sensitisation done with the district officials. This will help spread the message widely within the field project communities to avoid misunderstanding from community members. Radio Talk Shows to be adopted as they are widely used by the communities as a trusted source of information dissemination.

8 ANNEX I – Description of form used for segment survey

8.1 Preamble

This annex describes the structure of the smart form, the protocol to be followed, what kind of information it retrieves in the field and how to deal with issues when surveying in the field.

Before starting to collect field information, each enumerator must make sure:

1. He is using the **new form** with the new URL in the ODK Server setting as shown in Figure 16:
   - URL: https://kc.kobotoolbox.org
   - Username: geoglamuganda2
   - Password: see corresponding email
2. He is using the proper Reference Layer as shown in Figure 17. The enumerators have to use the **last MBTiles** from October/November 2021. The Figure 17 clearly shows that the MBTiles used are from October 2021 for all AOIs and each enumerator has the responsibility to check the proper use of the MBTile.

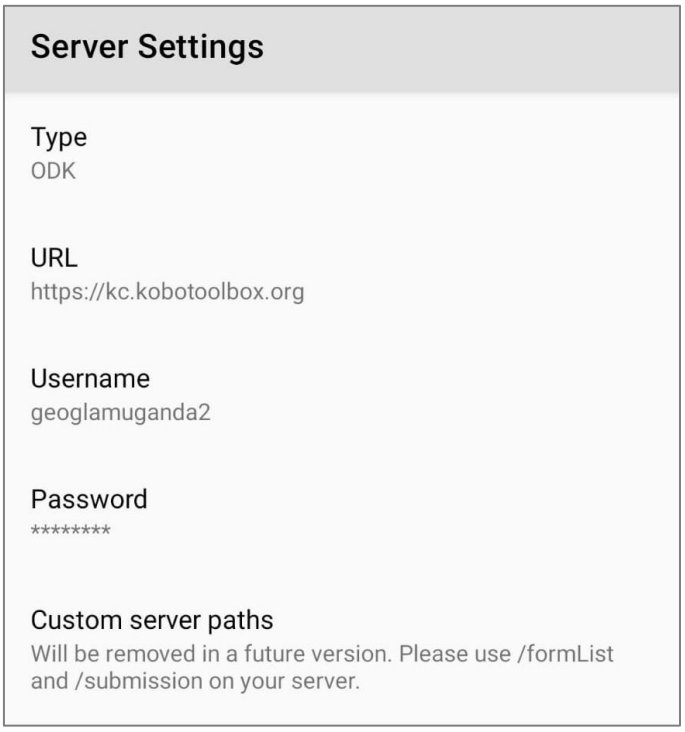


Figure 16: Server setting

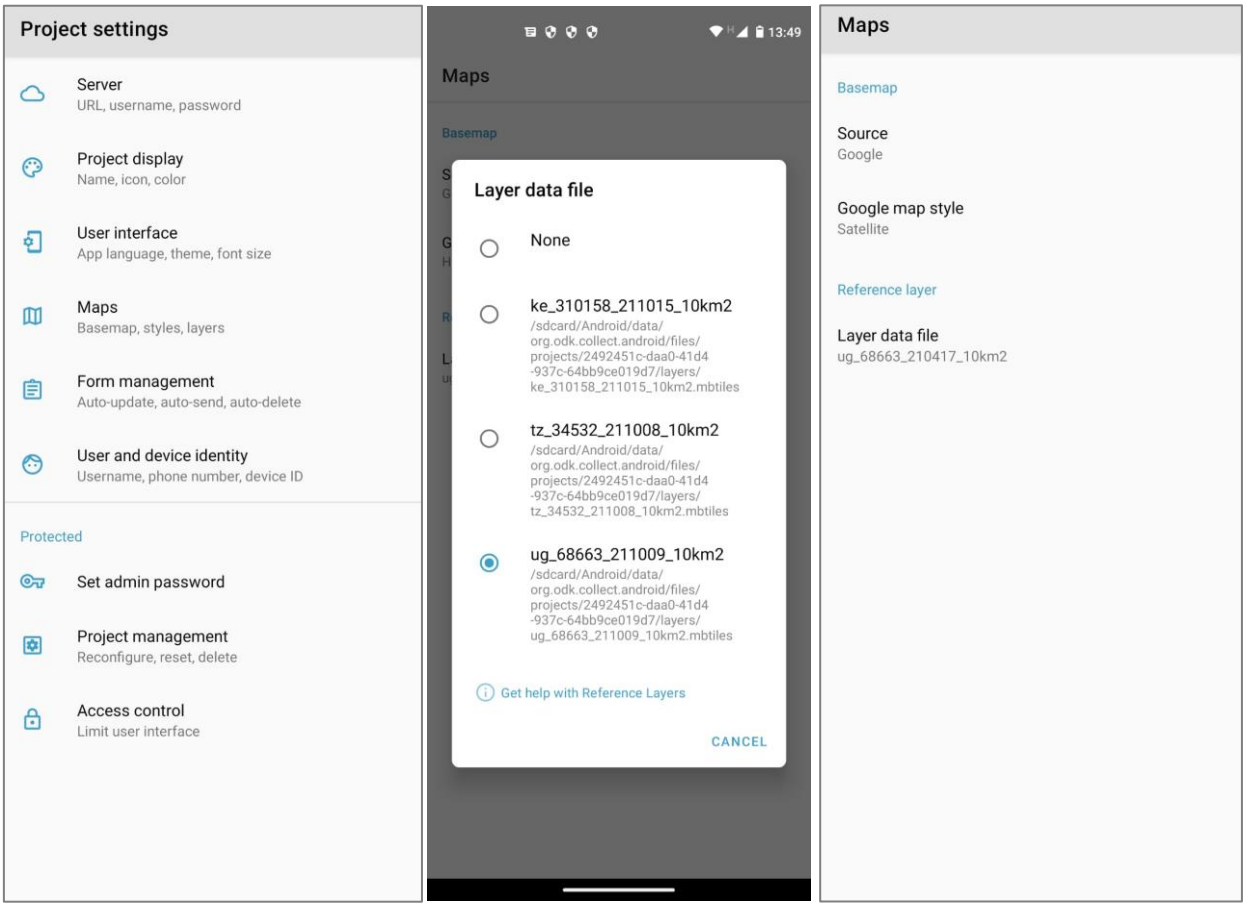


Figure 17: Map setting and MBTile selection

Hereafter, you will find the procedure to be followed for the configuration of the MBTiles, procedure based on a laptop where are stored the new MBTiles and the smartphone used in the field. This is a general procedure, and the configuration can vary from one device to another. Nevertheless, the steps to be followed:

1. Connect the smartphone with a USB cable to the laptop.
2. When connecting the USB to the laptop, the smartphone asks for the connection mode?
    a. If yes: choose the “File transfer” mode.
    b. If no: search for the general setting on the smartphone (with a “wheel” icon ⚙). Go to the “USB preferences” setting or in the search section, type “USB” and select the mode to be used for USB (File transfer) as shown in Figure 18.

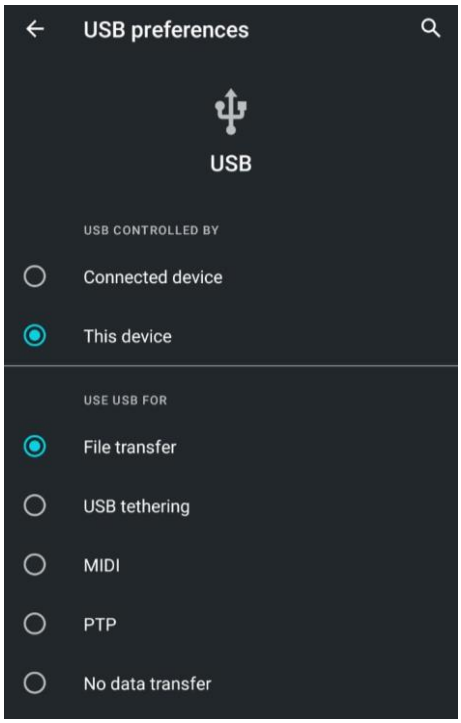


Figure 18: USB preferences

3. On the laptop, open an explorer window and navigate to the location where the MBTiles are stored (see example in Figure 19).
4. Delete all the old MBTiles.
5. Copy the new MBTiles.

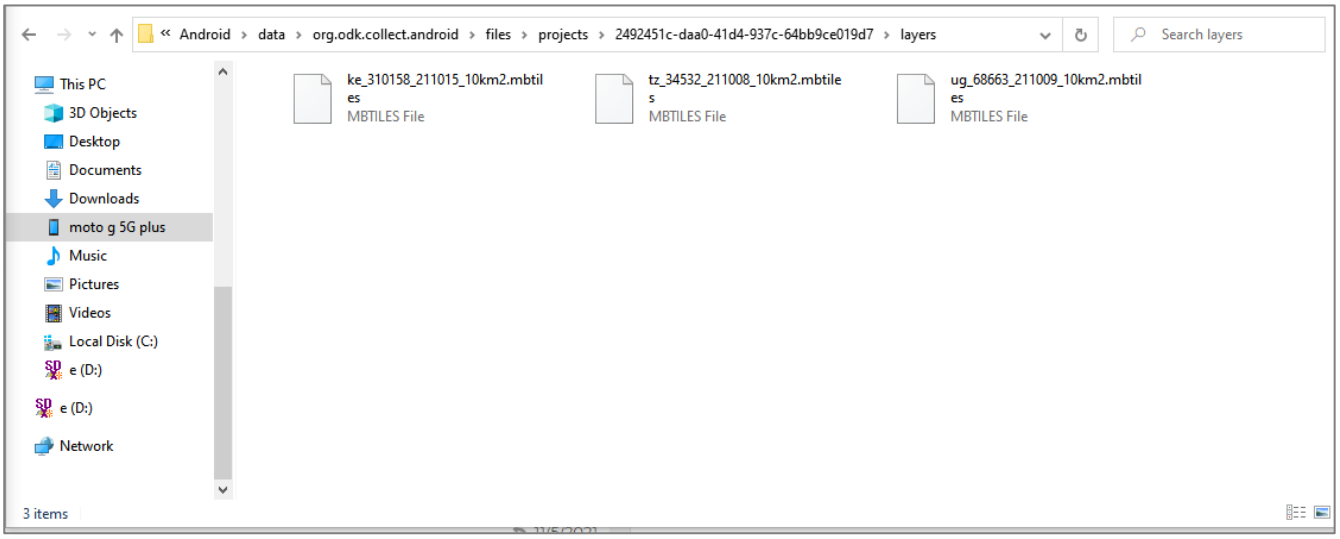


Figure 19: Configuration of the MBTiles in the smartphone used for the field campaign

Prior to the field campaign, each sample has been visually interpreted. All field boundaries (including cropland parcels) have been digitalised, resulting in polygons that constitute the sample. After digitalising the fields, the land cover of each field is determined. following the “Main Land Cover” nomenclature. Only cropland parcels should be surveyed during the field campaign.

8.2 Geolocation

When the surveyor is in the parcel, the first step is to pinpoint its current geographical position in the field as shown in Figure 20. The application will automatically use the coordinates given by the smart device.

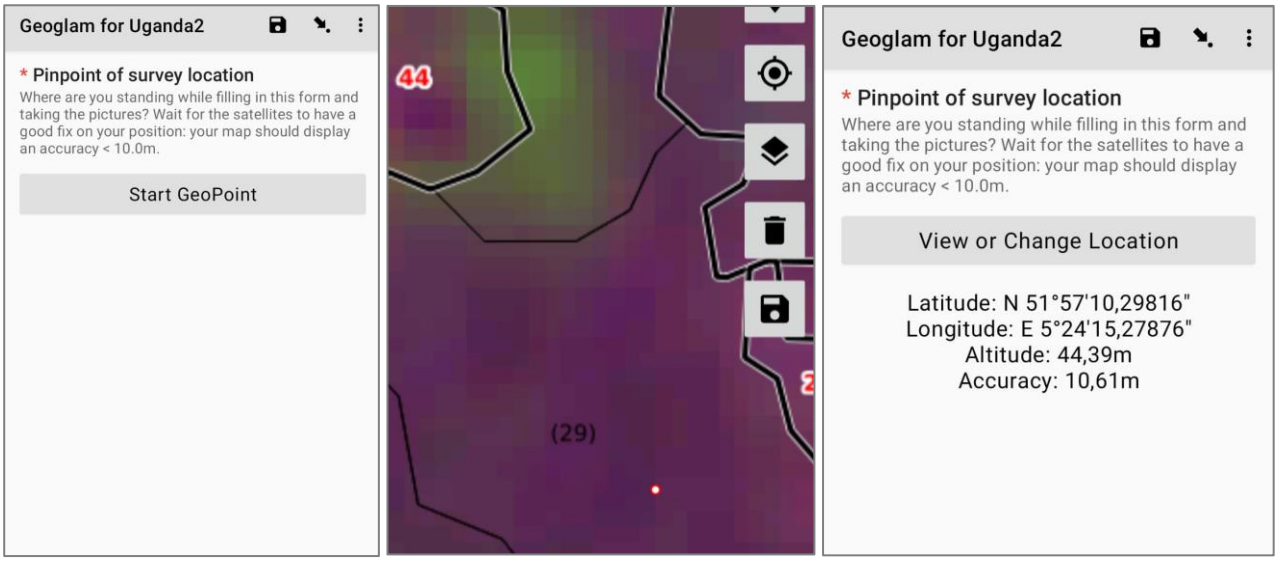


Figure 20: Pinpoint of survey location

The first geolocation concerns the position where the enumerator is standing when making its observation, filling in the form and taking the pictures.

The enumerators have to wait until the spatial accuracy is below **10 meters**.

The second step is to indicate/pinpoint the field actually surveyed as shown in Figure 21. In other words, the enumerator has to point the field surveyed on the screen (long press on the smartphone). It should be notice that no spatial accuracy is available for this second geolocation (field surveyed) because manually recorded by pressing the screen.

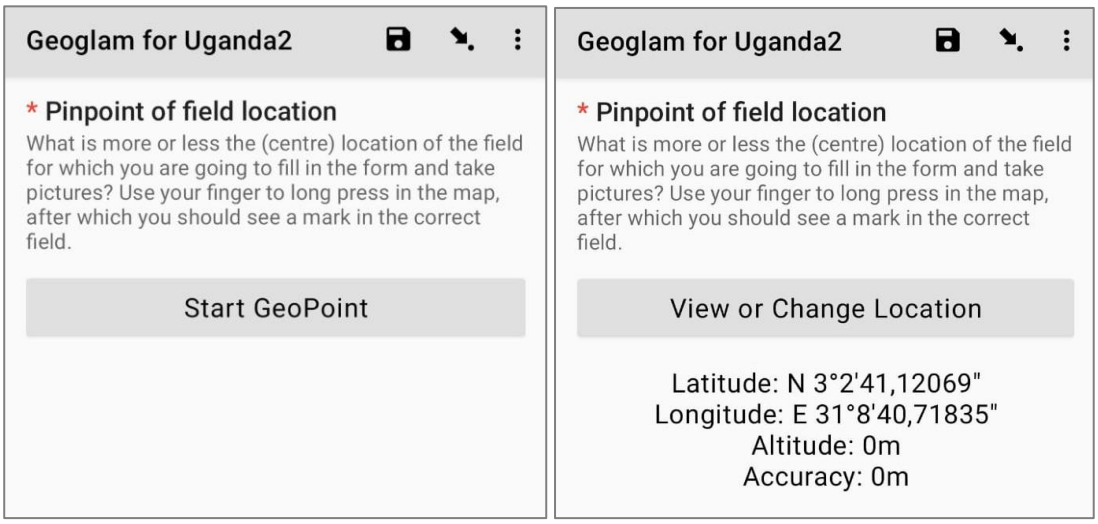


Figure 21: Pinpoint of field location

The enumerators have to access the field to collect the information (exceptions: any events like prohibition by owners or local governments or accessing issues due to heavy rain etc.). Indeed, the quality of the observation will be better when sitting in the field than observing from a long distance.

Special case: the field cannot be accessed

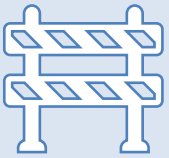
Case 1

If the field cannot be accessed BUT all the information concerning the cropland can be identified from a (small) distance the form can be filled in. In this case, during the second geolocation step, the pinpoint should be placed **within** the field observed and the collect make as usual.

Case 2

Many events like prohibition by owners or local governments or accessing issues due to heavy rain etc. can cause that a field can permanently not be accessed by the enumerator. If the field cannot be accessed permanently and no information can be retrieved, we still want to have the form filled-in, so that for the data-analysis it is clear that no data is to be expected in a later stage and that the field is not "forgotten".

In this case the enumerator can fill-in the form by: 1) **pinpoint** the field on the screen, 2) indicate "**No incorrect delineation"** to the question "Is the field correctly segmented with the desk digitization?" and put a note: "Field cannot be accessed due to [*with the reason*]", 3) indicate "cropland presence" with "No" and "Landuse" with "Other" and note that the field could not be accessed 4) make a mock-up picture and send the form.



Even if the **field cannot be accessed** permanently and **no information can be retrieved**, **enumerators have to fill in the form systematically**.

8.3 Meta-information

The next parts of the form are focusing on retrieving meta information concerning the fieldwork: “country_id”, “sample_id” and “field_id” (see Figure 22). For each segment of 500x500 meters a MBTile is created and the sample_id is given in the top middle of the MBTile (as seen in the third image in Figure 22).

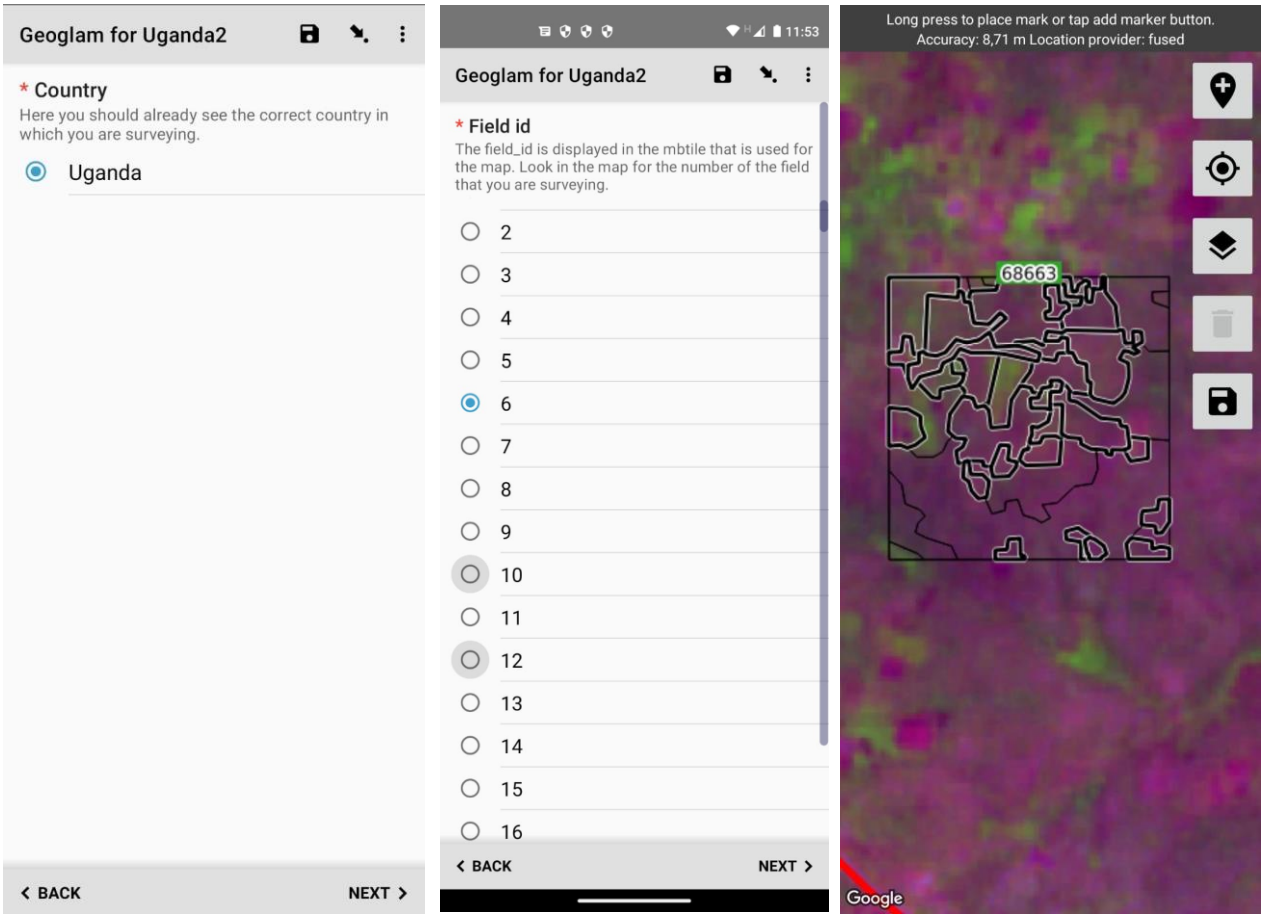


Figure 22 Collecting meta information

Each field has a unique id and ranges from 0 to the number of fields in the segment (see Figure 22). The combination of sample_id and field_id creates a unique combination for later data analysis. Each field_id which is indicated as potential **cropland should be surveyed** (unless the total amount exceeds the contractual amount agreed upon). **Other** digitalized fields with **landcovers** like homesteads, water and forest etc. **do not** have to be surveyed. The field_id number can be selected from a list in the form.

In the MBTile, **the crop fields to be surveyed are indicated with a red number** as shown in Figure 23**.** Other digitalized non-crop fields are indicated with black numbers and have parenthesis.

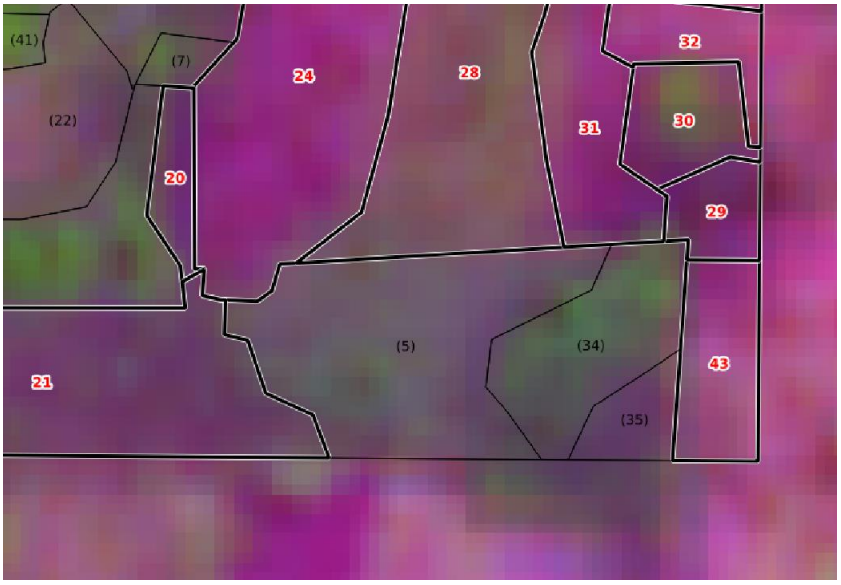


Figure 23 Digitalized sample with field IDs (crop fields with a red number and other landcovers in black)

Then, for each field id the enumerators have to collect data grouped in two categories and further detailed in the following sections:

3. First, the context of the sample with **field characteristics.** The time of visit will be automatically collected. Different field characteristics must be captured such as the correct delineation of the field.
4. Secondly, the **crop characteristics** have to be captured including especially the identification of the crop type for each field that is identified as cropland.

The field and crop characteristics to be collected in the field are shown in Table 4.

Table 4: Information to be collected and documented in the application

Additional information	Definition	Possibilities
Cropland presence	Presence of crop fields	Yes / No
Other landcover	If no presence of cropland, identification of the landcover	Bare soils / Forest / Natural grassland / Natural shrubland / Build-up / Water / Wetland
Cropping pattern	Identification of the cropping pattern	Monoculture / Mixed cropping / Agroforestry
Crop in monoculture	Identification of the name of the crop	
Dominant crop in mixed cropping	Identification of the name of the dominant crop (covering > 50% of the field)	
Crop in mixed cropping	Identification of the name of the crops	
Harvesting	Is the field fully harvested or not	Yes / No
Crop field status	Identification of the crop field status	Bare soil / Crops in ridges / ridges closed / field covered
Irrigation type	Identification of the irrigation type	Rainfed / Irrigated
Overview photo of the field	Photo indicating the field	
Detail photo of the field	Photo indicating details like crop stage or field preparation	

8.4 Field characteristics

The operators have to indicate if the field is correctly digitalized. Although the digitalization is done as precise as possible and using the most recent imagery the parcels in the field can be different. In this case discrepancies will be noted and described as a comment by the enumerator.

Case 1 – Field is aggregated with other fields
If the field surveyed should be aggregated to contiguous parcels and no distinction can be made concerning boundaries, crop type and crop stage, this has to be indicated in the form by selecting in the list the correct answer. In the note, the numbers of the other fields can be mentioned e.g. “field 6, 8 and 7 should be aggregated as one field”. For the other fields the forms should be filled in as well in similar fashion. This to avoid any possible doubt and to perform spatial joins during data analysis.

Case 2 – Field is split
If a field needs to be split, this can be indicated in the form as well. In the notes, enumerators have to put remarks concerning the split and the other crop(s) observed can be written.

Even if a field needs to be split because multiple crops can be observed, filling in additional forms for the different crops observed in the field is not needed and **completely forbidden**.

In other words, **enumerator have to collect one and only one observation per field surveyed.** Surveyors only have to indicate in the notes the different crops observed.

8.5 Crop(s) characteristics

First, the operators have to indicate if a crop is present in the field as shown in Figure 24.

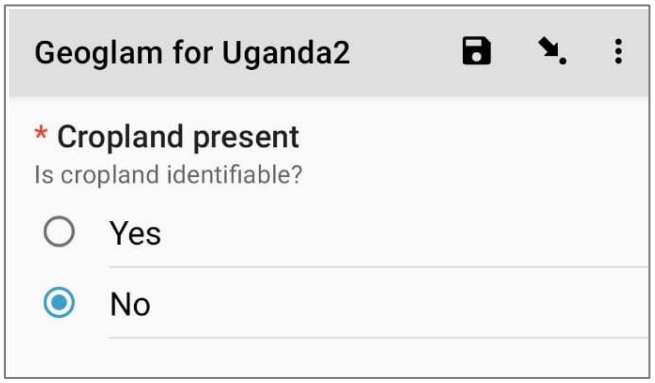


Figure 24: Cropland presence

Although the identification of possible cropland is done as precise as possible based on the recent imagery available, other landcover can be present in the field. In this case, enumerators just have to indicate that the field is not cropland, fill in the correct landcover observed from the list as shown in Figure 25 and take an overview photo of the landscape.

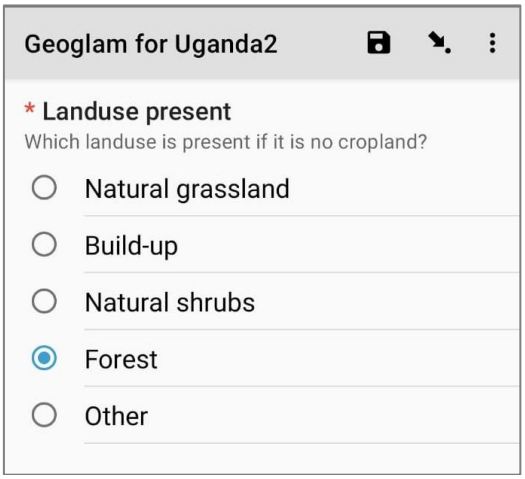


Figure 25: Other landcover identification

Even if no cropland can be observed in the field, the observation has to be made and a form sent to the server.

If a crop is present in the field, the enumerators have to identify the cropping pattern as shown in Figure 26.

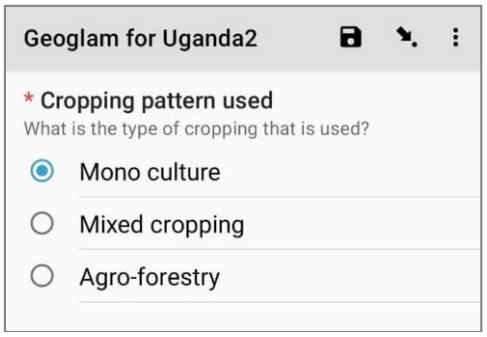


Figure 26: Cropping pattern

Then, from a list, surveyors have to indicate the name of the crop(s) observed in the field as shown in Figure 27 and Figure 28. The list of crops is derived from the first field campaign and should be exhaustive. Nevertheless, if the name of the crop surveyed is missing, the enumerator is allowed to indicate manually the name of the crop.

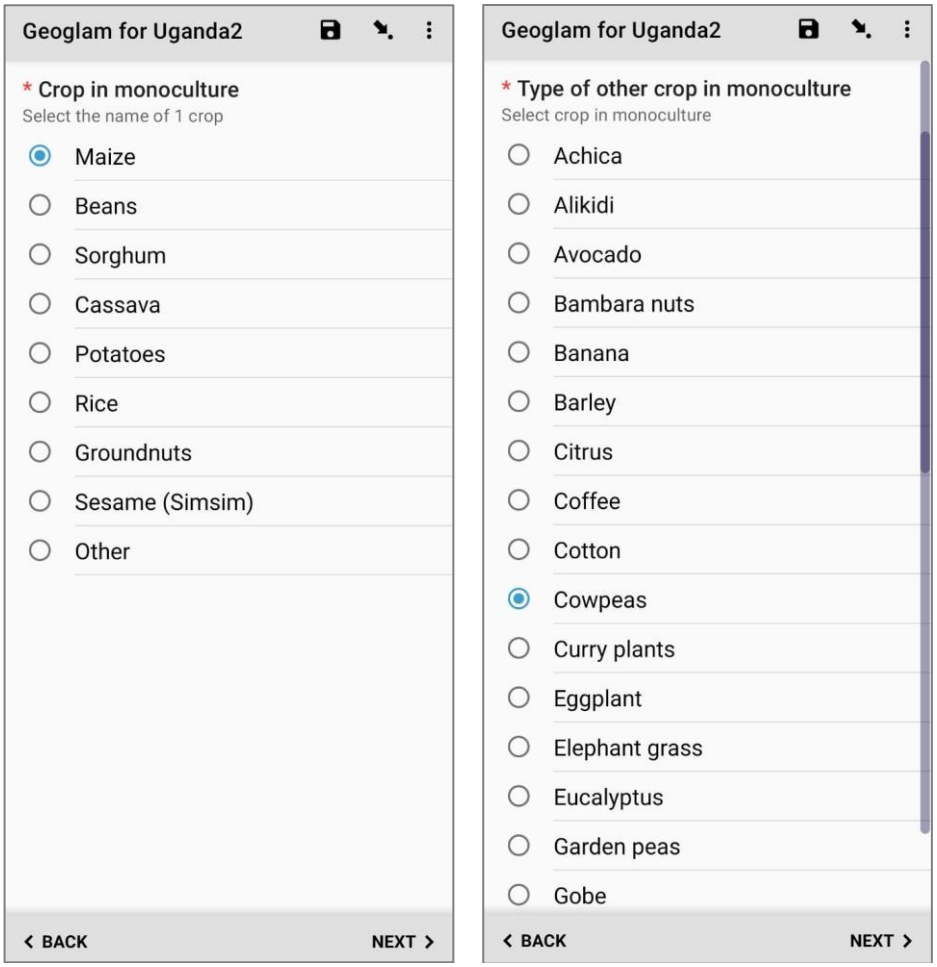


Figure 27: Identification of the crop in monoculture

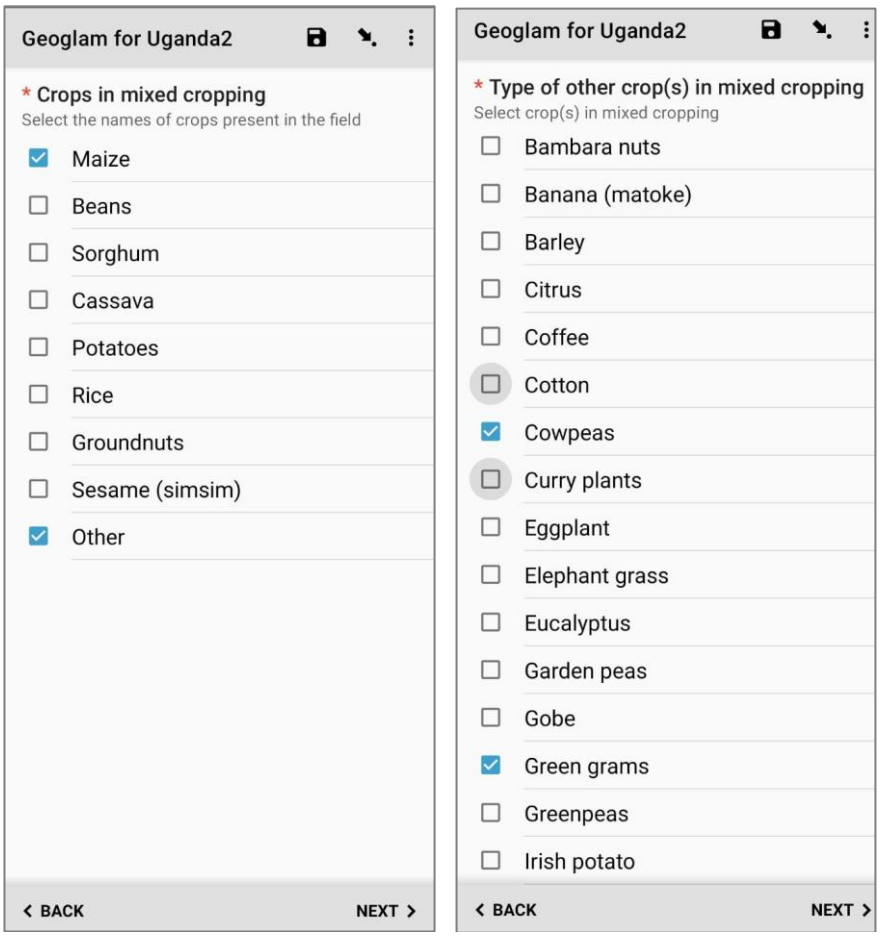


Figure 28: Identification of the crops in mixed cropping

Special cases

Agroforestry

For the agroforestry cropping pattern, the enumerators have to indicate the name of the crop present under the trees as shown in Figure 29. The name of the trees is not requested.

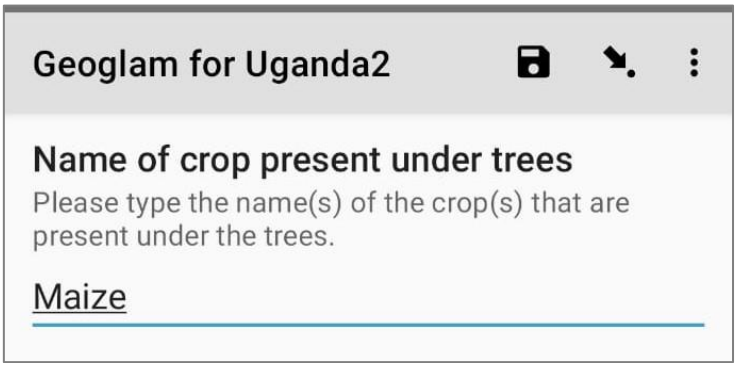


Figure 29: Identification of the crop in agroforestry

Mixed cropping

For the mixed cropping pattern, in order to improve the classification results, the surveyors have to indicate if a dominant crop is visible (from a pull-down list as shown in Figure 30).

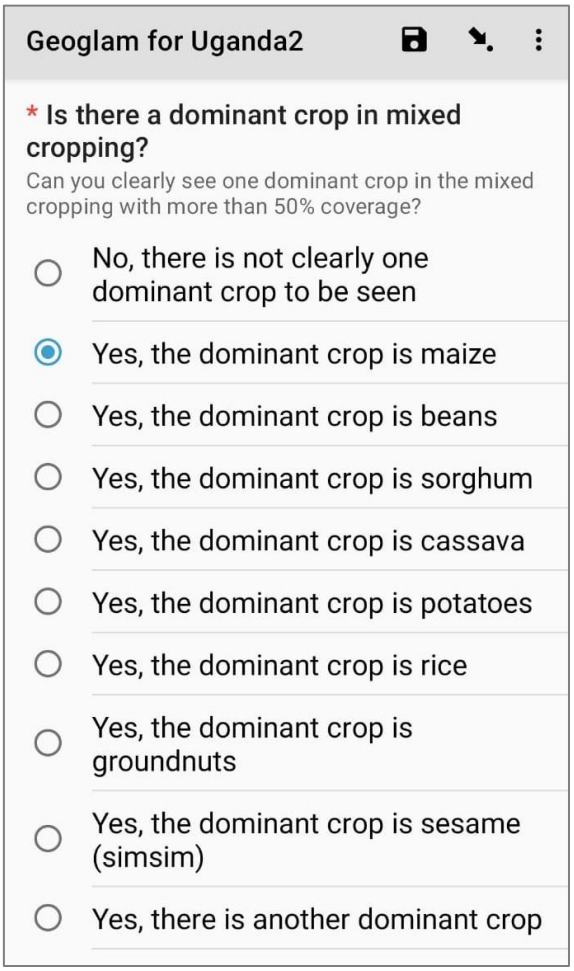


Figure 30: Identification of the dominant crop (if any)

A **dominant crop** covers **more than 50% of the area** (e.g. if it is a fifty/fifty situation, the answer is “No, there is not clearly one dominant crop to be seen”).

Then, the enumerators have to indicate different crop characteristics such as the crop field status (see Figure 32 and for examples), the irrigation system and the crop stage (harvesting status).

Crops in the field, in the ridges

Crops in the field, no ridges

Whole field covered by crops

Figure 31: Examples of crop field status

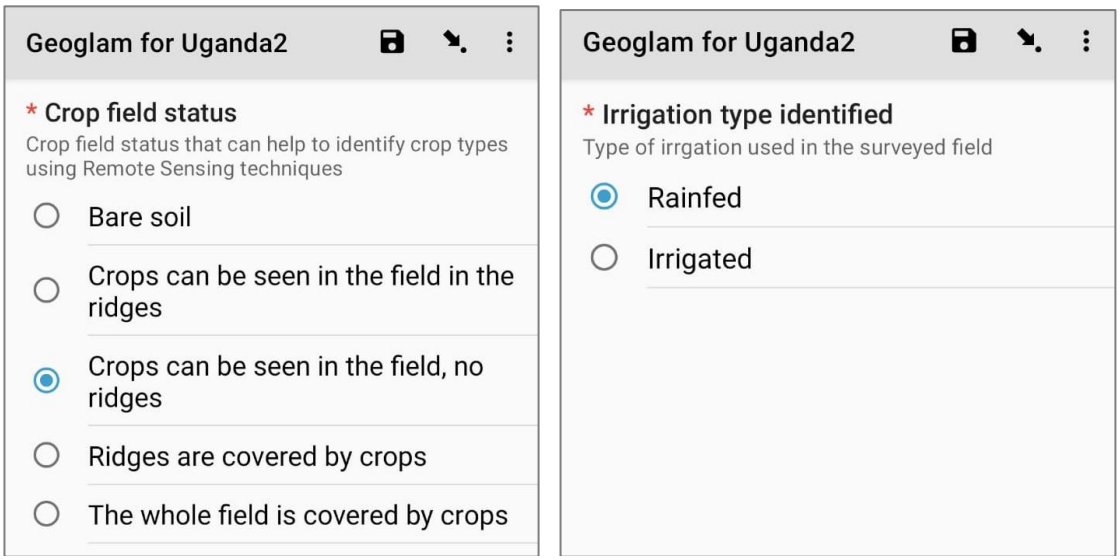


Figure 32: Crop field status and irrigation type identified

Special case: the crop stage harvested

In order to improve the classification results, the surveyors have to indicate if the whole field is fully harvested or not as shown in Figure 33.

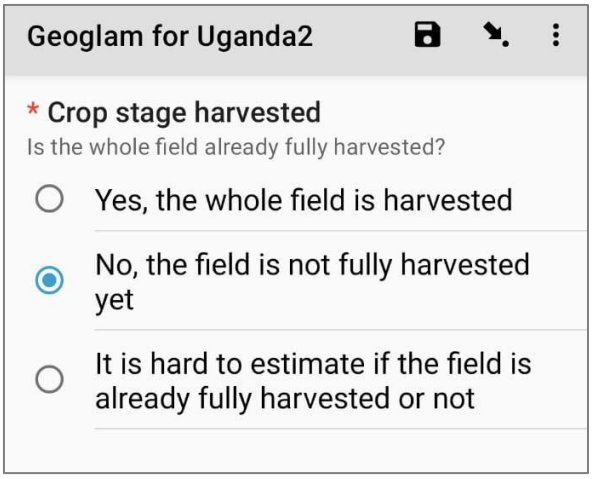


Figure 33: Crop stage harvested

If the field is **partially harvested**, with some parts of the fields still covered by crops, the answer to the question is "**No, the field is not fully harvested**"

Finally, the enumerators have to take two pictures of the field surveyed:

1. **An overview photo**: the operator takes an overview photo of the field zooming out at least 10-30m so the crop field or the landcover can be seen in relation with the surrounding as shown in Figure 34. The photo should be in landscape mode.
2. **A detailed photo**: the surveyor has to zoom out so crops are clearly visible, field characteristics can be inspected, and the crop phenology is clearly derivable from the close-up picture as shown in Figure 34.

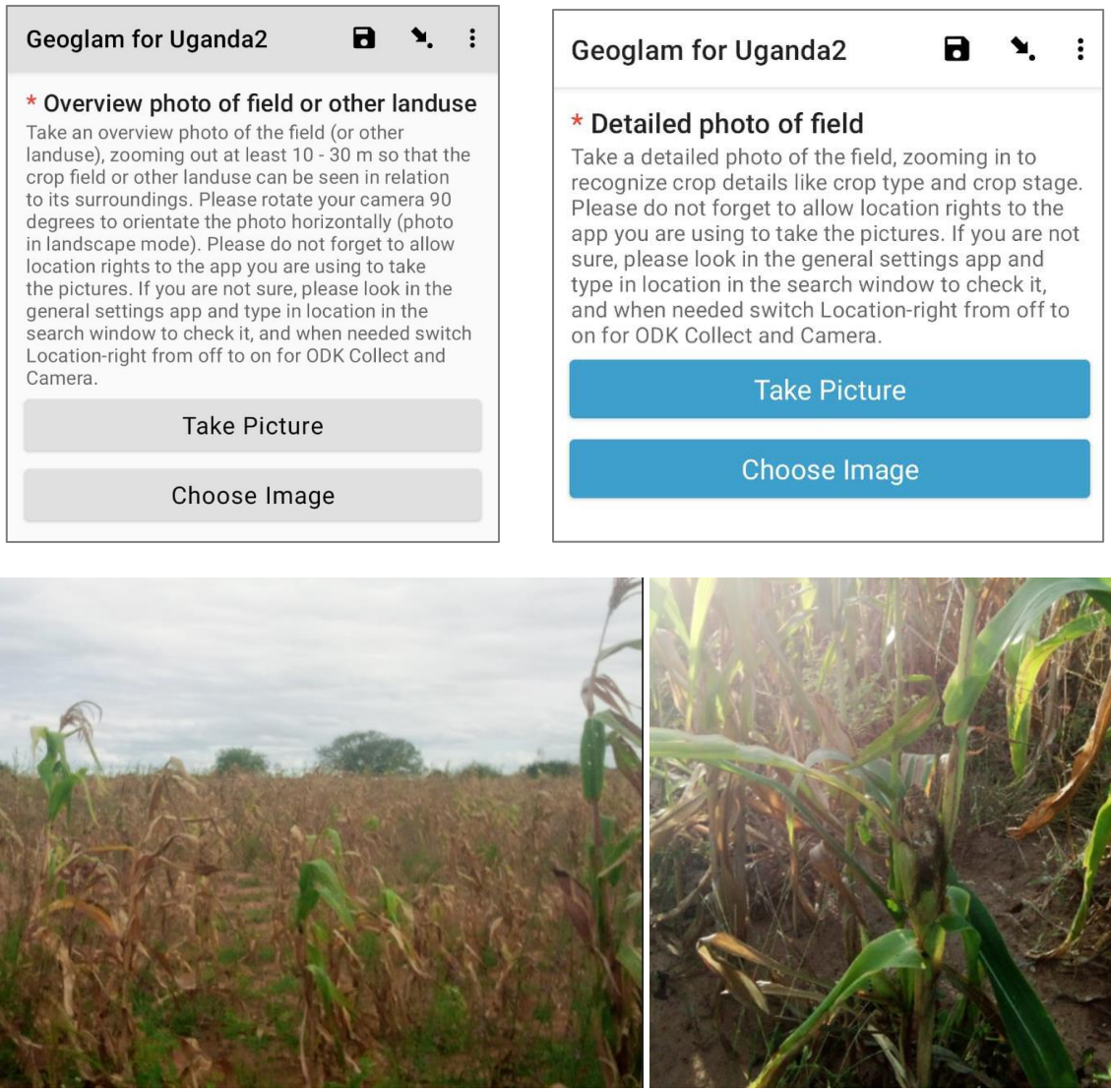


Figure 34: Overview and detailed photo and examples of good pictures (left: overview; right: detailed)

The enumerators have to **turn ON the GPS location on their camera** to enable geotag photos.

Depending on the used device used, this can vary, but in all cases one can use the search function with the general settings menu and search for "location" or "camera" or "app" as shown in Figure 35.

- Parameters of the smartphone / Privacy / Location;
- Parameters of the camera, enabling location.

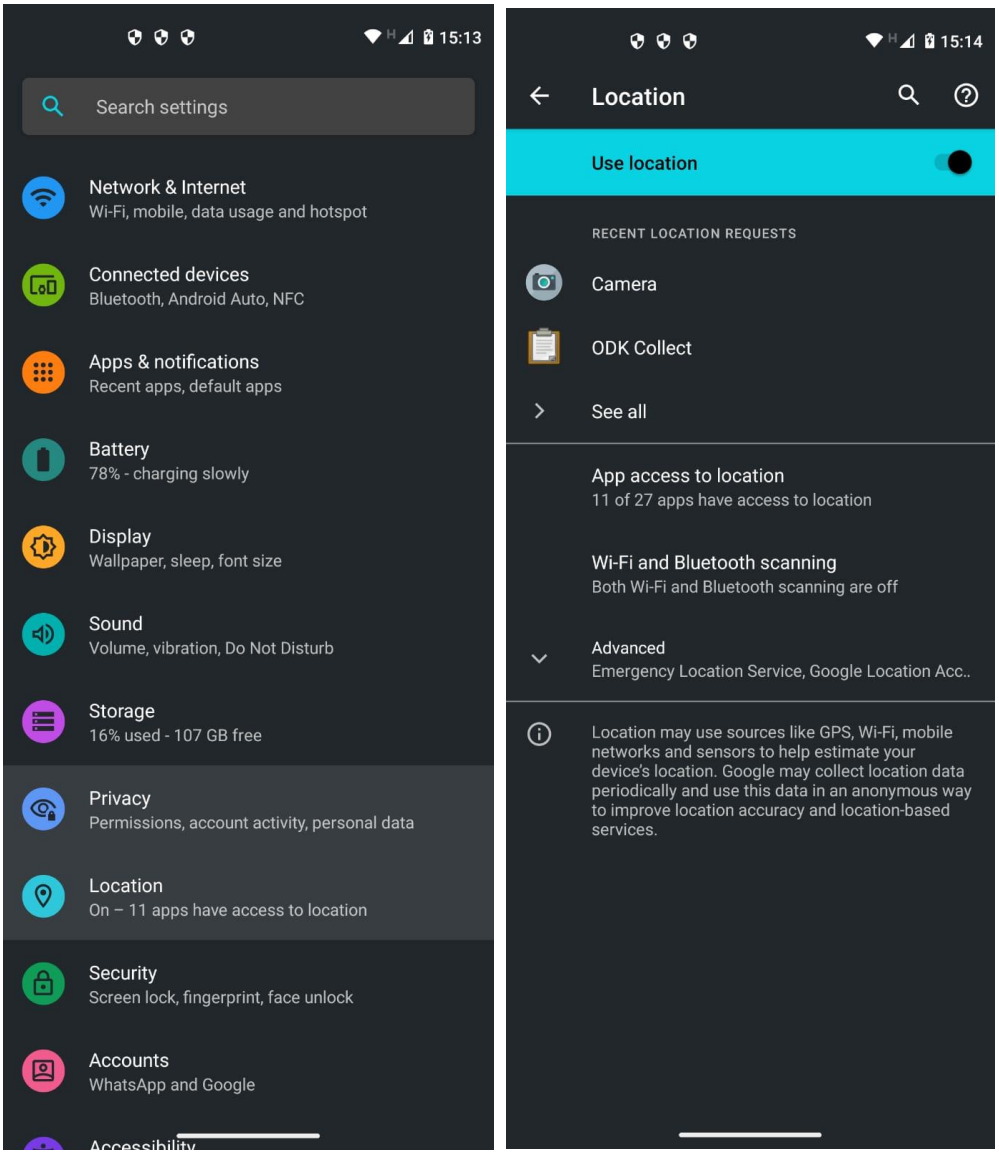


Figure 35: Turning ON the camera location

End result

The last step consists in saving the form (see Figure 36) and exit the data collection. After reviewing a complete segment, the data-analysis team expects to see a filled in form for all croplands (red numbers) in the segment.

Figure 36: Saving the form