

# Service contract for the Copernicus Land monitoring services



## Crop Mapping for GEOGLAM Country Level Support



Framework Contract N°939708-2020-IPR

First Specific Contract

### D2.1 Field Campaign for Uganda – Short Rains Season – Successful completion statement

Prepared by:



with support from:



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## LIST OF ABBREVIATIONS

AOI	Area of Interest
CLS	Collecte Localisation Satellites
EO	Earth Observation
GEOGLAM	Group on Earth Observations Global Agricultural Monitoring
JRC	Joint Research Centre
MAR	Model Assisted Regression
NGO	Non-Gouvernemental Organization
VHR	Very High 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.

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

The present document covers the D2.1 Deliverable highlighting the successful completion of the field campaign for the second rainy season (short rains season) and the presentation of the preliminary results derived from the field campaign implemented as described in the field campaign methodology report (D2.4). A first insight of the crop area estimates will be presented in this report. Consolidated figures will be provided in the Deliverable D3.3 when the crop mask and crop types classifications will be derived based on area estimate bias correction as described in the feasibility report for Uganda (D1.1).

## 2 Objectives of the field campaign

The objective of the survey was 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)

The field campaign took place over the three regions that experience two crop seasons (bimodal rainfall distribution), namely West Nile, Acholi and Teso. Karamoja shows one growing season only (unimodal rainfall) and is excluded from the second field campaign. 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 km<sup>2</sup>** (representing 24% of the country). Figure 1 shows the extent of the area of interest.

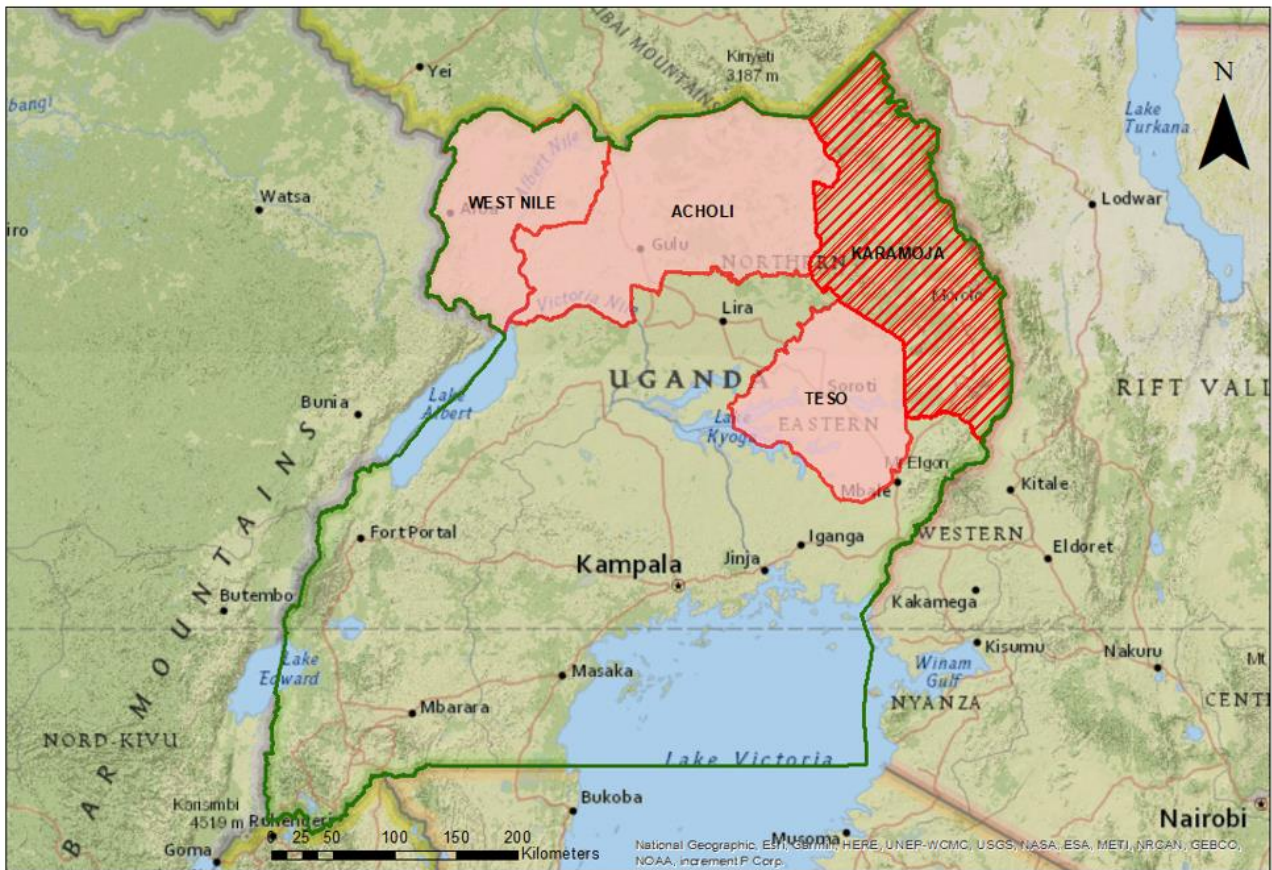


Figure 1: Area Of Interest (in red) in Uganda

## 4 Results of the field campaign

The following preliminary results are based on the 252 segments located in the three regions of Acholi, Teso and West Nile visually interpreted following the landcover nomenclature shown in Table 1 and the 160 segments visited in the field resulting in 7,613 parcels surveyed as described in the feasibility report for Uganda (D1.1) and the field campaign methodology report (D2.4). The field campaign permitted to collect information regarding the fields and crops characteristics.

It should be noted that 69 segments that were due to be visited were not surveyed due to denied access by the local authorities/people, for safety reasons when fields were located in regions with limited accessibility or insecure, and mostly because the second field campaign were interrupted during the process. In fact, 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.

As described in the field campaign methodology report (D2.4), the 69 cropland segments are mostly located in the Acholi region (Kitgum, Pader, Gulu districts). The West Nile and Teso show a good coverage (except for Adjumani and Kaberamaido districts), Acholi is more problematic, but the 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 1: Main Landcover nomenclature**

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

**It should be stressed that the results presented in the next sections are preliminary** and will be adjusted based on the area estimate bias correction as described in the feasibility report for Uganda (D1.1). The objective is to provide a first synthetic insight of the crop area estimates based on the harmonized field work dataset without taking into account the sampling rate. Therefore, considering that the non-surveyed crop segments are included in the following tables, the crop area estimates are likely to be slightly underestimated.

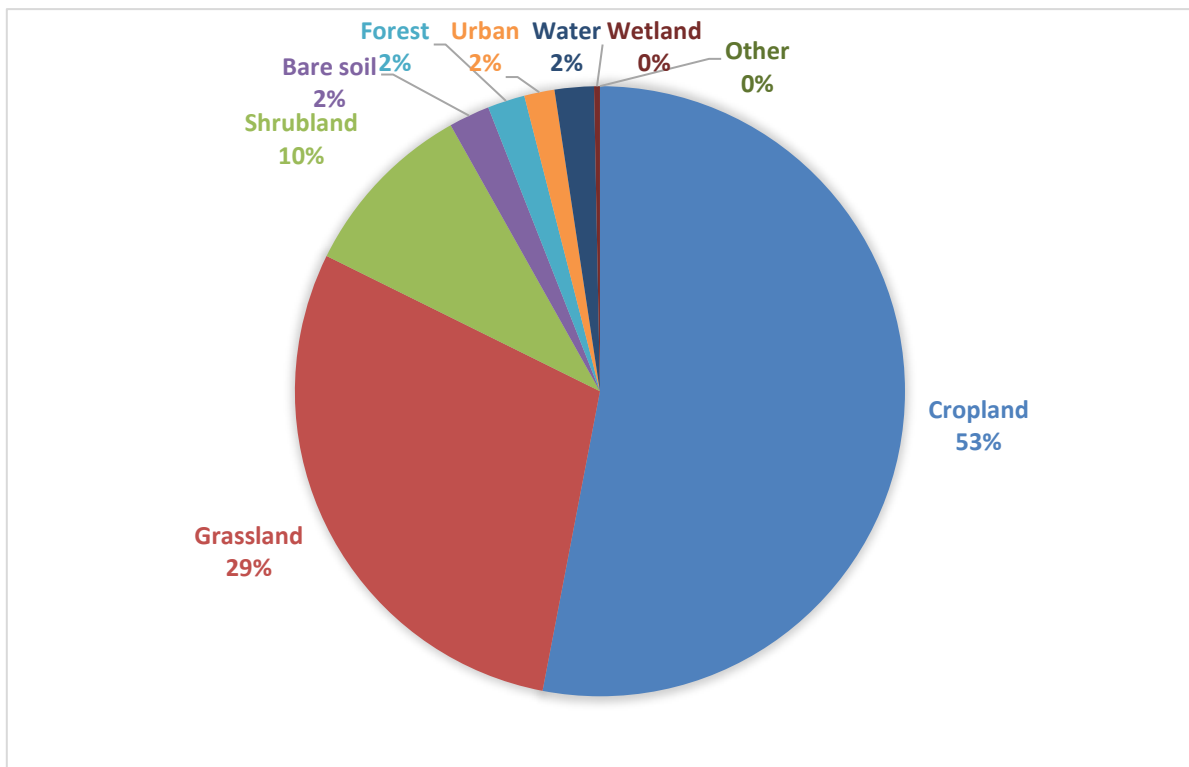
### 4.1 Overview

The Table 2 shows the segment-based areas and the AOI three-region area estimates for the 8 main landcover classes identified during the short rains season.

**Table 2: Area estimates for the main landcover classes identified at both segments and AOI level (Acholi, Teso and West Nile regions) for the short rains season**

Landcover	Segment estimates		AOI estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Cropland	33.30	53.02%	31,170.66
Grassland	18.40	29.30%	17,225.51
Shrubland	6.00	9.55%	5,613.38
Bare soil	1.36	2.17%	1,276.33
Forest	1.24	1.98%	1,161.98
Urban	1.01	1.61%	944.55
Water	1.30	2.08%	1,220.07
Wetland	0.20	0.31%	183.10
<b>Total</b>	<b>62.81</b>	<b>100.00%</b>	<b>58,795.57</b>

The preliminary results show that approximately 53% of the areas is covered by cropland, representing approximately 31,170 km<sup>2</sup> at the AOI level. Figure 2 illustrates the distribution of the main landcover classes derived from the 252 segments interpreted and/or surveyed.



**Figure 2: Distribution of the main landcover classes derived from the 338 segments interpreted and surveyed**



Table 3 shows the segment-based areas and the area estimates obtained during the long rains season for the three regions of Acholi, Teso and West Nile.

**Table 3: Area estimates for the main landcover classes identified at both segments and AOI level (Acholi, Teso and West Nile regions) for the long rains season**

Landcover	Segment estimates		AOI estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Cropland	<b>33.77</b>	<b>53.82%</b>	<b>31,646.10</b>
Grassland	17.21	27.42%	16,123.52
Shrubland	5.45	8.68%	5,103.24
Forest	1.83	2.92%	1,718.26
Urban	1.76	2.80%	1,647.49
Water	1.31	2.08%	1,223.20
Bare soil	1.24	1.97%	1,159.67
Wetland	0.13	0.21%	120.66
Other	0.06	0.09%	53.42
<b>Total</b>	<b>62.75</b>	<b>100.00%</b>	<b>58 795.57</b>

## 4.2 Cropping system

The Table 4 shows the segment-based areas and AOI area estimates regarding the cropping systems in the region of Acholi, Teso and West Nile for the short rains season.

**Table 4: Area estimates for the cropping patterns at segment and AOI levels for the short rains season**

Cropping pattern	Segment-based areas		AOI area estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Agroforestry	0.08	0.12%	72.02
Mixed cropping	3.97	6.31%	3,712.58
Monoculture	10.54	16.78%	9,864.56
Undetermined* or Non-crop	48.23	76.79%	45,146.42
<b>Total</b>	<b>62.81</b>	<b>100.00%</b>	<b>58,795.57</b>

\* 18.52 km<sup>2</sup> out of 45.28 km<sup>2</sup> of the fields identified as cropland during the interpretation based on VHR imagery were not surveyed due to budget constraint or inaccessibility as explained in the field campaign methodology report (D2.4)

The preliminary results show that three quarter of the cropland is in monoculture and the other quarter in mixed cropping, representing respectively 9,865 km<sup>2</sup> and 3,713 km<sup>2</sup> of the AOI. The agroforestry system only represents 0.12% of the area, representing 72 km<sup>2</sup>.

Table 5 shows the segment-based areas and area estimates derived from the long rains season field campaign.

**Table 5: Area estimates for the cropping patterns at segment and AOI levels for the long rains season**

Cropping pattern	Segment-based areas		AOI area estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Agroforestry	0.29	0.47%	274.02
Mixed cropping	11.06	17.62%	10,362.63
Monoculture	16.52	26.33%	15,480.87

Undetermined* or Non-crop	34.87	55.58%	32,678.06
<b>Total</b>	<b>62.75</b>	<b>100.00%</b>	<b>58,795.57</b>

The preliminary results show a decrease of the areas covered by crops in monoculture and mixed cropping from the long rains to the short rains season (respectively from 15,481 to 9,865 km<sup>2</sup> and 10,363 to 3,713 km<sup>2</sup>). These results can be explained by short rains during the second season compared to the first season. Moreover, Uganda faced drought<sup>1</sup> conditions during the short rains season, confirmed by the field team, which can also explain the preliminary results.

### 4.3 Crop stage

The Table 6 and Figure 3 show the segment-based areas and three-region AOI area estimates regarding the crop stages for the short rains season.

**Table 6: Area estimates for the cropping patterns at segment and AOI levels for the short rains season**

Crop stage	Segment-based areas		AOI area estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Bare soil	8.66	13.79%	8,107.68
Crop in ridges	1.82	2.89%	1,699.67
Crop not in ridges	2.05	3.27%	1,923.77
Field covered	1.63	2.59%	1,522.82
Ridges closed	0.42	0.67%	395.21
Undetermined* or Non-crop	48.23	76.79%	45,146.42
<b>Total</b>	<b>62.81</b>	<b>100.00%</b>	<b>58,795.57</b>

\* 18.52 km<sup>2</sup> out of 45.28 km<sup>2</sup> of the fields identified as cropland during the interpretation based on VHR imagery were not surveyed due to budget constraint or inaccessibility as explained in the field campaign methodology report (D2.4)

The preliminary results show that approximately 60% of the cropland is characterized with bare soil, representing 8,108 km<sup>2</sup> of the AOI. Only 11% of the cropland are characterized with crops still in their vegetative state (crop stage “Field covered”), representing 1,523 km<sup>2</sup> of the AOI. The crop stages “Crop not in ridges”, “Crop in ridges” and “Ridges closed” represent 14%, 13% and 3% covering respectively 1,924 km<sup>2</sup>, 1,700 km<sup>2</sup> and 395 km<sup>2</sup> of the AOI.

<sup>1</sup> <https://mars.jrc.ec.europa.eu/asap/>

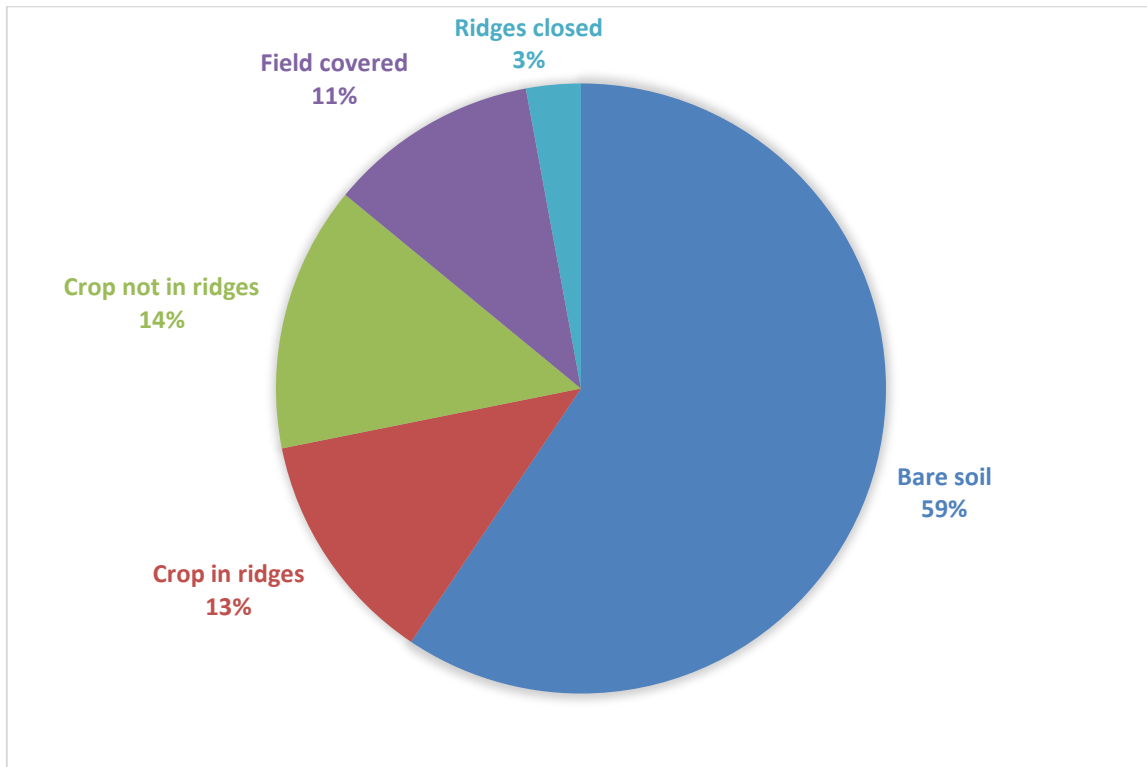


Figure 3: Distribution of the different crop stages for the parcels where crops have been identified in the field

Table 7 shows the segment-based areas and three-region AOI area estimates regarding the crop stages for the long rains season.

Table 7: Area estimates for the cropping patterns at segment and AOI levels for the long rains season

Crop stage	Segment-based areas		AOI area estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Bare soil	17.95	28.61%	16,820.54
Crop in ridges	1.08	1.72%	1,012.57
Crop not in ridges	5.69	9.06%	5,327.23
Field covered	2.58	4.12%	2,422.07
Ridges closed	0.52	0.83%	485.53
Undetermined* or Non-crop	34.93	55.66%	32,727.63
<b>Total</b>	<b>62.75</b>	<b>100.00%</b>	<b>58,795.57</b>

The preliminary results show a decrease of the areas covered by bare soils from the long rains to the short rains season.

## 4.4 Crop types in monoculture

### 4.4.1 5 main crop types identified by the applicant country

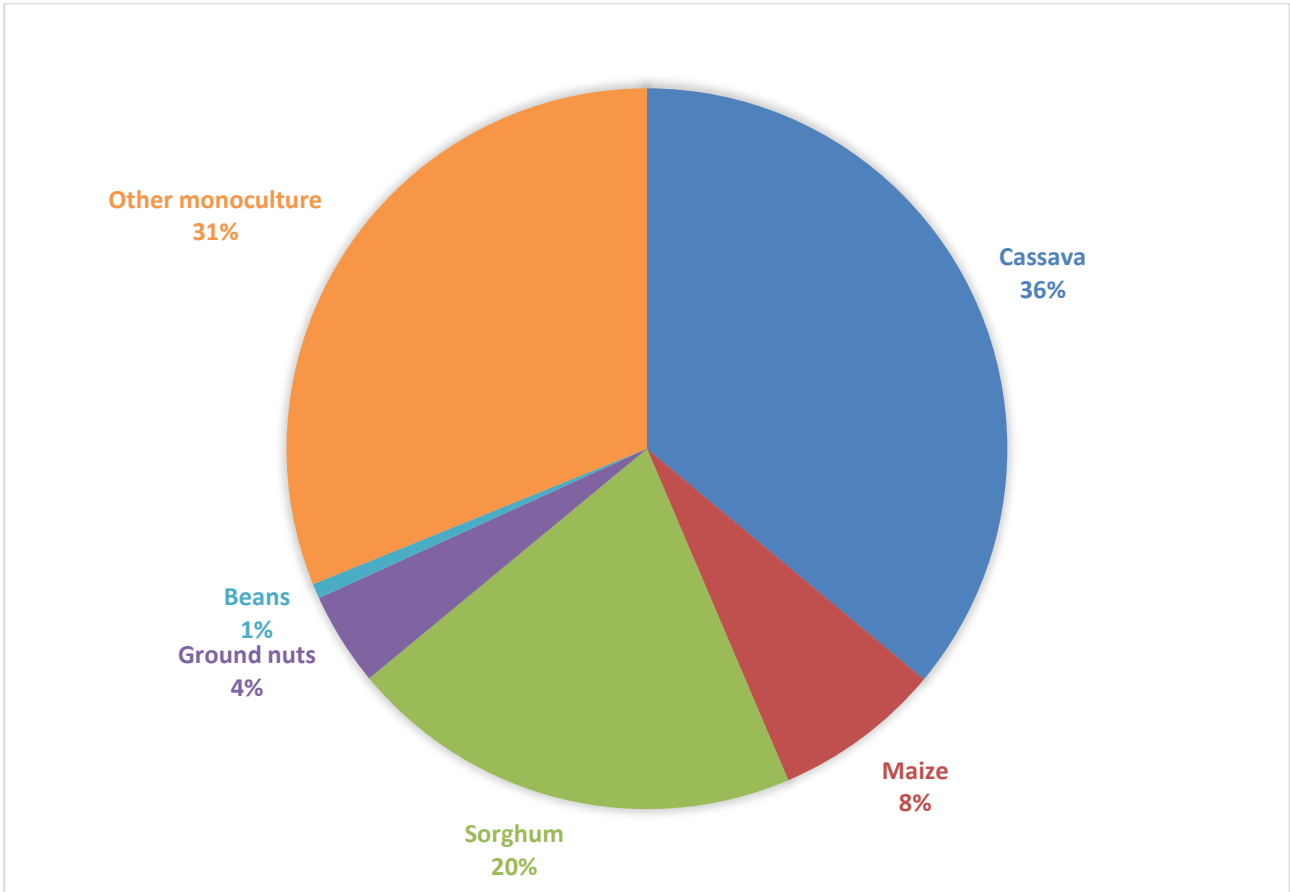
The Table 8 shows the segment-based areas and the AOI area estimates for the 5 main crop types identified by the applicant country in the regions of Acholi, Teso and West Nile and the other monoculture or landcover classes of the AOI.

**Table 8: Area estimates for the 5 main crop types identified by the applicant country in the AOI for the short rains season**

Crop type	Segment-based areas		AOI area estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Cassava	3.82	6.08%	3,575.90
Maize	0.80	1.27%	747.21
Sorghum	2.16	3.44%	2,025.46
Ground nuts	0.44	0.71%	415.86
Beans	0.07	0.11%	66.00
Other monoculture	3.30	5.25%	3,088.17
Other (undetermined*, mixed cropping, non-crop areas)	52.21	83.13%	48,876.97
<b>Total</b>	<b>62.81</b>	<b>100.00%</b>	<b>58,795.57</b>

\* 18.52 km<sup>2</sup> out of 45.28 km<sup>2</sup> of the fields identified as cropland during the interpretation based on VHR imagery were not surveyed due to budget constraint or inaccessibility as explained in the field campaign methodology report (D2.4)

The preliminary results show that the area estimates for the cassava, maize, sorghum, ground nuts and beans are respectively 3,576 km<sup>2</sup>, 747 km<sup>2</sup>, 2,025 km<sup>2</sup>, 415 km<sup>2</sup> and 66 km<sup>2</sup>. Cassava is the dominant crop type and represents approximately 6.08% of the area (36% of the crops in monoculture as shown in Figure 4). Sorghum represents 3.4% of the AOI (20% of the crops in monoculture). The 3 other crop types selected by the applicant country for this study represent approximately 1% and less of the territory. The other crop types in monoculture cover approximately 5.3% of the AOI (31% of the crops in monoculture), representing 3,088 km<sup>2</sup>. The section 0 shows the area-based dominant crop types in monoculture.



**Figure 4: Distribution of the 5 main crop types identified by the applicant country compared to the other crops in monoculture for the short rains season**

Table 9 shows the segment-based areas and the AOI area estimates for the 5 main crop types identified by the applicant country for the long rains season.

**Table 9: Area estimates for the 5 main crop types identified by the applicant country in the AOI for the long rains season**

Crop type	Segment-based areas		AOI area estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Cassava	2.70	4.30%	2,529.07
Maize	1.20	1.90%	1,119.97
Sorghum	0.35	0.56%	331.74
Ground nuts	0.59	0.94%	553.44
Beans	0.24	0.38%	224.94
Other monoculture	1.33	2.12%	1,246.67
Other (undetermined*, mixed cropping, non-crop areas)	56.34	89.79%	52,789.75
<b>Total</b>	<b>62.75</b>	<b>100.00%</b>	<b>58,795.57</b>

The preliminary results show substantial changes of the areas covered by certain crops in monoculture between the two seasons. Thus, the most important increase concerns the sorghum, from 332 to 2,025 km<sup>2</sup>. The cassava also shows an increase from 2,529 to 3,576 km<sup>2</sup>. On the other hand, the most significant decrease concerns the maize, from 1,120 to 747 km<sup>2</sup>.

#### 4.4.2 Main crop types resulting from the field campaign

The Table 10 shows the segment-based areas and the AOI area estimates for the main crop types surveyed during the second field campaign and the other monoculture or landcover classes of the AOI.

**Table 10: Area estimates for the dominant crop types for the short rains season**

Crop type	Segment-based areas		AOI area estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Cassava	3.82	6.08%	3,575.90
Sorghum	2.16	3.44%	2,025.46
Potatoes	0.86	1.37%	805.44
Maize	0.80	1.27%	747.21
Sesame	0.54	0.85%	502.63
Groundnuts	0.44	0.71%	415.86
Rice	0.43	0.68%	400.30
Sunflower	0.26	0.41%	243.44
Other monoculture	1.28	2.04%	1,202.36
Other (undetermined*, mixed cropping, non-crop areas)	52.21	83.13%	48,876.97
<b>Total</b>	<b>62.81</b>	<b>100.00%</b>	<b>58,795.57</b>

\* 18.52 km<sup>2</sup> out of 45.28 km<sup>2</sup> of the fields identified as cropland during the interpretation based on VHR imagery were not surveyed due to budget constraint or inaccessibility as explained in the field campaign methodology report (D2.4)

It is interesting to note that the preliminary results show that the 4 out of the 5 main crop types identified by the applicant country are part of the most representative crop types of the AOI (beans excluded). In addition to cassava, maize, sorghum and groundnuts, other crop types such as potatoes, sesame, rice or sunflower can be mentioned. This crop types cover between 805 and 243 km<sup>2</sup>, corresponding to 3.3% of the crop types in monoculture as shown in Figure 5. The preliminary results are fully in line with the land cover characteristics as described in the feasibility study (D1.1). These results demonstrate that the field campaign has been executed successfully.

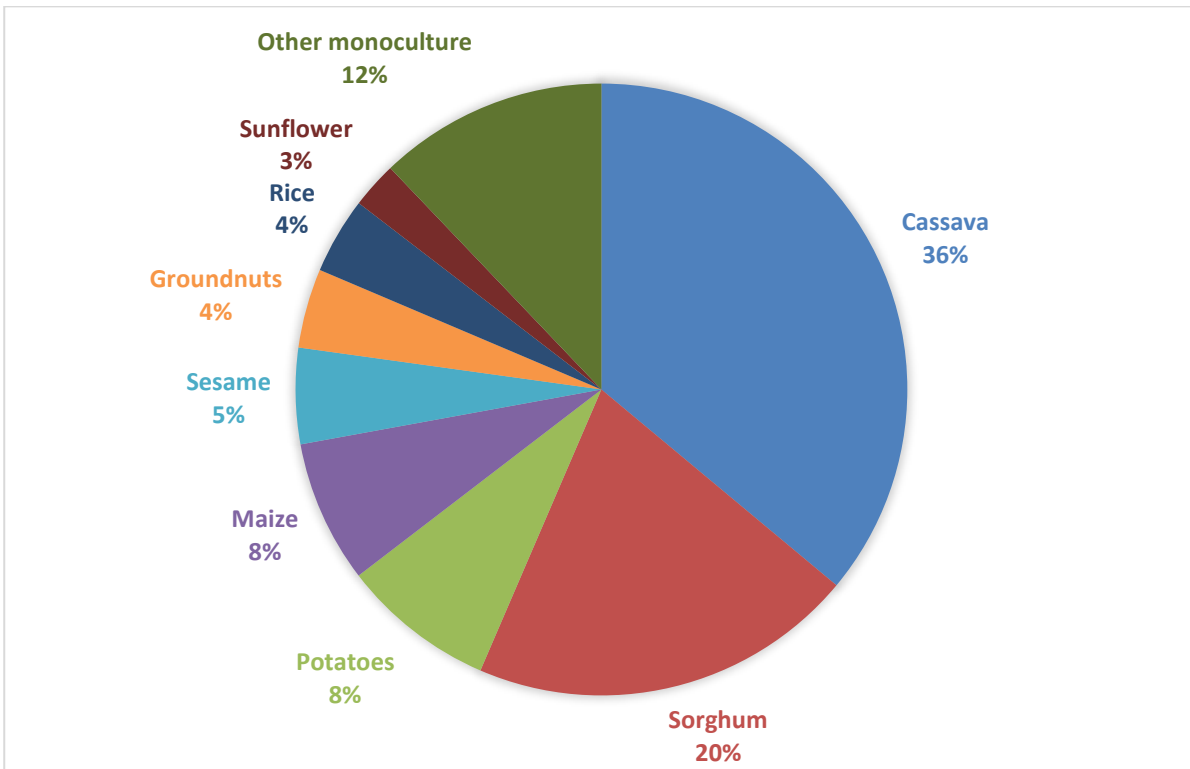


Figure 5: Distribution of the dominant crop types in monoculture

Table 11 shows the segment-based areas and the AOI area estimates for the main crop types surveyed during the first field campaign (long rains) for the three regions of Acholi, Teso and West Nile.

Table 11: Area estimates for the dominant crop types for the long rains season

Crop type	Segment-based areas		AOI area estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Cassava	2.70	4.30%	2,529.07
Maize	1.20	1.90%	1,119.97
Groundnuts	0.59	0.94%	553.44
Sorghum	0.35	0.56%	331.74
Beans	0.24	0.38%	224.94
Potatoes	0.18	0.29%	172.70
Rice	0.18	0.29%	168.89
Sesame	0.12	0.19%	113.67
Other monoculture	0.84	1.35%	791.41
Other (undetermined*, mixed cropping, non-crop areas)	56.34	89.79%	52,789.75
<b>Total</b>	<b>62.75</b>	<b>100.00%</b>	<b>58,795.57</b>

The preliminary results still show that the cassava, maize, groundnuts, sorghum, potatoes, rice and sesame are still the most dominant crops in monoculture. Beans have been replaced by sunflower.

## 4.5 Mixed cropping

Table 12 shows the segment-based areas and the AOI area estimates for the main mixed cropping classes surveyed during the second field campaign and the other landcover classes of the AOI. It should be noticed that the data collection procedure has been updated and improved during the second field campaign resulting in recording the dominant crop observed in mixed cropping (covering an area greater than 50% of the field parcel).

**Table 12: Area estimates for the dominant mixed cropping system for the short rain seasons**

	Segment-based areas		AOI area estimates
	Area (km <sup>2</sup> )	Area (%)	Area (km <sup>2</sup> )
Mixed cropping			
Cassava mixed with other crops	0.87	1.39%	818.42
Maize mixed with other crops	0.59	0.94%	551.95
Sorghum mixed with other crops	0.54	0.87%	508.68
Ground nuts mixed with other crops	0.34	0.54%	318.21
Sesame mixed with other crops	0.19	0.31%	180.69
Potatoes mixed with other crops	0.05	0.08%	44.48
Beans mixed with other crops	0.03	0.05%	27.96
Other mixed cropping	1.37	2.18%	1,281.69
Other (undetermined, monoculture, non-crop areas)	58.82	93.65%	55,063.49
<b>Total</b>	<b>62.81</b>	<b>100.00%</b>	<b>58 795.57</b>

\* 18.52 km<sup>2</sup> out of 45.28 km<sup>2</sup> of the fields identified as cropland during the interpretation based on VHR imagery were not surveyed due to budget constraint or inaccessibility as explained in the field campaign methodology report (D2.4)

The preliminary results show that cassava mixed with another crop types is the main mixed cropping system of the AOI, covering approximately 818 km<sup>2</sup>, representing 1.4% of the AOI (22% of the crop types in mixed cropping as shown in Figure 6). The maize, sorghum, ground nuts, sesame, potatoes and beans mixed cropping class represents respectively approximately 15%, 14%, 9%, 5%, 1% and 1% of the crop types in mixed cropping covering 552 km<sup>2</sup>, 509 km<sup>2</sup>, 318 km<sup>2</sup>, 180 km<sup>2</sup>, 44 km<sup>2</sup> and 28 km<sup>2</sup>. The other mixed cropping classes represent 2.2% of the territory and covering 1,282 km<sup>2</sup>.



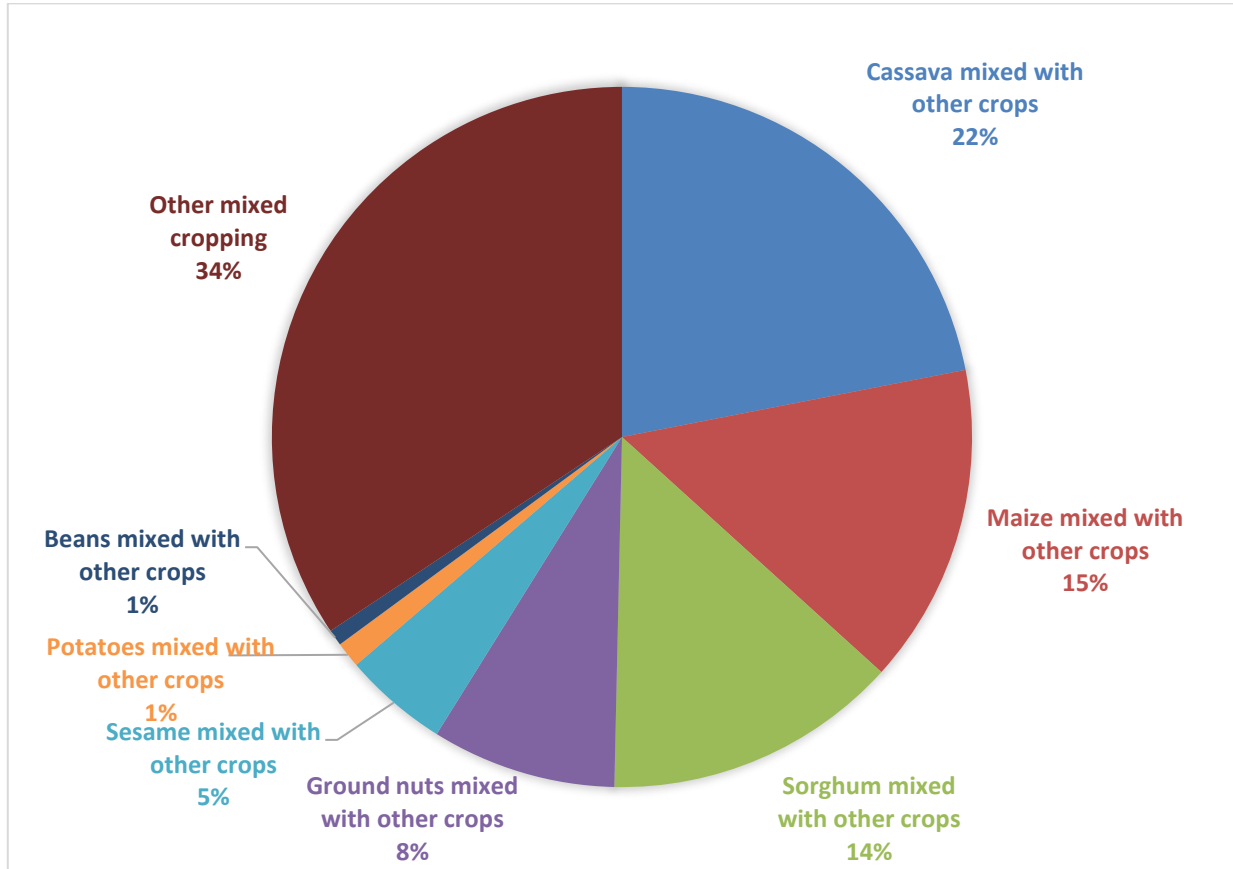


Figure 6: Distribution of the dominant crop types in mixed cropping

## 5 Successful Completion Statement and perspectives

This report only presents the preliminary results of the field campaign.

The figures will be adjusted during the area estimate bias correction procedure which allows the correction of bias in the sampling rate and the provision of crop area statistics

With the different crop mapping derived, the following crop area estimates will be provided:

1. Direct expansion estimates from the field data
2. First Model Assisted Regression (MAR) estimates for in season crop mapping
3. Second MAR estimates for end of season crop mapping

Even if the field campaign for the short rains season has been severely impacted by the interruption of the field campaign as described in the field campaign methodology report (D2.4), the preliminary results demonstrate that the field campaign has been executed successfully since they are fully in line with the land cover characteristics as described in the feasibility study (D1.1) or in the information sheet provided by the Joint Research Centre (JRC) based on country's feedback.

So the consortium confirms that the field campaign has been executed successfully and that the Tasks 3 to 7 can be executed on the basis of the data gathered during the field campaign.