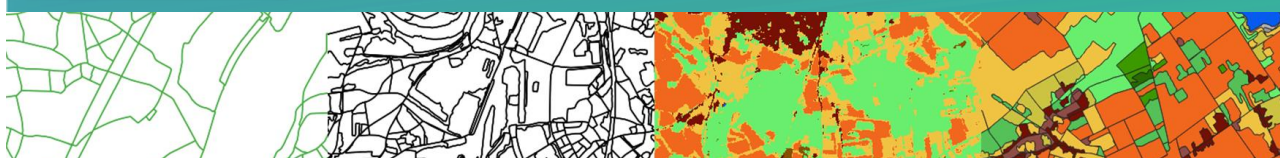


Service contract for the Copernicus Land monitoring services



Crop Mapping for GEOGLAM Country Level Support



Framework Contract N°939708-2020-IPR

First Specific Contract

D2.1 Field Campaign for Kenya – 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 |
| MAR | Model Assisted Regression |
| 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 Kenya for the short rains season, taking full profit of experience from the first field campaign and 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 type classifications will be derived based on area estimate bias correction as described in the feasibility report for Kenya (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 second field campaign took place over the counties in the western highlands counties; central and northern rift valley and central highlands (Busia, Kakamega, Bungoma, Vihiga, Siaya, Kisumu, Homabay, Migori, Kisii, Nyamira, Narok, Nakuru, Nandi, Elgeyo Marakwet, Trans Nzoia, Uasin Gishu, Kiambu, Nyandarua, Muranga, Kirinyaga, Embu, Meru, Laikipia, Tharaka Nithi, Nyeri, Bomet and Kericho). The total area occupied by the AOI is covering approximately **98,690 km²** (representing 17% of the country). Figure 1 shows the extent of the area of interest.



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

The region experiences two crop seasons (bimodal rainfall distribution) so no changes in the definition of the AOI have to be noted compared to the first field campaign.

4 Results of the field campaign

The following preliminary results are based on the 271 segments visually interpreted following the landcover nomenclature shown in Table 1 and the 175 segments visited in the field resulting in 5,065 fields surveyed as described in the feasibility report for Kenya (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 34 segments that were due to be visited were not surveyed due to denied access. Nevertheless, the 34 non visited segments are scattered over the area and will not pose an issue for subsequent activities.

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 Kenya (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 area estimates for the 8 main landcover classes identified during the second field campaign.

Table 2: Area estimates for the 8 main landcover classes identified at both segments and AOI level for the short rains season

| Landcover | Segment estimates | | AOI estimates |
|-----------|-------------------------|----------|-------------------------|
| | Area (km ²) | Area (%) | Area (km ²) |
| Cropland | 18.68 | 28.77% | 28,388.98 |
| Forest | 14.68 | 22.61% | 22,310.58 |
| Shrubland | 14.12 | 21.73% | 21,446.47 |
| Grassland | 7.62 | 11.74% | 11,584.49 |
| Bare soil | 4.71 | 7.25% | 7,158.30 |
| Urban | 4.00 | 6.16% | 6,076.57 |
| Wetland | 0.66 | 1.01% | 995.44 |
| Water | 0.48 | 0.74% | 725.83 |
| Total | 64.95 | 100.00% | 98,686.65 |

The preliminary results show that approximately 29% of the areas is covered by cropland, representing approximately 28,389 km² at the AOI level. Figure 2 illustrates the distribution of the 8 main landcover classes derived from the 271 segments interpreted and surveyed.

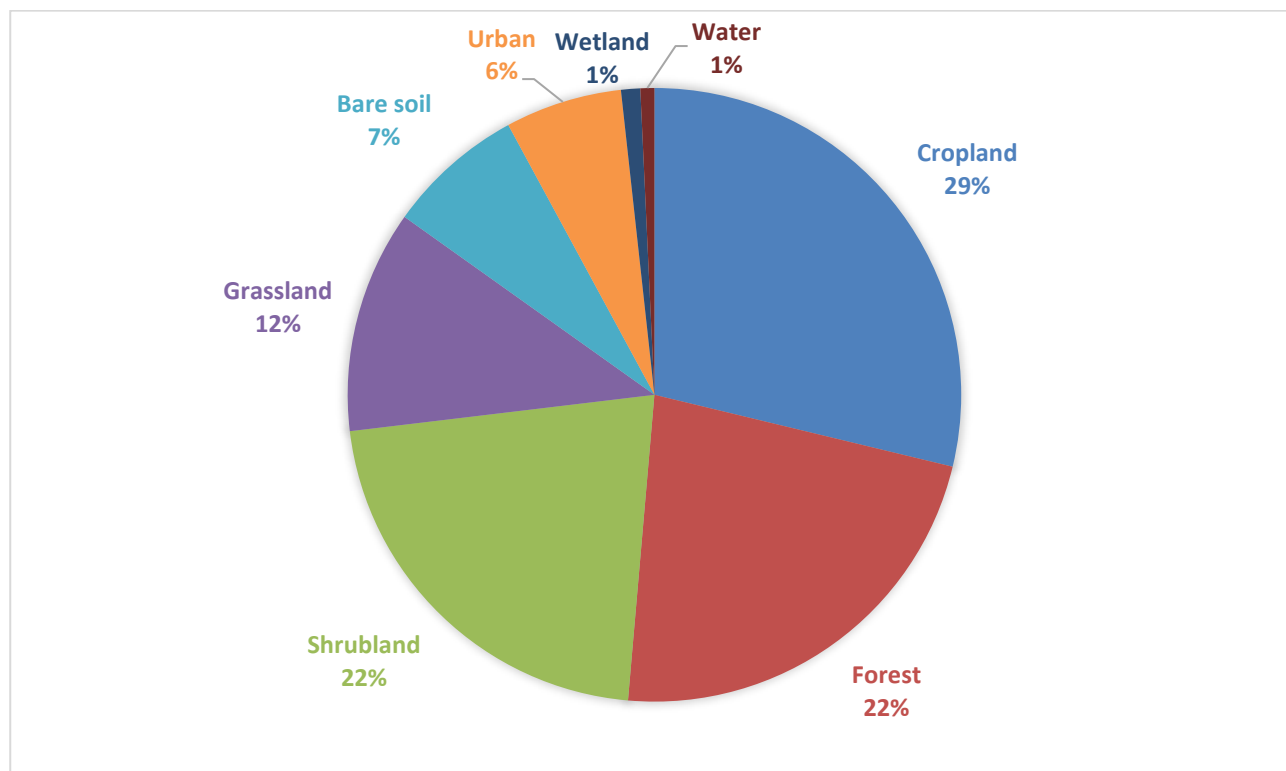


Figure 2: Distribution of the 8 main landcover classes derived from the 271 segments interpreted and surveyed

Table 3 shows the segment-based areas and the area estimates obtained during the first field campaign for the long rains season.

Table 3: Area estimates for the 8 main landcover classes identified at both segments and AOI level for the long rains season

| Landcover | Segment estimates | | AOI estimates |
|-----------|-------------------------|----------|-------------------------|
| | Area (km ²) | Area (%) | Area (km ²) |
| Cropland | 23.22 | 34.27% | 33,822.37 |
| Forest | 14.65 | 21.63% | 21,345.27 |
| Shrubland | 12.87 | 19.00% | 18,746.32 |
| Grassland | 7.61 | 11.24% | 11,092.99 |
| Bare soil | 4.52 | 6.67% | 6,585.96 |
| Urban | 3.70 | 5.46% | 5,392.14 |
| Wetland | 0.69 | 1.01% | 1,001.01 |
| Water | 0.48 | 0.71% | 700.58 |
| Total | 67.75 | 100.00% | 98,686.65 |

The preliminary area estimates show a decrease of the areas covered by cropland between the two rainy seasons (from 33,822 to 28,389 km²) and a significant increase of the areas covered by shrublands (from 18,746 to 21,447 km²). The preliminary results show that the agricultural activities in Kenya were preponderant during the first season. These results can be explained with short rains during the second season compared to the first season. Moreover, Kenya faced severe drought conditions during the short rains season^{1 2}, confirmed by the field team, which can also explain the preliminary results.

4.2 Cropping system

The Table 4 shows the segment-based areas and AOI area estimates regarding the cropping systems in the region.

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 ²) | Area (%) | Area (km ²) |
| Agroforestry | 0.15 | 0.22% | 221.93 |
| Mixed cropping | 2.87 | 4.42% | 4,364.42 |
| Monoculture | 10.83 | 16.67% | 16,450.90 |
| Undetermined* or Non-crop | 51.11 | 78.68% | 77,649.40 |
| Total | 64.95 | 100.00% | 98,686.65 |

* 4.35 km² out of 23.22 km² of the fields identified as cropland during the interpretation based on VHR imagery were not surveyed due to budget constraint 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 16,451 km² and 4,364 km² of the AOI. The agroforestry system only represents 0.2% of the area, representing 222 km².

The 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 ²) | Area (%) | Area (km ²) |
| Agroforestry | 0.13 | 0.19% | 187.71 |
| Mixed cropping | 5.68 | 8.39% | 8,275.86 |
| Monoculture | 10.40 | 15.36% | 15,153.41 |
| Undetermined or Non-crop | 51.53 | 76.07% | 75,069.66 |
| Total | 67.75 | 100.00% | 98,686.65 |

The preliminary results show a decrease of the areas covered by crops in mixed cropping from the long rains to the short rains season (from 8,276 to 4,364 km²). The areas covered by crops in monoculture remain stable.

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

² <https://nos.nl/video/2416284-ergste-droogte-in-40-jaar-in-hoorn-van-afrika>

4.3 Crop stage

Table 6 and Figure 3 show the segment-based areas and 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 ²) | Area (%) | Area (km ²) |
| Bare soil | 0.84 | 1.29% | 1,275.09 |
| Crop in ridges | 1.67 | 2.57% | 2,540.12 |
| Crop not in ridges | 5.91 | 9.10% | 8,980.10 |
| Field covered | 5.17 | 7.95% | 7,848.17 |
| Ridges closed | 0.24 | 0.37% | 365.44 |
| Undetermined* or Non-crop | 51.12 | 78.71% | 77,677.73 |
| Total | 64.95 | 100.00% | 98 686.65 |

* 4.35 km² out of 23.22 km² of the fields identified as cropland during the interpretation based on VHR imagery were not surveyed due to budget constraint as explained in the field campaign methodology report (D2.4)

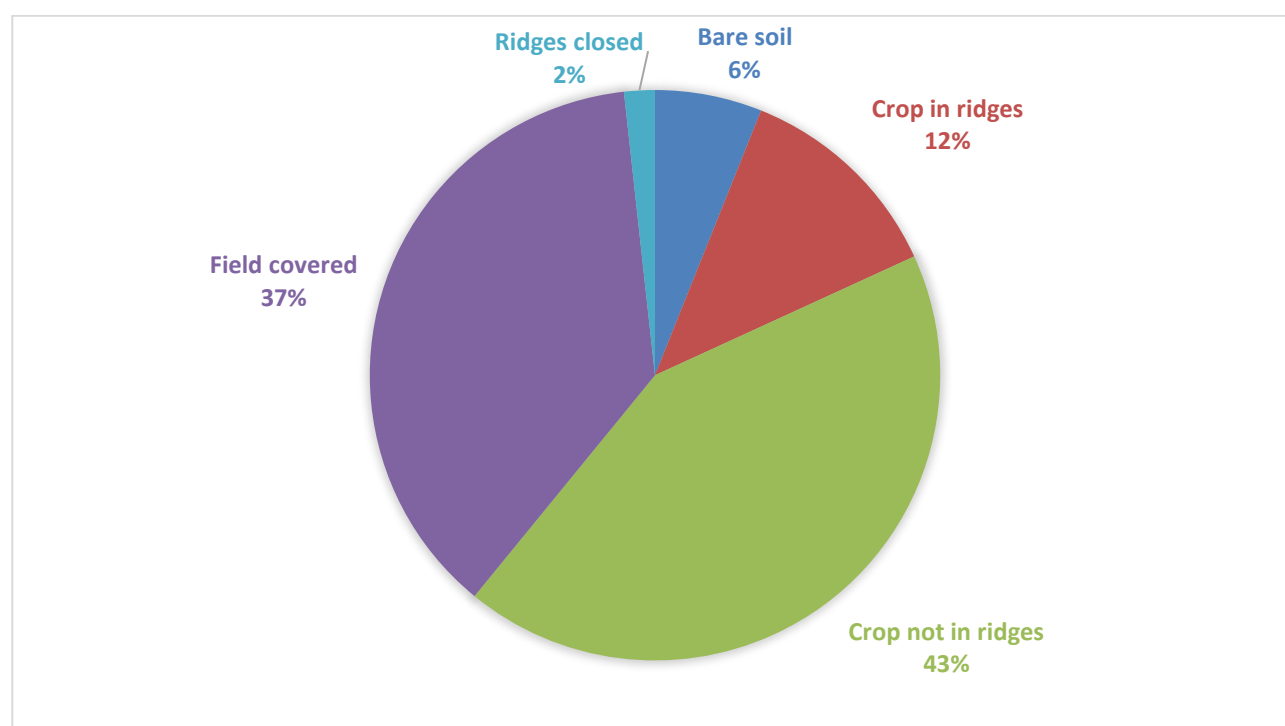


Figure 3: distribution of the different crop stages for the parcels where crops have been identified in the field

The preliminary results show that 37% of the cropland is characterized with a field covered (crops were still in their vegetative state), representing 7,848 km² of the AOI. The crop stages “Crop not in ridges”, “Crop in ridges” and “Ridges closed” represent 43%, 12% and 2% covering respectively 8,980 km², 2,540 km² and 365 km² of the AOI. The bare soil stage represents 6% of the area, representing 1,275 km².

The Table 7 shows the segment-based areas and 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 ²) | Area (%) | Area (km ²) |
| Bare soil | 0.20 | 0.30% | 296.22 |
| Crop in ridges | 1.66 | 2.45% | 2,413.14 |
| Crop not in ridges | 6.09 | 8.98% | 8,866.12 |
| Field covered | 7.53 | 11.12% | 10,976.29 |
| Ridges closed | 0.73 | 1.08% | 1,065.21 |
| Undetermined* or Non-crop | 51.53 | 76.07% | 75,069.66 |
| Total | 67.75 | 100.00% | 98,686.65 |

The preliminary results show an increase of the areas covered by bare soils and a decrease of the field covered with the crops which can be explained by the drought that affected the region during the short rains season.

4.4 Crop types in monoculture

4.4.1 5 main crop types identified by the applicant country

Table 8 shows the segment-based areas and the AOI area estimates for the 5 main crop types identified by the applicant country and the other monoculture or landcover classes of the AOI for the short rains season.

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 ²) | Area (%) | Area (km ²) |
| Maize | 5.61 | 8.64% | 8,525.00 |
| Potatoes | 0.54 | 0.82% | 813.17 |
| Beans | 0.53 | 0.82% | 807.30 |
| Wheat | 0.31 | 0.47% | 465.01 |
| Rice | - | 0.00% | - |
| Other monoculture | 3.94 | 6.07% | 5,989.76 |
| Other (undetermined*, mixed cropping, non-crop areas) | 54.03 | 83.18% | 82,086.43 |
| Total | 64.95 | 100.00% | 98,686.65 |

* 4.35 km² out of 23.22 km² of the fields identified as cropland during the first interpretation based on VHR imagery were not surveyed due to contractual reasons

The preliminary results show that the area estimates for the maize, potatoes, beans, wheat and rice are respectively 8,525 km², 813 km², 807 km², 465 km² and 0 km². The maize is the dominant crop type and represents approximately 8.6% of the area (51% of the crops in monoculture as shown in Figure 4). The 4 other crop types selected by the applicant country for this study represent approximately 1% and less of the territory. Despite the fact that rice has been identified as main crop type by the applicant country, such crop fields have not been found during the field campaign. So the training dataset based on the data collected in the field will be free of rice. Nevertheless, this crop type is well-known to be spatially located to very specific areas and we can envisage to add extra samples by mean of visual digitalizing of the EO imagery. It would permit the image classification of the rice fields if necessarily required. The other crop types in monoculture cover approximately 6% of the AOI (36% of the crops in monoculture), representing 5,990 km². The section 4.4.2 shows the area-based dominant crop types in monoculture.

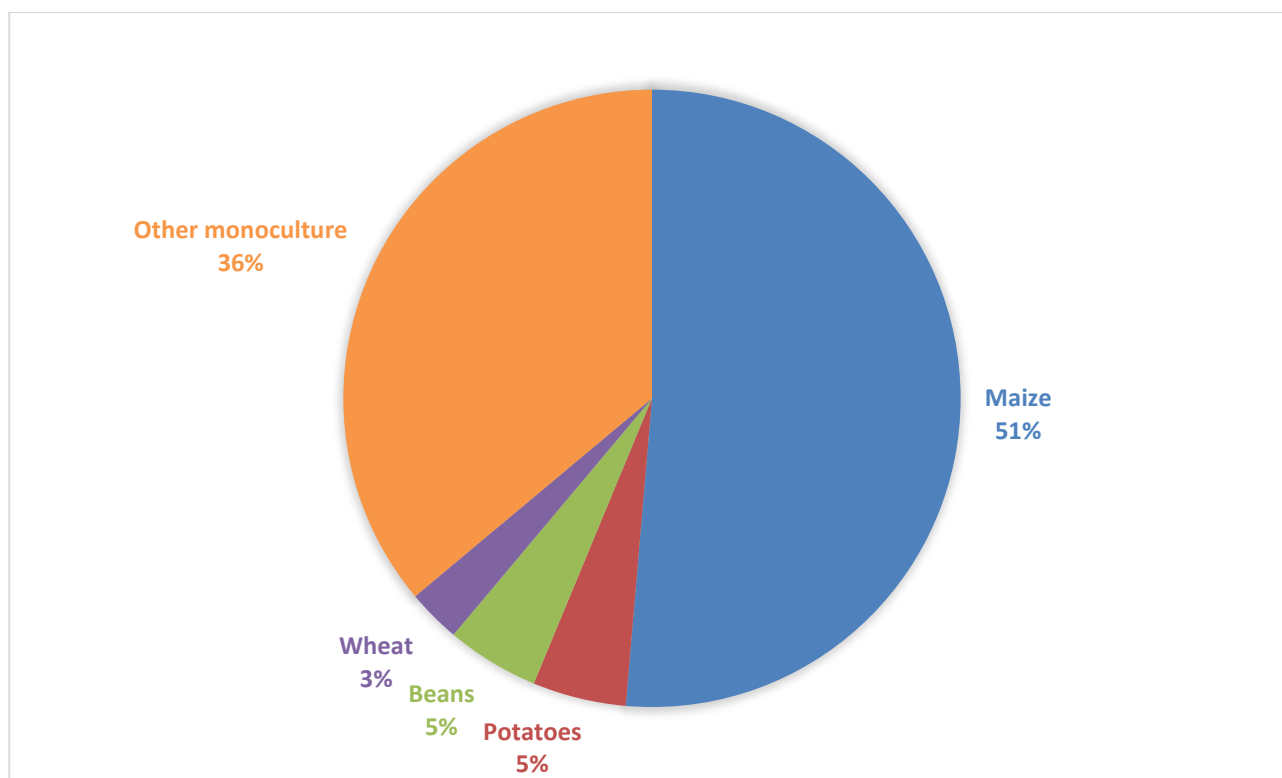


Figure 4: distribution of the 5 main crop types identified by the applicant country compared to the other crops in monoculture

The

Table 9 shows the segment-based areas and the AOI area estimates for the 5 main crop types identified by the applicant country and the other monoculture or landcover classes of the AOI 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 ²) | Area (%) | Area (km ²) |
| Maize | 5.60 | 8.26% | 8,154.06 |
| Potatoes | 0.72 | 1.06% | 1,046.75 |
| Beans | 0.37 | 0.55% | 542.92 |
| Wheat | 0.17 | 0.26% | 252.99 |
| Rice | - | 0.00% | - |
| Other monoculture | 3.66 | 5.40% | 5,331.46 |
| Other (undetermined*, mixed cropping, non-crop areas) | 57.22 | 84.47% | 83,358.48 |
| Total | 67.74 | 100.00% | 98,686.65 |

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 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 ²) | Area (%) | Area (km ²) |
| Maize | 5.61 | 8.64% | 8,525.00 |
| Sugarcane | 1.24 | 1.91% | 1,883.53 |
| Tea | 0.83 | 1.28% | 1,259.77 |
| Potatoes | 0.54 | 0.82% | 813.17 |
| Beans | 0.53 | 0.82% | 807.30 |
| Elephant grass | 0.32 | 0.49% | 483.00 |
| Wheat | 0.31 | 0.47% | 465.01 |
| Green peas | 0.22 | 0.34% | 339.92 |
| Other monoculture | 1.33 | 2.05% | 2,023.54 |
| Other (undetermined*, mixed cropping, non-crop areas) | 54.03 | 83.18% | 82,086.43 |
| Total | 64.95 | 1.00 | 98,686.65 |

It is interesting to note that the preliminary results show that 4 out of 5 main crop types identified by the applicant country are represented in the 8 most representative crop types of the AOI. In addition to maize, beans, potatoes or wheat, other crop types such as sugarcane, tea, elephant grass and green peas can be mentioned. This crop types cover between 1,884 and 340 km², corresponding to 11% and 2% 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) which indicates that croplands covering the area, consist of perennial crops like sugarcane, tea and coffee, and annual crops such as maize or beans. So these results demonstrate that the field campaign has been executed successfully.

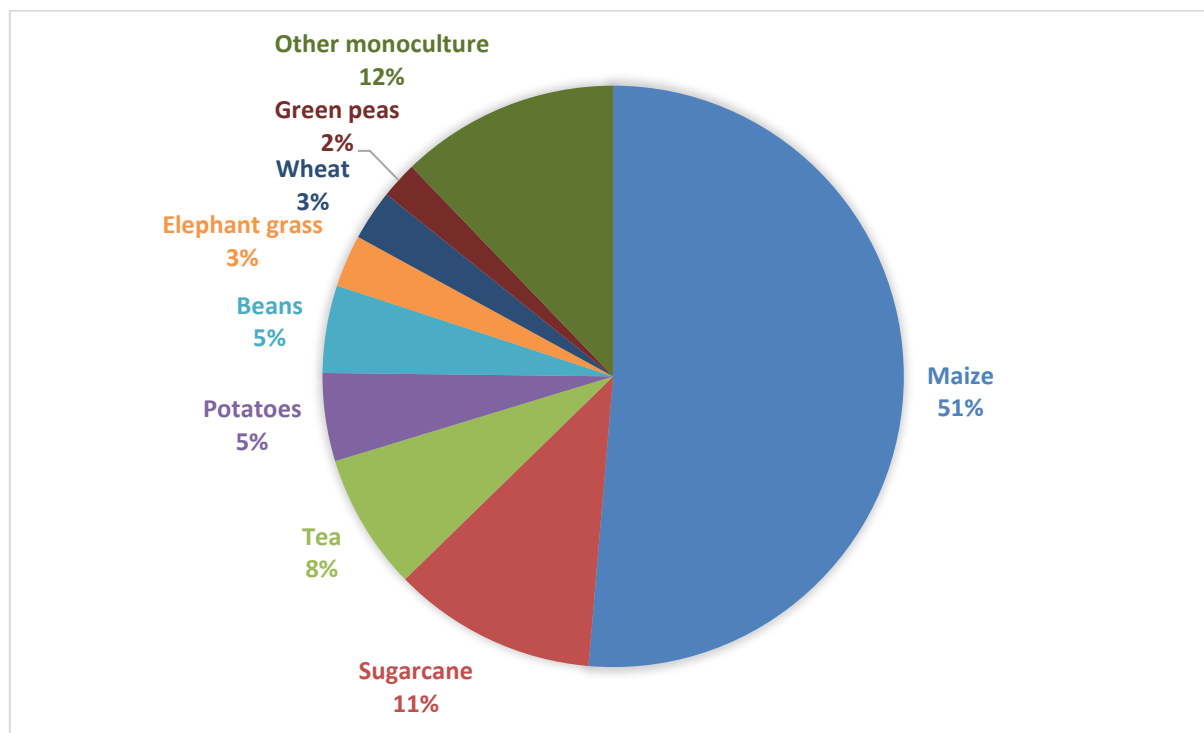


Figure 5: distribution of the dominant crop types in monoculture

Table 11 shows the segment-based areas and the AOI area estimates for the main crop types surveyed during the long rains season.

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

| Crop type | Segment-based areas | | AOI area estimates |
|---|-------------------------|----------------|-------------------------|
| | Area (km ²) | Area (%) | Area (km ²) |
| Maize | 5.60 | 8.26% | 8,154.06 |
| Sugarcane | 1.12 | 1.66% | 1,638.14 |
| Tea | 0.80 | 1.18% | 1,164.18 |
| Potatoes | 0.72 | 1.06% | 1,046.75 |
| Beans | 0.37 | 0.55% | 542.92 |
| Elephant grass | 0.37 | 0.55% | 542.17 |
| Millet | 0.27 | 0.40% | 391.10 |
| Coffee | 0.20 | 0.29% | 290.87 |
| Other monoculture | 1.07 | 1.58% | 1,557.99 |
| Other (undetermined*, mixed cropping, non-crop areas) | 57.22 | 84.47% | 83,358.48 |
| Total | 67.74 | 100.00% | 98,686.65 |

The preliminary results still show that the maize, sugarcane, tea, potatoes, beans and elephant grass are still the most dominant crops in monoculture, but millet and coffee have been replaced by wheat and green peas.

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 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

| Mixed cropping | Segment-based areas | | AOI area estimates |
|---|-------------------------|----------|-------------------------|
| | Area (km ²) | Area (%) | Area (km ²) |
| Maize mixed with other crops | 0.90 | 1.38% | 1,363.16 |
| Beans mixed with other crops | 0.17 | 0.26% | 252.84 |
| Potatoes mixed with other crops | 0.08 | 0.12% | 114.58 |
| Sugarcane mixed with other crops | 0.08 | 0.12% | 114.35 |
| Tea mixed with other crops | 0.05 | 0.08% | 82.34 |
| Other mixed cropping | 1.64 | 2.52% | 2,487.32 |
| Other (undetermined, monoculture, non-crop areas) | 62.05 | 95.53% | 94,272.06 |
| Total | 64.95 | 100.00% | 98,686.65 |

The preliminary results show that maize mixed with another crop types is the main mixed cropping system of the AOI, covering approximately 1,363 km², representing 1.4% of the AOI (31% of the crop types in mixed cropping as shown in Figure 6). The beans, potatoes, sugarcane and tea mixed cropping class represent approximately 0.6% of the territory covering respectively 253 km², 115 km², 114 km² and 82 km². The other mixed cropping classes represent 2.5% of the territory and covers 2,487 km².

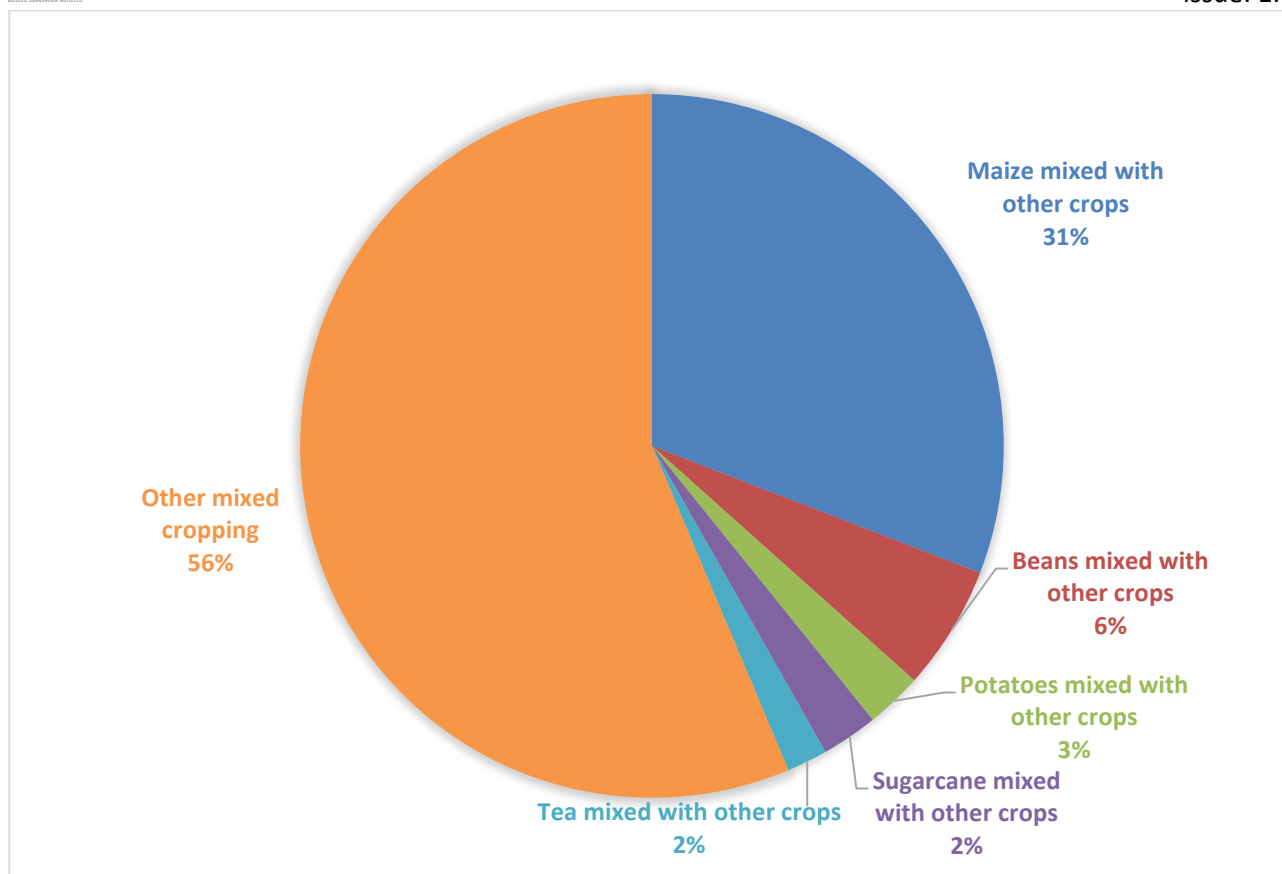


Figure 6: distribution of the dominant crop types in mixed cropping

During the long rains season, the enumerators didn't record the dominant crop visible in mixed cropping (data collection procedure implemented for the short rains season) so no comparison can be made at this preliminary stage.

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

Based on the results obtained, 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.