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Consultancy Services to execute Field Data Collection for Remote Sensing Based Large Scale Agricultural Investment Monitoring.

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1. Introduction

1.2 Background

The GIZ office of Addis Ababa has been implementing the S2RAI/RGIL project for the years of 2019 to 2023. Improving the framework conditions for responsible agricultural investment is among the major project actions. In this regard, a consultancy service was requested with the purpose of collecting spatial and non-spatial filed in-situ data in selected weredas of three project regions (regional states) of Ethiopia. The collected are meant to use as major input for remote sensing based large scale agricultural monitoring.

In Ethiopia, with an ultimate goal of fostering industrialization, Large Scale Agricultural Investment (LSAI) was introduced in 2005 which is aspired to contribute to agricultural transformation. Despite the success of the project potentially impacted by several factors, the governance of the project is a key component. Information-based planning is an integral component of the overall LSAI project planning and monitoring. Information-based planning of the LSAI project, which majorly applies spatial information, is beneficial both at pre and post project investment. Earth observation is one of the contemporary technologies that support information-based planning. Earth observation technologies notably Remote Sensing (RS), is preferred as it provides frequent, up to date, reliable (reasonable accuracy and fit to the purpose) and large area spatial information. However, the project regions in general and potential investment sites in particular lack the capacity of collecting and managing such spatial data.

AddisTag Systems PLC has signed a contract with the GIZ office of Addis Ababa to execute Field Data Collection for Remote Sensing Based Large Scale Agricultural Investment Monitoring. The consultancy service covers three regions of Ethiopia: Benishangul-Gumuz, Gambella and Amhara regional states. The in-situ data collection was conducted from October 2022 to December 2022. Therefore, this is a final project report delivered to GIZ. This report covers issues such as project implementation approaches and methods, activities, outputs and deliverables, results, challenges and lessons learned

1.2 Objective of the Consultancy Service

1.2.1 General Objective

The general objective of the assignment is to collect, store, organize, manage and deliver the spatial and non-spatial in-situ collected data in areas identified of the three project regions.

1.2.2 Specific Objective

- To collect a spatial data of a minimum of 100 numbers of plots for each of the crop types existed in the LSAI project sites of each wereda
- To collect phenological and terrain information for plots representing croplands
- To collect crop calendar and crop type and related agronomic data on previous cropping season
- To verify the collected spatial and non-spatial data and checking the accuracy
- To store the collected spatial and non-spatial data in vector and raster data format data
- To prepare a geo-database that integrates the spatial, non-spatial and captured photographs

2. Methodology

2.1General

To accomplish the requested task and deliverables three interrelated and complementary data collection, storage and management approaches were employed. These are base map preparation and desk review, In-situ data collection, and quality check, data storage and management. This consultancy service was implemented in seven weredas across three regions of Ethiopia (see figure 1). In the section follows, detailed descriptions for each of the approach and component methods are presented.

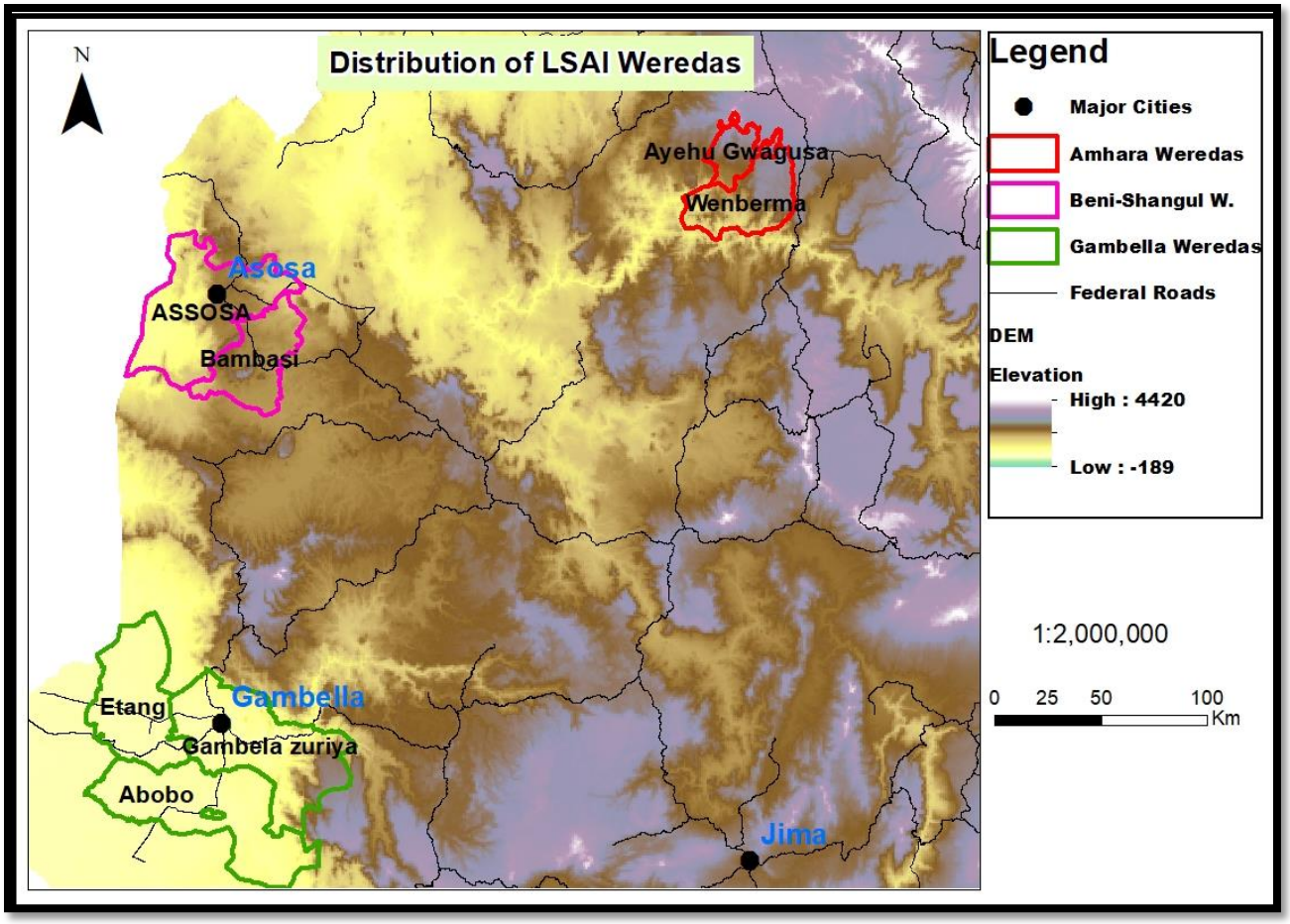

Figure 1. Map showing the distribution of weredas of the project sites

2.2 Pre-field activities

2.2.1 Base map preparation

A head of the in-situ data collection task, instruments that ease and facilitate the major data collection task were prepared. Accordingly, a base map was prepared using large mapping scale that majorly indicated road, project sites boundary, kebeles of the LSAI sites, kebeles of the adjacent sites, nearby towns and location of villages, nearby major land marks (government institutes) and used as bench mark sites, existing land use and cover layer. Using the large map scale, map indices were prepared and hard copies were printed and used by data collectors during pre and post field data collection.

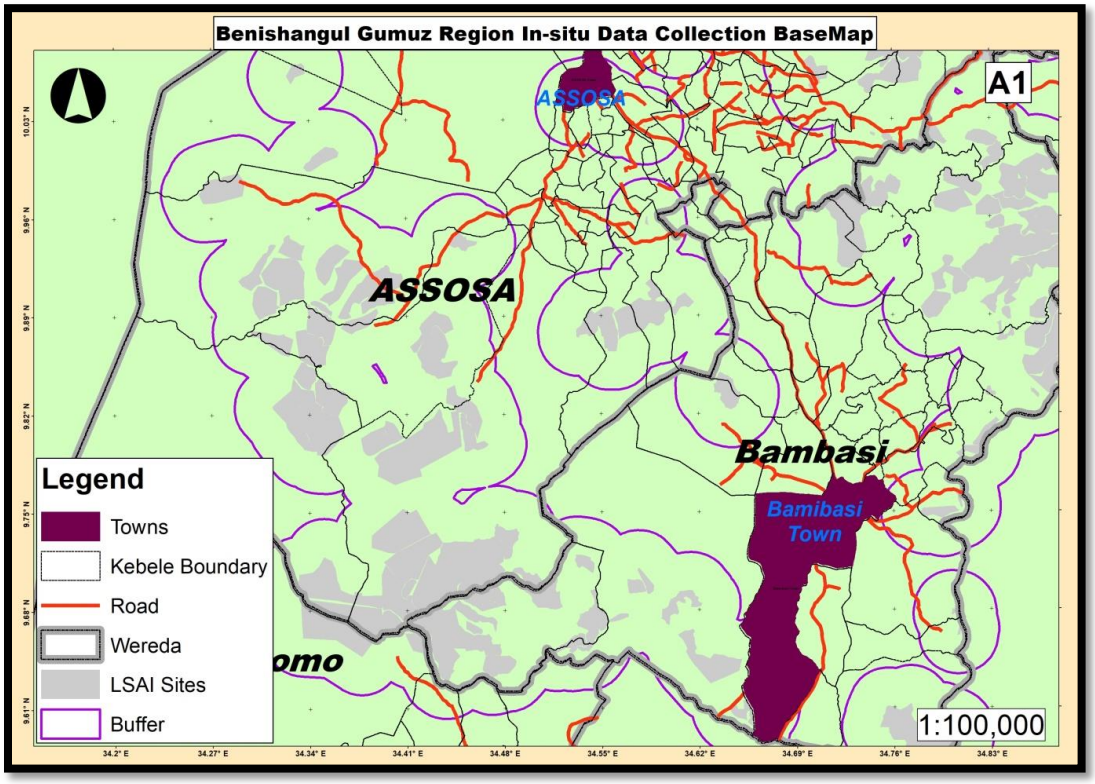

Figure 2. Sample Basemap used for insitu data collection at Benishangul Gumuz

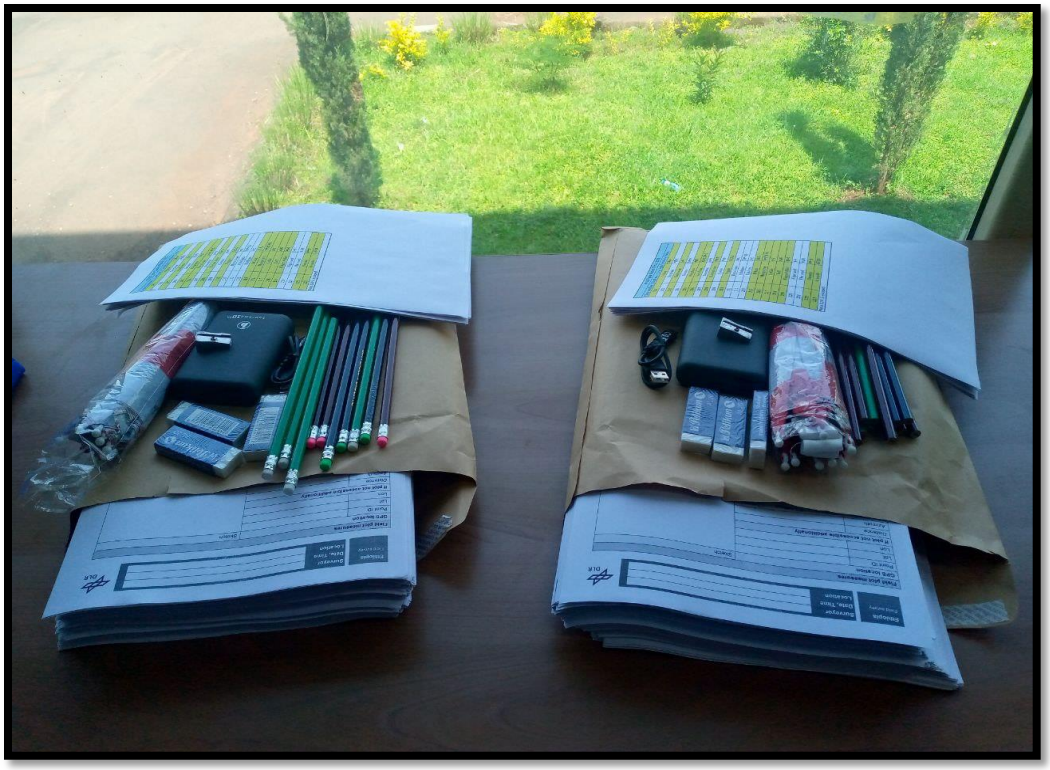

Figure 3. Showing printed data collection sheets and associated materials supporting data collection.

2.2.2 Stakeholders Consultation and Logistics Preparation

Stakeholder consultation was crucial for an effective and efficient execution of field activities. In this regard, stakeholder from federal, regional and local government was contacted. Through these engagements the project objectives were shared and common understanding was reached. The platform was also helped us to easily move and implement the field data collection activities in the LSAI sites.

2.2.3 Training of field data collectors and Piloting

The consultant hired well experienced and skilled experts meeting and satisfying the competency for data collectors. However, hands-on trainings were offered for each of the three regions. The primary objective was informing the objective of the project and creating common understanding why the data to be collected should meet the highest possible quality standards. The second objective of the training was familiarizing the data collectors on how to use the data collection instruments effectively. That is, how to use SMART Mobile phones and collect accurate spatial data (latitude and longitude), how to take screenshot photographs and cardinal photos. The third

major objective of the training was an exercise on filling the field data collection sheet and usage of data collection protocol.

The office training was followed by field pilot testing activities. Data collectors collected real data sets, feedback was given and hence assuring required skills were acquired by data collectors.



Figure 4. Showing office training sessions given to data collectors

2.3 Field Activities

This was the major task as articulated by the TOR, and in general, was implemented in accordance with the manual and protocol for field data collection that includes the suggested step-by-step procedure for field data collection and field protocol. Here we presented the major tasks, methods, tools, considerations and assumptions for in-situ data collection together with improvements that will furthermore help to achieve the stated objectives.



Figure 5. Displaying field activities by data collectors

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2.3.1 Data Collection Tools

In this project, the spatial data (latitude and longitude) was acquired using SMART Mobile phones GPS applications. Due to higher quality, with potential accuracy as higher as 1m positional error, and ease of usage, MGRS UTM GPS was chosen. Direction measurement was done using both digital compass (found in some SMART phones) and manual compasses in situation where the SMART phones did not support digital compasses. The same SMART Mobile phones were administered to captures photos (screenshots, Nadir, Azimuth, North, East, South and West directions).

2.3.2 Data Collection Approaches and Activities

Field data collection was implemented using two approaches: direct measures and distance measures. All farm fields should have a minimum of 60m*60m dimension to qualify for data collection. Unless and otherwise, measurements were done using direct approach (taking measurement at center of farms). However, where situations limited, distance measurements were also implemented. This involves standing at the adjacent field, record data collector position and measure distance and azimuth to the target point (the center of the 60*60 meters plot). A minimum

of 40 meters and preferably atypical 50 meters distance should exist between points where the distance measure is taken and the target point to guarantee 60*60 meters homogenous field plot. However, distance measures for instance beyond 100 meters where identification of target was difficult were avoided.

2.4 Post-field activities

After each of the field data collection date, the collected data were downloaded in to software (ArcMap) and mapped. Then, intensive quality control and assurance activities were conducted to assure the quality of the collected in-situ-data. Accordingly, the distribution of points, the number of expected points per kebele, the expected number of crop types, problems encountered during azimuth and distance measurement, and the correct usage of the guideline and protocol for filling the datasheets were checked. The quality of the photographs taken was also verified.



Figure 6. Showing distance measurement between sample points applied as quality control

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Figure 7. Showing poor quality (left) and good quality (right) photos taken

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Following the above presented data quality check; the collected data were stored using geodatabase. A comprehensive geodatabase was created for all of the project regions and collected data were stored.

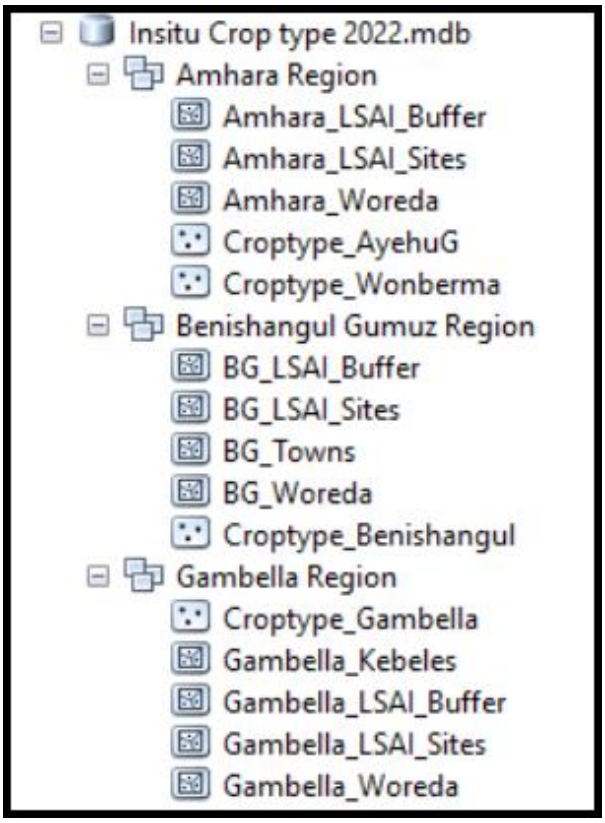

Figure 8. Showing geodatabase of the collected data

Finally, the overall deliverables, as shown below, were organized into three folders and two files. The Dataset description folder details how each of the three folders are organized.

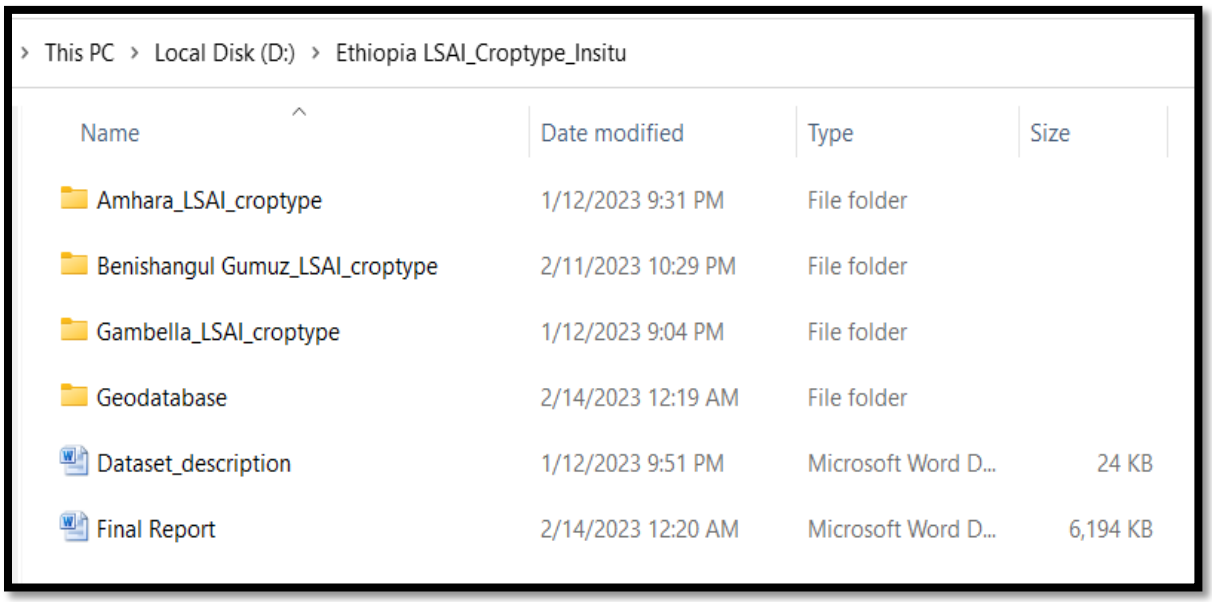

Figure 9. Showing how deliverables are structured in folders and files

3. Result

3.1In-situ Collected spatial and non-spatial data on crop types

After the field preparation, both spatial and non-spatial data of the crop types cultivated in the target LSAI sites in the seven woredas of the three project regions were collected during the 2022 cropping season. The section that follows presents detail descriptions of the collected data for each region and woredas of the project sites.

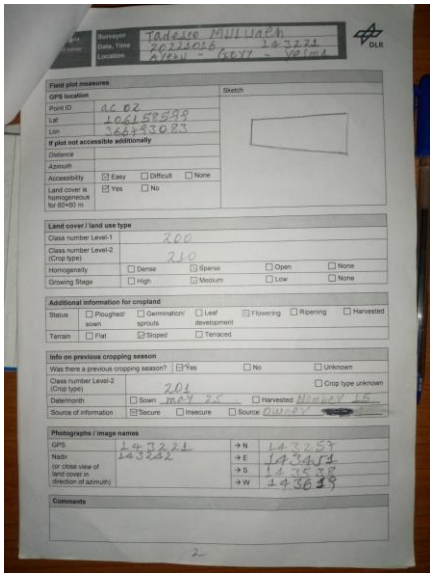

Figure 10. Displaying sample filled data collection sheet

Table 1. Showing the collected field data, description and some possible values for some attributes

No	Field Name	Descriptions	Values
1.	Surveyor_Name	Name of the surveyor	First name Second Name
2.	Date	Date of Survey (using GC)	YYMMDD
3.	Time	The time of the survey	(HH:MM)
4.	Location	The name of the woreda, village or kebele	-
5.	Measure_Type	Direct or distance	Direct or distance
6.	Point ID	Identification number given for GPS reading	**Direct measure** PT_wcxx W= wereda name initial, c=center/direct measure, xx = 01, 02,03…. e.g PT_ac01, PT_ac02…, a= **a**bobo wereda **Distance measure** PT_wcxx W= wereda name initial, d=distance measurement, xx = 01, 02,03…. e.g PT_ad01, PT_ad02…

7.	Lat	Latitude coordinate	In decimal degree
8.	Lon	Longitude coordinate	In decimal degree
9.	Distance	Estimated distance to the center of the plot	Distance in meter, e.g, 50 m
10.	Azimuth	The azimuth of the plot center	e.g. 128 ^{0}
11.	Accessibility	Accessibility description of the plot	-
12.	Homogeneity_size	Homogeneity of the plot in terms of area (same crop type at least for 60m*60m)	-
13.	CN_Level_1	Level 1 land cover class number	Crop = 200
14.	CN_Level_2	Level 2 land cover class number	Using the standard codes given
15.	Homogeneity_CT	The homogeneity (in terms of biomass coverage) of the crop type across the farm plot	-
16.	Growing_Stage	The growing stage of the cover	-
17.	Status_Phenology	The crop growing stage or phenology	-
18.	Terrain	The terrain of the crop land	-
19.	Pho_GPS	The digital number for the photograph of the GPS reading	Six digit number identifying the respective photo, this number may be given directly by the camera or by the surveyor during acquisition
20.	Pho_Nadir	The digital number for the photograph at the nadir view	Six digit number identifying the respective photo, this number may be given directly by the camera or by the surveyor during acquisition
21.	Pho_Azimuth	The digital number for the photograph at the azimuth direction of the plot center	Six digit number identifying the respective photo, this number may be given directly by the camera or by the surveyor during acquisition
22.	Pho_North	The digital number for the photograph at the north direction	Six digit number identifying the respective photo, this number may be given directly by the camera or by the surveyor during acquisition
23.	Pho_East	The digital number for the photograph at the east direction	Six digit number identifying the respective photo, this number may be given directly by the camera or by the surveyor during acquisition
24.	Pho_South	The digital number for the photograph at the south direction	Six digit number identifying the respective photo, this number may be given directly by the camera or by the surveyor during acquisition
25.	Pho_West	The digital number for the photograph at the west direction	Six digit number identifying the respective photo, this number may be given directly by the camera or by the surveyor during acquisition
26.	PS	Was there a previous cropping season	Yes, NO
27.	PS_CN_Level_2	Class number Level-2 (Crop type) at previous season	-
28.	PS_Date_Sown	Sowing date of the crop type at the previous season	YYMMDD
29.	PS_Date_Harvested	Harvesting date of the crop type at the previous season	YYMMDD
30.	PS_Source	Data source for the data/info on previous season	e.g owner, farm manager, laborer, etc
31.	Comment	Additional comment	-

3.1.1 Amhara Region

Ayehu Guagusa and Wonberma are the two woredas of the Amhara region where in-situ data was collected. In Ayehu Guagusa a total of 503 in-situ data was collected. Out of the total samples, 174 points were collected using a direct approach whereas 329 were collected employing distance measurement. The data collection period spans from October 10, 2022 to November 08, 2022.

At Wonberma woreda 322 data points representing nine crop types were collected in the period from October 16, 2022 to November 19, 2022. Using direct approach 179 points were collected while the 143 points were acquired via distance approach. Table 2 shows the number of collected samples per crop types from the two woredas.

Table 2.Summary table showing the collected sample points per crop type in the two project woredas of Amhara region.

No	**Code**	**Crop Name**	**Number of in-situ crop type data collected**	
			Ayehu Guagusa	**Wonberma**
1	201	Maize	118	143
2	203	Sunflower	89	-
3	204	Sesame	-	17
4	205	Mung bean	2	52
5	206	Soya bean	76	54
6	208	Haricot bean	3	7
7	210	Pepper	5	18
8	215	Wheat	97	3
9	217	Coffee	101	-
10	218	Teff	3	16
11	219	Finger Millet	-	11

The field collected data successfully achieved the data collection requirements. First, the sample points were uniformly distributed across kebeles of the woredas. Second, the crop types were also

distributed across the LSAI sites. See figure 11 for distribution of sample points across LSAI sites in Amhara region.

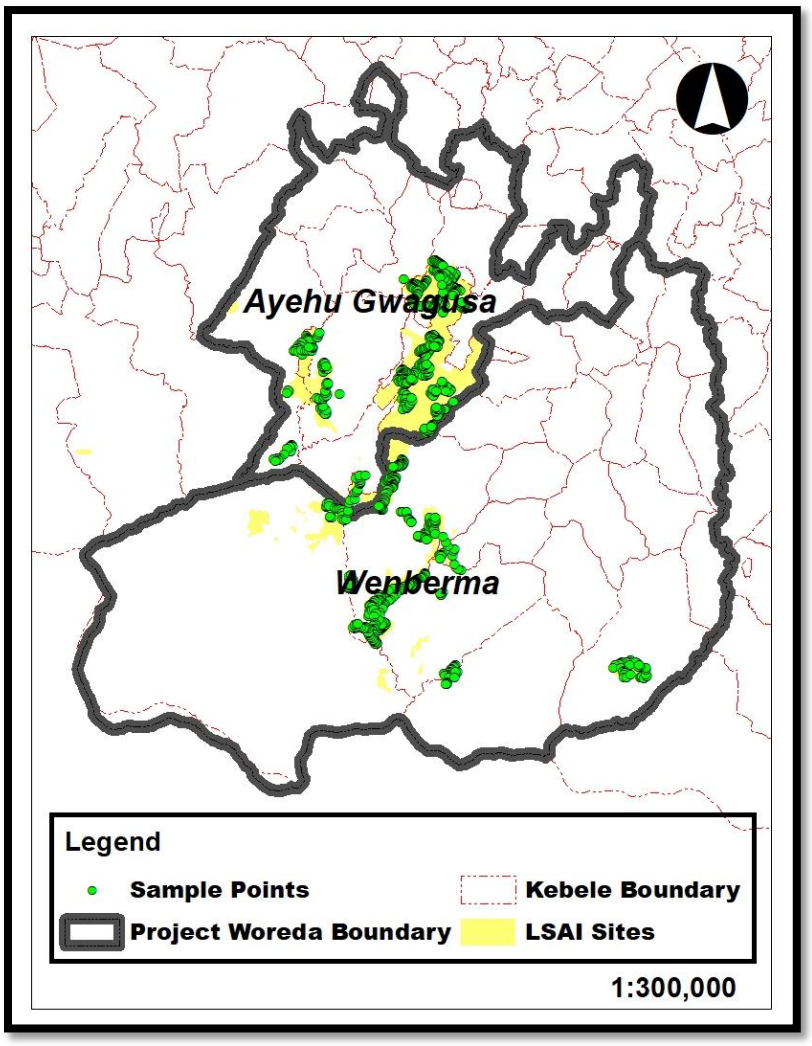

Figure 11.Showing distribution of in-situ data collected across LSAI sites in Amhara Region

3.1.2 Gambella Region

The field data collection at Gambella region was conducted from September 21, 2022 to November 23, 2022. Across the three woredas in the region, 950 samples were collected. Some sites known to be LSAI area were abandoned and hence not included in the data collection campaign. In the region nine crop types were identified of these Mung bean, cotton, maize and sorghum were the major crops grown in the LSAI sites.

Table 3.Summary table showing the collected sample points per crop type in the three project woredas of Gambella region.

No	Code	Crop Name	Number of in-situ crop type data collected		
			Abol	Abobo	Itang
1	201	Maize	37	39	38
2	202	Sorghum	23	19	-
3	204	Sesame	-	1	9
4	205	Mung bean	159	139	136
5	206	Soya bean	1	93	-
6	208	Haricot bean	-	-	1
7	209	Cotton	105	93	37
8	216	Mango tree	-	24	-
9	222	Banana	-	1	-

Sample points were uniformly distributed across kebeles and woredas of the LSAI sites. Nonetheless, some LSAI sites were abandoned/uncultivated and hence not included in the collection campaign. Whereas, some sites were totally inaccessible due to permanent security concerns and hence, not included in the campaign.

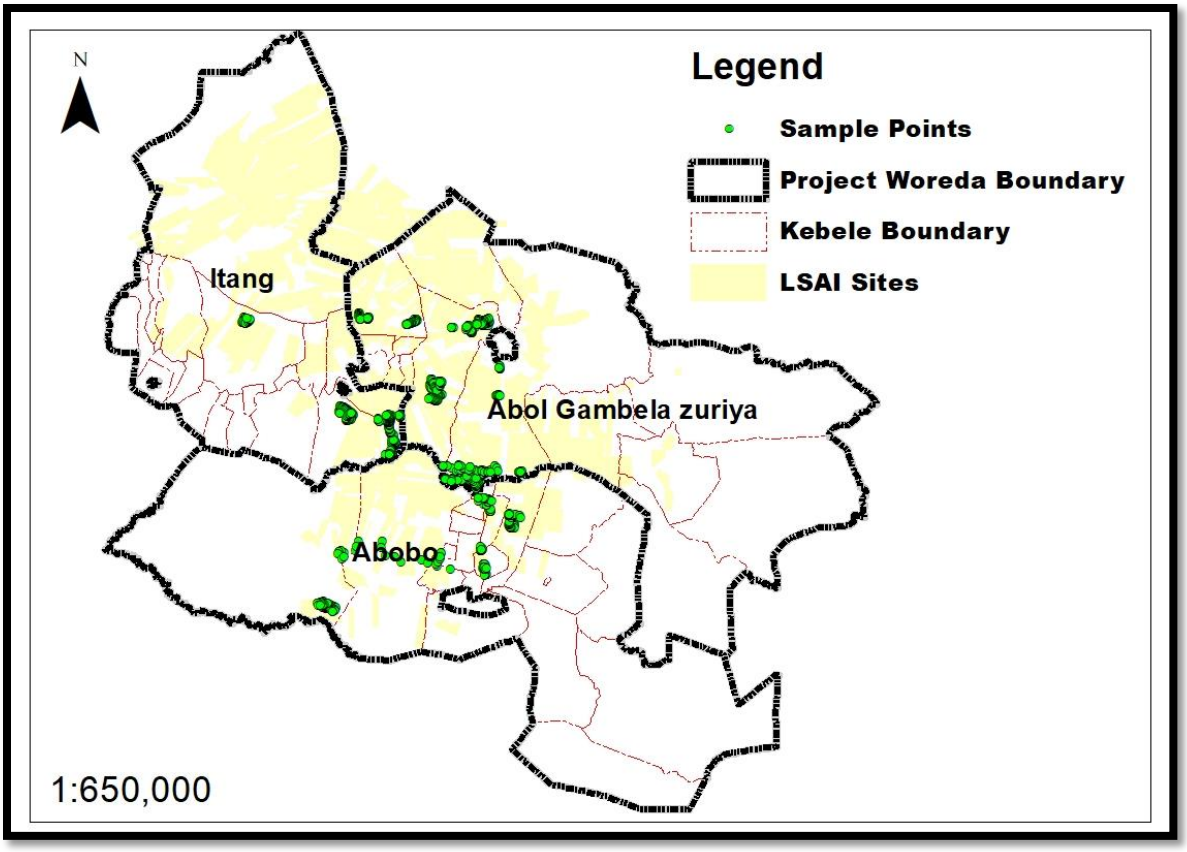

Figure 12. Showing distribution of In-situ collected sample points across LSAI sites in Gambella Region

3.1.3 Benishangul Gumuz Region

Assosa Zuria and Bambasi were the two woredas of Benishangul Gumuz region where data collection was done. The collection campaign spans from November 02, 2022 to December 11, 2022. In Assosa Zuria, 427 sample points from nine crop types and in Bambasi 280 sample points from four crop types were collected. The number of crop types and samples collected in the two woredas of Benishagul Gumuz region is presented in table 4. Accordingly, nine crop types were collected, of which maize, sorghum, soya bean, pepper were the dominant crop types

Table 4.Summary table showing the collected sample points per crop type in the two project woredas of Benishangul Gumuz region.

No	Code	Crop Name	**Number of in-situ crop type data collected**	
			Assosa Zuria	Bambasi
1	201	Maize	86	99
2	202	Sorghum	114	79
3	204	Sesame	2	-
4	206	Soya bean	58	5
5	207	Groundnut	1	-
6	210	Pepper	108	97
7	218	Teff	4	-
8	220	Niger seed	52	-
9	221	Flax seed	1	-

Despite maximum effort was exerted to collect uniformly distributed sample points, the persistent security problem in the region impeded the data collection activity only to concentrate in certain areas which had relatively better security situation during the collection. Nonetheless, major LSAI

farm lands were covered.

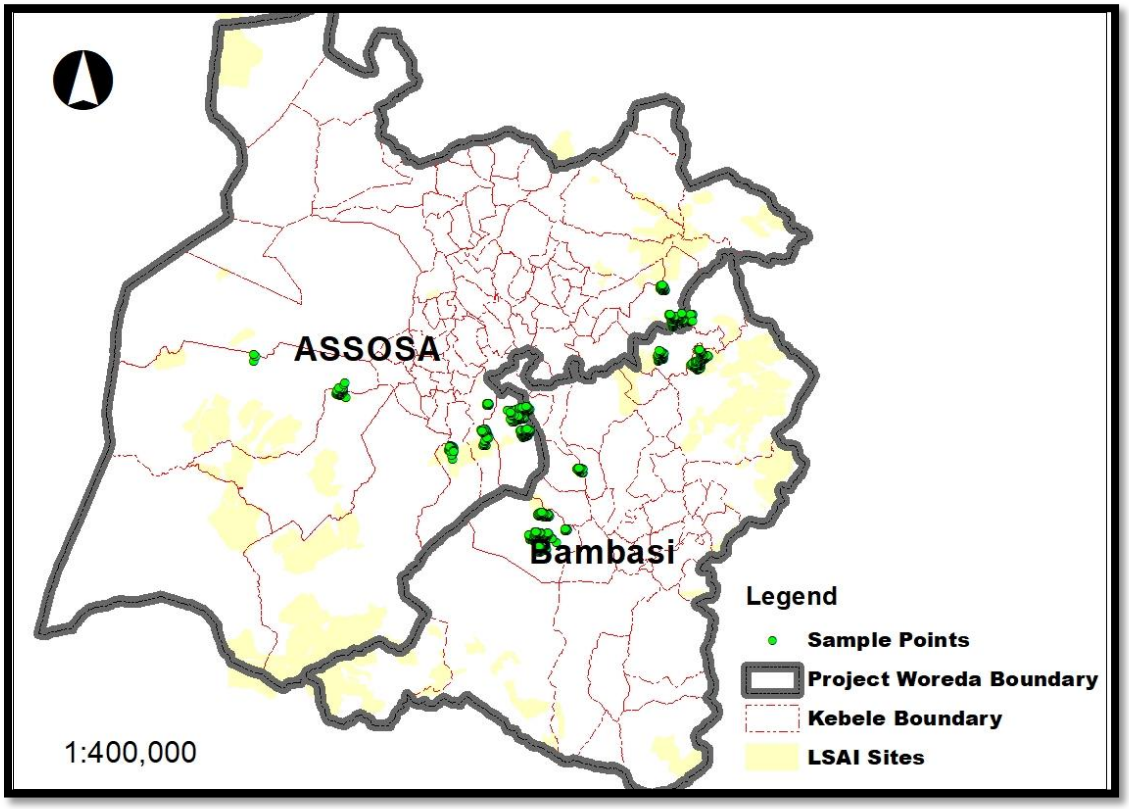

Figure 13. Showing distribution of in-situ data collected at LSAI sites in Benishangul Gumuz region

4. Challenges and measures taken

Despite the data collection campaign was successful across regions and project woredas, some challenges were encountered that delayed the overall project period. Security, Harsh weather condition and poor infrastructure are the three major constraints.



Figure 14. Showing challenges of data collection: data collectors crossing river

Throughout the data collection period, some kebeles and hence LSAI sites were not accessible to deploy data collectors, especially, at Benishangul Gumuz and Gambella regions. In some periods, the regions were administrated under the state of emergency due to active clashes between different parties. In some other period, some LSAI sites were not accessible due to the same danger. Consequently, several field campaign plans and schedules were cancelled and rescheduled. On the other hand, at times when relative peaceful situation occurred, farm managers and field workers, who are key informants, were not available due to perceived insecurity of the situation.

The second major problem encountered, in particular, at Gambella region was the harsh weather condition and prevalence of flooding. It was very challenging to our data collectors to travel long

distances and stay for long hours in the field due to higher temperature in some LSAI sites. Some LSAI sites were in accessible due to flooding that forced our data collectors to deploy via alternate routes.

Poor infrastructure status such as power/electric blackout and degraded roads were the third major impediment of the field activities. In some woredas, it was difficult to recharge data collection tools such as smart mobile phones and laptops.

Nonetheless, AddisTag Systems PLC has exerted maximum effort to successfully implement the project. This was made possible by the close collaboration between field data collectors, supervisors and team leaders. Frequent rescheduling of field activities were considered to compensate for the field activities that were not implemented due to insecurity. In some LSAI sites, security personnel (Guards) were hired to accompany the data collectors in the field.

We used four wheel drive cars to deploy data collectors and supervisors to the LSAI sites, however, where poor road condition limited field accessibility, motor bikes were used to get access to some LSAI sites.

Overall, the stated challenges were impacted to increase the data collection period. Besides, some sites were not accessible throughout the season; however, alternate sites were approached as substitute to fulfill the number of crop types and uniform distribution of samples across the LSAI sites.