



Geo-Quest

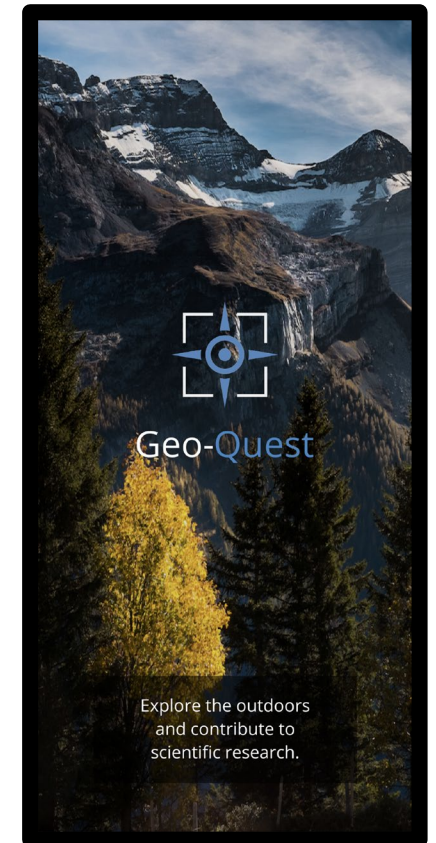


WorldCereal

Geo-Quest and WorldCereal: From in-situ data to EO-driven crop maps

Juan Carlos Laso Bayas, [Steffen Fritz](#), Santosh Karanam, Tobias Sturn,
Arun Pratihast, Hendrik Boogaard, Jeroen Degerickx, Kristof Van Tricht

WorldCereal consortium:



[Download the app here:](#)



<https://geo-quest.org>

- **Reference data collection: Field campaign**
- Sample / geo-tag areas where a specific land use is located
- WorldCereal needs thousands of samples of different crops worldwide at different times of the year
- These samples train a model that produces a “wall to wall” map – e.g. WorldCereal Maize Summer 2021



- But...
- not all field samples are created equally



Example: A geo-tagged maize field sample



Type:
Maize

Coordinates:
1.3658843° South
79.4180402° West

Is this a good sample?



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Example: A geo-tagged maize field sample



How was it taken?

In which direction?

When was it taken?

Let's have a closer look:



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Example: A geo-tagged maize field sample

The picture was taken from the road



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Example: A geo-tagged maize field sample



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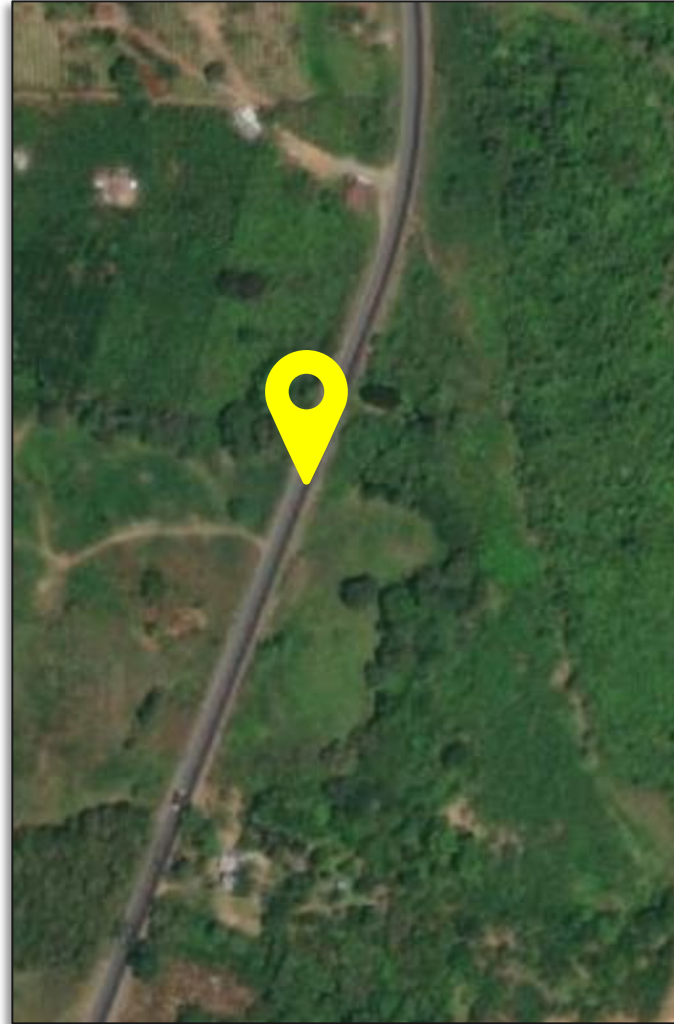


→ THE EUROPEAN SPACE AGENCY

Example: A geo-tagged maize field sample

and the
coordinates
are on the
road...

(shown on a high-
resolution satellite
image - Bing maps)

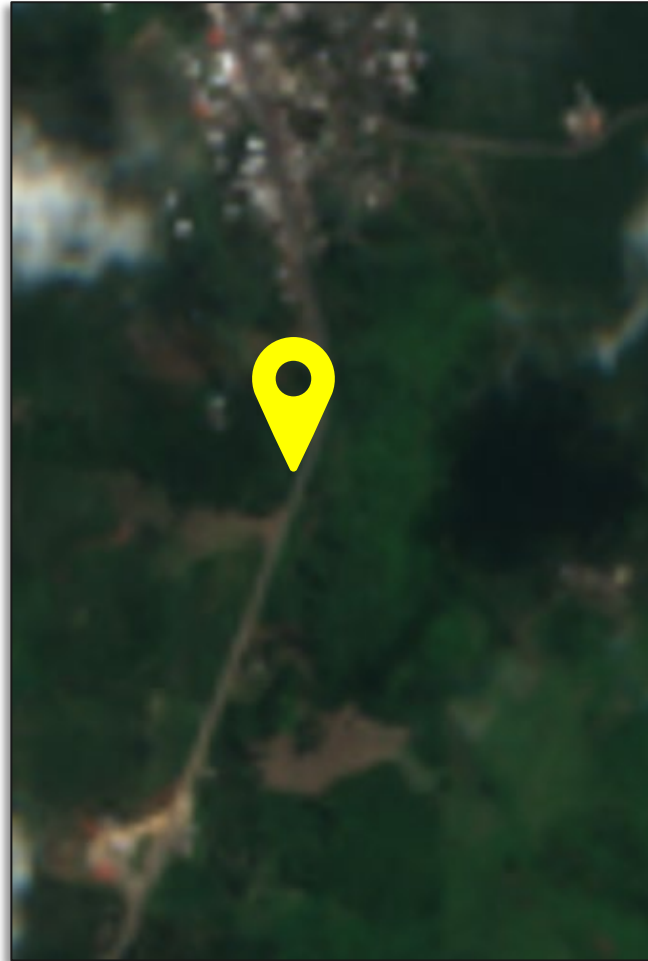


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Example: A geo-tagged maize field sample

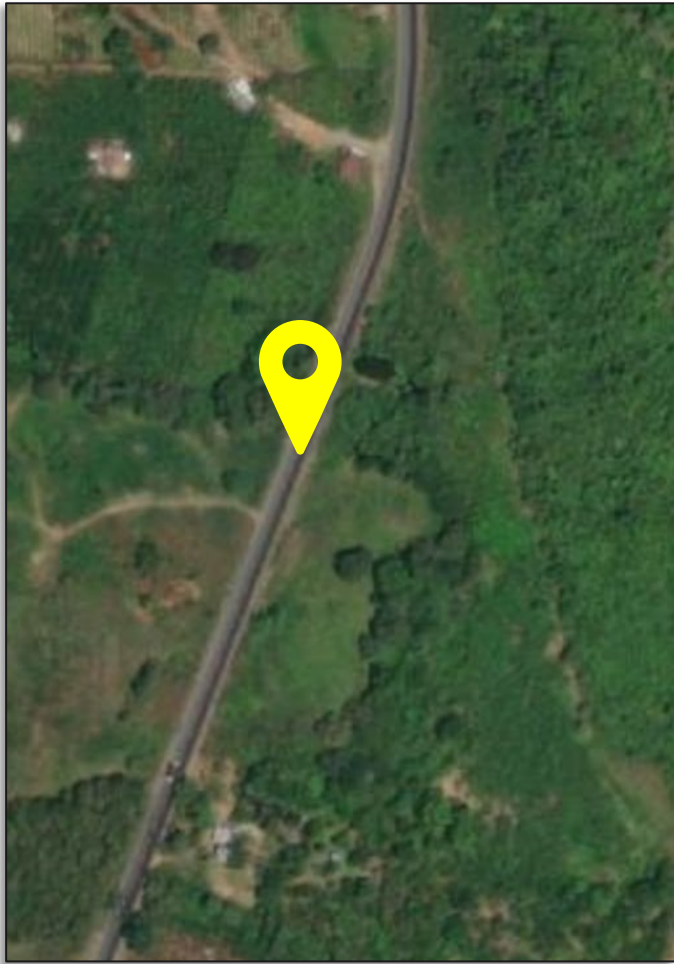
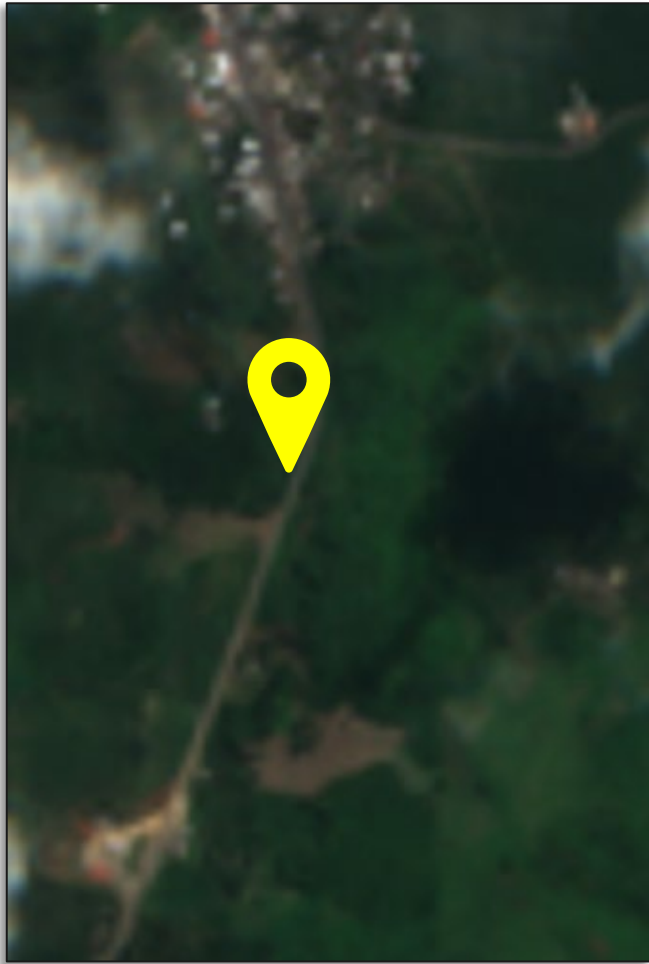
and seen on a
lower-resolution
satellite image

(Sentinel 2 –20 m)



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Example: A geo-tagged maize field sample



Good enough?



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Example: A geo-tagged maize field sample

But **which side of the road** is it showing?



Also: Unknown date



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Example: A geo-tagged maize field sample

Some hints help
figuring out the
exact location

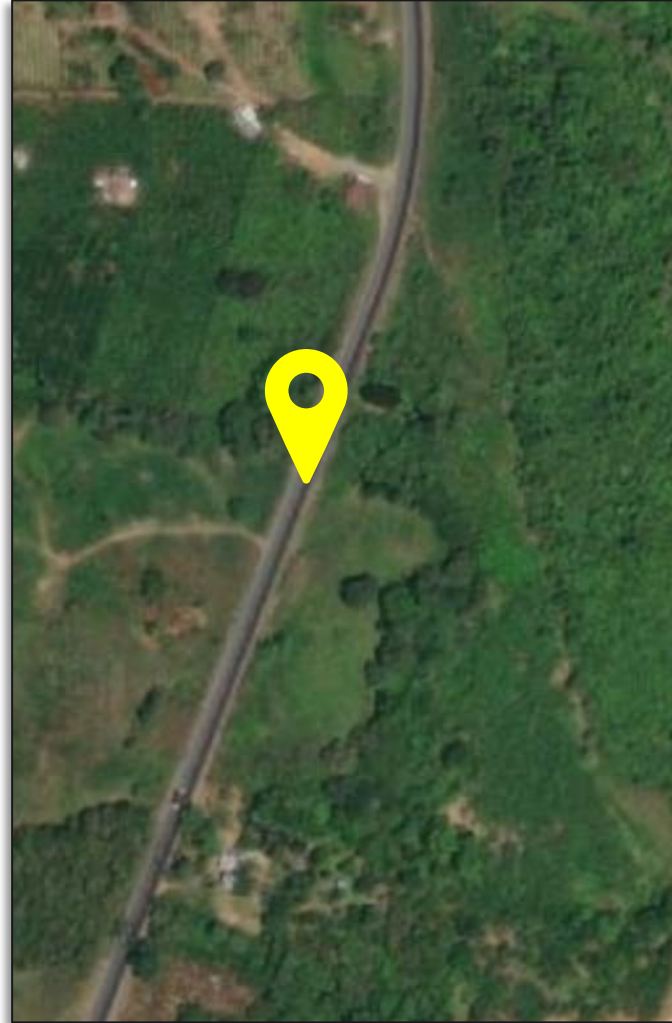


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Example: A geo-tagged maize field sample

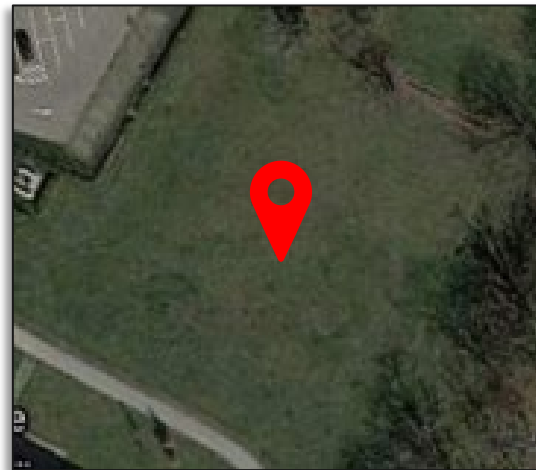
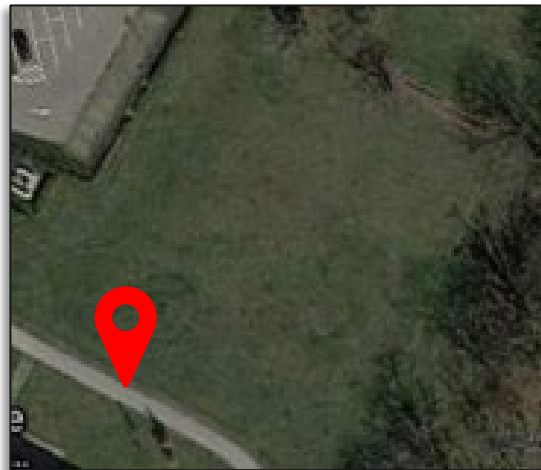
But...

with thousands of samples,
it becomes very difficult to
guess for each one!



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- Sample inside the desired land use or parcel, whenever possible in the center of the field



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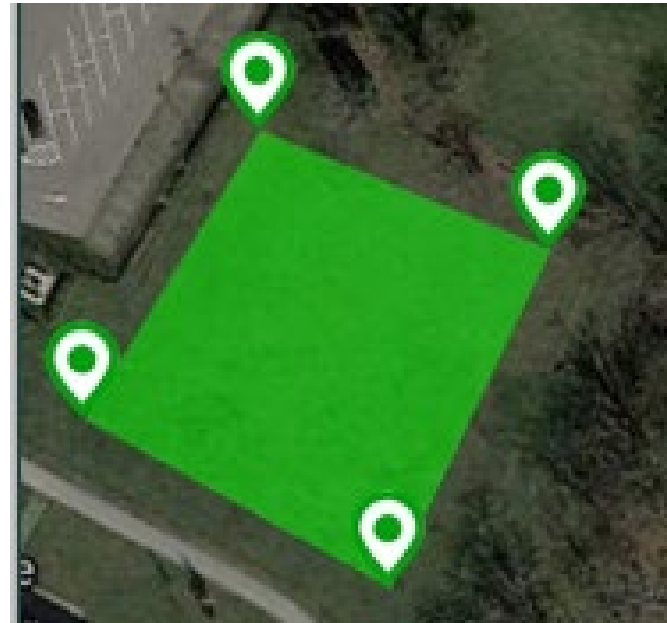
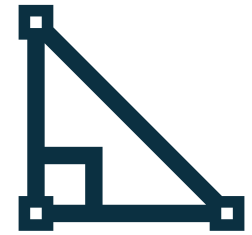
- Use full decimals on coordinates taken, preferably, use a device with enough geo-precision
- If possible, include pictures on different angles and directions
- Include exact date

0 0000000
,



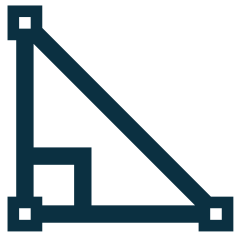
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- Preferably, create not only a point, but a polygon (perimeter of/inside the parcel)



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- But beware of only including homogeneous crop fields



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- **Virtual in situ data collection**
- **GPS device – analog (paper + pen)**
- **Phone – pictures with location**
 - **Mobile apps**



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•Virtual field samples collection

- Easy to use
- Low cost
- Allows polygon delineation
- Requires some expertise, but training is provided
- Has some limitations (e.g., identification of some crop types)

The image displays two screenshots of web-based tools used for virtual field sample collection. The top screenshot shows the GeoWiki interface, which includes a map with a blue polygon delineating a field, a sidebar with map controls, and a validation form with three steps. Step 1 asks for the predominant tree loss driver, Step 2 asks for other tree loss drivers, and Step 3 asks if roads or buildings are visible. The bottom screenshot shows the WorldCereal interface, featuring a map with a yellow polygon, a satellite image of a field, and a validation form for crop type and irrigation. The form includes fields for crop type, validation details, and values to submit.



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Tools to facilitate reference data collection



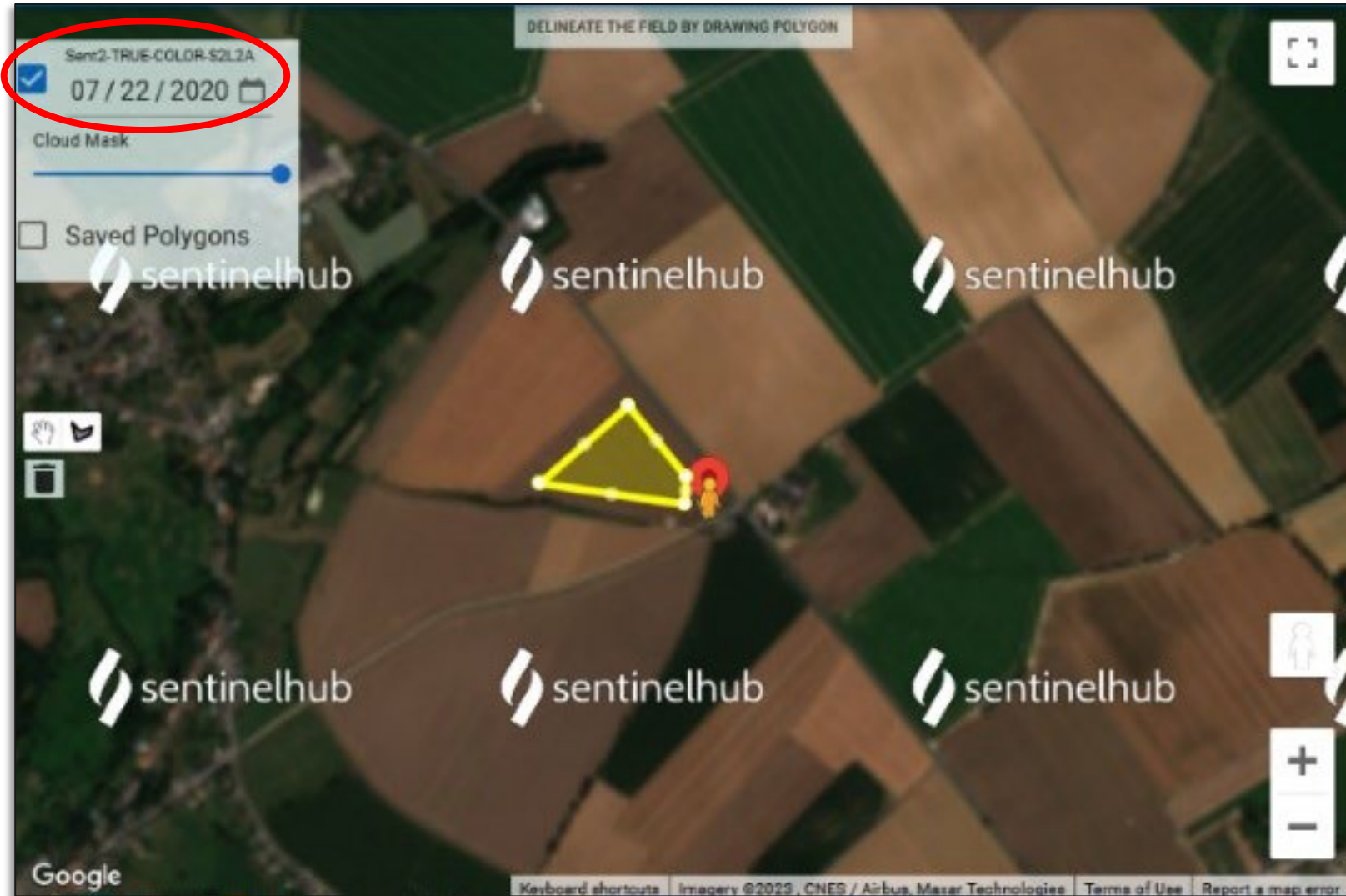
<https://svweb.cloud.geo-wiki.org/>



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Tools to facilitate reference data collection



•GPS / Analogue system

- High precision – allows precise delineation of borders
- Employed for cadastral work (high precision GPS)
- May require analogue annotations (depending on device)
- Needs some (basic) familiarization
- High(er) cost



Credit: ©2010CIAT/NeilPalmer



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• Phone pictures with location

- Low(er) precision
- Easy to use – enable location for pictures
- Low(est) cost
- Usually does not indicate direction or angle of tilt, but it can be obtained
- No easy polygon delineation



Credit: ©Juan Carlos Laso Bayas



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• Mobile applications

- Installed on phones or tablets
- For experts and non experts
- Easy to use – custom survey
- Allow polygon delineation
- Low(er) cost
- Some exploit device gyroscope (angle/tilt)
- Low(er) precision



CropObserve

 **KoboToolbox**

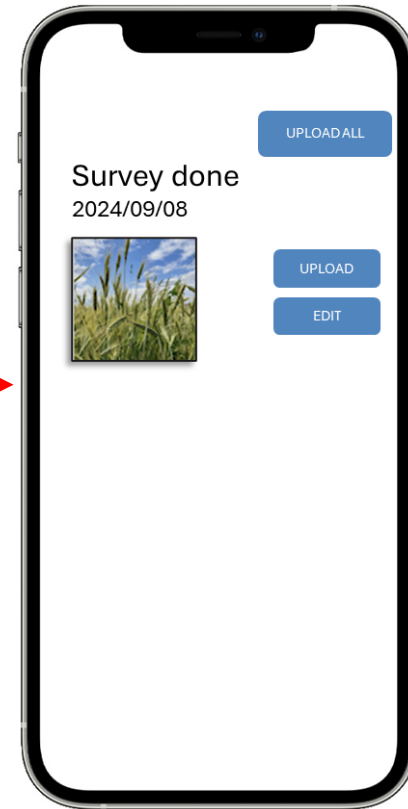
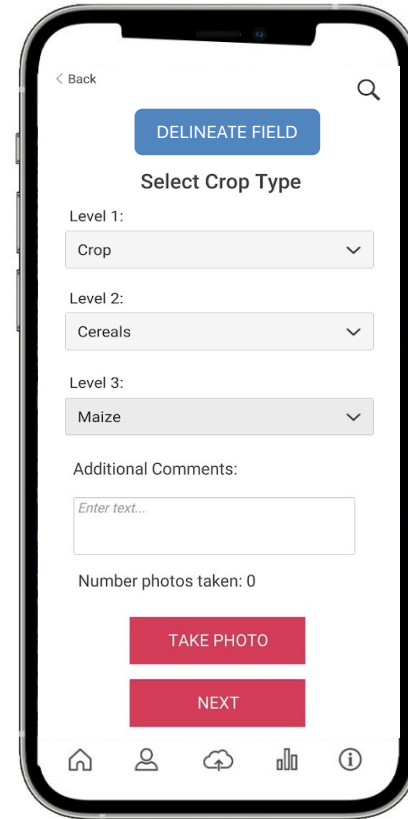
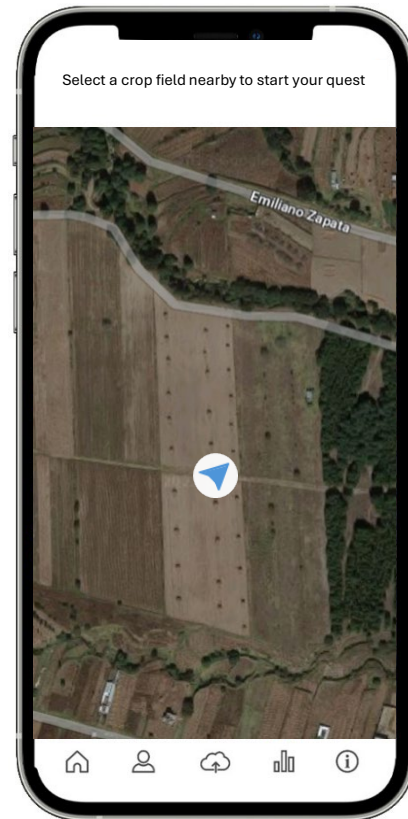


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Tools to facilitate reference data collection



Geo-Quest
Crop Capture



WorldCereal







Crop Capture


Powered by IIASA's Geo-Quest Platform

Capture spatial and temporal crop information directly from the field. Join our global community in advancing agricultural intelligence through citizen science.




SUBMISSIONS
12,777


IMAGES
13,026


USERS
44



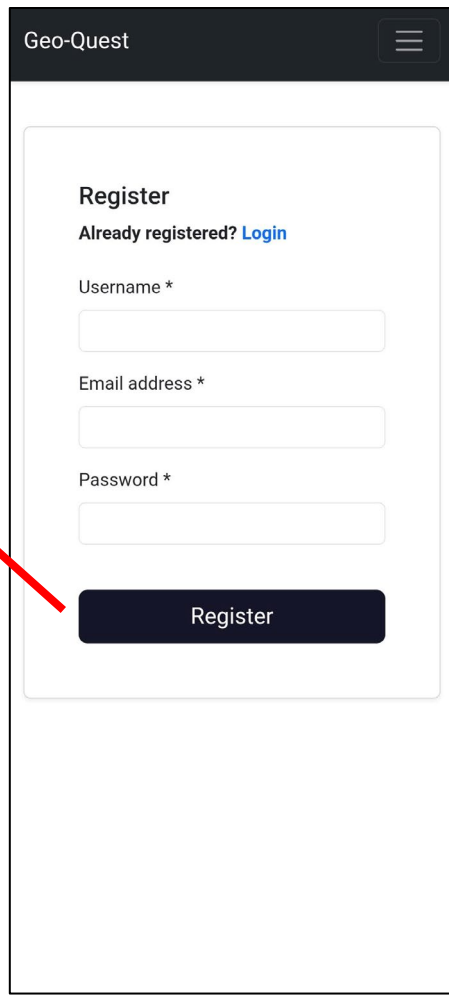
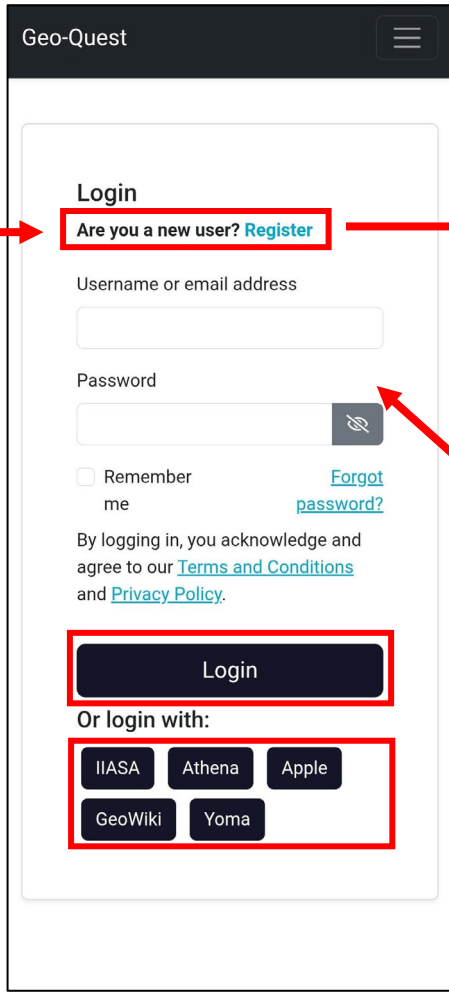
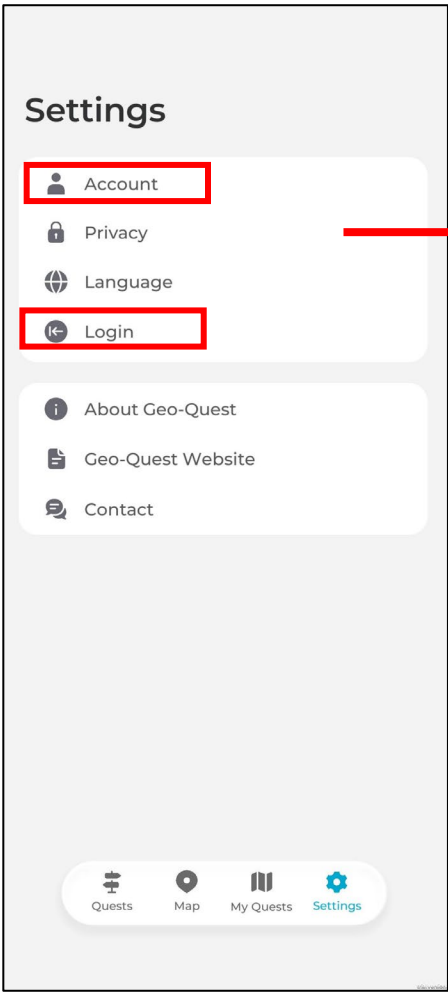
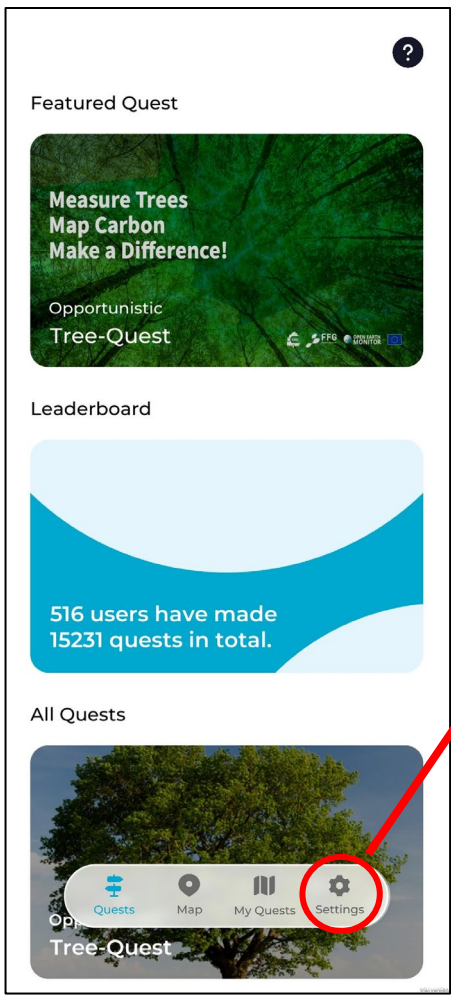
Or go to <https://crop-capture.main.geo-wiki.org/> and download **Geo-Quest**



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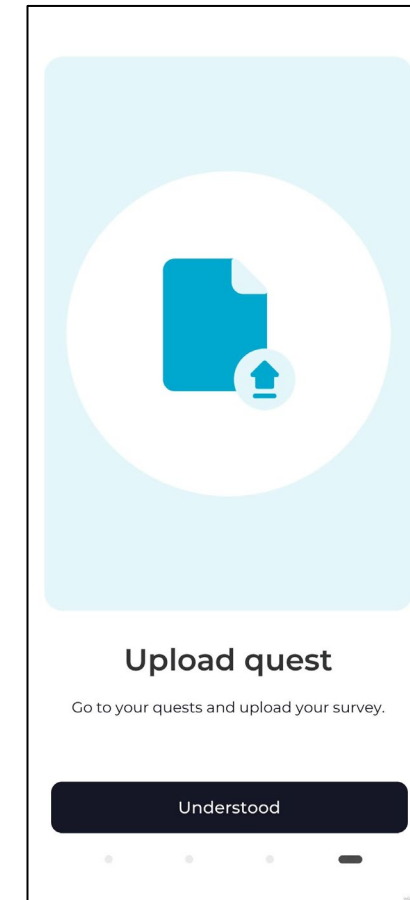
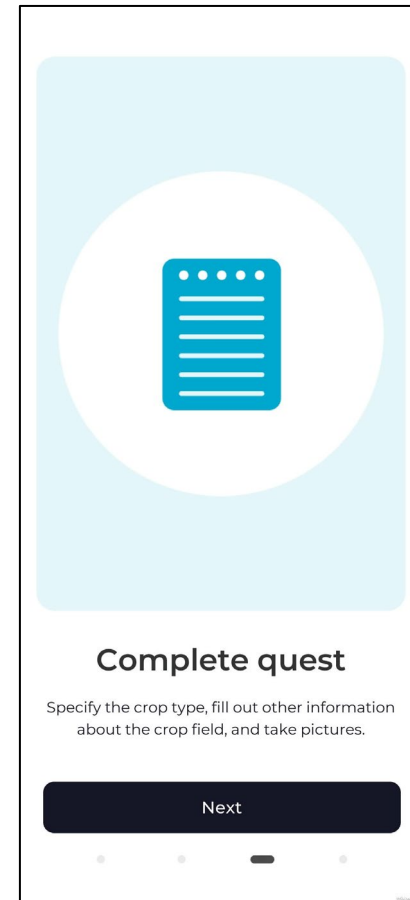
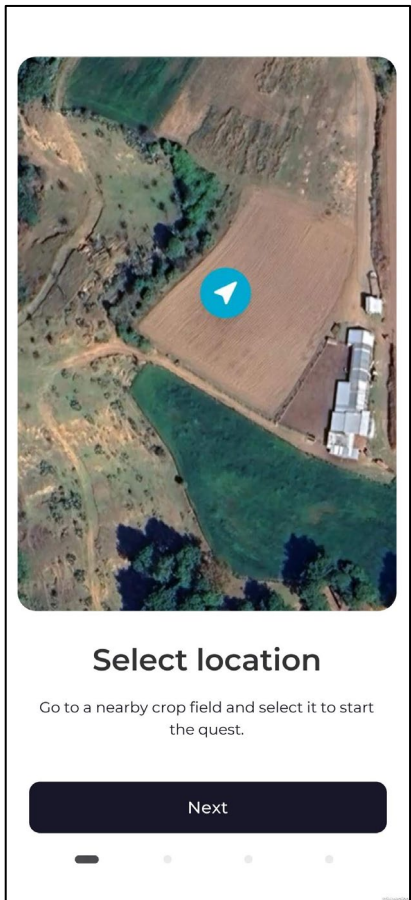
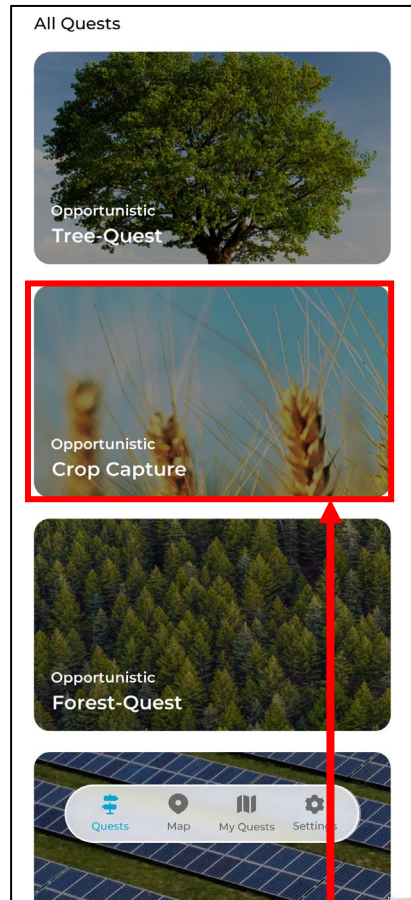
Geo-Quest: Registering



In Geo-Quest, register / login with a free account so you can upload your surveys



Geo-Quest Crop Capture: Overview



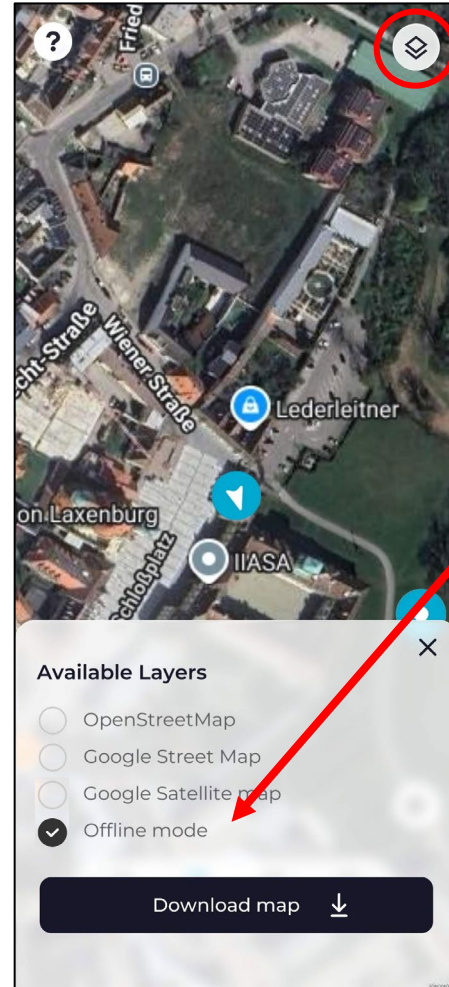
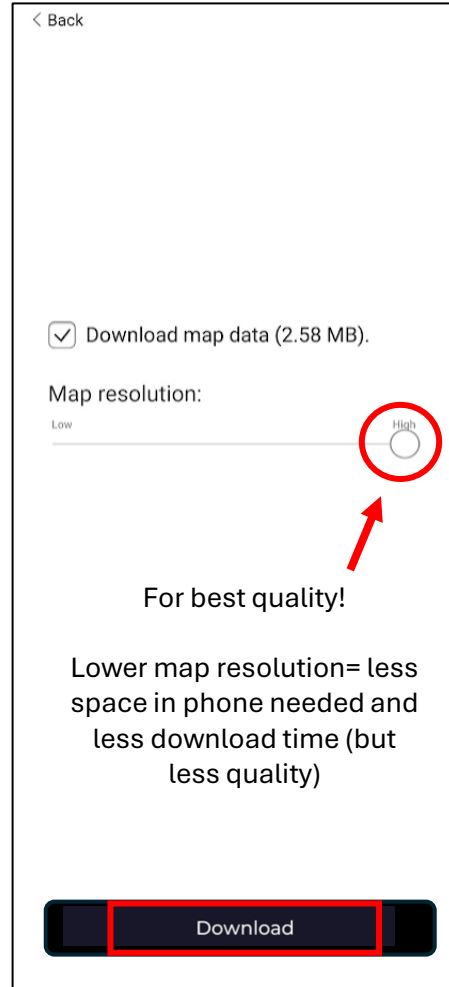
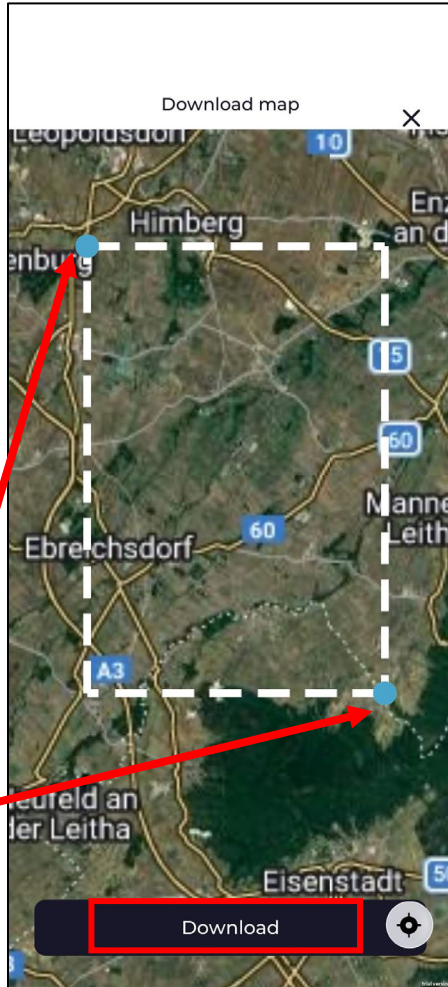
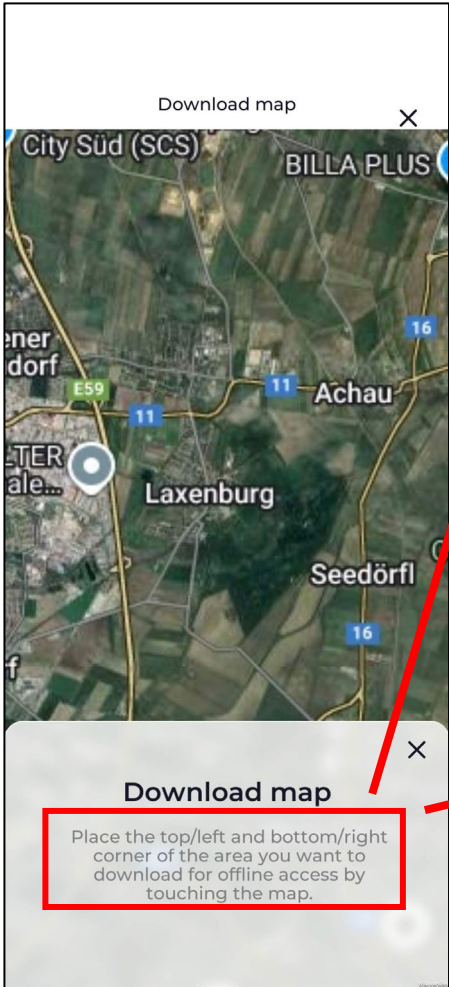
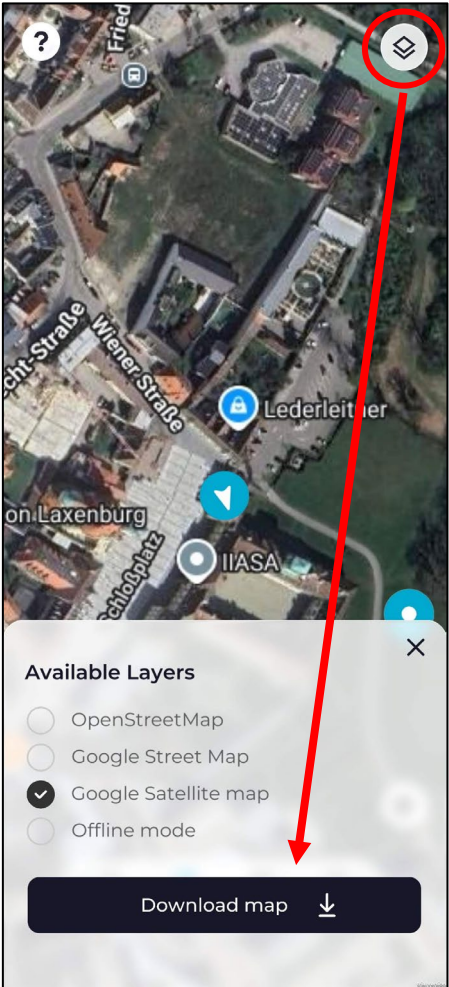
Select the **Crop Capture** Quest to start. Then select a location, delineate, answer and upload!



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Geo-Quest: Offline satellite imagery



When no signal is available, **activate** "offline mode" to use downloaded imagery

When phone signal returns, **deactivate** offline mode



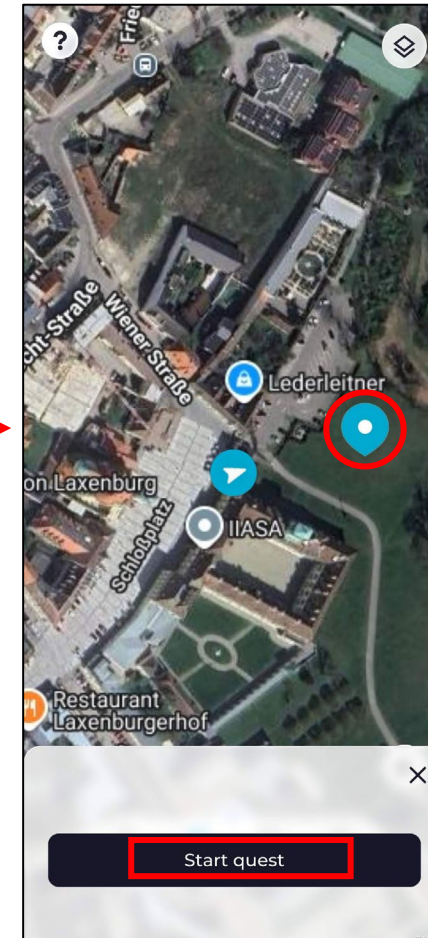
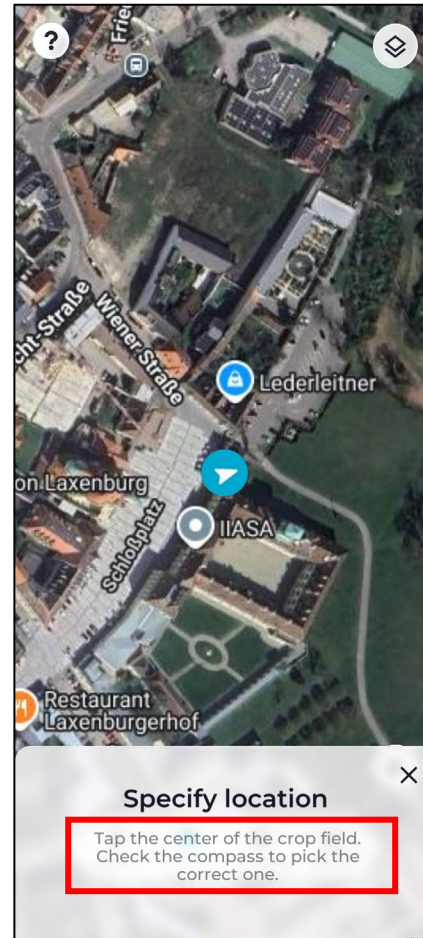
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Marking a field to survey

Specify the location of the crop field by touching on the map.

Aim for the center of the field

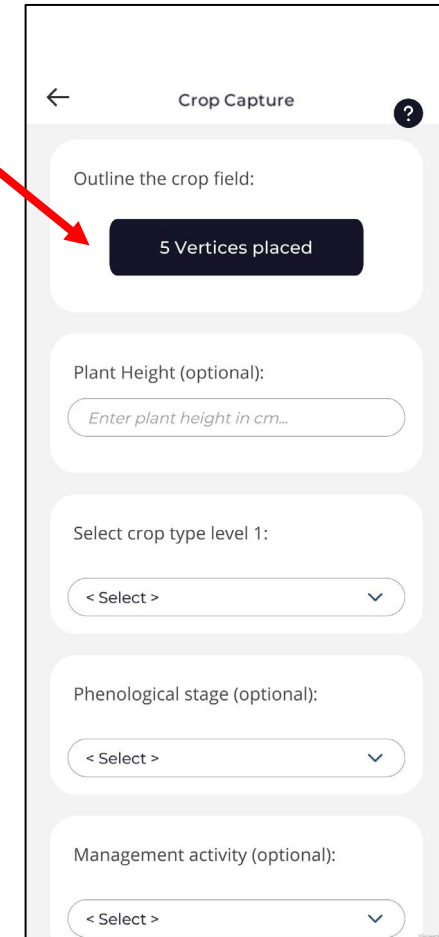
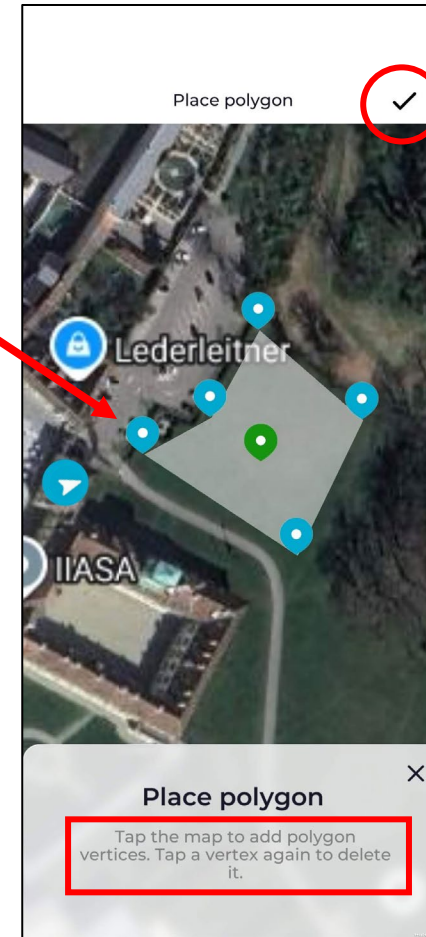
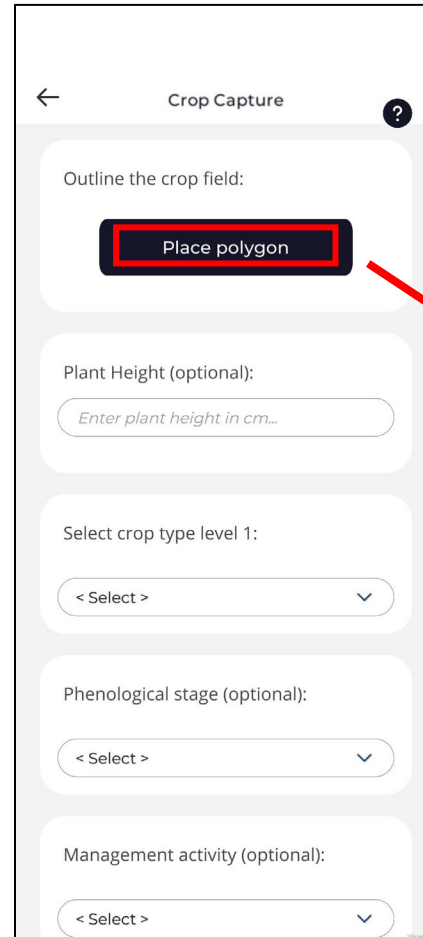


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Geo-Quest Crop Capture: Survey steps

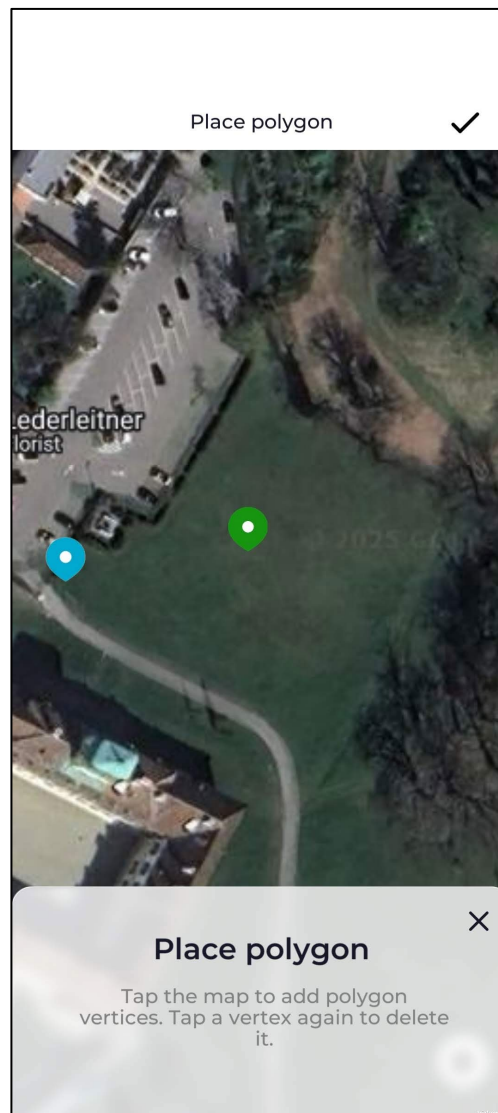
If possible, delineate the field.

Make sure that the polygon boundaries **do not overlap** other fields.



Geo-Quest Crop Capture: Delineation

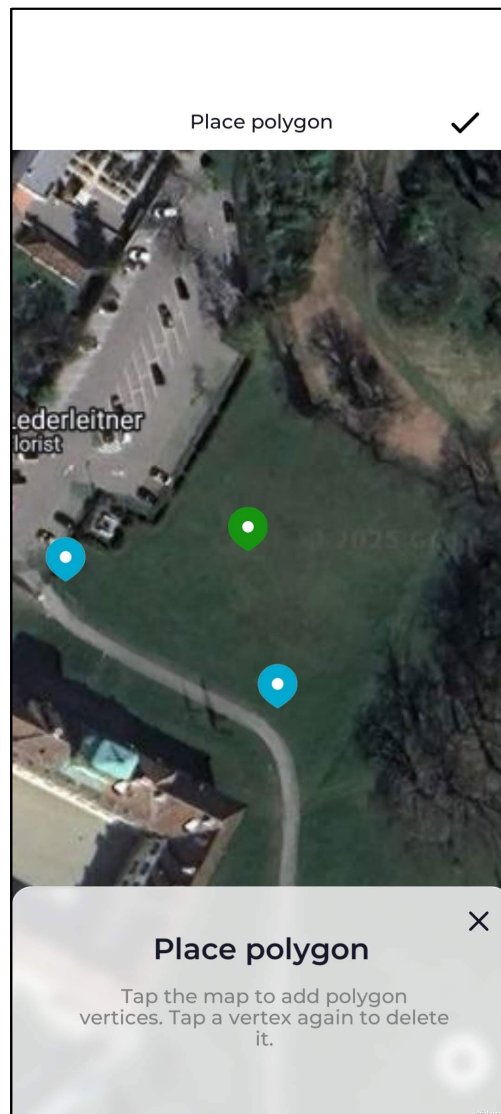
Delineate a polygon by marking each of the field corners on the map



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Geo-Quest Crop Capture: Delineation

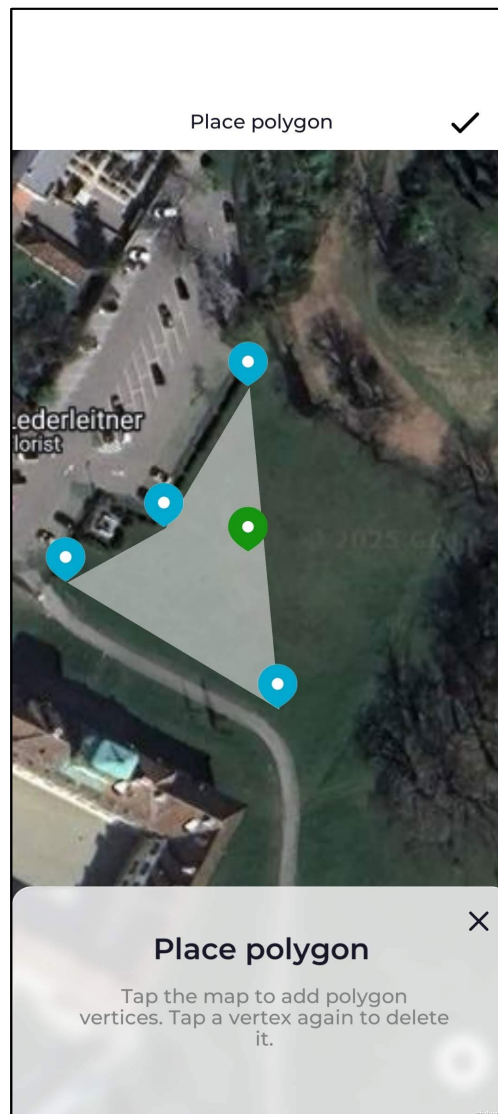
Delineate a polygon by marking each of the field corners on the map



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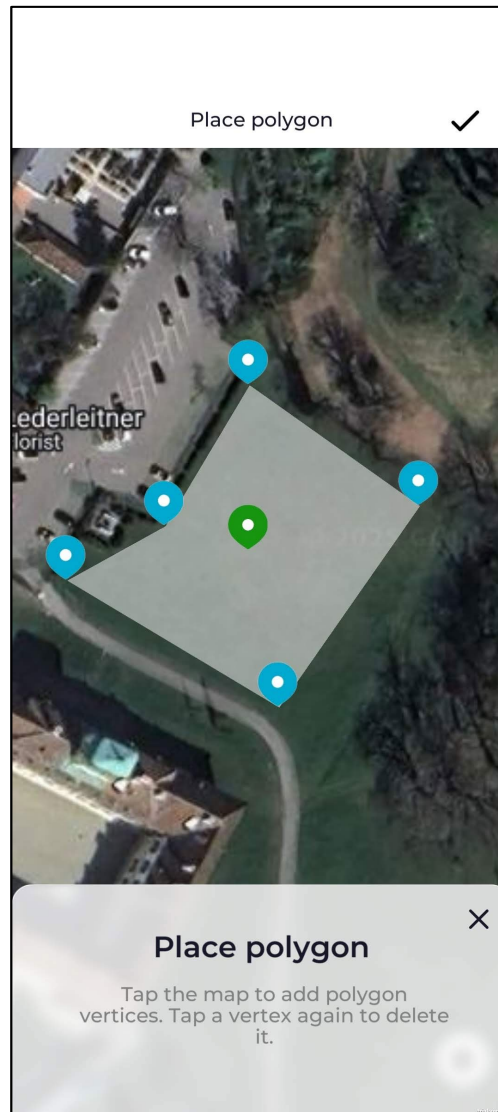
Geo-Quest Crop Capture: Delineation

Delineate a polygon by marking each of the field corners on the map



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Delineate a polygon by marking each of the field corners on the map




Caution:

Do this only if the satellite imagery matches reality:

Very high-resolution imagery is not always up-to-date.

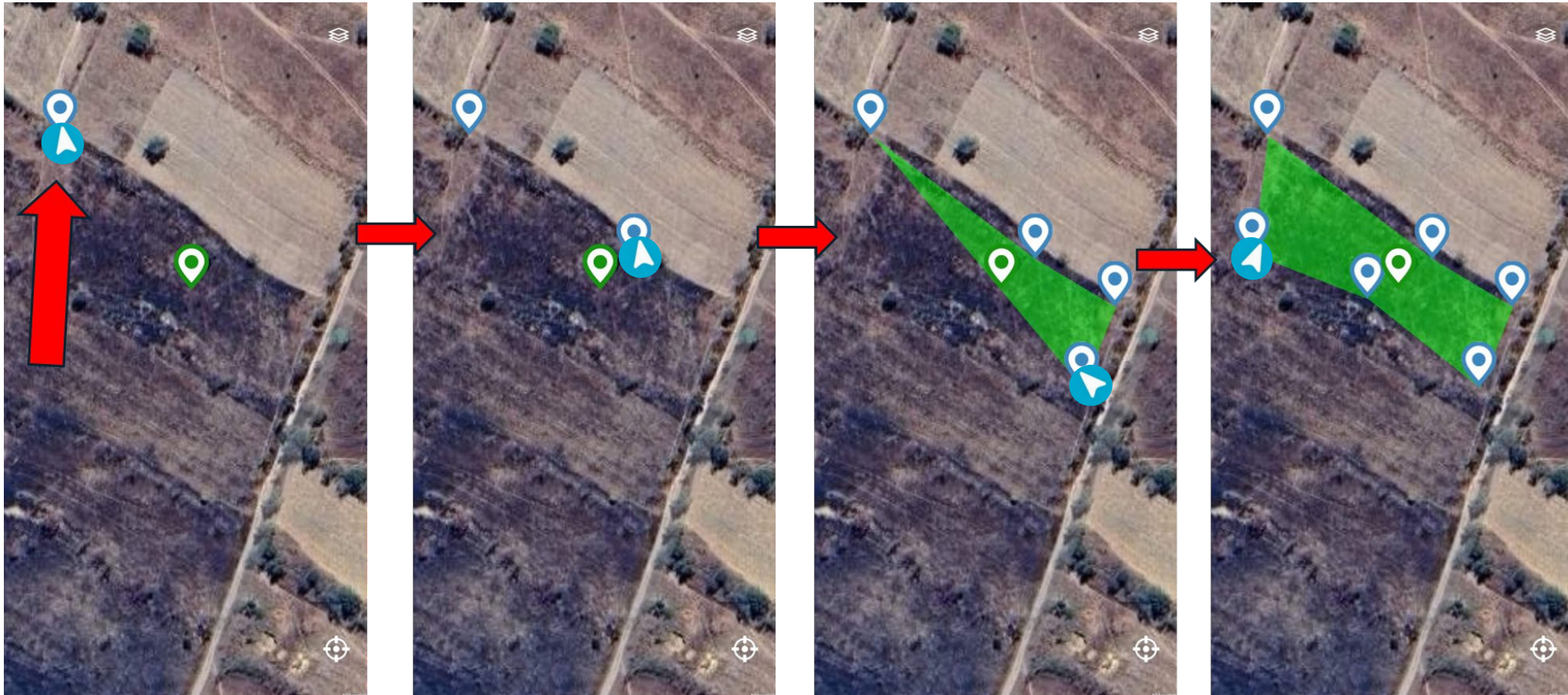
Alternative:

Use the position  shown in the app, walk and delineate (see next slide)



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Alternative: Using position as reference



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Geo-Quest Crop Capture: Survey questions

← Crop Capture ?

Select crop type level 1:
Crop

Select crop type level 2:
Cereals

Select crop type level 3:
Maize

Phenological stage (optional):
< Select >

Management activity (optional):
< Select >

Fill up the survey:

Start with **crop type level 1**
(crop / no crop)
and then select the best matching
levels **2** and **3** as needed

Some fields are **optional**

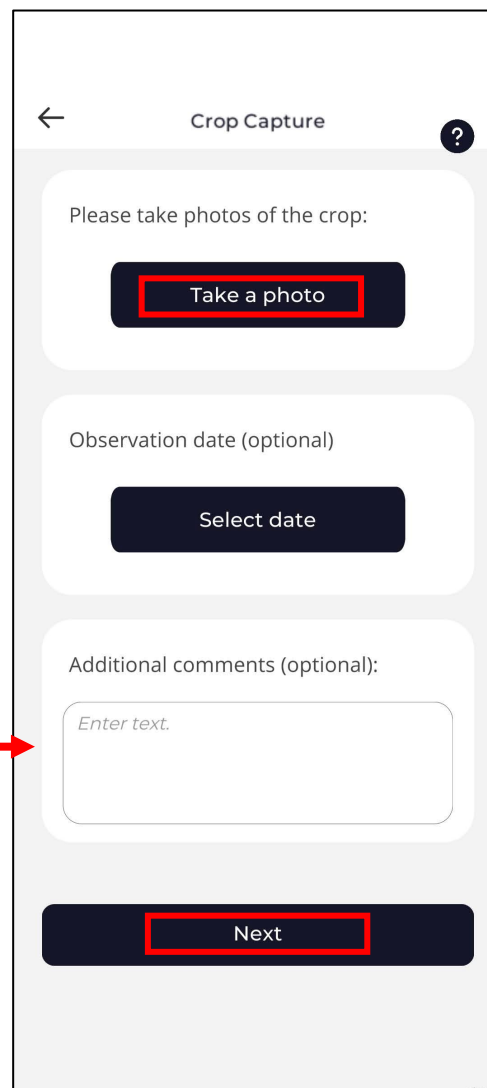


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Geo-Quest Crop Capture: Take photos

Take photos of the field to add to your survey

If you have additional comments or observations, use the Additional Comments box



Once you are done, press Next



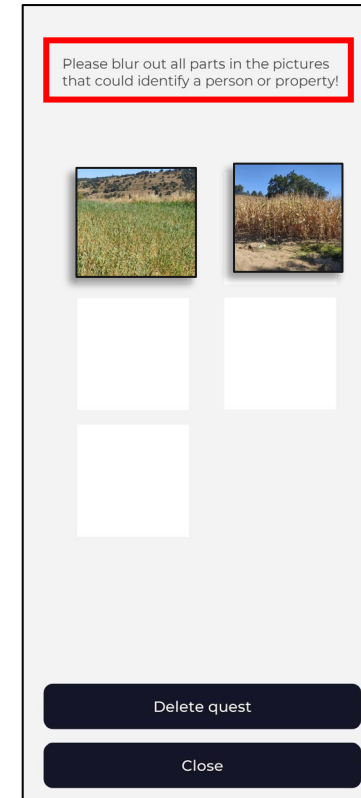
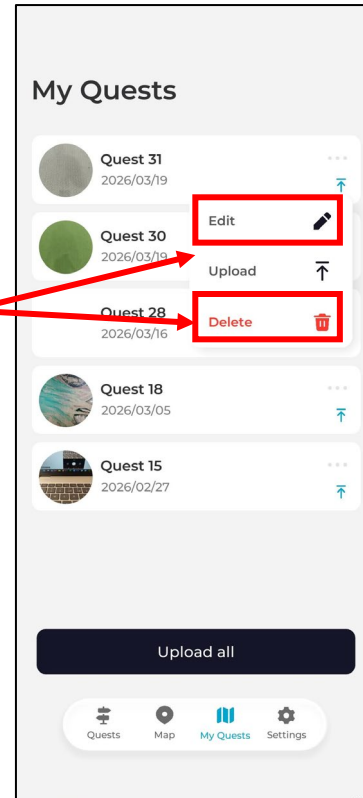
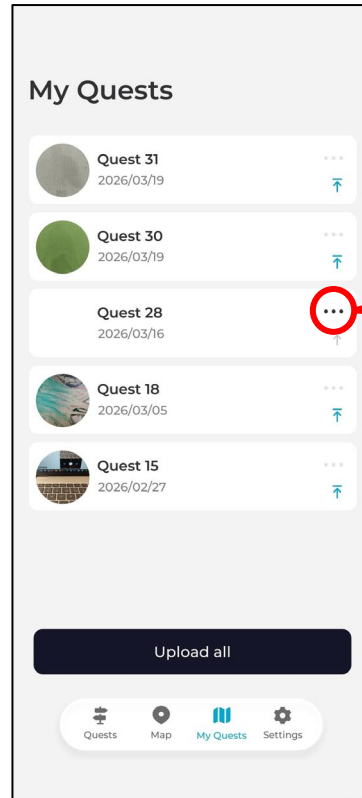
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Editing, deleting, uploading

Before uploading you can **edit** your survey if needed.

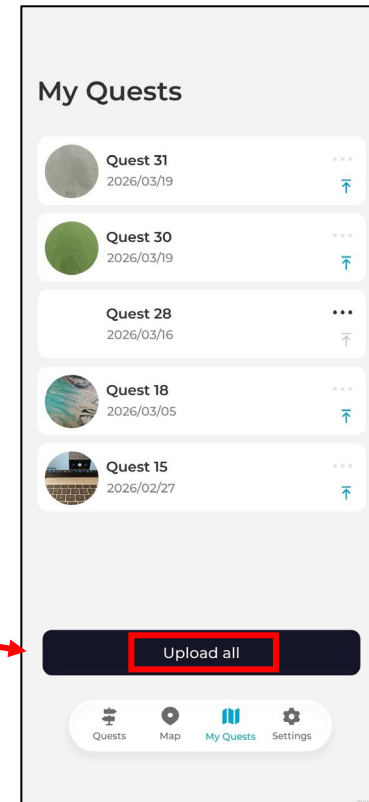
Please **delete wrong entries**: press edit and then **Delete quest**

Please **blur identifiable features** in the pictures, such as faces, license plates, etc.



Once you have internet connection, upload your survey.

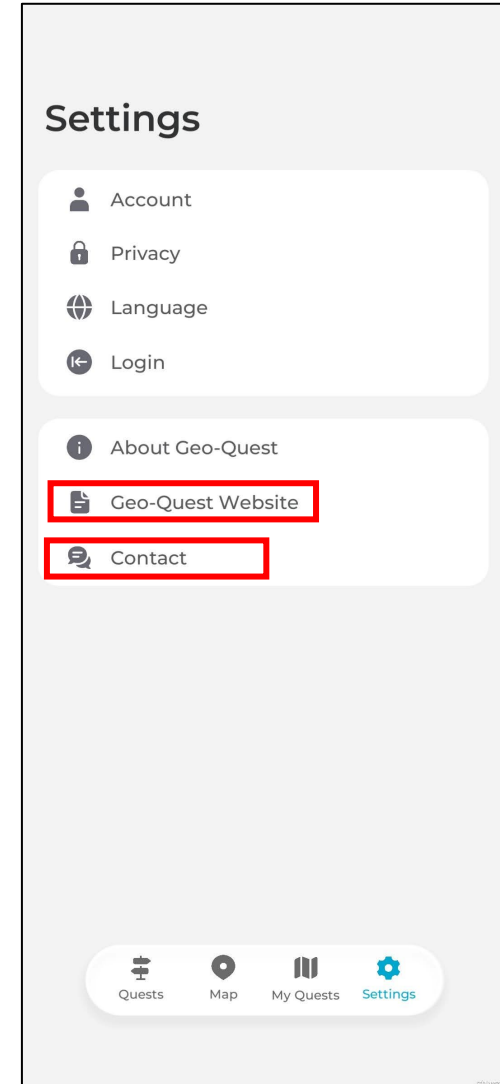
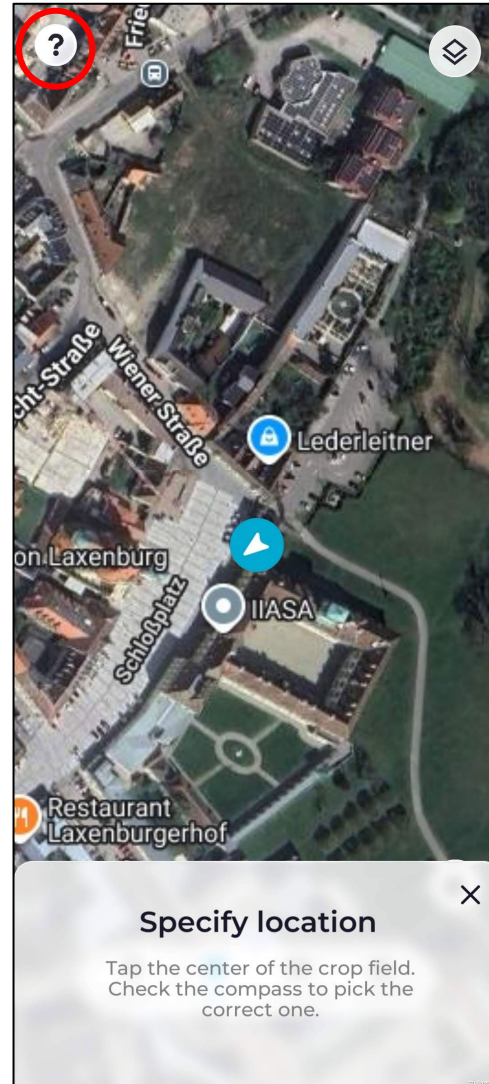
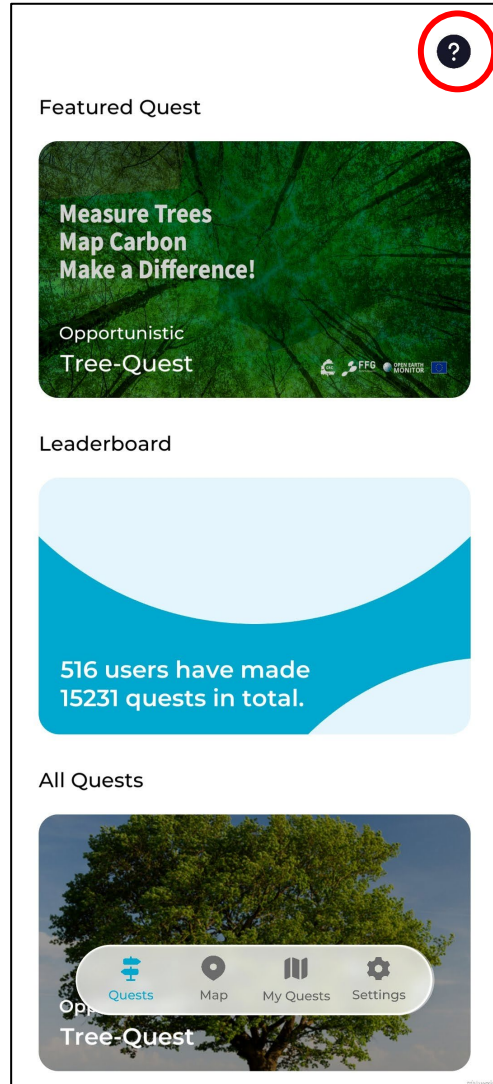
If you have recorded several fields, you can press **UPLOAD ALL**

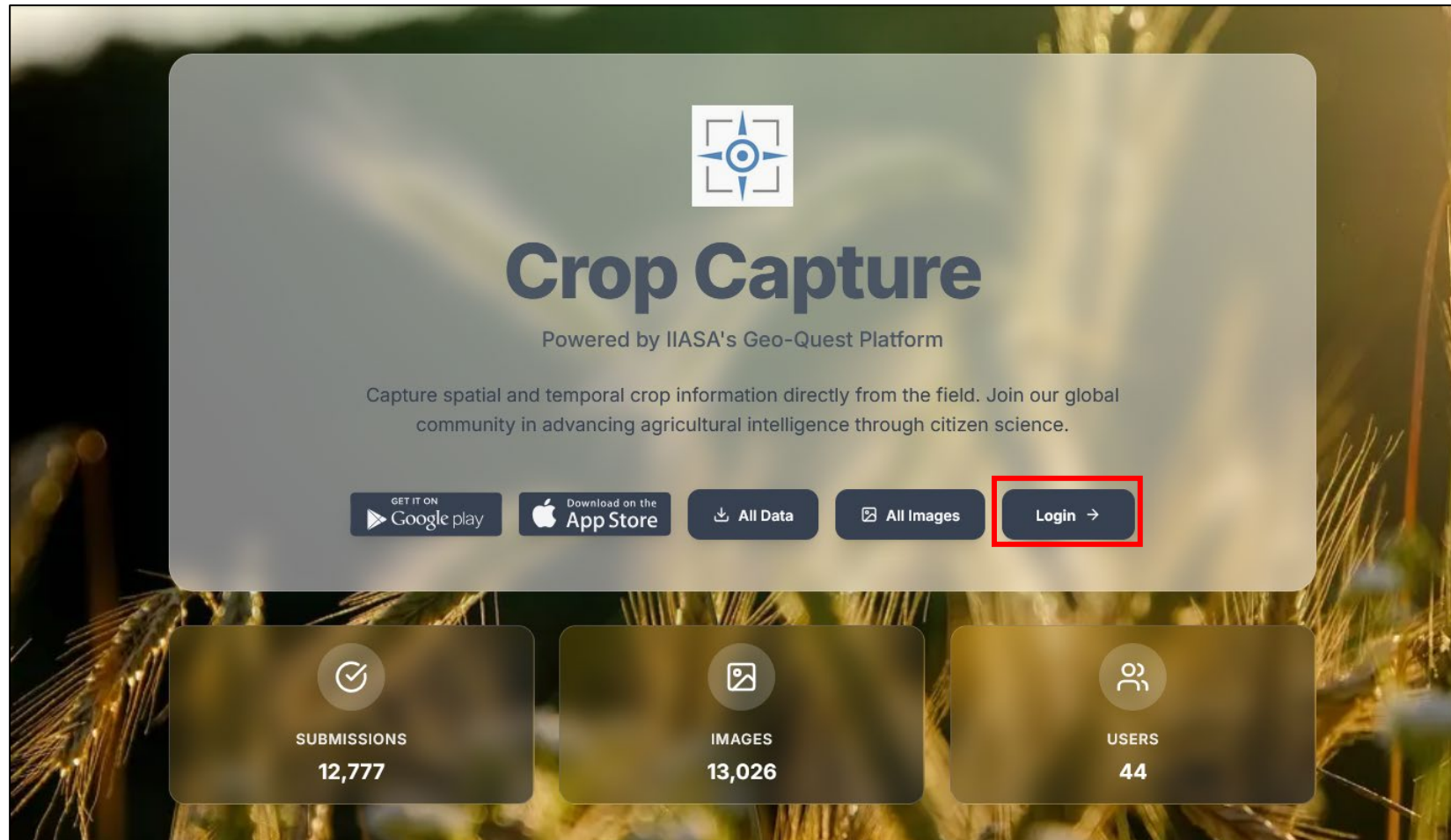



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Use the **help buttons** for more information and the **Contact** and **Geo-Quest Website** buttons to provide feedback and ask for support







Crop Capture

Powered by IIASA's Geo-Quest Platform

Capture spatial and temporal crop information directly from the field. Join our global community in advancing agricultural intelligence through citizen science.

GET IT ON Google play | Download on the App Store | All Data | All Images | **Login →**

Category	Count
SUBMISSIONS	12,777
IMAGES	13,026
USERS	44

Login to Crop Capture with your Geo-Quest username and password:

<https://crop-capture.main.geo-wiki.org/>



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Data visualization and downloading

Your Submissions

Username: juanlaso | Email: lasobaya@iiasa.ac.at | Total Submissions: 6 | Total Images: 4

Submission ID: 3a18c63b-af5f-388b-581f-7cea5363175d | Creation Time: 2025-03-20T14:57:06.392078 | Creator ID: 3a155e78-80f4-6920-a68b-f964759049c4

QUESTION/ATTRIBUTE	ANSWER/VALUE
crop2	cropCereals
cereals3	cerealsMaize
irrigation	rainfed
questStartTime	2025/03/20 15:52:03.000000
selectCropType	crop
sourceLocation	48.1977;15.36184
headingAccuracy	15
additionalComment	This is a comment
dateSurveyCreation	2025-03-20 03:56:01.000000
horizontalAccuracy	4.787534
userPositionSurveyCreatedLat	48.10143
userPositionSurveyCreatedLng	16.27972

Crop Capture

Total Users: 44 | Total Submissions: 12777 | Total Images: 13026

Quest Locations

Submission ID: 3a174b3-4c51-04d1-a8e...
Created: 2025-01-23T09:37:52.717021
crop2: cropOlseed | cropOlseed
olseed3: olseedTemp | olseedTemp
additionalComment: Test1

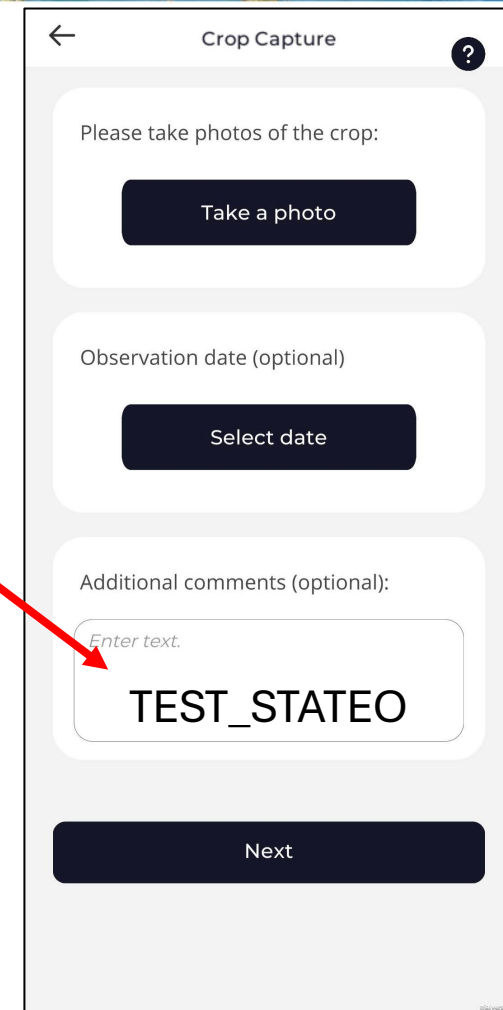
You can check and download your surveys

.parquet files (2 files, **points and polygons**) can be loaded directly into software such as QGIS and into the [WorldCereal RDM](#)

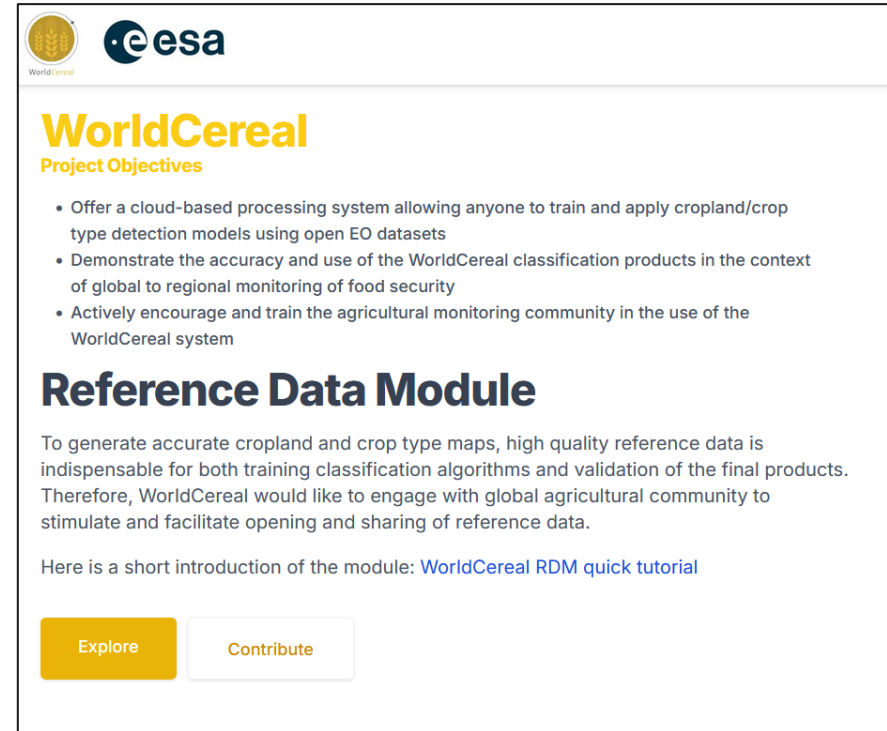


Hands On: using Geo-Quest

- Create 5-10 polygons and label these with crop/no crop
- Please label (comment) all your new quests as TEST_STATEO
- Upload your submissions
- Visualize them on the Crop Capture interface
- Download your submissions as .parquet files



- Harmonized data storage
- Data + metadata (web + API)
 - License
 - Citation
 - Original dataset information, etc.
- New datasets can be uploaded by users
- Public datasets are harmonized + QC by WorldCereal moderators



The screenshot shows the top of the WorldCereal website. It features the WorldCereal logo (a golden wheat stalk) and the ESA logo. Below the logos, the heading "WorldCereal" is followed by "Project Objectives". A bulleted list describes the project's goals: offering a cloud-based processing system, demonstrating accuracy, and encouraging the agricultural community. The "Reference Data Module" section explains the need for high-quality reference data and provides a link to a "WorldCereal RDM quick tutorial". At the bottom of the screenshot are two buttons: "Explore" (yellow) and "Contribute" (white).

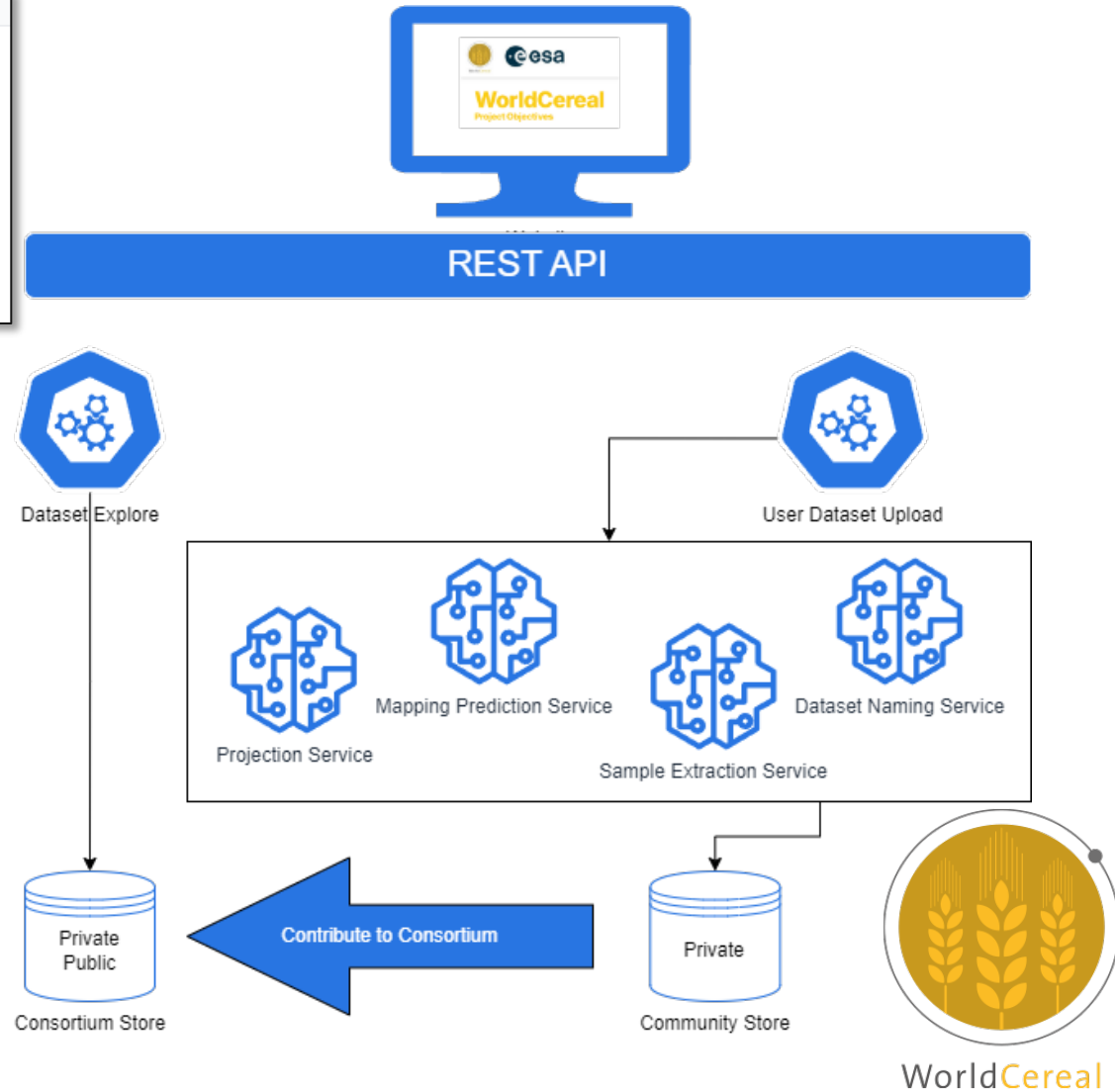
<https://rdm.esa-worldcereal.org>



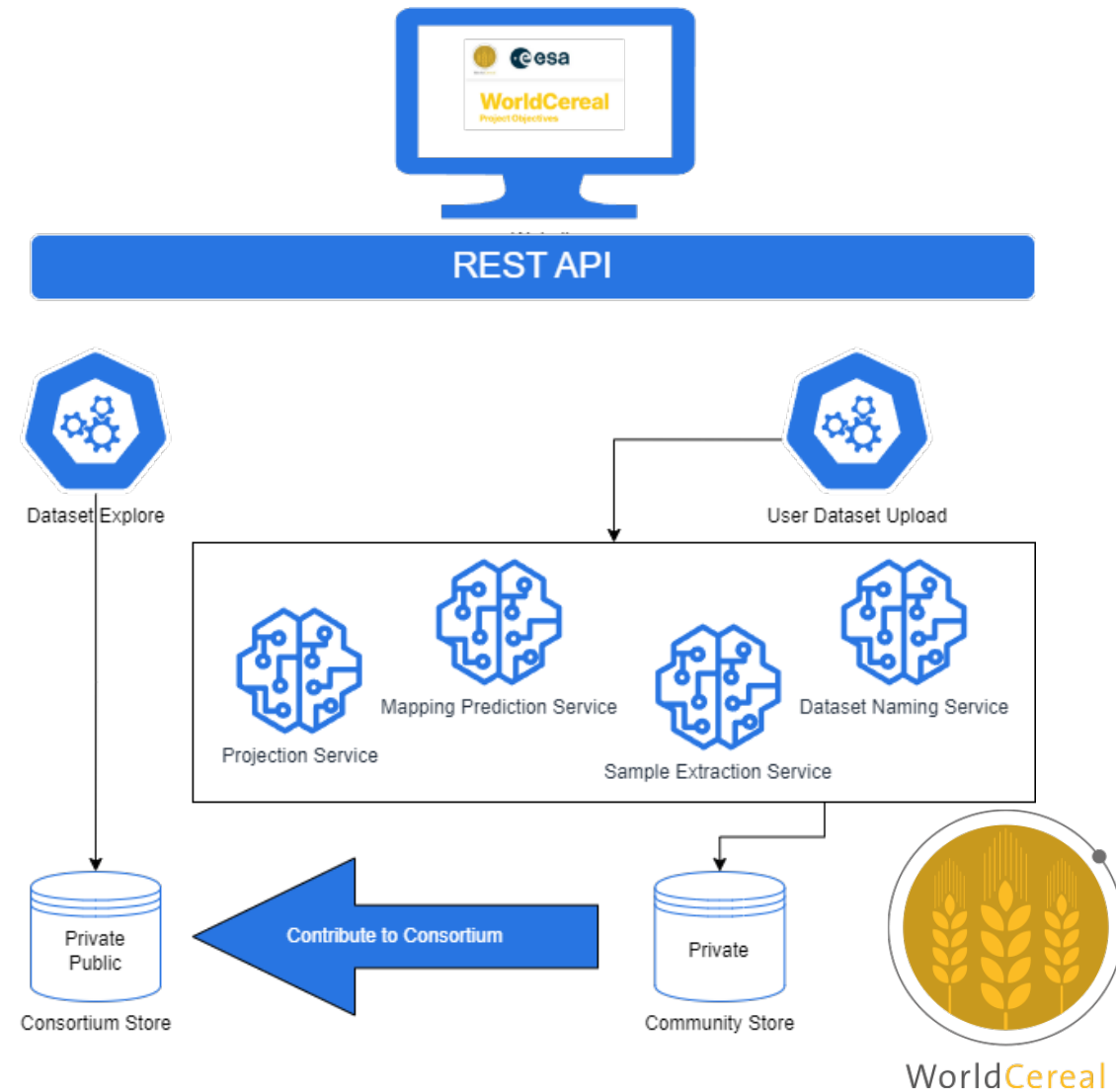
LICENSE TYPES*	REMARKS
CC0	No Rights Reserved
CC BY	Attribution
CC BY-SA	Attribution-ShareAlike
CC BY-NC	Attribution-NonCommercial
CC BY-NC-SA	Attribution-NonCommercial-ShareAlike
Private	Only accessible for the owner
Other	To be defined by the owner

* See Creative Commons licenses

- RDM Datasets
 - Consortium Store
 - Community Store
- Consortium Dataset Access
 - Public and private access.
- User datasets are private when uploaded.
- Users can choose to share their datasets privately to consortium. Users can make datasets public after QC review by WorldCereal moderators.
- User dataset upload workflow consists of
 - Projection service
 - Mapping service
 - Dataset Naming service
 - Sampling service
- Share datasets with License



- IIASA Kubernetes cluster for hosting
- Docker based containers/pods
- React with Next JS for the website development.
- Postgres with PostGIS for database and .Net Web API for REST API.
- Python (ver 3) based services for reprojecting, harmonizing and sampling the user uploaded datasets.
- OpenAI LLMs for legend mapping predictions.



Reference Data Collections

Public Collections available as input for processing

Collections
108

Features
66659005

Year
All

Crop
bare_spars

[Demo video on RDM](#)



Title
A crop type dataset on Central Asia, 2017 (Remelgado et al, 2020)

Collection ID
2017ascaawprojectpoly11

Feature Count	Dataset Downloads	Sample Downloads	Metadata Downloads
499	0	0	2

Region
AS

Geometry type
Polygon

Observation Time
Real Date

Date Range of Observations
2017-04-01 to 2017-09-01

Downloads

- Metadata Excel [Download]
- Harmonized Dataset [Download]
- Harmonization Steps [Download]
- Sample Extracts [Download]

Citation
Remelgado, R., Zaitov, S., Kenjabaev, S., Stulina, G., Sultanov, M., Ibrahimov, M., Akhmedov, M., Dukhovny, V. and Conrad, C., 2020. A crop type dataset for consistent land cover classification in Central Asia. Scientific Data, 7(1), pp.1-6.

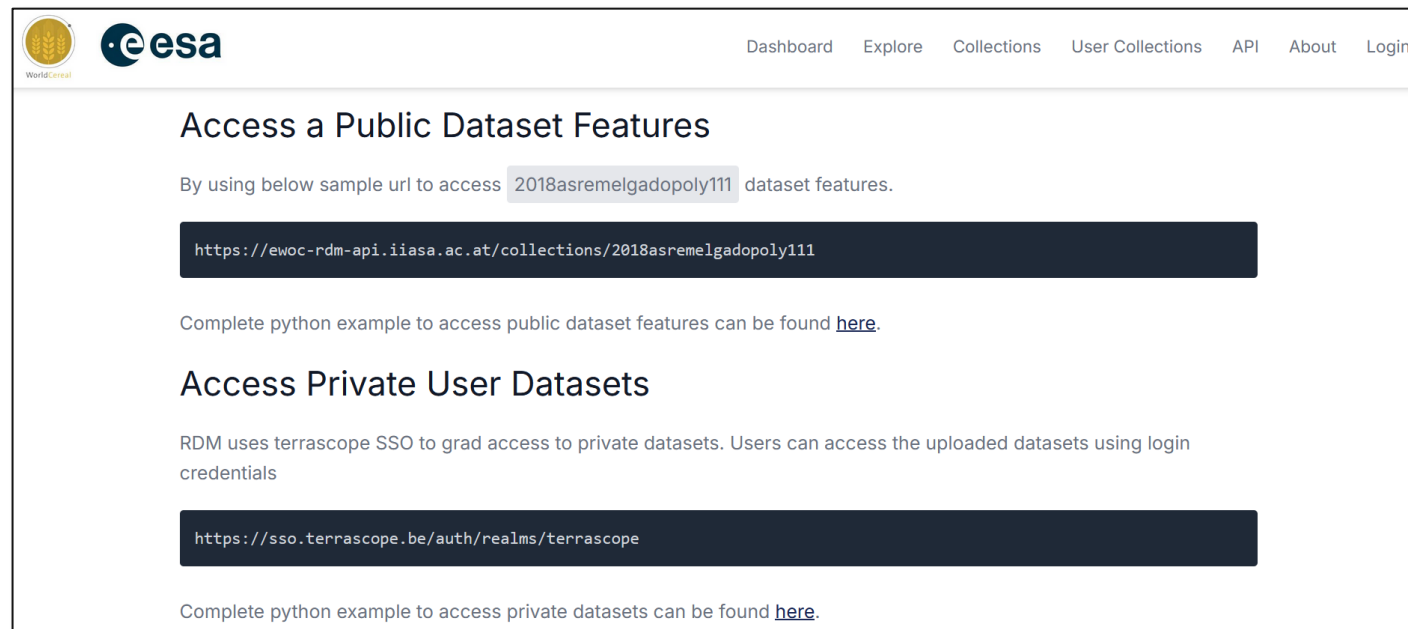
Crop Types [Feature Count]
unspecified_winter_wheat [163], cotton [127], rice [62], fruit_nuts [37], vegetables_fruits [37], temporary_crops [30], maize [14], unspecified_sorghum [11], unspecified_millet [11], permanent_leguminous_crops [2], soy_soybeans [2], spring_barley [1], vineyards_wine_vine_rebland_grapes [1]

Land Cover Types [Feature Count]
undefined [undefined]

Irrigation Types [Feature Count]
No Information [498]



- Access public datasets without credentials
- Download datasets and samples
- Download metadata
- Contributing private datasets requires a (free!) CDSE account
- Full API documentation on [Swagger](#)



The screenshot shows the RDM API documentation page. At the top, there are logos for WorldCereal and ESA, and a navigation menu with links: Dashboard, Explore, Collections, User Collections, API, About, and Login. The main content is titled "Access a Public Dataset Features" and explains how to use a sample URL to access dataset features. The sample URL is: `https://ewoc-rdm-api.iiasa.ac.at/collections/2018asremelgadopoly111`. Below this, it mentions that a complete python example can be found [here](#). The next section is "Access Private User Datasets", which states that RDM uses terrascope SSO for access to private datasets. The login URL is: `https://sso.terrascope.be/auth/realms/terrascope`. It also mentions that a complete python example for private datasets can be found [here](#).

<https://rdm.esa-worldcereal.org/api>



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- Access the notebook [HERE](#)
- RDM API interaction made easy!
- Filtering and downloading full collections and individual samples
- Checking collection metadata
- Quickly assessing availability of samples for a particular crop type
- Both for public and private datasets



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Uploading new datasets to the RDM

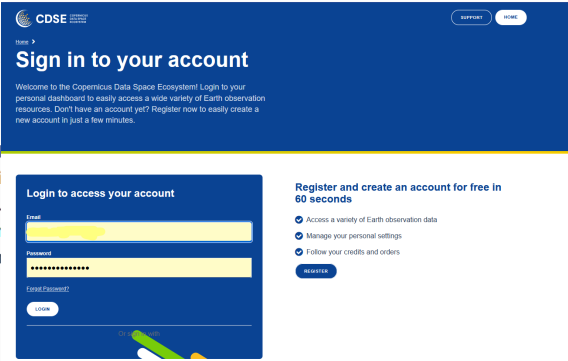
1 Contribute data

Reference Data Module

The RDM hosts a global collection of harmonized and curated in-situ reference data on land cover and crop type, freely accessible to everyone. It includes datasets from various sources with standardized metadata and attributes mapped to a unified crop type legend. The RDM also includes automated data quality checks, along with careful curation by WorldCereal data experts to ensure high and transparent data quality. Through the RDM, users can view, query, contribute to, and share in-situ reference data.

Explore

Contribute



2 Dataset Qualification Check ✓

The dataset must meet certain criteria to be eligible for upload. Please use the following checks to verify its compliance.

Does your dataset contain spatial geometry (e.g., points or polygons)?

Yes No

Does your dataset include land cover and/or crop type labels for each observation?

Land cover and crop type information should be combined into a single dataset attribute. The format of this attribute should be a string.

Yes No

Do you have information about the validity time of the observations in your dataset?

Validity time represents the date when the declared land cover or crop type was present at the specified location. It can be specified in one of two ways: (1) separately for each individual observation (in which case it should be included as a dataset attribute in string or date format), or (2) as a single date for the entire dataset (which can be selected during harmonization).

Yes No

Is the validity time of your samples later than January 1st 2017?

Due to reduced availability of satellite data prior to 2017, we currently do not support datasets before 2017.

Yes No

Next

Skip to Upload

3 Dataset Upload

Note on data privacy:

After a successful upload, your dataset will remain fully private by default and will not be shared with anyone. You will have the option to share your data with the WorldCereal consortium or make it fully public later.

Upload File

Supported file formats: (geopackage[.gpkg] / zipped shapefiles[.zip] / geoparquet / parquet).



Upload a file
or drag and drop file
file up to 100Mb

Identifier ⓘ

Min 3, max 20 alphanumeric identifier. Refer [dataset naming convention](#) for more information.

abcde

Back

Submit

4 Uploaded Attribute Extraction In Progress

WorldCereal supports the general movement towards data sharing and open science. Please check the below link to learn more about WorldCereal's view on opening reference data to society (<https://esa-worldcereal.org/en/situ-data-global-crop-mapping>).



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Uploading data: AI-assisted crop harmonization



Progress: Attribute Extraction (checked), Attribute Mapping, Harmonize, Completed

Dataset Harmonization

Step 1: Automated harmonization of land cover/crop type labels
All land cover and crop type labels in your dataset will be automatically converted to be compatible with our [hierarchical WorldCereal legend](#).

Select the dataset attribute that contains land cover or crop type labels (supported types: String and Int):

Step 2: Selecting validity time
Option 1: Select the dataset attribute containing information on validity time for each individual observation (supported types: date and string). In case of string format, please specify the used date format:

Option 2: Define a single validity time for all observations in the dataset. [Link to instructions](#)

Define a date for all observations in case observation date is missing.

mm / dd / yyyy

Step 3 (optional): Irrigation information
In case your dataset contains information on irrigation practices, we harmonize this information to our [WorldCereal irrigation legend](#).

Select the dataset attribute containing irrigation labels (supported types: String and Int):

5

Submit

Automated Mappings for Harmonization.

Definition of [Worldcereal Crop Types](#)

Land_Cover	Worldcereal Code
Bare soil	bare_soil
Beans	beans
Cabbages	brassica_oleracea_cabbage
Carrots	carrots_daucus
Clover	clover
Eggplant	aubergine_eggplant

6

Accept and Submit

Progress: Attribute Extraction (checked), Attribute Mapping (checked), Harmonize (checked), Completed (checked)

Share with us!

We are v... community.

- By accepting this option, you permit the WorldCereal consortium to use your dataset to improve services such as global land cover and crop type maps.
- The dataset will only be shared with the WorldCereal consortium and will not be made public. It will be handled in accordance with our data privacy policy.

WorldCereal Please check t... data to society (<https://esa-worldcereal.org/en/situ-data-global-crop-mapping>).

Open science. ning reference

Share Later

7



WorldCereal



Hands On: Uploading data into RDM

- Upload your **.parquet files** from your CropCapture Geo-Quest
 1. Enter to <https://rdm.esa-worldcereal.org/> and press Contribute
 - You will be asked to create a free CDSE account if you don't have one
 2. Once logged in, follow the steps shown in the interface

Uploading new datasets to the RDM

1 Contribute data

2 Dataset Qualification Check

3 Dataset Upload

4 Uploaded Attribute Extraction In Progress

The interface shows a multi-step process for uploading data. Step 1 involves logging in or creating an account. Step 2 is a qualification check with questions about spatial geometry, land cover labels, and validity time. Step 3 is the upload phase with a file selection area. Step 4 shows the progress of attribute extraction.

Uploading data: AI-assisted crop harmonization

5 **6** **7**

Attribute Selection → AI Based Mapping → Harmonization → Private Dataset → Public

Automated Mappings for Harmonization

Crop Types	WorldCereal Code
Bare soil	bare_soil
Beans	beans
Cabbages	brassica_vernice_cabbage
Carrots	carrots_daucus
Clover	clover
Eggplant	aubergine_eggplant

The interface details the AI-assisted harmonization process. It includes a progress bar for Attribute Selection, AI Based Mapping, Harmonization, Private Dataset, and Public. A table lists automated mappings for various crop types. Step 5 is 'Attribute Extraction', step 6 is 'Attribute Mapping', and step 7 is 'Harmonize'.




More info on WorldCereal RDM





For more information
join our Massive Online
Open Course (MOOC)

<https://esa-worldcereal.org/en/resources/free-massive-open-online-courses-mooc>



MOOC reference data

Exploring reference data in the WorldCereal
Reference Data Module



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