Global Development Assistance

Agriculture

March 2025

powered by esa in partnership with ADB

Contents

Case Studies

List of Abbreviations

ADB	Asian Development Bank
AID	Agile EO Information Development
ASIS	FAO Agricultural Stress Index System
AWD	Alternate Wetting and Drying
BAIMS	Belize Agriculture Information Management System
CLIMTAG	CLimate InforMation Tool for AGriculture
CRESAP	Belize Climate Resilient Sustainable Agriculture Project
DEM	Digital Elevation Model
DLIS	FAO Desert Locust Information Service
ECMWF	European Centre for Medium-Range Weather Forecasts
ESA	European Space Agency
FAO	Food and Agriculture Organization of the United Nations
FSRP	Food Systems Resilience Programme
GDA	Global Development Assistance
ICPAC	IGAD Climate Prediction and Applications Centre
IGAD	Intergovernmental Authority on Development in Eastern Africa
IFI	International Financial Institution
LCDS	Low Carbon Development Strategy
MRV	Monitoring, Reporting and Verification
NDVI	Normalized Difference Vegetation Index
RCP	Representative Concentration Pathway
SAFPA	Sustainable Agriculture and Forestry Policy Assessment
SAR	Synthetic Aperture Radar
SEOS	Satellite Earth Observation System
SOC	Soil Organic Carbon
SWI	Soil Water Index

What does ESA's Global Development Assistance thematic activity on Agriculture do?

The European Space Agency Global Development Assistance (ESA GDA) programme is a global partnership implemented with key International Financial Institutions (IFIs) to mainstream the use of Earth Observation (EO) into development operations. To achieve this mission, the ESA GDA focuses on targeted Agile EO Information Development (AID) applied to thematic priority sectors. The ESA GDA thematic activity on Agriculture supports activities aimed at enhancing sustainable and climate-smart agricultural development across low- and middle-income countries.

Agriculture plays a critical role in ensuring food security, rural livelihoods, and economic growth. To strengthen agricultural systems and address challenges such as climate variability, land degradation, and productivity loss, access to accurate, timely, and scalable information is essential. EO has strong potential to support agricultural transformation by delivering geospatial insights on land use, crop health, water availability, and environmental pressures. When combined with socio-economic and agronomic data, EO enables informed decision-making on policies, investments, and interventions that improve agricultural resilience and sustainability.

For further context please see: https://gda.esa.int/thematic-areas/

What topics of agriculture are included?

Improving agricultural planning and productivity

Smallholder farmers and rural communities in developing regions face persistent challenges related to food insecurity, land degradation, and climate variability. Enhancing agricultural productivity and resilience requires better access to data-driven tools that inform planning, resource use, and risk management. EO supports this by delivering critical insights on crop types, growth conditions, and yield forecasts—enabling more efficient and adaptive agricultural systems.

Sustainable land and water management

Effective management of soil, water, and vegetation is fundamental to long-term agricultural sustainability. EO provides spatial and temporal information on land use, evapotranspiration, soil moisture, and degradation risks. This helps guide the design of sustainable land and water practices, such as conservation agriculture, improved irrigation systems, and erosion control.

Climate-smart agriculture and risk reduction

To adapt to shifting climate patterns, farmers and policymakers require reliable seasonal forecasts, early warning systems, and indicators of agroclimatic stress. EO technologies enable early detection of droughts, floods, and heat stress, and support the implementation of climate-smart agricultural interventions tailored to local conditions.

Agri-finance and climate investment readiness

Access to agricultural financing and climate funds increasingly depends on transparent, data-supported reporting. EO supports the development of Monitoring, Reporting, and Verification (MRV) systems for carbon farming, climate insurance, and performance-based financing. These tools improve trust and accountability for investments in sustainable agriculture.

Pest and disease monitoring

Outbreaks of pests like locusts and crop diseases can devastate livelihoods. EO-based habitat suitability and environmental monitoring help anticipate risks and inform targeted responses to protect agricultural assets and ensure food supply stability.

Who runs the ESA GDA thematic activity on Agriculture?

The ESA GDA thematic activity on Agriculture is implemented by four European companies and institutions leading in the fields of EO, agricultural mapping and monitoring, risk assessments, climate services and the integration of technology into international development contexts. The partnership is led by GMV.

The partners are GMV, unique land use, CGI and VITO.

Priorities for the ESA GDA thematic activity on Agriculture

In close collaboration with the World Bank (WB) and Asian Development Bank (ADB), the ESA GDA thematic activity on Agriculture engages directly with agricultural and rural development teams to understand operational needs and identify opportunities where EO can provide added value. This user-focused approach has led to the development of EO services across 9 IFI-supported projects in Africa, Asia, and Latin America.

The EO services provided are:

1. **Demand-driven**: The IFI or client government has identified specific agricultural or environmental challenges that require geospatial insights to improve decision-making or implementation.
2. **Innovative**: The services go beyond standard EO offerings, incorporating advanced analytics, Artificial Intelligence (AI) models, and tailored mapping solutions not currently available on the market.
3. **Scalable**: Each solution is designed for broader application, enabling replication across countries or integration into larger agricultural support programmes and climate finance mechanisms.

Case studies examples

Enhancing carbon monitoring in Himachal Pradesh - India

EO-based soil organic carbon mapping (SOC) and change assessment

Challenge: The World Bank-supported 'Integrated project for source sustainability and climate resilient rain-fed agriculture' in Himachal Pradesh needed robust data to assess and incentivize sustainable farming practices.

EO solution: EO data from Sentinel-2 and Landsat-8, combined with ground-truth soil samples, enabled the mapping of SOC levels across cropland areas. The SOC estimates were generated using an AI model, providing scalable, high-resolution maps of soil carbon content from 2018 to 2023.

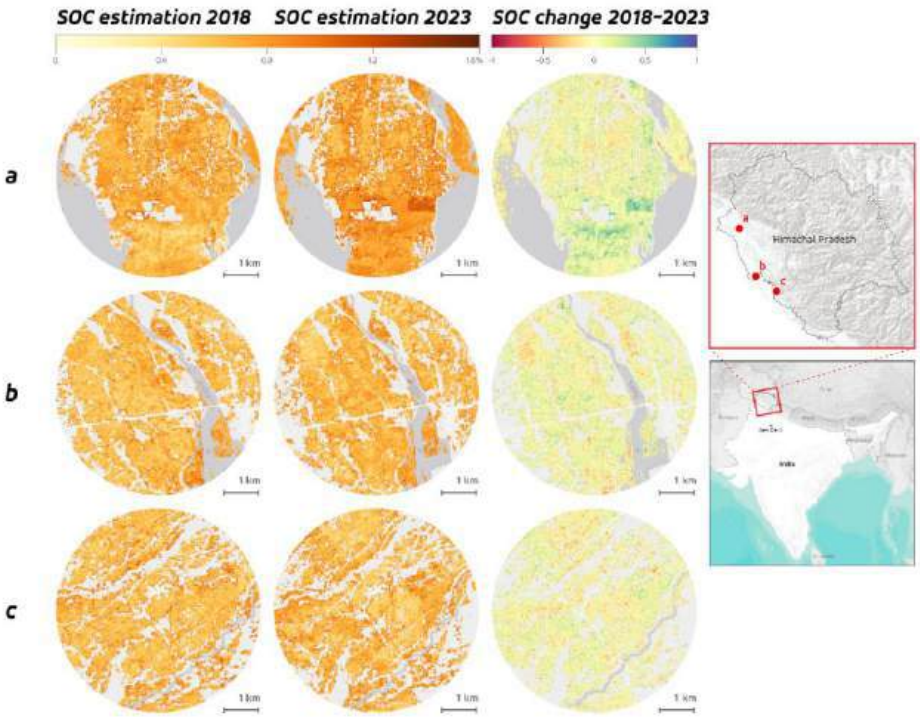
Input: Sentinel-2, Landsat, soil sample data (sourced by the WB), ESA World Cover, HydroSHEDS Basins

EO products: SOC baseline map, SOC change, Multi-year composite vegetation and soil indices

Spatial resolution and coverage: 10–30 m, global | **Frequency:** Annual, under request

Benefits:

- SOC maps revealed temporal trends and spatial variation, identifying areas of carbon gain/loss.
- Model showed strong performance with ~13.6% relative error.
- Enabled discussion on carbon markets and soil monitoring integration in planning



SOC estimations for three plots for the years 2018 (left) and 2023 (center) and SOC change in the period 2018-2023 (right).

Case studies examples

Estimating rice methane emissions – Vietnam

Mapping of rice paddy inundation and methane emission quantification

Challenge: . Methane from flooded rice fields is a potent greenhouse gas, yet there is limited data to monitor emissions. The World Bank needed tools to assess irrigation practices—particularly alternate wetting and drying (AWD)—to inform its climate-smart agriculture strategy in East Asia and to estimate emissions.

EO solution:. Using Synthetic Aperture Radar satellite imagery, ESA GDA Agriculture developed a methodology to detect irrigation patterns in rice paddies. This enabled the identification of AWD practices and supported methane emissions estimation

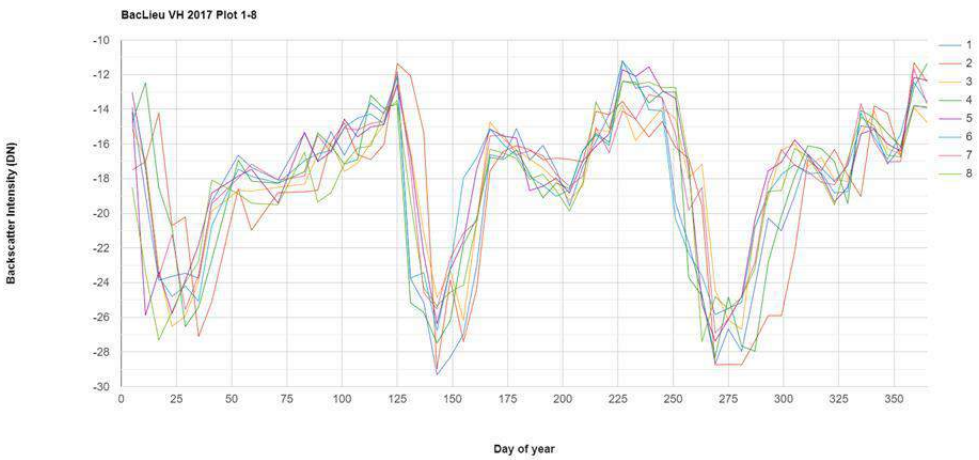
Input: Sentinel-1, PALSAR2, rice emission factors

EO products: Rice paddy inundation status, Methane emissions map

Spatial resolution and coverage: 10–20 m, global | **Frequency:** Annual, seasonal, under request

Benefits:

- Successfully demonstrated EO-based methane estimation in An Giang and Bac Lieu provinces.
- Enabled spatially explicit monitoring of AWD practices.
- Suitable for the design of a result-based CH_4 reduction program and MRV for carbon markets



Vietnam, Sentinel-1 backscatter intensity, ascending geometry, HV polarization in Bac Lieu (B), backscatter allows the detection of alternate irrigation (low backscatter) and drying (high backscatter)

unique land use

Case studies examples

Improving irrigation management – Indonesia

Evapotranspiration and water use efficiency analysis for irrigation performance assessment

Challenge: Indonesia's dryland areas face poor irrigation efficiency, impacting food security and sustainability. The Asian Development Bank needed solutions to assess water use and optimize irrigation in horticulture projects across six provinces.

EO solution: Through geospatial platform, EO products tracked evapotranspiration, biomass productivity, and irrigation performance. EO insights support the performance assessment of irrigation systems under the ADB's Horticulture Development in Dryland Areas Project.

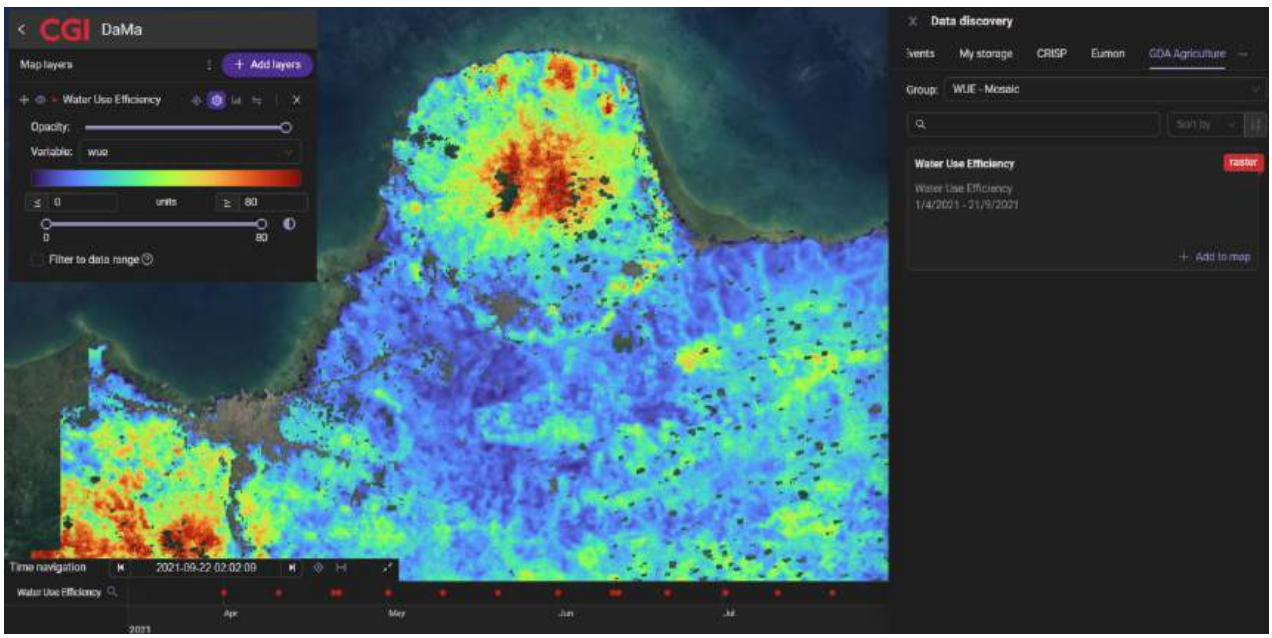
Input: Sentinel-2, Sentinel-3, ERA5-Land, ESA WorldCereal, ESA WorldCover

EO products: Evapotranspiration, Dekadal and seasonal Water Use efficiency, Analysis per crop/irrigation areas

Spatial resolution and coverage: 20, 100 and 300 m, global | **Frequency:** Daily, dekadal, seasonal

Benefits:

- Evaluated water use efficiency at dekadal and seasonal scales.
- Delivered actionable insights over 18,257 km² in two major river basins.
- Informed ADB's SEOS (Satellite EO System) development for scaling EO use across Asia



Water Use Efficiency Product available via the CGI's Insula platform UI

CGI

Case studies examples

Boosting resilience in Ghana's food systems

Crop type mapping, drought monitoring, and climate projection integration for food system planning

Challenge: Ghana's agricultural systems are vulnerable to climate shocks. The World Bank sought data to inform adaptation strategies, improve crop planning, and reduce food system risks under the Food Systems Resilience Programme (FSRP) Phase 2.

EO solution: GDA AGRI delivered crop mapping (rice and maize), drought monitoring, climate projections, and crop suitability models, tailored to FSRP target districts.

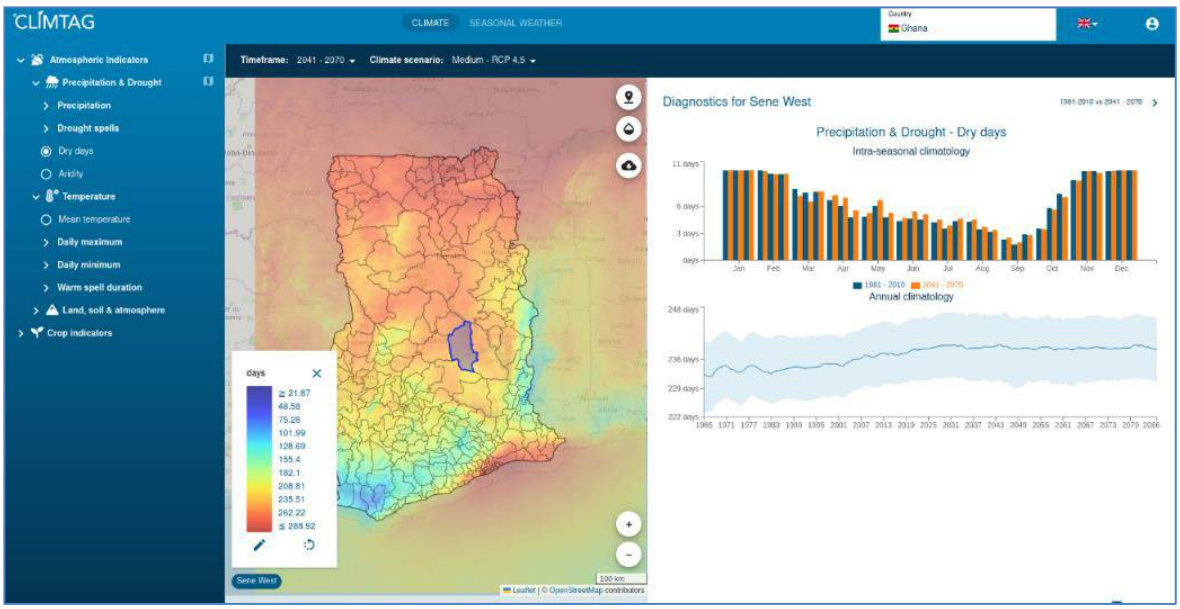
Input: Sentinel-1, Sentinel-2, FAO-ASIS drought indicators, ERA5 Reanalysis, Climate Projections CMIP5, ECMWF seasonal forecasts, local data.

EO products: Crop Type Mapping; Drought Indicators; Decadal Climate Change Prediction; Long-Term Climate Change Projections; Climate Seasonal Forecasting; Crop Suitability Map

Spatial resolution and coverage: 10 m, 1000 m, global | **Frequency:** Annual, seasonal

Benefits:

- Enabled near-real-time drought alerts.
- Improved baseline data for resilient planning.
- Strengthened Ghana's capacity to respond to food crises and plan agricultural investments.



Ghana CLIMTAG Climate dashboard: showing # of dry days for specific district "Sene West" for timeframe "2041-2070" for climate scenario "RCP 4.5"

Case studies examples

Food security financing – Belize

EO-enabled crop mapping, drought monitoring, and deforestation risk assessment for climate finance applications

Challenge: Belize needed geospatial data to inform credit risk analysis and enhance agricultural financing under its Climate Resilient and Sustainable Agriculture Project (CRESAP).

EO solution: GDA Agriculture delivered high-resolution crop mapping, deforestation tracking, and drought monitoring using ASIS. These products enabled geospatial targeting of subsidies and finance while informing risk assessments.

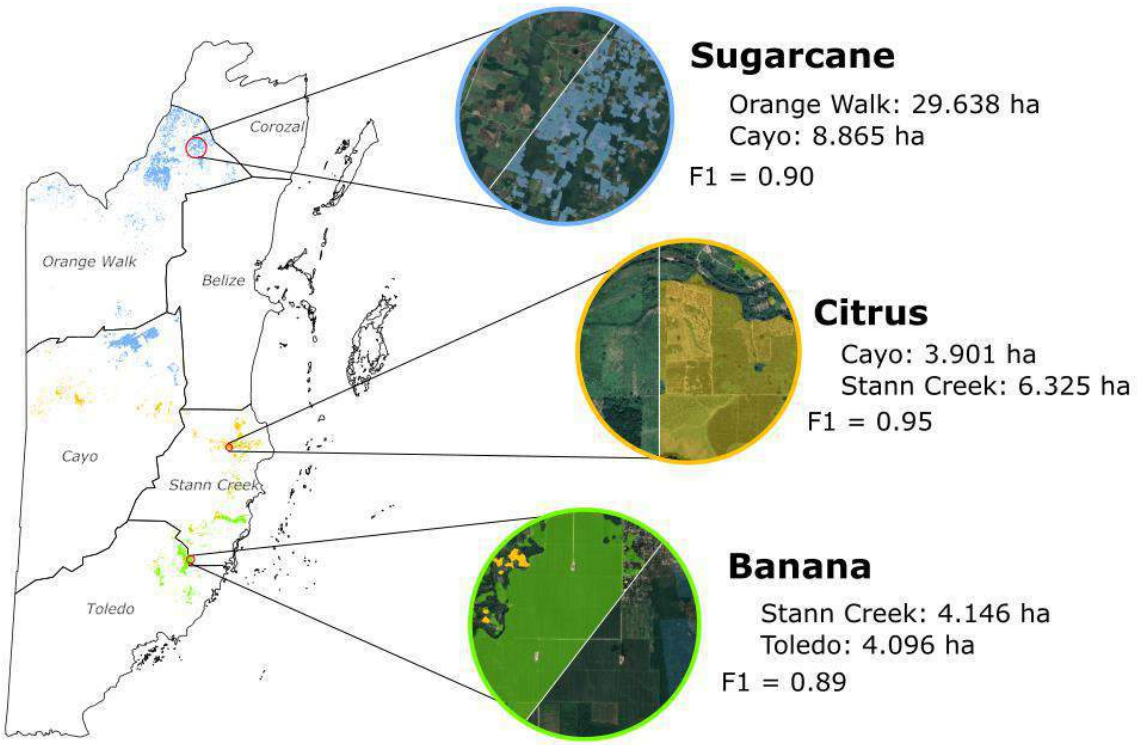
Input: Sentinel-1, Sentinel-2, Global Forest Watch, FAO-ASIS, ESA WorldCover 2021

EO products: Sugarcane, banana and citrus maps; Deforestation monitoring; ASIS drought alerts.

Spatial resolution and coverage: 10 m, 1000 m, global, global | **Frequency:** Annual, seasonal

Benefits:

- Created a digital baseline of key crop areas in Belize.
- Mapped historical forest loss and drought exposure.
- Informed the setup of Belize's Agricultural Information Management System (BAIMS).



Major crops mapping, Sugarcane, Citrus and Banana in Belize

Case studies examples

Deforestation-free value chains – Guyana

EO-based information products to support sustainable agri-commodity supply chains

Challenge: Guyana's expanding agricultural exports raised concerns about land-use change and deforestation. The World Bank's SAFPA initiative required data to assess and promote zero-deforestation value chains.

EO solution: Multi-year land cover and forest loss maps, crop suitability analysis, and predictive urban growth models to guide sustainable market development and identify deforestation risks.

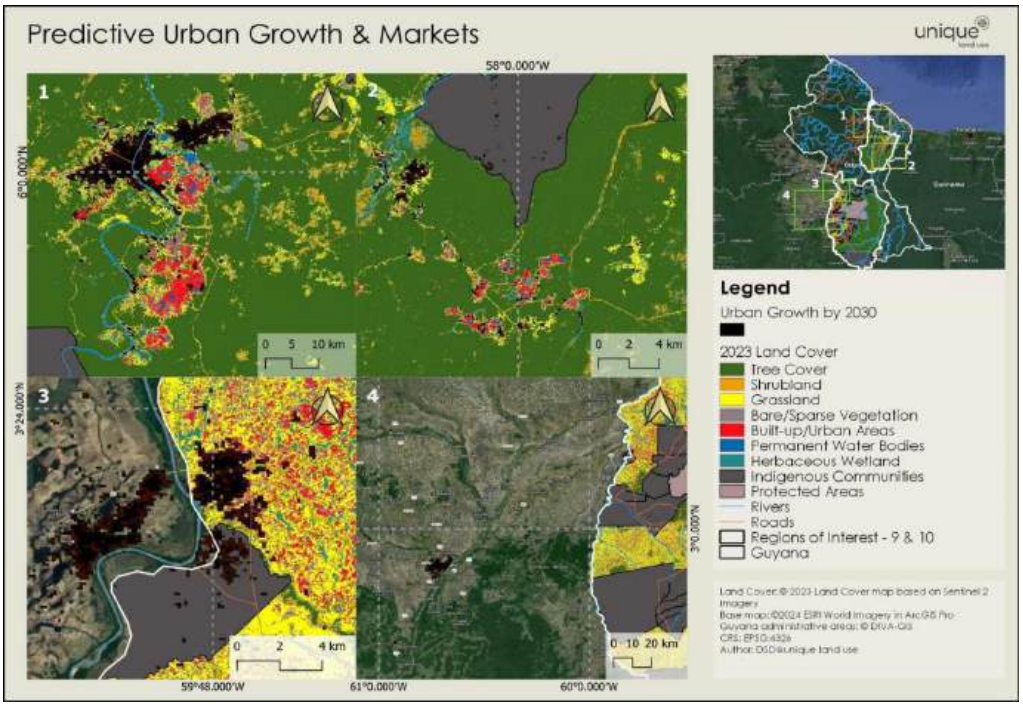
Input: Sentinel-2, Land tenure, Soil type, Conservation areas, WorldClim, ESA WorldCover 2021,

EO products: Land cover classification; Forest loss maps; Value chain suitability zones; Urban expansion forecasting.

Spatial resolution and coverage: 10-m, national to global | **Frequency:** Annual, seasonal

Benefits:

- Supported low-carbon planning in Regions 4, 5, 6, 9, and 10.
- Identified suitable areas for soy, rice, peanuts, poultry.
- Contributed to regional trade forecasts and to inform future investments.



Predictive urban growth and potential markets for target value chains within regions 9 and 10, Guyana: urban growth in (1) Linden, (2) Kwakwani; (3) Lethem, Guyana and Bomfim, Brazil and (4) Boa Vista, Brazil

unique land use

Case studies examples

Locust egg breeding mapping – Eastern Africa

Suitability analysis for locust breeding grounds and early warning

Challenge: Recurring locust outbreaks in Eastern Africa threaten food security. The World Bank needed scalable tools to monitor egg-breeding suitability and enable early interventions

EO solution: GDA Agriculture created locust breeding suitability maps using EO-derived soil moisture, vegetation indices, and topography. Outputs were tailored for integration with FAO Desert Locust Information Service (DLIS) and national early warning systems

Input: Copernicus DEM, Copernicus Soil Water Index (SWI), Sentinel-3 NDVI, AGERA5, SloilGrids, FAO locust database on hopper presence (2017-2022)

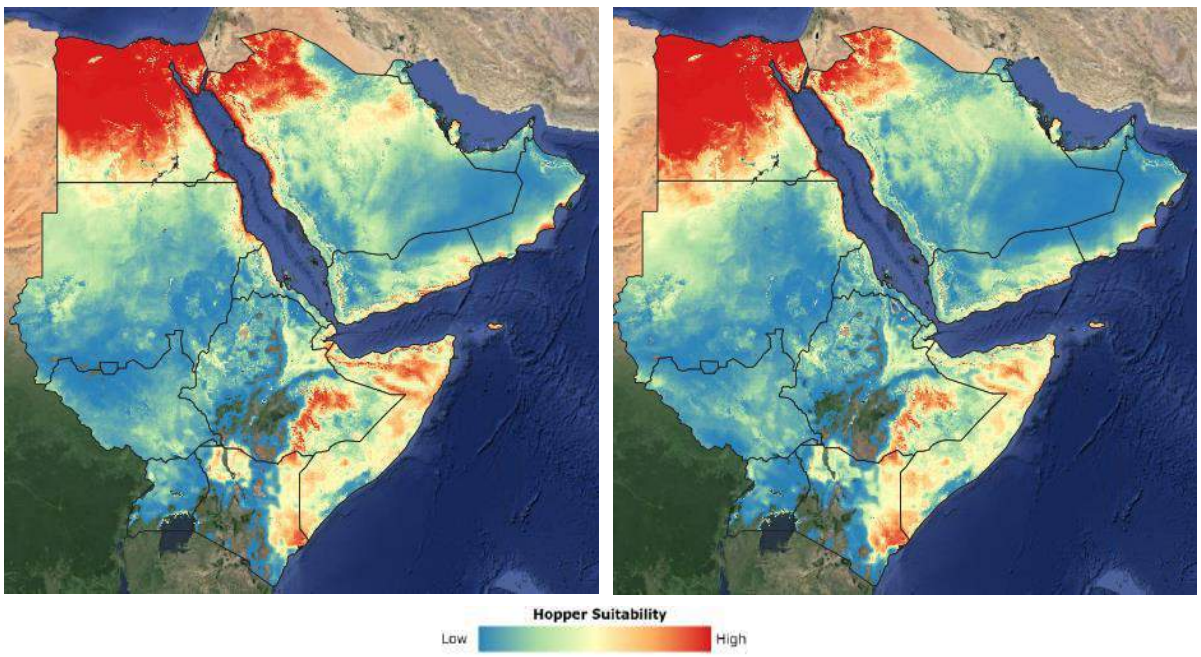
EO products: Breeding suitability maps; Rainfall and vegetation condition; Risk zone overlays.

Spatial resolution and coverage: 12.5 km, regional to global | **Frequency:** Annual, seasonal

Benefits:

- Supported WB and ICPAC Emergency Locust Response Project in Kenya, Ethiopia, and Somalia.
- Mapped 12+ million hectares for breeding suitability.
- Enhanced risk profiling and temporal resolution (10-daily) for local response teams and planning

April 21st 2020 | **May 1st 2020**



Modelled hopper suitability for April 21st and May 1st, 2020.

Case studies examples

Agroclimatic resilience – Rwanda and Uganda

Seasonal crop monitoring for climate-resilient agricultural planning

Challenge: Climate volatility impacts smallholder productivity in Rwanda and Uganda. The World Bank required scalable information products for agroclimatic monitoring and agricultural production to inform climate-smart agriculture and financial instruments

EO solution: GDA Agriculture delivered seasonal yield estimations, coupled with seasonal vegetation dynamics (crop phenology) and crop condition indicators in both countries

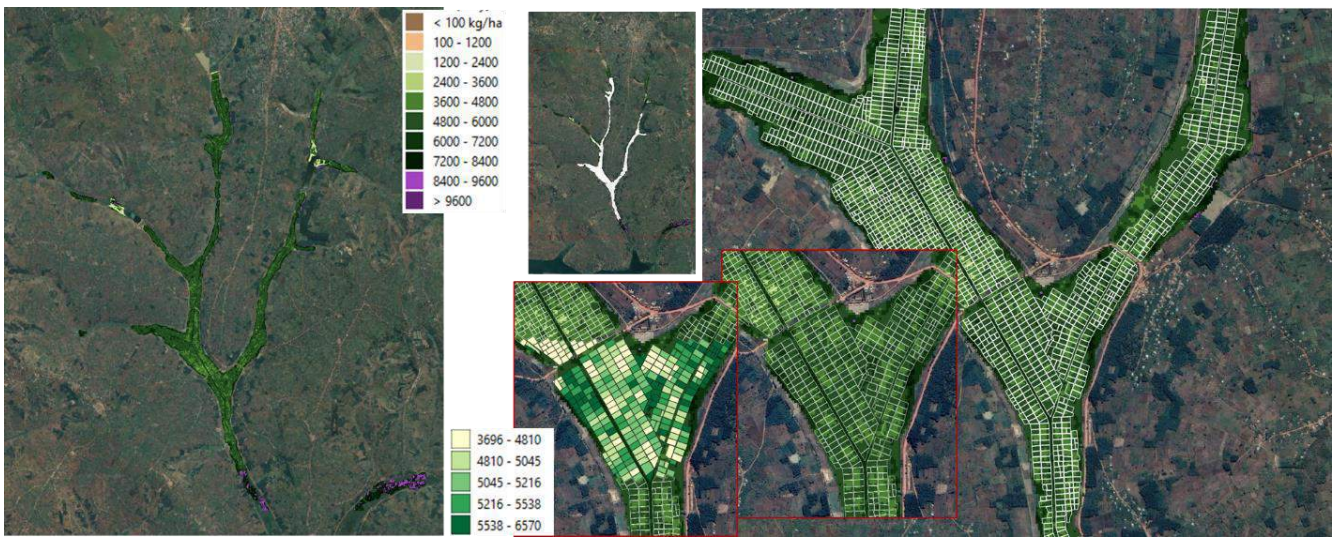
Input: Sentinel-1, Sentinel-2, FAO WaPOR crop maps (Rwanda), ground reference data (Uganda)

EO products: Rwanda (country wide) rice map; Rwanda rice phenology; Rwanda rice yield; Uganda district level (Mityana and Kassanda) maize maps; Uganda maize phenology; Uganda maize yield.

Spatial resolution and coverage: 10 m, local to global | **Frequency:** Annual, seasonal, monthly, dekadal

Benefits:

- Delivery of EO data for better-informed agricultural policies and resource allocation.
- Improved Food Security Planning, enhancing the ability to plan for food production and supply chain stability.
- Assists in the design and monitoring of Climate Smart Agriculture interventions.



Rice map and estimated yield in Rwanda

Case studies examples

Livestock productivity – Paraguay

EO-driven pasture condition monitoring and biomass productivity estimation to enhance livestock management

Challenge: The World Bank's Low Carbon Development Strategy (LCDS) in Paraguay seeks to reduce emissions from cattle production. There was a need for pasture condition and forage productivity maps to guide grazing management.

EO solution: The project delivered maps of pasture biomass and vegetation health, along with grazing condition indicators to support productivity assessments and sustainable rangeland practices

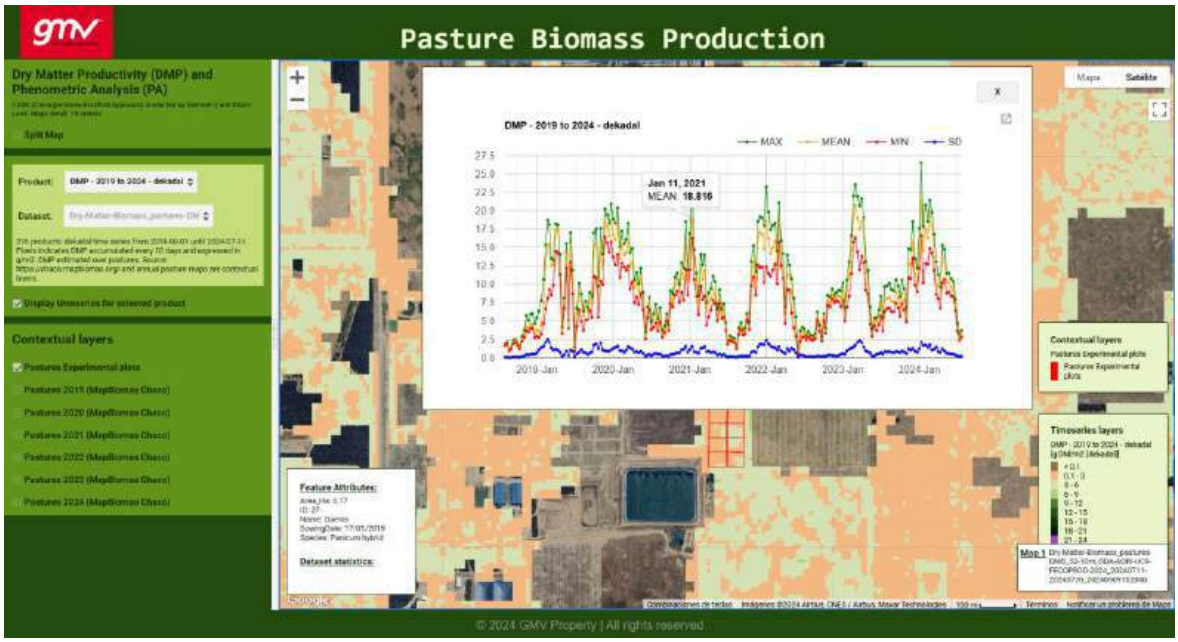
Input: Sentinel2-, Landsat 8/9, ESA World Cover; MapBiomas, test plots (facilitated by the final user)

EO products: Pasture biomass productivity; Pasture condition; Forage productivity estimation and production monitoring.

Spatial resolution and coverage: 10 m, local to global | **Frequency:** Annual, seasonal, monthly, dekadal

Benefits:

- Enabled and enhanced pasture management across ~50,000 km² in eastern Paraguay.
- Informed national Low Carbon Development Strategy indicators.
- Supported WB engagement with production cooperatives, Ministries of Agriculture and Industry and Commerce and the Paraguay's Development Finance Agency.



Time series zonal statistics for FECOPROD pasture experimental plots

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