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Optimizing Digitalization and Traceability of Smallholder Farmers in Africa to Transform Agro-forestry Systems

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Optimizing Digitalization and Traceability of Smallholder Farmers in Africa to Transform Agro-forestry Systems

The Kampala Declaration emphasized harmonized, real-time data solutions to support decision-making from farm to consumer. Africa's rural communities generate immense untapped data—on food production, trade, and nutrition—but fragmented systems limit its potential.

How do we ensure data is safe, validated, accessible, actionable, and used effectively to trade safe food, combat malnutrition, build economic and climactic resilience?

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Digital Ecosystems 4 Stakeholder Impact

#DigitalAGRA prioritizes creating impact for key actors across the value chain – with farmers at the center.

Women and Youth
Target Solutions and Opportunities for them

Extension and Village Based Advisors
Improve access to content, earning opportunity and reach

Government
Improve policy, services and decision-making capacity

SME's and Co-Ops
Improve capacity and ability to support farmers

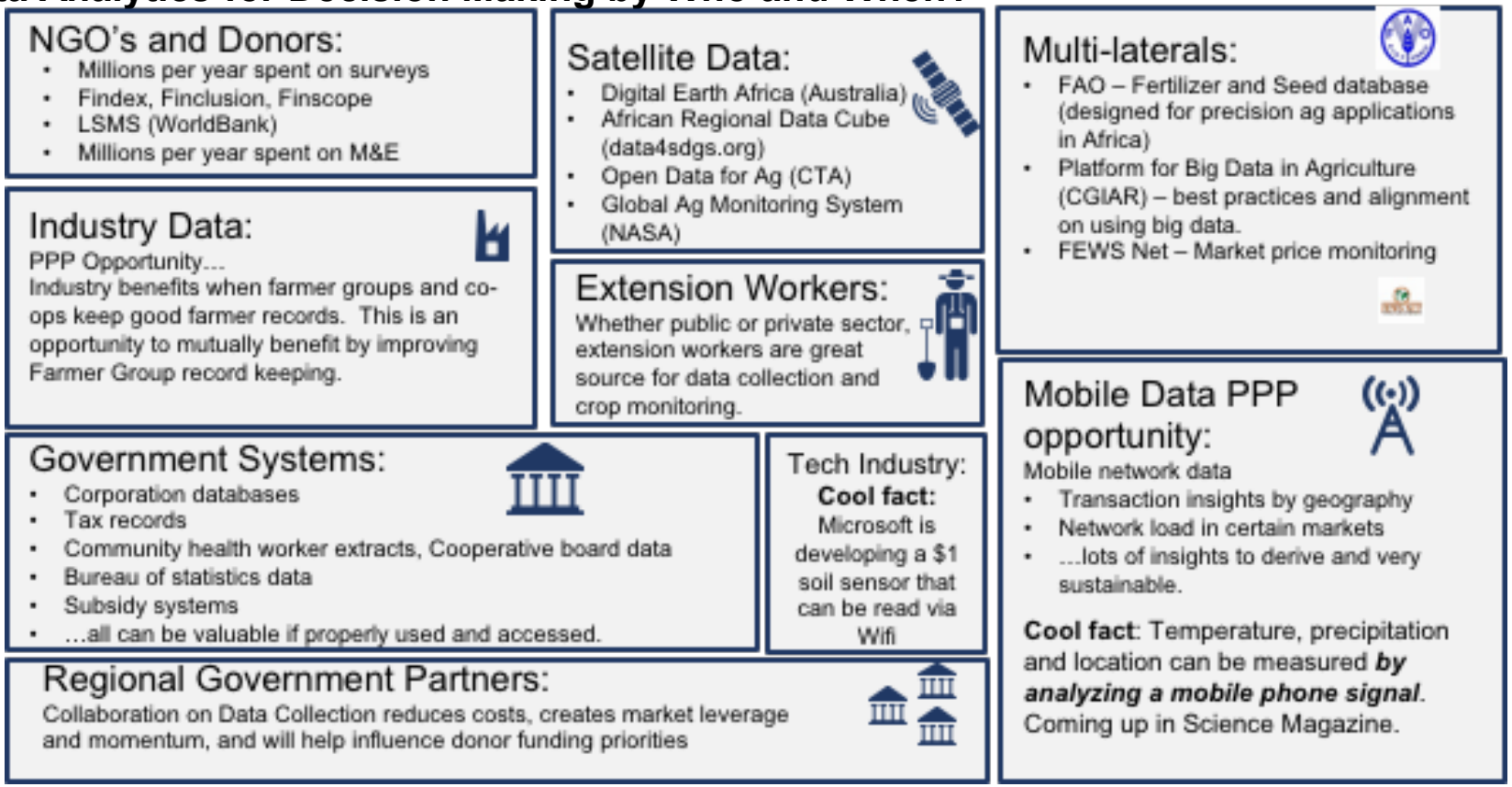
Lenders
Create opportunities to provide lower risk, higher impact finance.

Ag Industry
Enhance sustainable scale and quality

Challenge and Opportunity: Data Lake

Every country in Africa has a networks of data sensors and collectors – people, systems, services and organizations that are already doing work to generate data. The challenge is to prioritize: What data, from who, and how to integrate it…? and how to convert it to inter-operable digital data….? And always, how do we align and compare disparate collection periods and measurements, standards, and variable parameters?

Key considerations include: Data ownership, Data management, Data Integration, Sustainable real-time updates, Accessibility, Data Analytics for Decision Making by Who and When?



Case Studies on Data-Driven Innovations

1. Kenya Integrated Agricultural Management Information System (KIAMIS): KIAMIS is a national farmer database that streamlines access to input subsidies, extension services, and financial inclusion, and now extended for EUDR mapping and tracking.

- Impact: Supports climate-smart agriculture, enhances traceability, and strengthens food and nutrition security planning, as well as deforestation monitoring.
- Pathway: Interoperability with private agri-tech solutions and AI-driven analytics can improve nutrition-sensitive agriculture policies.

2. Ethiopia's e-Voucher System for Smallholder Farmers: Ethiopia's e-Voucher system digitizes inputs subsidy distribution, reducing inefficiencies and ensuring farmers receive quality inputs.

•Impact: Increases farmer productivity, food security, access to improved seeds & fertilizers

•Pathway: Linking e-Voucher systems with nutrition-focused agricultural programs can improve dietary diversity and household nutrition.

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Tools, Capabilities & Deliverables 4 Scale

3. COMESA Regional Food Balance Sheet: The Regional Food Balance Sheet (RFBS) aggregates real-time data on food availability, trade, and consumption trends across East Africa.

- Impact: Helps policymakers and private sector actors manage food surpluses and shortages, ensuring market stability.
- Pathway: Expanding RFBS with AI-driven predictive analytics can improve early warning systems for food insecurity and malnutrition hotspots.

4. EU Deforestation Regulation (EUDR) Compliance for Coffee in Uganda: Uganda is developing digital traceability systems to comply with the EU Deforestation Regulation (EUDR), ensuring coffee is sourced from deforestation-free supply chains.

•Impact: Farmers and exporters use geo-mapping and blockchain to meet EU market requirements, securing livelihoods and trade relationships.

•Pathway: Scaling EUDR compliance tools across cocoa, palm oil, and other high-value crops can drive sustainable trade while enhancing data transparency for food security and nutrition.

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Scaling Investments in Digitizing Agro-forestry Systems

1. **Strengthening Digital Infrastructure for Food & Nutrition Data**
   - Governments must invest in open, interoperable data ecosystems that integrate agriculture, health, trade, and climate resilience.
   - Public-private partnerships are crucial for scaling real-time, actionable insights that drive better food and nutrition outcomes.

2. **AI & Predictive Analytics for Food & Nutrition Security**
   - AI-powered tools can support nutrition monitoring, food safety risk detection, and supply chain optimization.
   - Investment in machine learning models can predict food shortages and malnutrition trends, enabling proactive policymaking.

3. **Farmer-Centric Data Governance & Digital Inclusion**
   - Smallholders must own and benefit from their data, accessing digital finance, better inputs, and premium markets.
   - Expanding digital literacy programs ensures rural communities can leverage data for improved resilience and nutrition.

Benefits of traceability to stakeholders

Farmers

- Enhanced Market Access:
- Higher Profit Margins
- Data-Driven Decision -Making
- Reduced Risk

Agribusinesses

- Efficiency and Cost Savings
- Market Expansion
- Improved Quality Control
- Data-Driven Strategy

Government Agencies

- Regulatory Compliance
- Data for Policy
- Market Oversight
- Economic Growth

Consumers

- Food Safety
- Transparency
- Quality Assurance
- Ethical Sourcing

Retailers and Distributors

- Quality Assurance
- Efficient Inventory Management
- Supply Chain Visibility

How Traceability can solve climate change & support EUDR, and measure decarbonization and assess climate resilience

Well managed traceability solutions collect, analyze and apply data to support climate action in smallholder farming, offering comprehensive insights into crucial on -farm decarbonization efforts. Tech today measures and evaluates adoption of climate -smart agriculture practices, the utilization of organic fertilizers, and the integration of trees and agroforestry into farming practices.

Address deforestation:

Traceability systems can integrate real-time deforestation data and protected areas to assess deforestation risks

Reduce carbon emissions:

When deforestation is avoided, loss of biomass and soil carbon is prevented, reducing emissions. Some platforms enable monitoring at scale to identify clearing, excluding non -compliant producers so forests are protected. This avoidance of deforestation translates to less carbon emitted.

Avoid EU-driven deforestation:

Through the tracking of commodities from origin to import with user friendly interfaces, Traceability with satellite verifications can verify imports do not come from illegally or recently deforested land. This should disrupt the causality link between EU demand and deforestation

Key features of Traceability platforms

Cloud -Based Architecture: Leveraging cloud infrastructure for scalability, high availability, and accessibility, ensuring data is securely stored and processed.

Geographic Information System (GIS) Integration: Utilizing GIS data to map and visualize agricultural assets, including farms, storage facilities, and distribution networks.

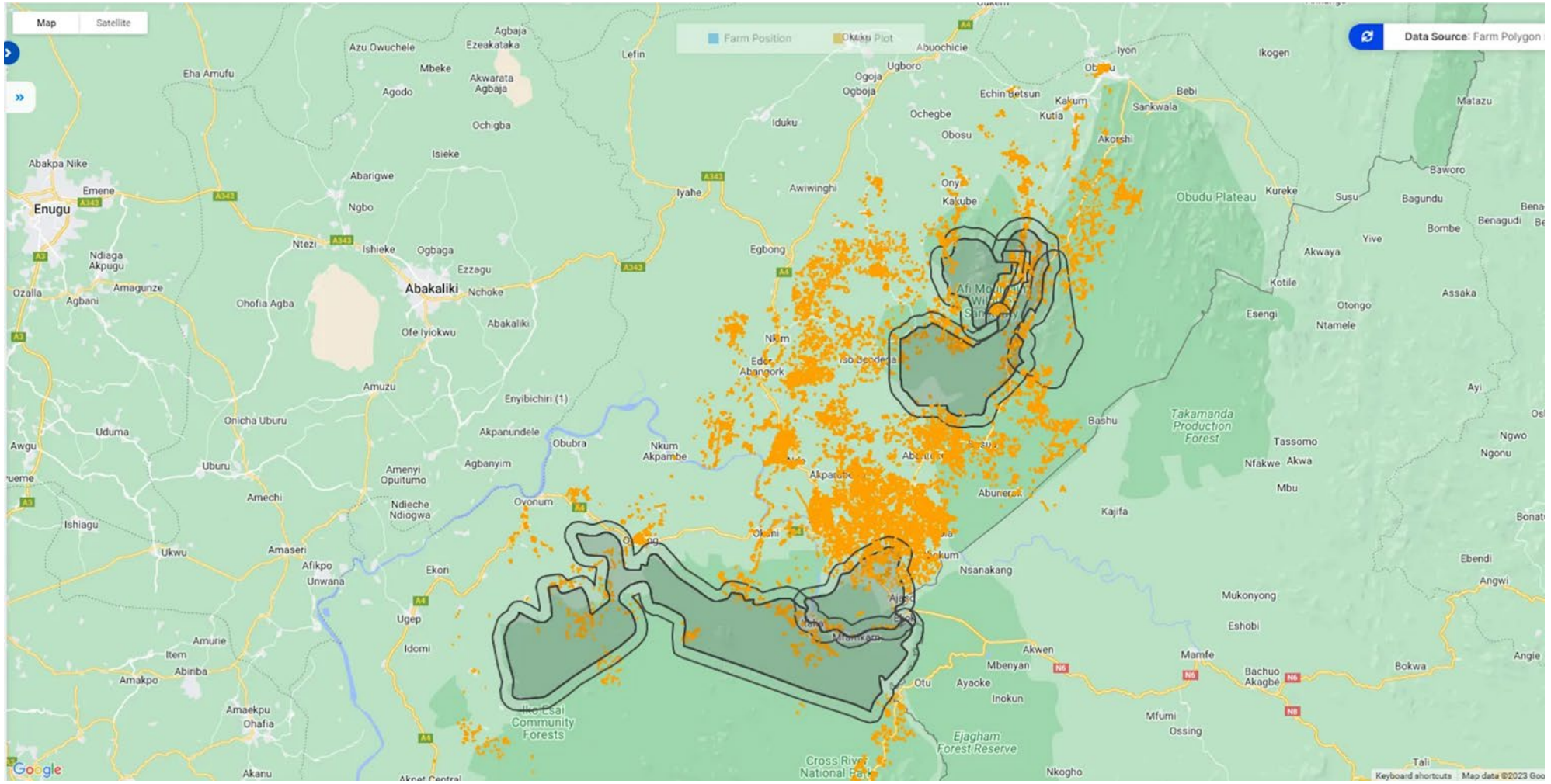
Mobile Applications: Modeled with user-friendly mobile application to enable data input, access to market information, and traceability features even in remote areas.

Data Analytics: Employing advanced analytics, including machine learning and artificial intelligence, to process large datasets for predictive insights, yield optimization, and anomaly detection.

Open APIs: Providing open APIs for seamless integration with government databases, regulatory systems, and third - party applications to ensure data interoperability.

Offline Capabilities: Ensuring that the platform offers offline functionality for data collection and input in areas with limited internet connectivity.

Example of acreage monitored through advanced Protected area and Deforestation dashboard



Over **280 million acres** forest and protected areas monitored to halt deforestation **in 5 countries**

Analysis on Deforestation Compliance

Out of **707,029 plots** analysed for Deforestation compliance on Farmerline Mergdata, **668,614 were EUDR compliant** plots or **93%**

EUDR compliance risks

EUDR Compliance Risk		Digitalization Solutions
"Ensuring the truthfulness and precision of geolocation information is a crucial aspect of the responsibilities that operators and traders must fulfill. Providing incorrect geolocation details would constitute a breach of the obligations under the Regulation." **Source: EUDR FAQ, 29 June 2023**	**Data Quality**	• Risk rating on data truthfulness at farm level (geolocations and attributes) • Covering data integrity, consistency and plausibility
"Adequately conclusive and verifiable information that the relevant products are deforestation-free." **Source: EUDR Article 9(1)a**	**Deforestation**	• Deforestation tests according to the EUDR definition, based on reputable sources
"Adequately conclusive and verifiable information that the relevant commodities have been produced in accordance with the relevant legislation of the country of production." **Source: EUDR Article 9(1)h**	**Legality**	• Risk rating on legality at farm level • Covering land use and indigenous rights; Environmental and forest protection; Human rights
"Operators and traders that are not SMEs are required to ensure that the required information on traceability that they supply to competent authorities in the Member States is correct, regardless of the length or the complexity of their supply chains." **Source: EUDR FAQ, 22 December 2023**	**Traceability**	• Risk rating on truthfulness of traceability data at batch level (chain of custody) • Covering data integrity, consistency and plausibility • Full traceability back to individual farmer

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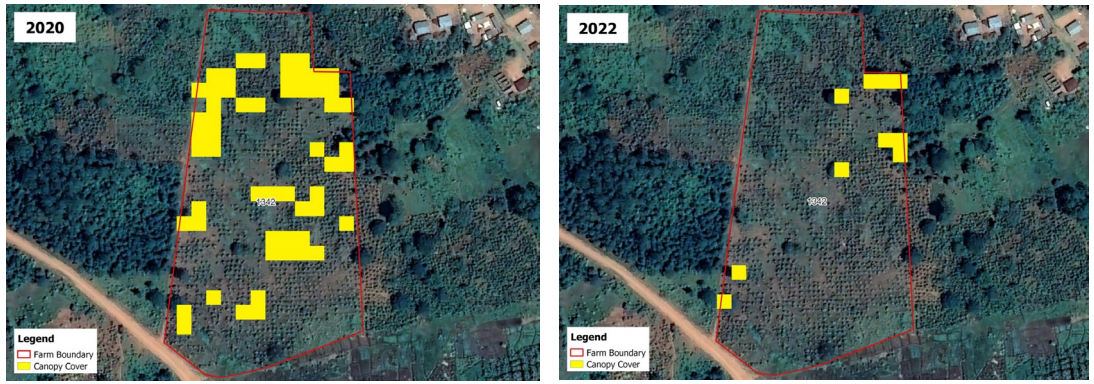
Sample analyses from smallholder farmer collected data contributing to EUDR compliance efforts

2. Enhance Traceability

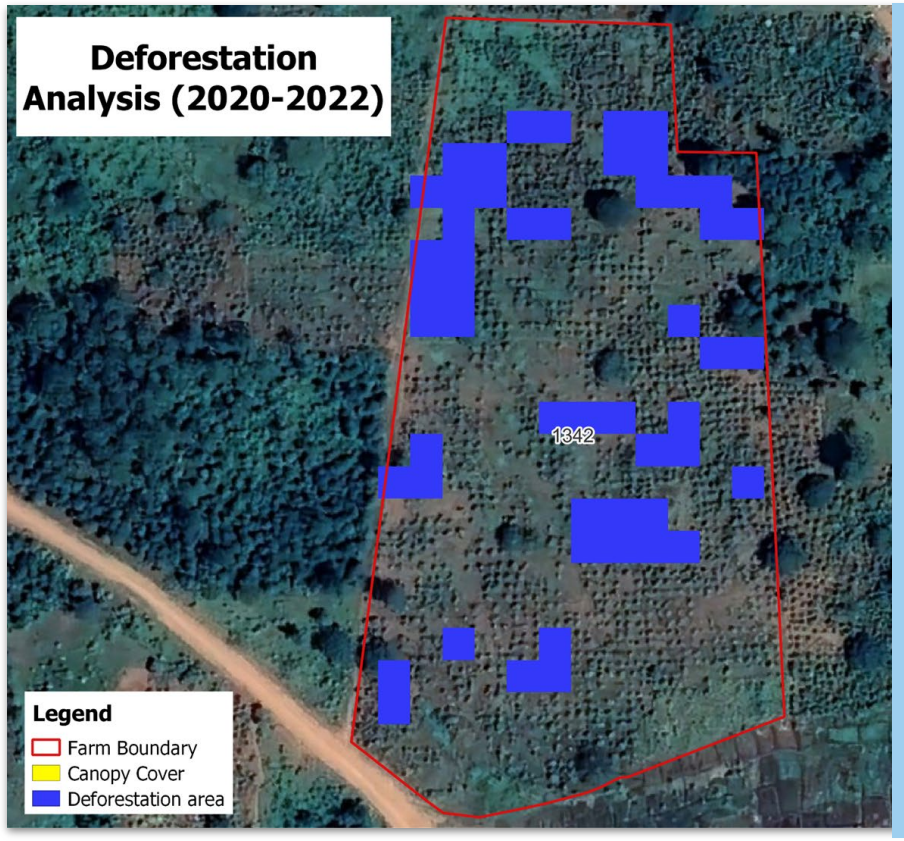
*SAMPLE ANALYSIS

1. Google Reference Images

2. Deforestation Analysis



3. Deforestation Map



Deforestation Map - Areas where trees have been cut from 2020 to 2022, this help in visualizing which areas has been affected the most.

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Strategic Digitization in Africa, Best Practices in Implementation

1. Focus on developing Innovations and Investments at Scale
2. Databases enable precise targeting of specific agriculture populations and practices (risk assessments)
3. Analysis of the data can help identify inefficiencies and plan using risk prevention
4. Data can help in formulating of policies for better targeting
5. Real-time data enables analysis of trends and forecasts
6. Inter-operable data sets are key to scale successful adoption and decision-making

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Case Studies:

Uganda, Ivory Coast & Ghana, & Ethiopia

Comprehensive EUDR solution for public-private coffee consortium in Uganda

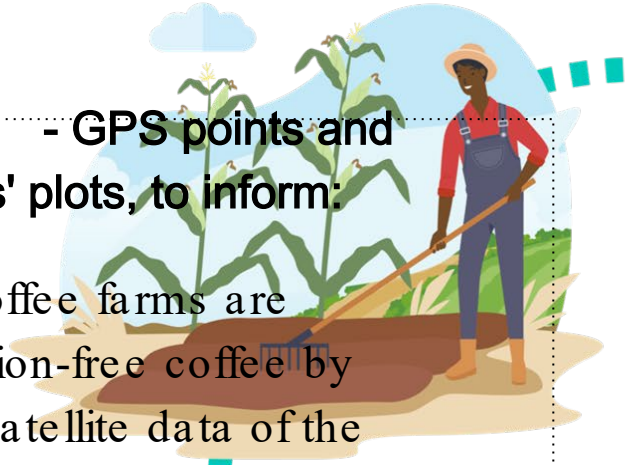
Solution → PULA is currently providing Geo Mapping, Risk Assessment and Supplier traceability

Country
Contracted by the Coffee Consortium in Uganda

Scale → Mapping more than **1,170,000 farmers in Uganda and Kenya**

Pula collected geolocation - GPS points and polygon maps from farmers' plots, to inform:

- Validating that the coffee farms are producing deforestation-free coffee by reviewing historical satellite data of the geolocation polygons.
- Polygons represent the precise plantation size of the surveyed farms
- Surveyed Farm Photos



In collaboration with other service providers, PULA also provides end -to-end support for → EUDR mandated Due Diligence, including risk assessment and mitigation consulting, supply chain traceability support, and capacity building support for local farmer association leaders and field staff.

Coffee Case Study: Data Collection for 1.2M coffee farmers in Uganda

Regions	Coffee Districts
Central	12
Western	7

Step 1:

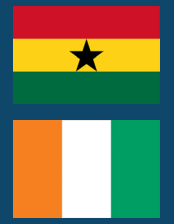
- Work with Kyagalanyi to identify Coffee Associations across 19 or more districts in Central and Western regions
- Training of all FAs (E-learnings + Regional level practical trainings)
- Identify farmer plots, embark on data collection and polygon mapping with Automated Data Quality Control framework

Step 2:

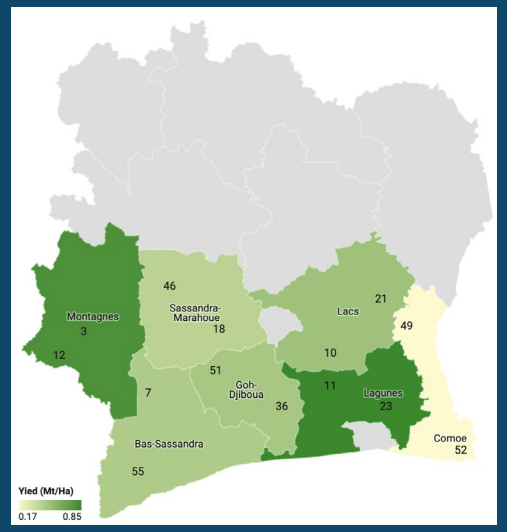
- Work with Kyagalanyi to undertake supply chain traceability
- Do detailed risk assessment on:
  - Deforestation risk for polygons collected
  - Adherence to local laws
  - Area overlap with indigenous area ownership
  - Adherence to all EUDR norms
- Provide Risk Mitigation strategies for each identified risk
- Assist Kyagalanyi with finalizing the Due Diligence statement and all supporting documentation

No. of coffee growing Districts	19
Number of farmers	1.2M Million
Productivity per day	20,000 farmer polygons + data collection
No. of months	5

Cocoa Case Study: Thousands of data points collected from 12 districts in Ivory Coast and Ghana

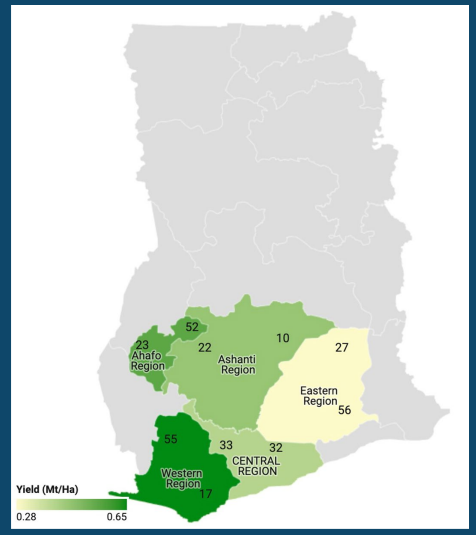


Ivory Coast



Regions	7

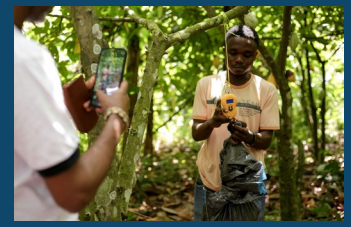
Ghana



Regions	5

1. **Farmer Mapping**
   Register farmer details
2. **Box Placement**
   Average Box Size is 10m2
3. **Wet & Dry Harvests**
   Yield measurements
4. **Additional Data**
   Collect GAP data

No. of Cocoa growing Districts	12 districts
Data Points Collected	42,580 yield data points
Productivity per Day	1080 field visits per month
No. of months	20



Bridging gaps between stakeholders in **Ethiopia** EUDR implementation

ILLUSTRATIVE

	Government	Bilaterals, Multilateral & Development Agencies	Private Sector
Key / Sample Stakeholders	MINISTRY OF AGRICULTURE; MINISTRY OF FINANCE	TRAIDE; USAID; International Trade Centre; UNDP; Foreign, Commonwealth & Development Office; giz; European Chamber in Ethiopia; THE WORLD BANK	
EUDR Efforts	- National Action Plan - Commitment & Collaboration - Stakeholder Engagement	- Technical and Financial Support - Advocacy and Stakeholder Engagement: - Policy and Planning Support: - Sustainable Practices and Certification Systems:	- Dialogue and Advocacy - Sustainability and Compliance Practices
Digital and Data Services	**End to end to EUDR compliance services:** - Capacity building for key stakeholders - farmers, field agents and trainers - Polygon mapping, geo-tagging and analysis services - Farmer data collections services - customizable field surveys		

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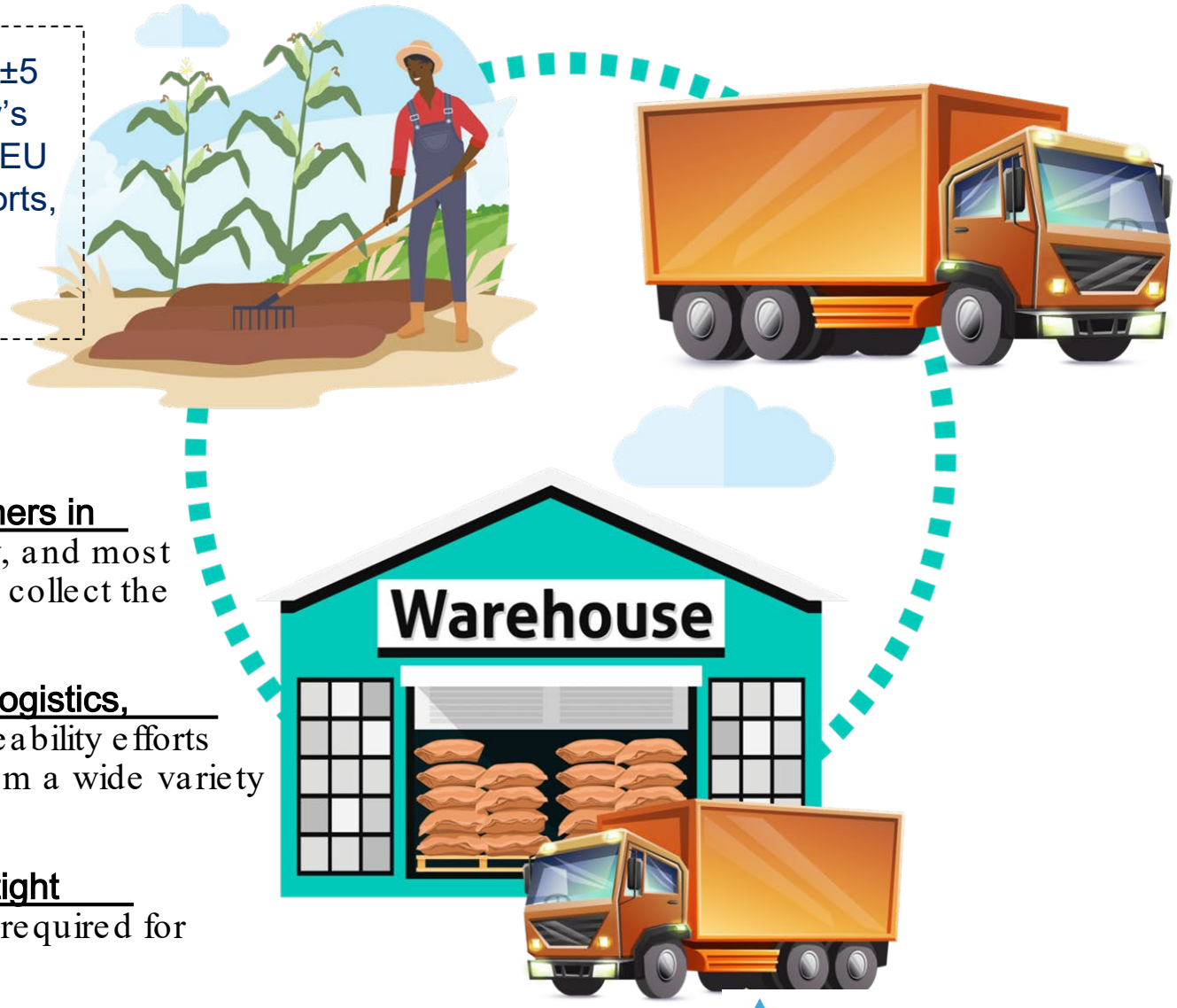
Given coffee's vital role in **Ethiopia's** economy, **EUDR poses a significant risk unless timely measures are taken**

The Coffee sector is vital to Ethiopia's economy, grown by ±5 million smallholder farmers and around one third of the country's export earnings - it is one of the major sources of forex. Given EU is the destination for a significant portion Ethiopia's coffee exports, **EUDR poses a significant risk on the countries' economy.**



→ We see several challenges to timely implementation:

- Coffee is estimated to be grown **±5m smallholder farmers in Ethiopia**, spread across various regions in the country, and most smallholders do not have the expertise or resources to collect the complex data to show EUDR compliance.
- The **supply chain is complex, often involving farmers, logistics, brokers, processors**. This poses a challenge for traceability efforts given that one single shipment of will include beans from a wide variety of sources
- **The timelines for implementation and compliance are tight** considering current capacities and scale of operations required for collecting and assessing accurate data

Merci. Asante Sana.
Meda woe se. Ameseginalehu.
Thank you.

We look forward to your questions.

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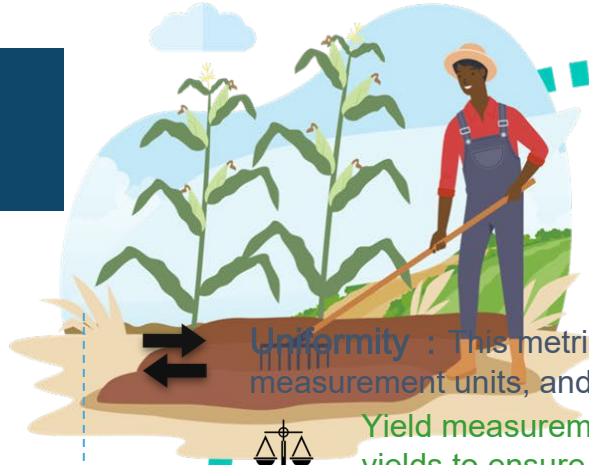
Data quality checks to ensure high-quality clean data

To achieve high-quality clean data, Pula has **designed and automated over 150 data quality checks.** These checks measures the quality of the data on **7 Key Metrics :**



Accuracy : This metric measures the correctness of the data. Example:

Farmer location - using the collected gps coordinates, the farmer location is checked to verify if the data has been collected in the correct district, or ward

Completeness : This metric measures the degree to which the required data points are present in a dataset. Example:

Required fields - to ensure data completeness, a check is run on the required fields to ensure there are no missing fields

Uniqueness : This metric measures the degree to which the records in a dataset are not duplicate. Example:

Farmer details - the farmer details are checked to ensure there are no duplicated records

Consistency : This metric measures the degree to which the data aligns with the expected patterns and reality. Example:

Planting and harvest dates - the checks are ran on the planting and harvesting dates to validate and to ensure the dates conform to the expectations of a given season

Uniformity : This metric measures the degree to which the same measurement units, and the same format is used in dataset. Example:

Yield measurements - the checks are ran against the harvested yields to ensure the yield has been recorded in the same unit of measurement, in this case, Kilograms

Timeliness : This metric measures the degree to which the dataset is available in realtime and as expected as per the SLA. Example:

Yield data - this is checked against the expected harvest dates. If the expected harvest dates have passed, we should have yield data, otherwise this is flagged as delayed harvest and prompt corrective measures are taken

Errors & Outliers : This metric measures the degree to which the dataset is free of any errors and checks on data points that significantly differ from the rest of the dataset. Example:

Extreme yields - yields are analyzed using statistical tools (distribution plots and interquartile range analysis) to identify the extreme cases

The objectives of EUDR

The EU Deforestation Regulation (EUDR) requires companies importing certain commodities like timber, palm, soy, coffee, cocoa and beef into the EU to ensure their supply chains are not linked to deforestation.

The new regulation aims to:

address all deforestation driven by agricultural expansion to produce the commodities in the scope of the regulation, as well as forest degradation

reduce carbon emissions caused by EU consumption and production of the relevant commodities by at least 32 million metric tonnes a year

avoid that the listed products Europeans buy, use and consume contribute to deforestation and forest degradation in the EU and globally

What is required to **ensure smallholder farmer supply chains meet EUDR requirements?**

Key steps to compliance	1. Assess Readiness	2.Enhance Traceability	3.Assess & Mitigate Risks	4. Comp. Statements
Pula's solutions	1. Free readiness assessment questionnaire / scoring 2. Conversation with one of our experts to establish a game plan	3. Satellite imagery and Polygon mapping 4. Regional level yield data through +2,000 Field Staff, to compare satellite data with with actual deliveries	5. Pula's Risk assessment checklist & mitigation consultancy 6. Capacity building (through field staff & global presence) for both local farmer associations & EU operators	7. Assistance in submitting your Diligence Statement or can handle it on your behalf, leveraging Pula's Switzerland-based European entity status
	- SWOT of your current practices against EUDR demands	- Supply Chain Traceability - Farm land geolocation and deforestation-free check - Trader information	Risk Assessment criteria: - Deforestation risk - Compliance to local laws - Overlap with indigenous areas - Child Labour, etc.	Statement Data Collection and inputs from risk assessment/ mitigation analysis (Plantation species, country of production, farm ownership details, etc.)

Pula, in partnership with partners and key agencies, can provide end to end EUDR Due Diligence support.

Sample data collected from a polygon mapping exercise

2. Enhance Traceability

Identify Results

Feature	Value
01_UgandaFarmsMoreThan1Ha	
boxes_case	7a8c8454-5e58-41ea-...
(Derived)	
(Actions)	
boxes_case	7a8c8454-5e58-41ea-...
farmer_nam	Kivumbi Samuel Wil...
planting_d	NULL
planting_1	1997/03/07 00:00:00.0...
crop_varie	robusta
planting_s	Season B
year	Season B
UAI	24
final_cce_	Masaka
final_cc_1	Butale
PlantSpeci	Robusta
farm_polyg	NULL
farm_pol_1	[{'latitude': -0.412174...
farm_gps_a	NULL
farm_gps_1	NULL
farm_gps_r	-0.4121663
farm_gps_2	31.647176500000000
farm_pol_2	[{'latitude': -0.412174...
Latitude	-0.4121663
Longitude	31.647176500000000
swapped_fa	[{'longitude': 31.6471...
UID	1342
Area(ha)	2.5938894380

Mode: Current Layer

View: Tree

The table shows the various data points that we collect from the farmer.

Essential information is collected, such as:

- Farm polygon area,
- Farmer name,
- Administrative units,
- Planting date, season,
- Trees present on the farm
- Average tree height