

Use of Remote Sensing Technology in Smallholder Supply Chains in Asia

Abstract: Majority of farmers in Asian countries like India and Vietnam are smallholders, farming on less than two hectares of land. As food demand increases by 20% and arable land keeps getting scarce, yield improvements through smart land-water use management has the potential to increase food availability. Yield gaps exceed 50% and above in many Asian countries owing to lack of technology adoption. New business models in agriculture and technology innovations in data analytics and artificial intelligence help farmers access information related to their land, agri-inputs, weather, finance, and markets, thereby helping them increase yields, improve incomes, resilience and traceability. In this scenario, IFC MAS advisory is working with CropIn and Farm force in sugar and coffee value-chains of DSCL (India) and Simexco (Vietnam) respectively to use:

- GIS, GPS and Remote Sensing solutions for digital monitoring and digital management of 5000 sugarcane and 5000 coffee farmers
- Smart weather-risk digital solutions to help farmers by providing real-time weather forecast and crop-advisory

I. Introduction

This paper based on both primary and desk research, presents the learnings from implementing two different applications of technology, in India and Vietnam. This paper discusses how these new technologies create

- increased efficiency of smallholder supply chain and production planning of sugarcane and coffee through secure, reliable and real-time data collection to help the private sector companies (agri businesses) and the farmers
- opportunities to manage yield and harvest risks brought on by erratic climate patterns (Climate change is further aggravating the vulnerability of smallholder farmers who have limited access to knowledge and resources)

The first section describes the nature and extent of the reliable/quality data crisis that exist in agricultural landscape across Asia. The second section elaborates IFC's work in India and Vietnam with two emerging applications using innovative technologies, the third section describes lessons learnt for potential replication and scale up in the specific geographies which fits in well with the regional strategy.

Low productivity is a key factor leading to smallholders in Asia growing larger areas of under-productive crops rather than intensifying production. In addition, using paper records to manage supply chain lead to low trust of data, lack of traceability and unclear field activity. With a view to increase smallholder productivity and efficiency, training and technical assistance-based agronomy information are provided digitally in real-time to farmers. Increased and easy access to right information and training to smallholder farmers make them more productive and efficient, which in turn results in yield increase and better management practices.

Digitally collecting smallholder farmer data and using spatial technologies (GIS, GPS and Remote Sensing) to collect farming data (crop planting, harvest plan, soil condition etc.) improves quality of data collected, builds farmer profiles that are dynamic and enables faster supply chain decisions to offer timely support to the farmer.

1. The use of granular data (for example, plot level data) and analytical capability to integrate various sources of information (such as weather, soil, and market prices) helps in increasing crop yield and optimizing resource usage, lowering cost. Since, climate change and extreme weather events will demand proactive measures to adapt or develop resiliency, data can bring in the right information to the farmers and other stakeholders in the value chain to take informed decisions
2. The more a farmer knows about his or her farm, the better their opportunities to supply chain relationships. Data helps farmers eliminate volatility and risk which is beneficial not just to the grower but also to the supplier/agri business co. – so the supplier is more apt to work with that farmer on a long-term basis. At the same time, the data allows the farmer to work with the supply chain to help companies and retailers increase the transparency of their ingredients.

The challenges and opportunities of data in agriculture is immense and varied in-particularly in countries of South Asia and South East Asia. For example, in the South Asian country-India with 638,000 villages and 130 million farmers speaking around 800 languages with 140 million hectares of cultivable land under 127 agro climatic regions capable of supporting 3,000 different crops and one million varieties-data collection, management and data integration and interpretation for analysis becomes a significant challenge. On the other hand, in South Asian countries like Vietnam, which aims to become a producer and exporter of high-standard food products to improve its export of value-added products, agri farm data for traceability and transparency becomes the key issue. While governments in both countries has encouraged the growth of this ecosystem on agri tech fueled by data (through favorable regulatory framework and policies) participation of private sector (agri businesses) is redefining the sector.

II. METHOD AND METHODOLOGY

IFC has adopted the “lead firm (private sector agribusinesses) to incorporate into their supply chains technologies that deliver farm and/or farmer based information and data leading to crop-related advisory, digital training and extension programs, weather patterns or markets or enable off-take support. Working with private sector firms, IFC is attempting to establish the business models, demonstrate level of scale-up and commercial viability on the ground, with specific crops and geographic focus. IFC is working with ICT solutions providers such as Farm Force in Vietnam and CropIn in India where IFC has supported in product development, market-testing with real-sector companies and farmers in the value-chain for adoption at scale. The below two sub sections elaborates the work done in the two mentioned countries with respect to farm and farmer data collection leading to overall strengthening of the smallholder supply chain.

A. IMPROVING DCM SHRIRAM SUGAR VALUE CHAIN, INDIA USING CROPIN

IFC has collaborated with DCM Shriram Limited in central India where more than 85 percent of the farmers are small and marginal farmers (hold less than 2 Hectares of land). DCM Shriram is one of India's largest business conglomerates with a strong focus on agribusiness in rural India. Smallholder farmers in the sugarcane procurement area of DSCL Sugar (a division of DCM Shriram Ltd.) face challenges related to low farm yields, compared to sugarcane farmers in other parts of the country. Low farm yields increase the cost for cultivating sugarcane for smallholder farmers. Some of the reasons for low farm yields include lack of technical know-how among sugarcane smallholder farmers, low-technology adoption and unsustainable inputs usage leading to an increase in the cost of cultivation without a matching yield increase.

In response to the DCM Shriram's demand (to above mentioned challenges) IFC's agribusiness advisory collaborated with CropIn (data analytics and service provider firm) in developing a smartphone/tablet/PC-based Information and Communication Technology (ICT) application for use by DSCL's sugar agri-extension staff in the project sites of Hardoi, Uttar Pradesh. This is a pilot carried out by IFC to train DSCL staff to use CropIn application that enables digital monitoring of 5,000 smallholder plots.

Program Objectives:

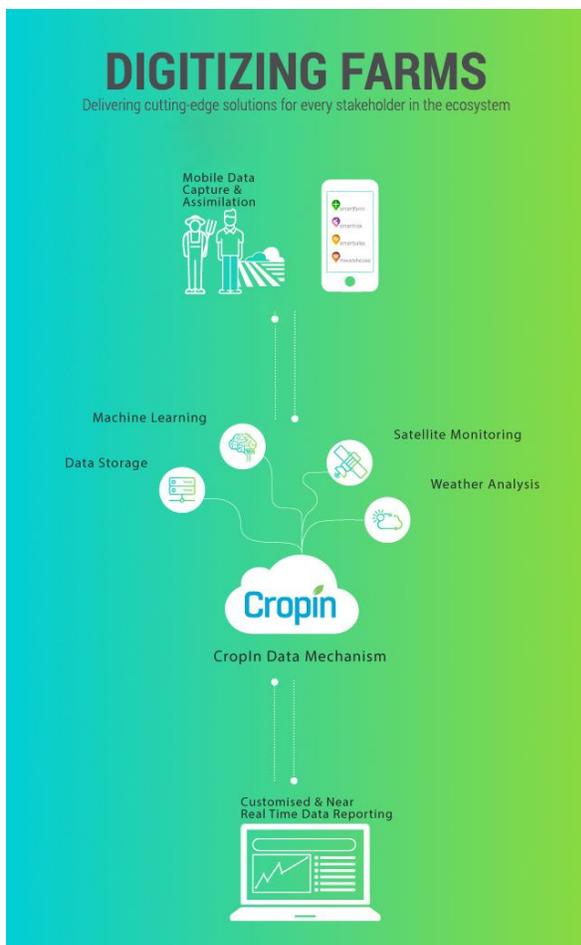
CropIn application uses remote sensing technology and offers geotagging of plots to measure the area accurately so that

- use of inputs can be optimized
- daily tasks and scheduling field staff activities and registered and monitored
- crop stages and growth are monitored through satellite imagery
- weather forecasts and climate risks are offered in real-time as part of farm advisory

Solution in Action:



CropIn offers a web application accessed on PCs, laptops and tablets and a mobile-based application accessed on Android phones to help agribusinesses collect and store real-time information from the field, record farm and farmer data with historical accuracy and leverage this data to increase the farm productivity and incomes of farmers.



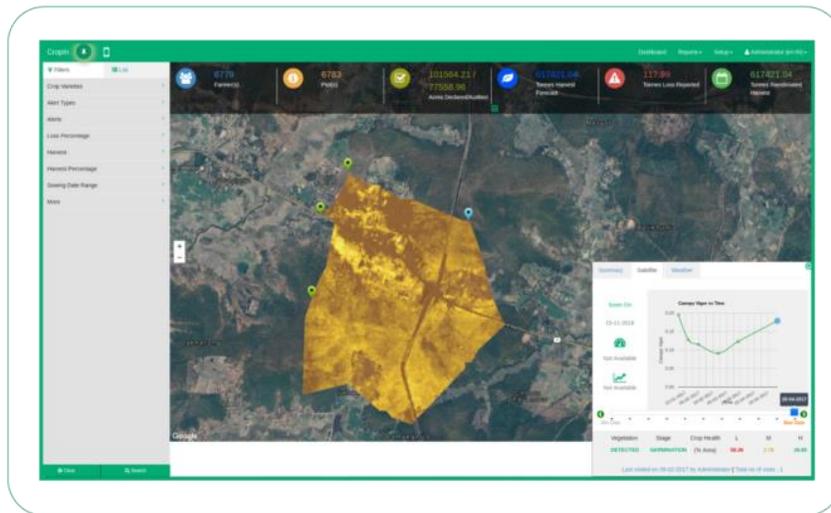
The features of this product are:

- The application firsts hosts registration details of the farmer, the farm details such as the size, crops cultivated. This information then immediately syncs on the web application via mobile internet
- The first time the farmer is registered, the application geo-tags the farmer location through GPS and helps to scan the area and get local plot details
- Satellite images (two per month) are provided for the geotagged plot to monitor the crop stage and develop a yield forecast
- Through this application, the field officer can also enter details on the activities undertaken by the farmer such as inputs used, pesticides sprayed, stage of cultivation and upload images of the crop growth. Field officers can also record any issues through a voice application feature.
- Information on plot-wise weather details is also made available on-demand through this application to the farmers

Solution Highlights:

	<p>Plot area audit for correct acreage measurement to measure the area of the land accurately so that use of seeds, fertilizer and pesticides can be optimized</p>
	<p>Crop stage monitoring with remote sensing satellite images helps track the various stages of the crop while providing adequate information about the crop growth status.</p>
	<p>Farm activities management ensuring on-time harvest and adoption of best practices</p>
	<p>Daily task scheduling for field supervisors based on plans supported by location tracking and task completion monitoring</p>

Solution Snapshots:



Satellite images of farmer plots

Weather Forecast-based Advisory

Program Benefits:

At the end of Year 1, CropIn solution created the following benefits for DSCL sugar (lead private firm):

- **5,000 sugarcane farmers'** plots are geo tagged and area audited
- More than **5,000 satellite images** of plots collected in the system to monitor crop growth stage-wise
- **200 field staff** trained on mobile app to collect farm data on good agri water (farm) management practices data
- **200 field staff** use weather forecast data to provide customized farm advisory to **5,000 farmers**

B. IMPROVING THE SIMEXCO COFFEE SUPPLY CHAIN, VIETNAM USING FARMFORCE

Program Objectives:

- Create efficiencies in contract farming management for the lead firm by integrating even the first mile of supply chain that usually is not connected to existing ERP systems
- Use technology to collect data digitally across farm and farmer surveys so that lead firm and other stakeholders in the value chain have access to accurate, efficient, reliable and real-time information
- Use technology to automate data collection where possible through GPS-based field maps and timestamped images to create auditable, digitized data on farms and farmers
- Monitor GAP adoption by farmers and measure input usage/adherence
- Establish farm-to-inventory traceability and create accurate yield and harvest forecasting
- Conduct credit assessment digitally and maintain score card for farmers that helps in financing farm operations

Solution in Action:

Farmforce leverages mobile and web-based technology innovations to make traceability and compliance part of farm operations.

Farmforce provides web-based tools that are used by lead firms, cooperatives, farmer business organizations and aggregators in offices and an Android-based mobile app that is used by field agents when interacting with the smallholder farmers.

The Farmforce tools enable digital data collection, field staff monitoring and collect real-time, auditable information to build efficiencies.



Solution Highlights:

	GPS-based coordinates to track location and monitor field staff activities through authenticated access on the mobile app
	Product traceability enabled by barcodes attached to produce supplied
	Credit assessment survey aided by printed, verifiable receipts at inventory
	Integrated scales to collection points to provide real-time yield and harvest information
	GIS-based location maps for farms verified through map locations and digital satellite images

Program Benefits:

At the end of Year 2, Farmforce solution created the following benefits for Simexco Daklak Ltd. (lead firm):

- **6,177 farmers** (5,817 coffee and 360 pepper farmers) are inducted into the system and data digitized
- **223,610 farming records** collected in the system
- **10 field staff** trained on mobile app to conduct farm, credit assessment surveys and collect data on GAP practices followed/adherence
- **Bi-weekly data update** followed in the system to keep the information current, reliable and accurate

III. LESSONS LEARNT FOR REPLICATION AND SCALE UP

The lessons learnt from the above two case studies include:

1. Crop classification and mapping is the most challenging task among the land use/land cover classification problems. The technology works largely if the diversity of crops is not very wide (for monocrop regions). Important precondition for successful classification are good machine-level training backed by a good number of validation data sets. Machine learning/algorithm based on “Normalized Difference in Vegetation Index-NDVI” model particularly yields good analysis in single/monocropping land use. A few parameters often hampers the accuracy of this technology. Erratic weather conditions, especially clouds and rain hamper the interpretation of optical satellite data and it makes the computations on time series much more complicated. Intelligent data processing and analytics also becomes challenging when large amount of unstructured, heterogeneous data requires a smart interplay and interpretation between skilled data scientists and domain experts. Integration of many different data sources becomes challenging and as this is crucial for the business model to become successful, the technology, integration of data sources and interpretation of spatial data has to be done in a sustainable manner;
2. Digital literacy training: While all extension staff of farmers of the companies use mobile phone, repeated trainings had to be provided to them on how to collect quality /reliable data. The biggest challenge is to collate that data generated from multiple sources, verify its relevance/accuracy and turn it into actionable information that a farmer can use to make informed decisions with the help of real-time data dashboards, analytics-based insights, and decision support tools.
3. The issue of protecting farm and farmer data used in the two mentioned cases is essential for the successful deployment, scale up and replication of the projects. Contract negotiation in this field is crucial for achieving all the possible benefits while protecting the value of data as an asset. Data quality, data-ownership and related privacy, security issues – must be properly addressed, as they are key to a farm management system.

Digital platforms should offer a blend of human and technological solutions, which aid/enhance the agriculture value chains/supply chains and not eliminate role of agronomists. Data-based decision making has the potential to cause major shifts in roles and power relations among different stakeholders existing agri value chains. The promise of data-driven ICT solutions in agriculture value chains in case of the two mentioned case studies is immense, but the challenges above must be addressed for increased uptake. Although there are certainly technical issues to be resolved, it is important to identify and design suitable business models specific to farmers and business needs in an agribusiness value chain