

CASE STUDIES

DIGITALISATION FOR AGRICULTURE

THE CASE OF MUIIS UGANDA



“

The case of MUIIS project is an epitome of digitalisation for agriculture in which access to digital solutions by smallholder farmers and other value chain actors has led to more efficient operations within the agricultural innovation system, resulting in equal access to finance by women, men, young and old; increased resilience; improved production and income. ”

Michael Hailu,
CTA Director

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EXECUTIVE SUMMARY

Uganda has a very low extension worker to farmer ratio: 1:5,000 in 2016 compared with the global recommended ratio of 1:500. However, the agricultural space is affected by a plethora of challenges including access to quality inputs, access to finance from the formal tiered financial institutions, climatic vulnerability (most crops grown in Uganda are affected by the climate) and weather variability. Farmers who practise smallholder agriculture are most affected.



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The Market-led, User-owned, ICT4Ag-enabled Information Service (MUIIS) project ran from 2015 to 2018 and set out to reach 350,000 maize, soya bean and sesame (simsim) farmers in Uganda within three years. The project provided a bundle of timely, accurate and actionable weather, agronomic tips, index-based drought insurance services, and financial services including index-based insurance to farmers in central, eastern, northern and western Uganda. The core product, the MUIIS service bundle, was meant to serve their sole consumer, the smallholder farmer. As the project progressed, the product portfolio has diversified into six interlinked products with the potential to serve both B2B and B2C markets.

This was achieved by a well-constituted public-private partnership (PPP) of seven partners – CTA, EARS-E2M, eLEAF, aWhere, AGRA/NARO, Mercy Corps and EAFF¹ – and multiple associate partners such as Rabobank Foundation, UCA, UNFFE, Ensibuuko, New Wave Technologies, AIC, NARO and UCCFS. This multi-stakeholder approach recognised and leveraged the specific interest and unique expertise of each partner towards the delivery of ICT-enabled extension services to farmers. Partnerships were created within five areas: overall project management, satellite data management, knowledge management, information management and credit.





The overall project management and administration was conducted by CTA. The three private sector partners (eLEAF, EARS and aWhere) coordinated the satellite data acquisition, processing and storage, analysis and modelling, and decision support services. The data partners (satellite data partners) worked in close collaboration with the knowledge partners (CTA, EAFF and AGRA) to transform the satellite data into usable/actionable information services based on agronomic knowledge and ground data from the users. These knowledge partners are mainly international and public organisations that utilised their in-depth understanding of farmers to support the building of the appropriate networks around their needs and to develop and deliver capacity building activities as well as carry out monitoring and evaluation of the project. Information partners (Mercy Corps, UCA and UNFFE) ensured that end products were correctly communicated to farmers. In 2018, MUIIS partnered with Rabobank Foundation to offer a unique product, the MUIIS Agricultural Input Loan (MAIL) to vetted smallholder farmers. This brought on board savings and credit cooperative organisations (SACCOs) and UCCFS as a delivery channel to the individual farmers across central, eastern and south-western Uganda.

In-depth assessments on the concepts of digitalisation, farmer-to-farmer e-Extension service and credit within the realm of MUIIS were conducted; the assessments generated a multitude of achievements and lessons learned. Some of the achievements include: a farmer database, MUIIS system, established MUIIS service agent (MSA) network, leverage with existing farmer organisations

that improved crop productivity, access to financial services, farmers' resilience to climate change, and farmer education.

Although multiple achievements were attained within the last three years, there are several lessons learned at the project design and project implementation levels that would tremendously improve the MUIIS project. Lessons learned at project design include:

- clearer alignment of roles and responsibilities
- a more private-sector focused business model
- an increase in project timeline as three years was highlighted as too short a time to see impact
- incorporation of local context or recommendations during implementation
- better selection of marketing and communication
- better resourced local implementation team to run this calibre of project with the support of the MUIIS Steering Committee.



At the project implementation stage, the lessons that were highlighted included:

- better project and process control
- involvement of other market actors such as input dealers, market players and large commercial technical partners such as a financial institution, which would have greatly improved the proposition.

At the beneficiary level, other avenues for improvement include:

- the engagement of SACCOs that have financial relationships with farmers as an avenue for MUIIS
- maintaining and adequately remunerating the agent network
- incorporating demonstrations and sensitisations that help farmers appreciate the e-Extension services that will be augmented by other MUIIS products and services such as the MUIIS Knowledge App (MUIIS- KA).

As the project transitions to a business, the recommendations have been informed with the assistance of a business model (see Box 1 for an excerpt) that seeks to maximise the current assets of the MUIIS project: technology, agent network and farmers in the database. This model uses two revenue streams: farmer subscriptions and monetisation of the database. The balance between these two will ensure consistent revenue for the business owner. To improve the current subscription rate, the agent network will be our lever. This will require a re-engagement of the 125 trained agents who will be used to re-engage the farmers into their eventual subscription. To realise this, there is need to:

- a) develop a robust commission and referral-based marketing strategy
- b) establish beneficial strategic PPPs
- c) increase value chains to include both food and cash crops, once the business is growing organically and can finance such investments as profiling and value chain addition itself.

For purposes of the development of the business model and this case study, the exact mechanisms through which the database will be monetised have been left unrestricted.



INTRODUCTION

Overview of Uganda and its agriculture sector

Uganda key information:

Area:

236,000 km²

2017 Population:

37.7 million

Proportion of arable land:

28%



Number of farming households:

3 million

Agricultural contribution to GDP:

26%



Agricultural contribution to Uganda's foreign exchange earnings:

50%



Population of farmers:

75%



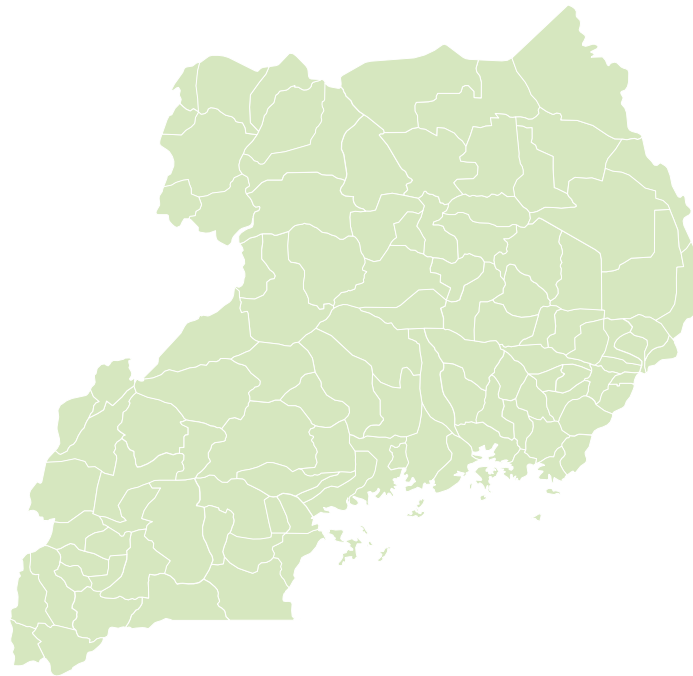
Private sector credit to agriculture:

14%



Ugandans who depend on agriculture:

84%



Uganda's agriculture sector:

Agency in charge	Ministry of Agriculture, Animal Industry and Fisheries, but there is fragmentation and limited policy coherence, which is being addressed with the current policy and strategy.
Extension services	District extension workers do not have the capacity to make measurable impact.
Access to inputs	One of the main factors limiting farmers from producing at their full potential is inefficiencies in the input distribution chain.
Access to finance	Most agribusinesses do not have access to finance from formal tiered financial institutions. Within agriculture, crop income dominates, with maize, beans and bananas accounting for half of the total value of crop sales nationally.
Regional trade in agriculture	Uganda is the largest regional supplier of grains, contributing more than 70% of intra-East African Community trade. Grain exports include maize, sorghum, millet and pulses.
Climate vulnerability	Most crops grown in Uganda are highly vulnerable to climate and weather variability.
Pests and diseases	Most farmers experience low yield due to pests and diseases.



Overview of the MUIIS project

Box 1 MUIIS business model canvas

This box contains an extract of the original business model canvas of the MUIIS project.

This business model canvas has been adapted over the span of the project to ensure smooth implementation.

Broad objective

Reaching 350,000 maize, soya bean and sesame farmers in Uganda within three years with a bundle of timely, accurate and actionable weather, agronomic and index-based drought insurance services

Business model

Key partners: CTA, EARS-E2M, eLEAF, aWhere, AGRA/NARO, Mercy Corps, EAFF², UNFFE/UCA, SACCOs, Rabobank Foundation, Ensibuuko and AIC

Key resources:

- Intellectual: partnerships; customer database
- Human: experienced and knowledgeable resources; sales network
- Technological: hardware infrastructure (mobile communication technology)

Key activities:

- Collect satellite data and develop weather, crop disease and pest models, and crop insurances
- Invest in information infrastructure and integrate data into platform
- Approach farmer-based organisations and agribusinesses, profile and train MUIIS service agents (MSAs) and farmers
- Work with local tech partners to serve farmers

Value proposition

- MUIIS – one-stop solution for farmers to grow more and sell more
- Offering low-cost, bundled mobile services and crop insurance to agriculture smallholder farmers in Uganda
- Paid subscribers receive mobile information related to agriculture extension advice, weather forecasts, drought, early warnings and crop stress indices. In addition, farmers have the option of crop insurance

Customer relationship

- Over 30 years of sustained relationships with CTA with countries in Africa including Uganda
- AGRA's network of SMEs, farmer groups, research experts on inputs and cordial relations with knowledge workers in Uganda
- Farmer organisations' ability to mobilise farmers
- Existing relationship with 47 farmer cooperatives in northern Uganda with a reach of 350,000 farmers by MC-Uganda
- EARS and aWhere have ongoing relationships with other information and communication technology (ICT) service providers and/or insurance companies in Uganda
- Personalised human interaction with MSAs in charge of subscription process and post-profiling/subscription support

Customer segments

Smallholder farmers who grow maize, beans, soybean and sesame in central, eastern, northern and western Uganda (excluding Karamoja)

Distribution channels

MSAs, farmer organisations, farmer groups, media, print material, workshops, conferences and agricultural trade shows

Cost structure

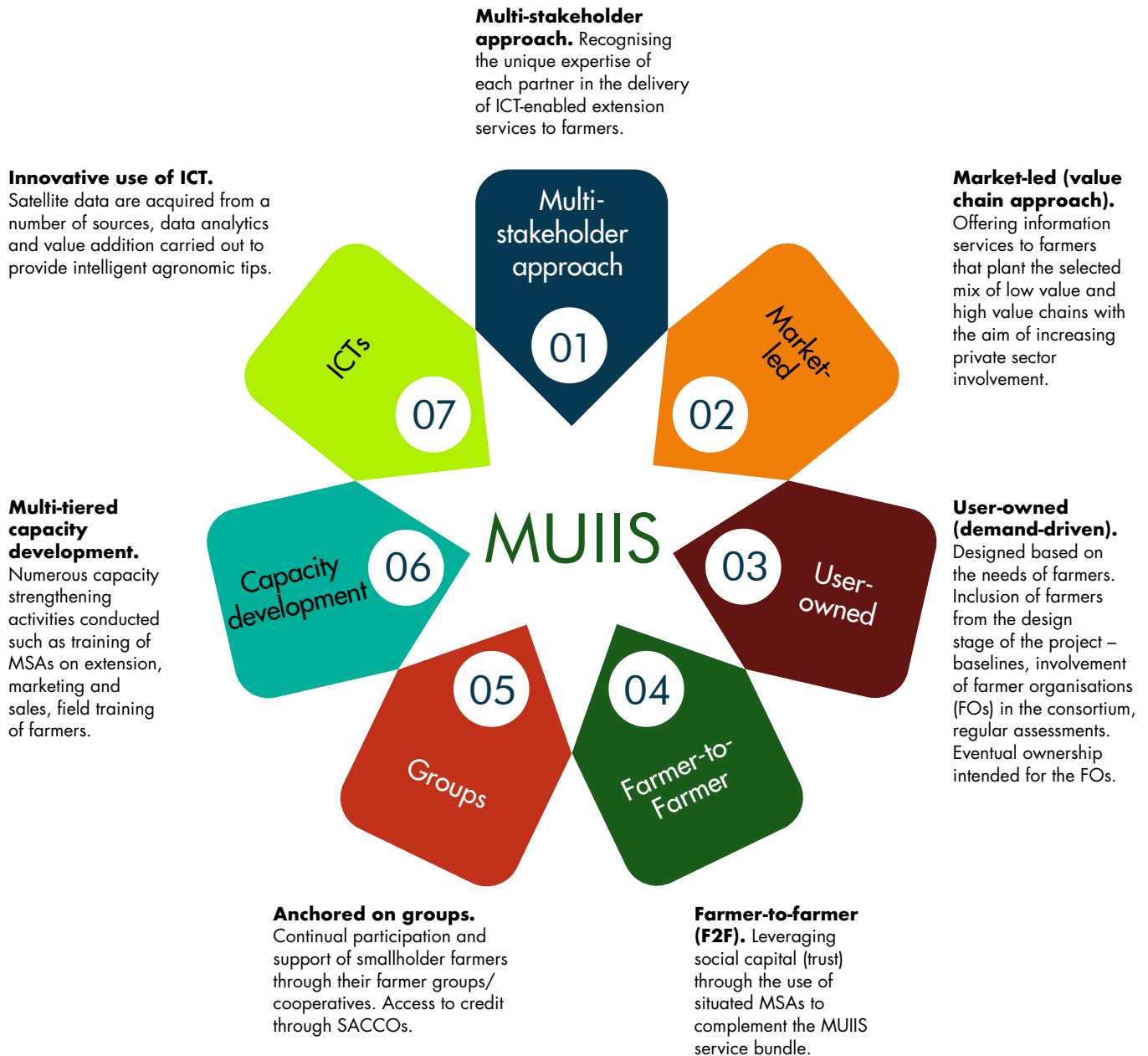
Satellite data management, cost of market assessments for value chains and ICT services, marketing and sales, training, mobile profiling devices, project management

Revenue streams

Transactional revenues resulting from one-time customer payments (subscription fee)

Fixed pricing mechanism where price could be dependent on product feature. Farmers would pay US\$20,000 (€4.75) for the basic service bundle package; price can vary based on number of hectares and crops covered

MUIIS seven design principles



The design of the project is based on:

- the need for timely, accurate and actionable information regarding crop management and climate risks
- the production and post-harvest demands of the selected value chains in the country
- the proof of concept that satellite data-enabled extension and advisory services can lead to an approximate 40% increase in farmers' productivity
- a globally acclaimed success story of ICT4Ag services being provided by farmer cooperatives in India
- the fact that a number of mobile platforms have been taken to market in Uganda with users willing to pay for agricultural and financial information services.

MUIIS product portfolio

- MUIIS service bundle. Weather alerts, agronomic tips and drought index insurance.
- MUIIS Knowledge App. Mobile application for MUIIS service agents and other extension agents developed to support farmers and gather feedback. Contains agri-advisory tips, market info and fertiliser optimisation tool.
- MUIIS Agricultural Input Loan (MAIL) credit to individual farmers through SACCOs using the MOBIS platform.
- MUIIS farmer database. Digital profile of 260,000 (and continuing) farmers has been built with detailed information on each farmer including the GPS locations of their fields.
- MUIIS SMS delivery platform. A functional ICT system based on USSD technology and a live dashboard that enables SMS service delivery and monitoring of activities.

- MUIIS service agent network. A network of field agents (MSAs) with support of district farmer associations (DFAs) and area cooperative enterprises (ACEs) built, trained and equipped with ICTs.

The sole purpose of the project is to provide bundled information products related to weather forecasting and alerts, crop management and agronomic tips, and financial services including index-based insurance to farmers in central, eastern, northern and western Uganda.

MUIIS's core product is the MUIIS service bundle that serves the sole consumer – the smallholder farmer. As the project progressed, the product portfolio has diversified into six interlinked products with the potential to serve both B2B and B2C markets. This is further augmented by the desire to transition MUIIS from a project into a business which requires the expansion of not only product offerings but also revenue streams. Previously, revenue streams mainly included farmer subscriptions. However, the transition into a business will allow for revenue from sale of data products, surveys and data collection, advertisements, farmer group subscriptions to mention but a few.

MUIIS value chains of choice

MUIIS targeted the following crops: maize, soybean, sesame (simsim) and beans. Of the selected crops, maize is the most important followed by soybean, beans and least sesame which is mainly grown in northern Uganda. Maize is a staple crop with up to 33% of national production concentrated in eastern Uganda. It also constitutes 4% of Uganda's non-coffee exports.



Demand and value of selected commodities

MAIZE

Consumption:
2.5 million tonnes (MT) in 2018¹

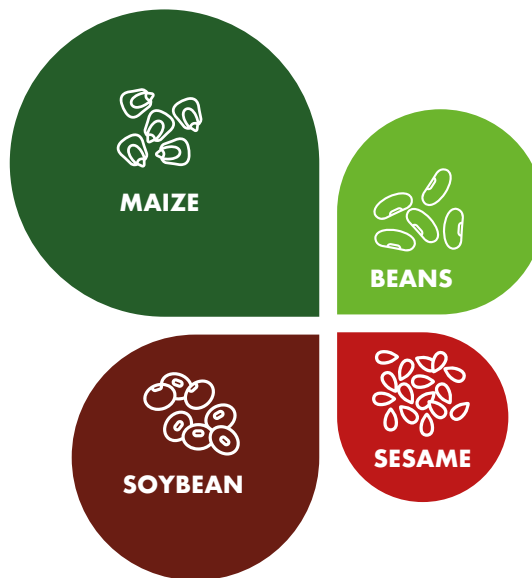
Production:
2.6 MT (2016)²

Area harvested:
1.1 million hectares (2016)

Productivity/yield per hectare:
2.3 MT/ha (2016)

Potential:
>8 million MT/year and intensified production in the selected regions could lead to export and increased income

Challenges:
Pests and diseases (maize lethal necrosis disease, maize streak virus, *Striga*)

**SOYBEAN**

Production:
152,000 MT (2016)

Cultivated land:
121,000 hectares (2016)

Productivity/yield per hectare:
2.3 MT/ha (2016)

Potential:
Huge market as Kayonza (Mt. Meru) oil company has put up a factory with annual crushing capacity of 45,000 MT

Challenges:
Drought and leaf rust



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BEANS

Consumption:
904,800.00 MT³

Production:
1 million MT

Area harvested:
670,737 hectares

Productivity/yield per hectare:
1.5 MT

Potential:
Increasing demand from export market. Value of exported beans increased by a compound annual growth rate of 46% between 2012 and 2017.⁴

Challenges:
Highly vulnerable to increasing variability of precipitation; increase in pests and diseases due to rising temperatures

SESAME

Consumption:
Uganda is a net exporter⁵, so consumption can be assumed to be the same as production

Production:
130,000 MT (2016); fifth largest in the world and second in Africa; produced mainly in the northern and eastern regions; northern region alone about 90% of total production

Productivity/yield per hectare:
About 0.6MT/ha (2016)

Potential:
Drought tolerant and huge market (value of exported beans increased by a compound annual growth rate of 8% between 2012 and 2017)

Major markets:
Egypt, Netherlands, Middle East and Africa

Challenges:
Low yielding varieties

Notes

- <https://www.indexmundi.com/agriculture/?country=ug&commodity=corn&graph=domestic-consumption>
- Faostat: Production, area cultivated and yield are from FAOSTAT
- Computed based on a consumption per person of 24 kg (index mundi) and 2017 population from UBOS statistical abstract
- Computed using data from the Bank of Uganda (BOU) statistics webpage: https://www.bou.or.ug/bou/rates_statistics/statistics.html
- Sector Analysis Studies for the Commercial Agriculture for Smallholders and Agribusiness Programme, Uganda: Country Value Chain and Market Analysis Report, submitted to the IMC-led EACDS Lot C framework (PO 7468) by LTS International Limited in partnership with Cardno Emerging Markets UK Limited: <https://beamexchange.org/resources/1054/>

MUIIS multi-partnerships

PPP project development and implementation

The MUIIS project took a multi-stakeholder approach by recognising and leveraging the specific interest and unique expertise of each partner towards the delivery of ICT-enabled extension services to farmers.

The information chain (circle) has three components: data, knowledge and information. All MUIIS partners fall into these three components to create synergy. The three private sector partners (eLEAF, EARS and aWhere) coordinated the satellite data acquisition, processing and storage, analysis and modelling, and decision support services. The data partners worked in close collaboration with

the knowledge partners (CTA, EAFF and AGRA) to transform the satellite data into usable/actionable information services based on agronomic knowledge and ground data from the users. These knowledge partners are mainly international, and public organisations utilised their in-depth understanding of farmers to support the building of the appropriate networks around their needs, and to develop and deliver capacity building activities as well as carry out monitoring and evaluation of the project. Information partners (Mercy Corps, UCA and UNFFE) ensured that end products were correctly communicated to farmers. In 2018, MUIIS partnered with Rabobank



Foundation to offer a unique product, the MUIIS Agricultural Input Loan (MAIL) to vetted smallholder farmers. This brought on board SACCOs and UCCFS as a delivery channel to the individual farmers across central, eastern and south-western Uganda.

MUIIS: PPPs at work

Partnership has proven to be an enabler for MUIIS. The MUIIS consortium comprises seven implementing partners (CTA, EAFF, eLEAF, AGRA, EARS-E2M, Mercy Corps and aWhere) with multiple associate partners such as Rabobank Foundation, UCA, UNFFE, Ensibuuko, New Wave Technologies, AIC, NARO and UCCFS. CTA initiated this partnership bringing together partners with complementary expertise and experience to ensure the delivery of combined quality service and smooth execution of the MUIIS project.

Having signed a partnership cooperation agreement that defined, among others, purpose and duration of the agreement, financial and payment regulations, project organisation, publication of results, intellectual property and liabilities, the project was organised in the following way:

- CTA, as the facilitator and lead of the partnership, maintained the overall financial and administrative supervision.
- A steering committee was established that utilised a partner deliverable matrix that clearly outlines the responsibilities or joint responsibilities of each partner in each of the activities and their corresponding deliverables.
- Other project management structure issues.

The attempt to lay out the relationships within the MUIIS project into a relationship map can be seen in Figure 1. The interconnectivities cut across country, expertise and role. From the assessment, many relationships can be described as strong while others will need to be strengthened as MUIIS transitions to a business. Given the multiple roles and responsibilities, partnerships were created in five areas: overall project management, satellite data management, knowledge management, information management and credit, as shown in the following sections.

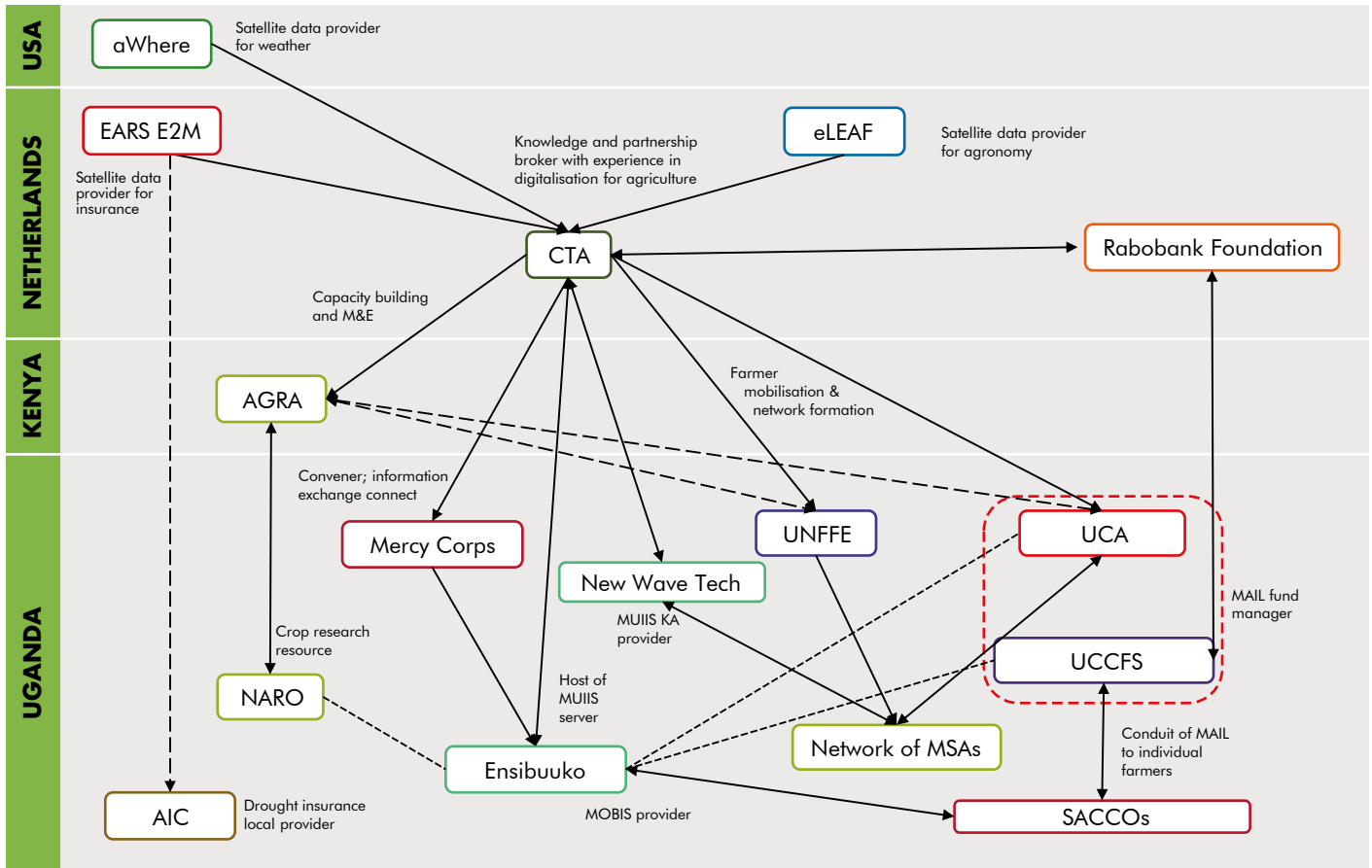
It is also evident that many activities were conducted by multiple partners; however, no one partner was held responsible for an activity causing a lack of follow-through and accountability. These, along with the differences in culture, work style and language, were bound to cause misunderstanding and tension. In spite of this, from the work package and updates of reports it is clear that the steering committee and CTA continually held partners accountable for their responsibilities or joint responsibilities.

Interconnectivities within the MUIIS project

The relationship map in Figure 1 shows the interconnectivities within the MUIIS project.



Figure 1 Interconnectivities within the MUIIS project



“

MUIIS has been a flagship initiative for CTA demonstrating the power of digitalisation of smallholder agriculture. MUIIS combines the potentials of big data analytics, the power of digital services and solutions, and the promise of the innovative business approach to sustain and scale smallholder digital agricultural projects. To transform African agriculture, governments, development partners and donors need to provide the impetus and the enabling environments for such initiatives in order for the private sector to scale. ”

Benjamin K. Addom, MUIIS Manager, CTA



Overall project management

The Technical Centre for Agricultural and Rural Cooperation (CTA), based in the Netherlands, is responsible for overall project management. CTA is a joint institution operating under the framework of the Cotonou Agreement between the ACP Group of States (Africa, the Caribbean and the Pacific) and the EU Member States (European Union). CTA is funded by the European Union.

CTA's mission is to advance food security, resilience and inclusive economic growth in Africa, the Caribbean and the Pacific through innovations in sustainable agriculture. CTA sees smallholder agriculture as a vibrant, modern and sustainable business that creates value for farmers, entrepreneurs, youth and women, and produces affordable, nutritious and healthy food for all.

- utilise its track record in facilitating and implementing partnership projects to

manage the project and its resources (CTA carried out financial and administrative supervision of the consortium)

- content generation
- monitoring and evaluation
- knowledge management and cross-sectorial learning.

Satellite data management

aWhere

- Provided daily, field level weather data and alerts on pest and disease risks, seasonal analysis and comparisons, actionable insights, and generation of regular project status reports.
- Smart content and high resolution weather data generated were sent through aWhere's application programming interface to integrate structured data sets from eLEAF and EARS-E2M.



EARS

- Received hourly Meteosat data and generated daily data fields of daily temperature, radiation, evapotranspiration, cloudiness and precipitation data fields using an energy and water balance monitoring system.
- Worked with local insurance companies to develop the products, provided indices for yielding information on precipitation, relative evapotranspiration, and solar radiation.

eLEAF

- Acquired and processed satellite data using its PiMapping © technology to deliver vegetation indices weekly such as the normalised difference vegetation index (NDVI), leaf area index and fractional

vegetation cover, and quantified crop data that give relative information on the status of crops, biomass production and volume of water consumed by the vegetation.

There are five activities within satellite data management:

- Satellite imagery acquisition – ground data acquisition – manage and execute imagery orders, rapid pre-processing development; development of derivatives with best practices.
- Archiving of imagery through automated protocols, execute protocols for imagery storage and access. Execute protocols for imagery processing, manage imagery procurement of database, generate regular reports, ensure efficient quality control and assurance metrics.



“

The MUIIS project has shown the power of approaching advisory services with a sustainable business model that bundles financial services, agronomic advisory services and insurance. Critically, MUIIS has taken this product to market by working through local farmer organisations yet supported by a locally developed technology platform that integrates robust back end global data providers of weather, agronomic modelling, crop insurance indices and satellite-derived crop information. MUIIS is a unique consortium that brings together like-minded business-oriented content providers and technology companies with farmer engagement and delivery partners to build a robust platform that delivers value to farmers in a self-sustaining way. ”

Stewart Collis, CTO, aWhere

- Compare, test and evaluate varieties of satellite data assimilation models and approaches.
- Develop and maintain decision support services with networks of deliverables, data streaming platforms, geospatial data acquisition, integration, visualisation, display plans to optimise the system.
- aWhere integrated its own satellite data with that of EARS and eLEAF combined with agronomic data made available by NARO/AGRA.

Knowledge brokering

CTA

- coordinated knowledge brokering with AGRA.

AGRA

- business development services and capacity building of MSAs, FOs, etc.
- knowledge management
- monitoring and evaluation.

Uganda Cooperative Alliance Ltd

- led the mobilisation of the MSAs and farmers
- in co-operation with AGRA, conducted knowledge management and learning for dissemination and replication purposes
- provided support for monitoring and evaluation (M&E)
- promoted information services and insurance to farmers and farmer groups.

The activities under the knowledge brokering service include:

- context analysis
- supporting formation of alliances/networks
- gatekeeping of new innovations and matchmaking of new demands from users
- adding value and repackaging knowledge products
- mobilising extra resources and communicating the presence of new information products



- assessing and evaluating information products
- management of alliances.

These activities were aimed at ensuring that the information needs of the target groups meet their demands.

Information management

CTA

- in charge of M&E on Mercy Corps' exit from the consortium.

AGRA

- complemented the satellite data with ground data on the selected crops such as inputs acquisition and use (type of seeds, fertiliser).

Mercy Corps

- led the ICT platform development through a third-party service provider

- provided support for business models for the products together with the end users and managed the information services
- leveraging MC's experience in Uganda (Agri-Fin programme) and technical resources such as its data storage server, MOBIS platform developed with Ensibuuko.

Ensibuuko

The activities under the information exchange service include:

- customising existing, developing new services and feeding into information exchange system
- evaluating information awareness creation among its broad audience
- developing toolkits, manuals, creating feedback mechanisms.

These activities were aimed at ensuring that users of the information are informed and trained on the value of the services and products.



The MUIIS service bundle is an exemplary public-private partnership that employs state of the art (satellite) technology to provide climate resilient agricultural advice and insurance allowing smallholders to obtain maximum agricultural productivity. eLEAF is proud to be part of the partnership providing satellite technology transforming data into viable, accurate and timely agronomic advice services. ”

Remco Dost, Project Manager, eLEAF

Credit

Rabobank

Rabobank Foundation was the MAIL funder who provided US\$1 billion (€238,000) to be disbursed to smallholder farmers profiled under MUIIS.

Rabobank Foundation's funding was based on the assumptions that:

- the MUIIS database would act as a guarantee to loans disbursed
- the MAIL would have an impact on smallholder farmer productivity and improvement of yield through financing quality inputs.

Rabobank Foundation signed a memorandum of understanding with CTA and UCCFS to manage and distribute the loan to four of the selected SACCOs.

Provision of credit through MUIIS proved to be a strategic catalyst that dramatically increased the uptake of MUIIS products by smallholder farmers.



“

MUIIS project has given farmers in Uganda an opportunity to practice precision agriculture guided by satellite-based weather and agronomic tips. It has been a complex consortium project where all the partners complemented their technical expertise, along the agricultural value chain to improve farmers' food production and income levels. ”

Abed Kiwia, Programme Officer, AGRA



“

The reason Rabobank Foundation decided to participate in the MAIL pilot was because of our interest in the bundle of remote sensing-based services offered by the MUIIS consortium, being weather alerts, farming tips and index-based drought insurance.

When we started this pilot, the number of projects with these combined services with a rather substantial pool of profiled farmers was rather limited. However, we believed that access to credit for inputs was an important additional factor to make the service more relevant to the end-users. We hoped the loan of Rabobank Foundation could facilitate that.

At the same time, we understood that implementation could pose challenges. Yet, we believed it would be important to test the viability of the product, the quality of the data and services in real-time to understand the potential of such a proposition and key factors to enable a successful implementation. ”

Martine Jansen, Manager, Data-driven Innovations, Rabobank

UCCFS

Uganda Central Cooperative Financial Services is a member-based national cooperative that provides financial services to all types of cooperatives in Uganda. As a member-based organisation, UCCFS is owned, used and controlled by its members and benefits its members (cooperatives) across the country.

UCCFS ensures it follows best practice through its objectives to:

- provide financial services including liquidity management to its members
- provide financial linkage and payment arrangements to all its members countrywide

- provide any other cooperative development support services demanded and approved by its members.

In order to secure these objectives, UCCFS had key indicators that certify credit-worthiness of its members such as internal governance policies, operational structures, financial capacity, record keeping and experience of SACCO staff and board members.

UCCFS's role was to manage the distribution of MAIL funds to selected SACCOs and monitor the performance of the loan.





IN-DEPTH ASSESSMENT



Concept of digitalisation of smallholder agriculture

Big data analytics

In recent years, big data has become a phenomenon not only because of the massive volume of structured and unstructured data and the speed at which they are created and collected, but also because they come from multiple sources, arrive in multiple formats and have the potential to be mined for information. Digitalisation of agriculture brings together big data analytics, digital solutions and services, and associated business development services within an enabling environment. MUIIS embodies all these components which need to be teased out accordingly.

Smallholder agriculture is one area that has the ability to create and collect data that have not yet been harnessed. It is bound to create varying data surrounding farmers and farmer groups such as demographics and socio-economic status questions, as well as farming specific data: crops being grown, fertilisers and pesticides being applied, weather conditions, machinery used and labour, among others. These data can be analysed to uncover information and can be enhanced to guide programmatic decision-making, provide insight and discovery into smallholder agriculture, support and optimise their agricultural processes.

This process of identification, data collection and mapping of farmers has proven to be a strong catalyst for agricultural interventions in Africa. It has had an influence on successful programmes such as the Feed the Future Senegal Naatal Mbay. It has been estimated that over 500 million farmers cultivating on small pieces of land are responsible for feeding up to 2 billion people. These farmers operate largely in informal market spaces whereby they sell a portion of their produce and reserve the rest for personal consumption (Hollingworth, 2018).

Farmer profiling and the use of technology can be the backbone of inclusive agricultural models that will spur the improved supporting functions, access to services and inputs.

Through its component of digital farmer profiling, slightly over 250,000 farmers have been profiled, providing rich data on demography, incomes and sources, energy uses, expenditures, access to services and agricultural practices.

Geo data or remote sensing data

Another form of data that MUIIS harnessed was geo data. Geo data or remote sensing can be defined as the ability to extract geographic data and map land uses to enable precision



agriculture. Remote sensing data complement farmer data to enrich and further customise the solutions to farmer needs and circumstances. One successful example is the International Center for Tropical Agriculture (CIAT), which is currently using a data-driven agronomy approach using climate observation data, farmer profiling data and historic data to support farmers in Colombia. Remote sensing data have further been used by the Grameen Foundation FarmerLink programme in the Philippines using weather data, farmer profiles and plant science.

Like many of these programmes, MUIIS was formed with similar strategies using the context of big data to provide carefully packaged solutions to smallholder farmers. While this farmer profiling data (aka farmers' database) combined with remote sensing data can be used to serve the farmers, it is also advantageous to developmental partners, policy-makers and private sector players. Local partners such

as UNFFE and UCA and the participating SACCOs agreed that having a database within their reach would ease operations, analysis, accessibility to farmers and streamline agricultural programmes and interventions.

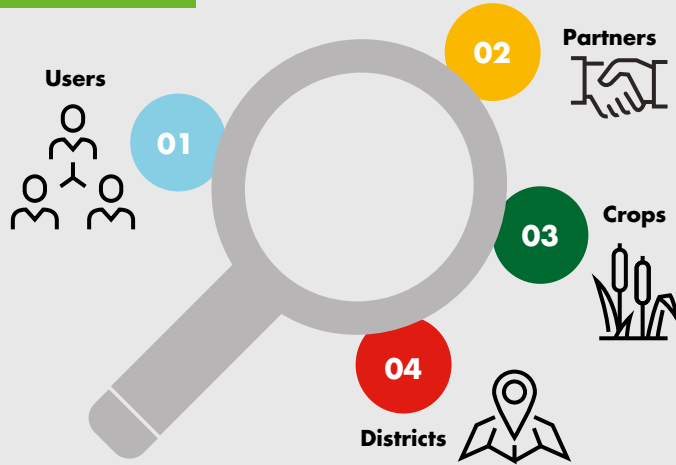
Remote sensing data play a significant role through strong algorithms combined with farmer data. This information is powerful primarily because it has the potential to guide farming practices and on-farm decision-making and provide early warning about pests and weather-related forecasts. Farmers appreciate weather-based information and updates that can inform their farming projects. Limitations arise with the conversion of information into multiple languages applicable to the farmers.

It is important that big data serve as the foundation for building digital solutions relevant to the MUIIS subscribed farmer.

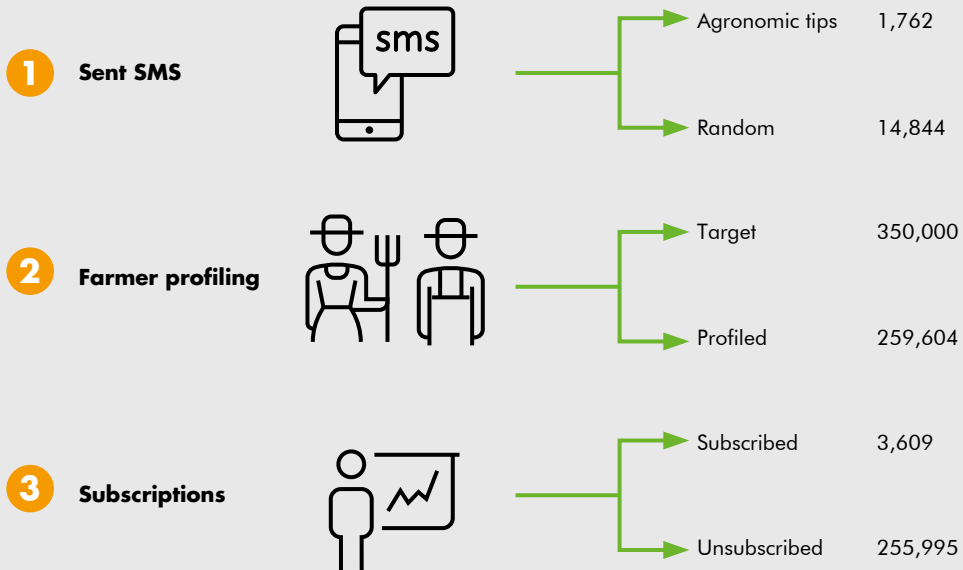


Key elements captured in the MUIIS dashboard

Displays



Data analytics on 3 types of data



As of December 2018



Digital solutions (with AI)

The combination of data and technology has been the pinnacle of MUIIS. This complex process involves compilation of remote sensing data contributed by aWhere, eLEAF and EARS, farmer profiling data and scientific information (NARO/AGRA) which is run through algorithms developed by Ensibuuko.

MUIIS system: its components and architecture

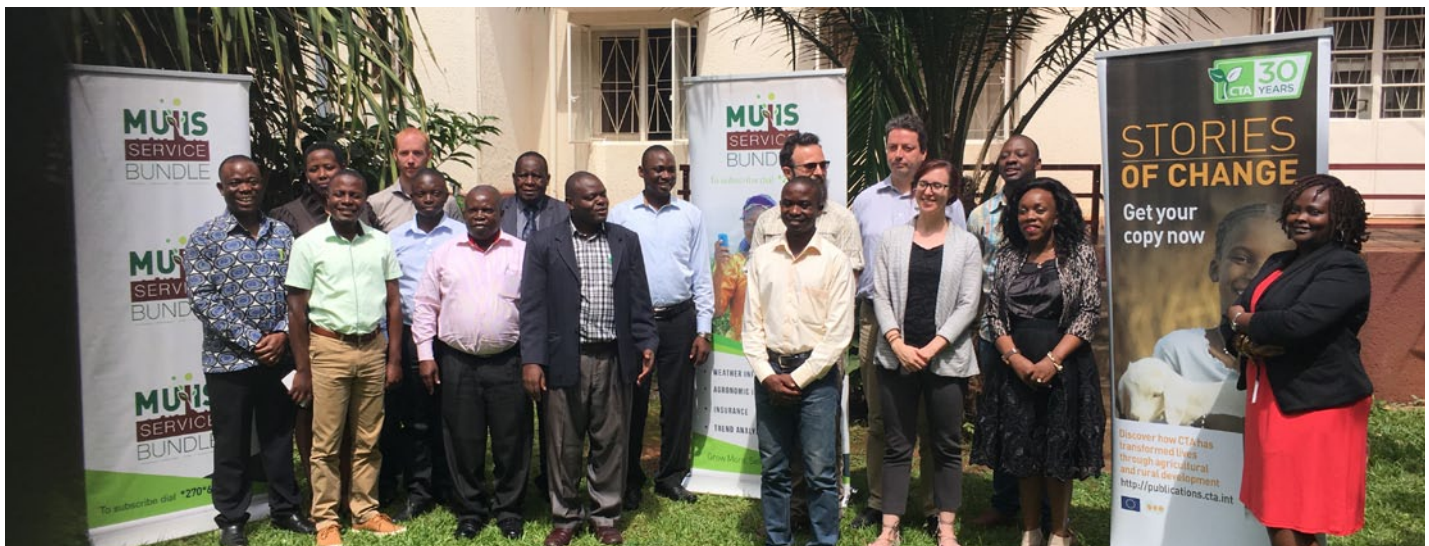
The MUIIS system is divided into three major components: data collection, subscription, and dashboard and messaging. Below is a brief description on how data collection, subscription, and dashboard and messaging work together.

Data collection using ONACollect. Farmers were profiled capturing specific information about their biodata, livelihood and production statistics, access to technology and financial services, and specific location of the farmer.

Data collection is handled through Open Data Kit (ODK) facilitated by the ONA platform. ODK is a free and open-source set of tools which helps organisations author, field and manage mobile data collection solutions. It helps one build, collect and aggregate data from the field with ease.

Forms are developed and coded into ONACollect. The forms are deployed to smartphone devices with no need for internet to fill them out, allowing MSAs to reach the most remote areas without access to internet-only location services activated on the phone. The data collection tool is designed to be simple to use, providing the backbone of the entire data collection process.

MUIIS dashboard. All information on the MUIIS system is aggregated and stored in the database. To provide access to all this information and added functionality, the MUIIS dashboard was built.





The MUIIS dashboard is a central place that partners and project stakeholders can use to access data and reports; i.e., to monitor farmer profiling, crops planted, MUIIS subscriptions and tracking of tips sent out. The dashboard is built with an application programming interface (API) first approach to facilitate separation of concerns and isolate functionality from look and feel. Optimisation for mobile devices as well as accessibility have been taken into consideration to support even the more dated devices.

The dashboard is built with an advanced role-based permission system to provide different levels of functionality for the various users of the system. The roles are granular across use case and level of access for each user for each function.

Local partners believe that tools like these that harness the power of data would greatly improve structures both at farmer group or SACCO level and umbrella association levels. Adaptations have been made to improve data quality, such as algorithms to eliminate data duplication and decentralisation of data to give access to farmer groups through a unique login.

MUIIS Knowledge App. The dashboard is supported by the MUIIS Knowledge App (KA) that provides a simple way for agents to access data and to provide more information to support the extension work of the agents.

The KA provides fertiliser optimisation tools for the specific crops the farmers are growing to allow farmers to use fertiliser in the most cost-efficient way possible. It also provides a feedback



mechanism through the agents back to the MUIIS design team.

Messaging. To generate real-time actionable messages, data partners provided satellite data:

- aWhere – satellite weather data
- eLEAF – satellite agronomic data.

The satellite data are queried against the location of the farmer and the conditions are analysed using a machine learning decision matrix algorithm. The algorithm is designed to take into account crop models, planting calendars and weather conditions, sending a 160-character message to the farmer. The current model is based on pre-approved messages which are translated in local languages and sent via SMS based on the conditions of the farmers. Some messages related to pre-season, post-harvest are queued since they are cross-cutting. The review and approval of messages is done by agronomists from NARO and UNFFE.

This is followed by an amalgamation of weather data from satellite images, using profiled farmer GPS coordinates and agronomic expertise to generate tips, and dispersed through SMS with support from the MUIIS-KA. Profiled farmer data are compiled, including GPS coordinates of farmers' gardens, which are synchronised with weather-based satellite imagery and compared with respective crop calendars to develop applicable tips. Despite all this artificial intelligence, quality control had to be implemented through reviews with Ensibuuko, NARO and private agronomists. The tips or alerts are then translated into eight languages to ensure easy comprehension and execution.



Upcoming digital solutions include design of a fertiliser optimisation tool, an intelligent platform fundamental to increasing farmer yield within their financial means. Using data such as farm size, crop planted and available funds, the tool is able to determine the optimal amounts and costs of fertiliser necessary for the farmers to have a profitable season. Data-centric tools like this create a strong market linkage between farmers and input suppliers as the suppliers are able to access their demand directly and understand their needs through the seasons.

Message generation algorithm. Raw data for points across the weather and agronomy spectrum are accessed via API from the MUIIS system. Weather data returned from aWhere include temperature, precipitation, humidity, solar radiation and forecast weather data,





and agronomic data include leaf area index, biomass, water deficit and water user.

Of these data the message generation algorithm uses temperature, precipitation, forecast precipitation and leaf area index to generate the appropriate message for the particular location.

Steps involved in generation of the messages:

- 1 Query MUIIS database for farmer details and GPS.
- 2 Use GPS location of farmer to query for weather data from aWhere via API.
- 3 Use GPS location of farmer to query for agronomic data from eLEAF via API.
- 4 Use weather and agronomic data to generate appropriate message tag based on weather conditions and the decision tree.
- 5 Access translation of the message tag generated from the database.
- 6 Send message to the farmer.

The algorithm that generates the messages from the data comprises a set of conditions and decision trees. Machine learning has been employed from historical messages sent as well as the learning model used to further fine-tune the outcome of the messages.

Inputs and outputs. Inputs to the current algorithm in order for a message to be generated include the crop tag, the growth stage of the plant based on planting date supplied by the farmer, the AEZ (agricultural ecological zone), the weather points (temperature, precipitation and forecast) and the agronomic point (leaf area

index). These are assessed and a tag is generated as the output.

The tag is run through the translation engine to define the appropriate message for the end user (farmer).

Output message categorisation

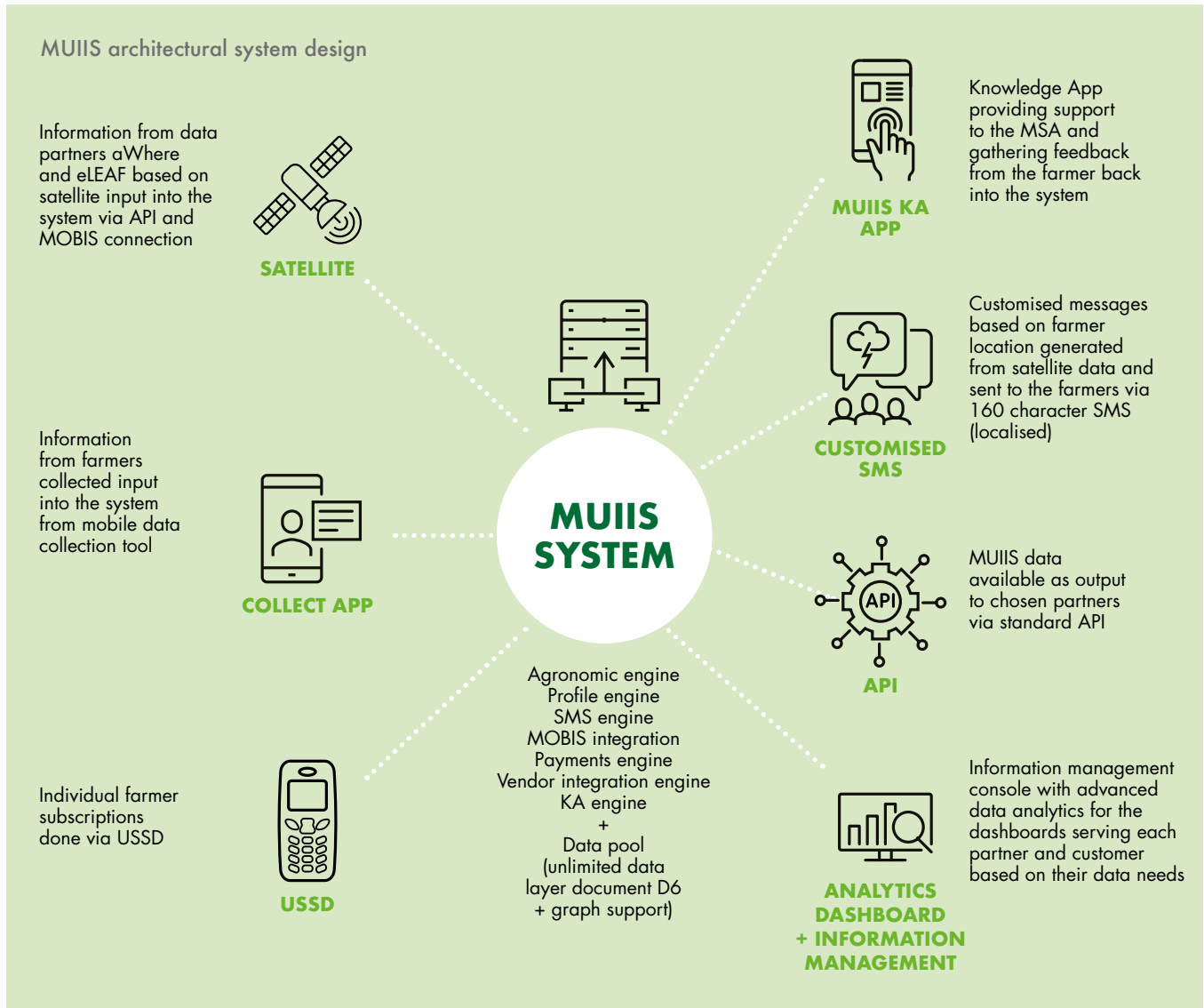
- Pre-season messages: messages sent before the start of the season mostly around land preparation, seed selection and weather conditions favourable for start of season.
- In season messages: messages sent within the season that stipulate best agronomic practices and monitor crop growth and advise farmers according to weather conditions through the season.
- Post-harvest messages: messages sent after harvest centring on harvesting, drying, storage and sale of produce from the farmer.

Improvements

- Expansion of the data points. The algorithm currently uses four data points for generation of messages; agronomists are currently researching involvement of other weather and agronomic indicators not currently in use to further improve the output.
- Inclusion of new crops. Currently the system supports four crops; we are researching the concept of including more crops to interest more farmers in the advisory service.

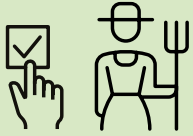
MUIIS system architecture

The system is split into separate sections with a service-based architecture to eliminate single points of failure. The different components of the system can run independently even if one of the points is down.





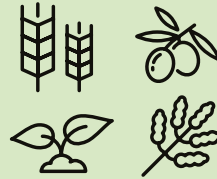
MUIIS customer journey



- 1** DFA/ACE representative can subscribe the farmer



- 2** DFA/ACE representative can transfer cash collected to DFA/ACE mobile wallet



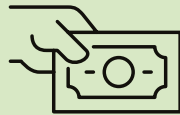
- 3** DFA/ACE representative has an option to subscribe for the farmer more than one crop with its respective acreage



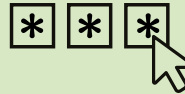
- 4** DFA/ACE representative is able to view list of crops selected (if more than one)



- 5** A farmer can make payment via mobile money or



- 6** Make payment by cash to the DFA/ACE representative



- 7** Farmer can approve payment immediately by entering PIN or



- 8** Receive approval instruction via SMS



Farmer-to-farmer e-Extension

The ratio of extension worker to farmer is 1:5,000.³ ICTs provide avenues to bring extension services and agri-advisory services closer to the farmer. Through the formation of the MSA network and liaison with farmer-based organisations, many more farmers are able to receive agronomic tips and access better quality inputs and finance.

Status of the 'extension work' in Uganda

Farmers have a great need for agricultural extension and advisory services for pre-production (weather, inputs), production (agronomic tips, weather) and post-harvest (post-harvest handling, market prices and information and off-takers).

These services are often offered by public agricultural extension staff from the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) and agricultural NGOs that also either employ extension service providers or support existing government structures. Still in early development and varying degrees of formality are private extension service providers, e.g., spray service providers. Under MUIIS, UNFFE and UCA were the farmer organisations identified that offer extension services. The original farmer support structures within Uganda comprise DFAs (supported from UNFFE) and ACEs (supported by UCA). Farmer groups are advantageous to farmers because they share information and experience, access loans, farm inputs and labour together.

In the recent past, SACCOs have also developed; many of which have farmers for members.

However, DFAs and ACEs have faced many challenges including few extension staff, limited resources to support extension workers and smallholder farmers, limited access to continual capacity building and minimal linkages to other extension workers in other regions. On the other side, the farmers sometimes resist joining farmer groups because of corruption or genuine lack of interest or knowledge. However, the e-Extension has the ability to reach a farmer that is outside the sphere of a farmer group.

In spite of these challenges, many of the extension workers have been able to diversify their offerings to farmers through starting or being part of input provider companies such as seed, fertiliser and pesticide companies, supporting extension work for projects much like MUIIS, as well as participating in other income-generating activities such as mobile money service agent work.

e-Extension

Because of the varying needs of farmers, an extension worker takes on many functions: e.g., farmer promoter, community knowledge worker, lead farmer. Because of the expense and strain of extension work, adoption of technologies has the ability to improve the service and delivery of the agricultural extension and advisory services





in a more cost-efficient manner. MUIIS chose the use of SMS. This can be augmented with the use of other technologies such as apps. It is to this effect that MUIIS is releasing a MUIIS Knowledge App meant to support MSAs and other extension workers with the necessary knowledge required to serve their farmers better. This knowledge spans across agronomic tips by crop, to market information (in particular price), to fertiliser optimisation using budget constraints.

Impact of e-Extension services on farmers

Increased outreach

e-Extension's most eminent benefit is the ability to reach a much larger number of farmers; in particular the ability to serve a farmer similarly by the choice of crop, language and

location allowing for more comprehensive and customised services (weather, price information). Nevertheless, there are factors that favour or hinder e-Extension services to smallholder farmers.

Frequent and/or comprehensible weather information

This should be addressed because weather alerts are crucial as they enable the farmer to plan properly to overcome the effects of erratic weather patterns by, for instance, selecting the more resistant crop varieties, deciding a suitable time to plant and to harvest. All this would not be possible unless farmers' access to and use of information and technologies is increased in order to increase resilience to the effects of climate change.

Limited knowledge of insurance

Before the introduction of ICT-enabled information services such as MUIIS, farmers were heavily dependent on chance and choice on when to plant and harvest their crops with little or no influence on or knowledge of the weather. The ability to offer insurance products alongside e-Extension decreases the risks the farmer might face during crop production. Notably, reduction in crop yield or total crop failure are increasing because of erratic rainfall patterns which normally cause water deficits which lead to long dry spells that impede optimal crop growth. The same can be said for other challenges such as pests and diseases and floods that might need insurance products that are not covered under the MUIIS project. These insurance products are in line with the government's vision for

setting up the Agriculture Insurance Premium Subsidy Scheme.

Absence of permanent market centres or market linkages

This has affected prices which traders offer to smallholder farmers for their small amounts of produce. The produce is normally sold on a cash basis and normally within their locale to attain income for immediate survival. e-Extension presents an opportunity to place farmers' access to both market and agronomic information at their fingertips which enables farmers to adopt the technologies and increase their production. It is also important that farmers can access productivity enhancement technologies to increase crop yield to allow them to increase their incomes without compromising their own livelihoods.

Farmers are extremely practical

Farmers still prefer demonstrations as a mode of delivery of training and capacity building; that has proven to be the best way to create new behaviours and practices among smallholder farmers. For instance, fertilisers, in particular inorganic fertilisers, are not yet widely used. This is rooted in the false belief that the soil is already fertile, dung is good enough, and lack of awareness and access to inorganic fertilisers. Its proper use is hard to explain over text. Adoption of other modes such as video and audio as well as demonstrations will inform the most illiterate of farmers.

Diversified services

New knowledge allows farmers to participate in an economy that they had never known.






Through linkages with MSAs and other farmers within their farmer groups, new practices are adopted ranging from the decision to purchase improved seed, to collective use of machinery, to savings and access to finance together. Collectively, these farmers will have access to off-takers and access to finance that would never have been achieved with normal practices. This will resolve the current mentality that most smallholder farmers have that farming is just a way of life but not a business. That has influenced the way they handle their land, the planting practices, the costs and the risks they

are willing to take. The extension worker is the link between the usual practices and the new, improved agronomic practices with the promise of better yields.

It is therefore imperative that the two co-exist. Adoption and uptake of ICTs will allow for access to information, products and markets while the extension workers and district agricultural officers will continue to serve where elements of social capital are still required such as mobilisation, demonstrations, supervision, advice and the like.

MUIIS information services

<p>WEATHER DATA</p> 	<p>AGRONOMIC CROP TIPS</p> 	<p>FINANCIAL INFORMATION</p> 
<ul style="list-style-type: none"> ▶ Appropriate seed variety and quantity ▶ Seed bed preparation and land preparation ▶ Timing for sowing and transplanting ▶ Input to advisory or extension services on start of growing season, its window, its length ▶ Drought risk 	<ul style="list-style-type: none"> ▶ Appropriate amount and use of fertilisers and agro-chemicals ▶ Preventive practices on adverse weather conditions and/or early warnings ▶ Prevention and rehabilitation in case of pests or plant disease attacks ▶ Input to post-harvest (marketing) services ▶ Agronomic drought ▶ Actual start of growing season ▶ Crop yield forecast 	<ul style="list-style-type: none"> ▶ Drought insurance services ▶ Design and monitoring of drought index insurance ▶ Design and monitoring of excessive precipitation index insurance ▶ Resilient financing

Other information includes distribution channels such as MSAs and partner channels such as farmer organisations, farmer groups, TV and radio, and print materials as well as workshops, conferences and agricultural roadshows.



My MUIIS experience

“ I am a 56-year-old farmer with a wife and one son. I practise intercropping for household consumption and sell commercial crops for a living. Previously, I was farming on 2 acres; however, this season, I expanded my farm to 4.5 acres growing maize, beans, groundnuts, cassava and pumpkins. This land was hired from the church in Naggalama.

I was introduced to MUIIS by Alex Kasajja, the manager of Nakifuma Farmers SACCO. Alex informed us about how the project works and the advantages of the different products under the programme. As a person who is passionate about farming, I subscribed to MUIIS in the first season of this year with 1 acre of maize. Throughout the season, I received messages with tips on land preparation, mulching and quality fertiliser and pesticide use. I also appreciated the fact that through the season, the MSA maintained contact with me via phone

call, trainings during SACCO visits and visits to my farm.

Under MUIIS, I was able to receive an input loan whose terms were extremely friendly and patient. As farmers, we face challenges accessing stress-free loans. I was able to receive USh400,000 [€95] for 2 acres of maize planted. With this loan and my savings, I was able to purchase seed, pesticides, fertiliser and meet labour costs. I still have an outstanding loan due to the price drop in maize which affected my expected earnings. However, this will not deter my repayment as I grow a diverse number of crops that can provide alternative income. It would be good if MUIIS could offer me revolving credit season over season to help kickstart in case my sale is not as productive as expected.”

John Gamusi, farmer, 4.5 acres maize and beans, Mukono District.



“ I am a 32-year-old mother of two. I am a commercial farmer of beans and banana (matooke). I plant these crops on a piece of land I hire from a neighbour in the area. As a woman in farming, many of my colleagues do not consider it as a money-making activity. However, because of my continuous persistence and experience, I have been able to make a living and support my household.

I got to know about MUIIS through Nakifuuma Farmers SACCO which profiled me, and I subscribed to the project for two seasons. Through the seasons, I was receiving messages on soil management, how to use fertiliser and which pesticides to buy. Previously, I would plant my beans and depend on the weather and good luck to harvest a good yield. Now, with MUIIS, I can properly care for my crops to ensure that I harvest big.

I was glad to be selected to receive the input loan. I received US\$400,000 [€95]. I combined this loan with my initial planting capital and purchased fertiliser, pesticides recommended, hiring labour and extending my plantation. I have been able to pay back half the loan due to drastic weather changes that affected my plantation. Heavy rains affected my harvest that reduced my yield and furthermore, the market price for beans dropped.

I am currently strategising to change to soybean which is fortunately under MUIIS project and has much more stable prices of around US\$2,000 [€0.48] per kilogram. My request is that messages with tips should be less technical and in our local language to ease my understanding.”

Martha Nantongo, farmer, 2 acres beans, Mukono District.



My MUIIS experience

“STRIDE, a SACCO based in south-western Uganda, has 1,758 members of different professions with a composition of 54% male and 46% female. Although the members have different professions, many of them farm to earn complementary income. The farmers under this SACCO grow a mixture of both food and cash crops. All MUIIS crops (maize, beans, sesame and soybean) are grown here in Kasese. Farmers also plant cash crops such as cotton and coffee. However, Kasese is famous for planting maize on a large scale. STRIDE offers savings products to farmers at no cost and provides credit at a varying interest rate between 2.7 and 4% per month. To cater for the changing needs of farmers, this rate varies depending on the purpose of the loan. In particular, the interest rate at production level is at 4% per month.

We were introduced to the MUIIS project by Ensibuuko, our MOBIS system provider for the

last two years. MAIL was a good concept and it complemented our products very well. While the period was very short, due diligence could have been improved. However, as a SACCO, we improvised by including some preventative steps such as engaging farmers within their original groups, conducting a sensitisation session prior to disbursing the loan and hiring a full-time resource to manage the loan portfolio.

As I had said, MAIL is a good product. We need to collectively work to make it profitable for the farmer and for the SACCO. Increasing the involvement of SACCOs in the appraisal and monitoring process would make loan payment and performance more successful. This eases our level of risk and concern as we are the on-ground actors that are fully aware of these farmers, their needs and their creditworthiness.”

**Bwambale Jofred, SACCO Manager,
STRIDE, Kasese District.**



“ I consider myself first a farmer, then an MSA or an extension worker. I currently have one and a half acres of maize in Lira District. But I have worked with farmers under multiple programmes, training them in the use of herbicides, weed control, agronomic practices and managing costs of production.

I was invited to join the MUIIS project as an MSA under the Apac DFA. At the introductory workshop in Nebbi, we were introduced to the project and its objectives which were very relatable especially for my farmers that face a lot of drought in northern Uganda in districts like Lira, Oyam, Amolatar. So I joined as an MSA involved in farmer profiling under the supervision of Apac DFA.

As an MSA, I was very optimistic about MUIIS; however, the work proved to be more difficult than anticipated. Northern Uganda (NU) is unique and quite different from other regions. For instance, NU smallholder farmers are spread out over long distances. This made profiling difficult and costly without receiving any facilitation. It was also difficult to convince farmers to subscribe after profiling;

this required frequent visits and follow-ups prior to actual subscription. Furthermore, technology adoption in NU is very low with numerous farmers having no access to phones and electricity. This made my work hard since I had to travel long distances and filter worthy farmers.

I was further discouraged by the project when farmers I had profiled did not receive the MUIIS loan. This affected farmers' perception of MUIIS because they were told that loans are a part of the service bundle. Other challenges included receiving untimely text messages due to the difference in seasons in NU.

Unfortunately, I was forced to leave the project because it was not sustainable for me as an individual due to lack of facilitation, delayed remuneration and the unsatisfied farmers. MUIIS is a very good project. Aside from other MSA challenges, I recommend more demonstrations to farmers and provision of tangible support in form of ox ploughs, drought resistant seeds.”

Francis Oyuru, MSA and extension worker, Lira District.



MAIL for smallholder farmers

Selected SACCOs

Four SACCOs were identified, scrutinised and disbursed funds to be distributed to appraised farmers. SACCOs selected and identified were required to have a network of farmers, have a functioning MOBIS system and provide extension services to the members. UCCFS played the role of fund manager managing the credit facility and scrutinising the creditworthiness and management of these SACCOs. These included:

- **Stride Development SACCO** in Kasese district, south-west Uganda with 1,758 members. The membership is composed of farmers who grow all the MUIIS crops as

well as coffee, groundnuts and cotton. Maize in particular is grown on a large scale.

Loans were issued using group guarantees and had the following loan recovery mechanisms: sale of harvest, sale of livestock and reduction of savings.

- **Sebei Farmers SACCO** in Kapchwora district, eastern Uganda with 2,000 farmers. The farmers' crops are differentiated by the low land and high land areas. At higher altitudes, farmers grow sunflower, Irish potatoes, coffee, wheat, barley, cabbages and matooke while in the low belt, maize, coffee and beans are grown. Their usual loan is given under group guarantees that require four group leaders before it is disbursed.



- **Baitambogwe SACCO** in Iganga district, eastern Uganda with 9,500 members serviced by five branches; 60% of the membership are farmers who plant maize, beans and groundnuts. Loans were issued directly to farmers in cash. Farmers were called to different branches to receive their loans. Each farmer was added to the MOBIS system to ensure tracking of repayments.
- **ZAABTA SACCO** in Luweero district, central Uganda with 4,321 farmers in 153 groups. The farmers grow a vast number of crops such as maize, beans, rice, tomatoes, fruits and lettuce. The members of ZAABTA did not receive cash but inputs of the same value, which is a model we recommend going forward. E-vouchers were issued to qualified farmers to redeem their inputs from accepted dealers.

Impact of MAIL on SACCOs

All the SACCOs selected for the MUIIS project experienced growth in geographical coverage of operations and membership.

- Stride Development SACCO recorded a 43% increase in membership since joining the MUIIS project.
- Sebei Farmers and Baitambogwe SACCOs also recorded an increase in membership of 22% and 5%, respectively.
- The increase in membership for the SACCOs indirectly meant that their geographical area of operations expanded and there was a significant increase in share capital.
- Stride Development and Sebei Farmers

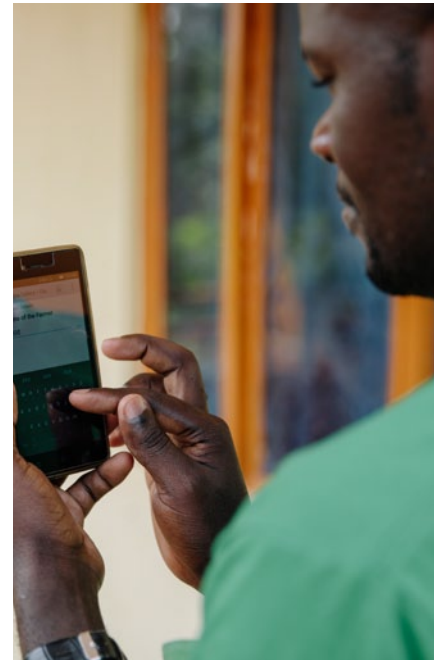
SAACOs were able to record 11% and 7% increment in share capital, respectively, after joining MAIL.

Despite the positive impact of increased membership and area of operations, the SACCOs faced challenges managing the MAIL. One of the notable challenges was the perception of the loan by the farmers. Baitambogwe and Stride Development SACCOs shared that some of the farmers believed the loan was from the government and payback was not consequential. This, coupled with price fluctuations, unforeseen climate changes and limited market access for produce, led to high default rates.

Due to the high portfolio at risk, SACCOs felt an instant pinch in their operations in the loan recovery process.

Taking inference from Stride Development SACCO, the cost-to-income ratio increased by 6% and net profit margins dropped from 26% to 24% due to the increase in MAIL management costs. It was also mentioned that they hired a designated loan officer to follow up on loan recoveries whose facilitation, salary and needs for two months superseded the 3% SACCO revenue earned from the MAIL facility. Sebei Farmers SACCO faced similar challenges reflected in an increase in the cost to income ratio of 20% due to MAIL management costs.

The SACCOs have had to deploy alternative methods to collect the loan repayments, some of which include involving the judicial system, attending farmer meetings to collect payments and withholding guarantors' savings.





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However, these methods continue to eat into the potential profitability of the SACCOs. A shared sentiment from the SACCOs was the need to have been involved in the appraisal process of loan recipients.

Opportunities for future agri-credit: Focus on smallholder farmers

Working with input suppliers

Smallholder farmers usually cultivate their gardens depending on the available resources. With products such as MAIL, SACCOs working with regional input suppliers can provide farmers with quality inputs on credit. This has a twofold advantage in that farmers receive verified quality inputs and there is control of loan diversion by the farmers.

Strengthening extension services

The MUIIS service bundle offers the e-Extension services; however, there is a need for demonstrations at SACCO level. Farmers are practical entrepreneurs who need seasonal training, regular checks and demonstrations. While farmers received the agronomic tips, they did not have reliable supporting functions to guide them in practice.

Access to markets

Accessing markets with stable prices remains a challenge for smallholder farmers. This has an adverse effect on the financial market due to the risk involved in providing credit to farmers with no guarantees that they will find a market for their produce at favourable prices. It is therefore

imperative to create linkages between off-takers and smallholders to ensure a financially sustainable market system.

Working with SACCOs

SACCOs are the most important financial point of contact for smallholder farmers. In spite of this, SACCOs face major challenges and need capacity building and technical assistance to empower and manage their members. Notably under the MUIIS project, Stride Development SACCO undertook MAIL sensitisation training on the MUIIS project, the SACCO and the expectations of the loan.

UCCFS also recommends that farmer SACCOs need to be strengthened in governance, financial and operational capacity. This will ensure they serve their members, meet their objectives and remain commercially sustainable.

Data and analytics

The MUIIS project harnessed the power of big data and the analytics behind it. With over 250,000 farmers profiled, local partners such as UNFFE, UCA and selected SACCOs have appreciated the importance of these data banks.

Farmers can easily be accessed, engaged and appraised as part of the process to improve financial inclusion. Furthermore, data on the platform can be used to support linkages between farmers and their target markets, as well as provide information and trends on market prices.



ACHIEVEMENTS AND OUTCOMES OF THE MUIIS PROJECT

Achievements

- **Farmer database.** The ability to profile over 250,000 farmers across agro-ecological zones in Uganda. Despite the low conversion rate of profiled farmers to subscriptions, the project was able to identify necessary mechanisms to sustain and improve the subscription rates.
- **Development of supporting software and platforms.** The project achieved the development of the necessary software, maintained and supported by satellite data providers and technology partners. This achievement has set the basis for the project to strategically change its model to a viable business with the potential to earn revenue from subscriptions and monetising its database.
- **Leveraging existing farmer organisations and cooperatives.** MUIIS was able to penetrate and use the existing farmer support structures in place to access farmer groups, organisations and cooperatives. Several groups and associations are active, aware and participating in the project. These groups will be engaged and will evolve with MUIIS as it is converted into a business entity.
- **Establishing and securing an agent network.** MUIIS has used the current structures to access farmer groups and



cooperatives through its service agents. The MSA network has not only provided income generation opportunity for agents, but has additionally improved farmer extension service support. MSA agents have been trained on the use of smartphones, agro-economic information and climate smart farming techniques which have been passed on through text messages and the MSA's direct communication. Through this agent network, farmers outside farmer groups were also reached. This agent network will continue to be a key element in the roll-out of the e-Extension services to farmers across Uganda.

- **Distributors brought on board.** (44 distributors joined in 2015–2017) MUIIS has been able to work with distributors to access farmers.

Outcomes from the adoption of MUIIS

- **Improved crop productivity and water efficiency** through agro-economic and weather tips that have been sent out through the SMS platform. MUIIS has ably reached out and improved farmers' production cycles through improved practices which have influenced the yield of the smallholder farmers under the project.
- **Access to financial services.** Through the MAIL under the MUIIS project, 1,890 farmers accessed credit totalling US\$1 billion (€238,000). Despite the challenges in managing the credit, MAIL exposed the reality that there is a need for smallholder farmer credit financing that significantly improves productivity.
- **Resilience through insurance.** The MUIIS product portfolio offered drought insurance to 1,890 subscribing farmers. This product is in line with the government's initiative, the Uganda Agricultural Insurance Subsidy, which provides a subsidy to the farmers. Remarks from farmers and others allude to the need for insurance cover for pests and diseases, excessive rain and other challenges that farmers are bound to face that might currently be outside the scope of the MUIIS.
- **Education of farmers, farmer organisations and SACCO leadership.** MUIIS has provided for a good amount of awareness on the products and climate smart agricultural practices and 141 representatives of farmer organisations were trained. However, a great amount of learning around the concept of digitalisation of smallholder agriculture came from the implementation of the project.
- **Traceability of productive land use year on year.** The MUIIS dashboard and database have enabled tracking of productive land use remotely, from 41 hectares (2016), to 2,690 (2017), to 2,731 hectares (2018). This traceability provides for a trackable investment necessary to capture climate-smart agricultural practices through agronomic and weather-based tips.



Note that these achievements have been informed by internal plans as well as farmers, MSAs and SACCOs visits.



LESSONS LEARNED

Lessons learned at project design

Number of partners and alignment of roles

MUIIS was a consortium of 15 partners (seven primary and eight third party) working together to provide services to smallholder farmers. While each partner brought strong experience and expertise, individual partners approached the project with mixed objectives. Partners were able to deliver input and strategies at the design stage of the project; however, the original implementation considerations lacked local context. The partnerships were adapted to include local partners to support operationalisation of the project.

Business model

Development of the MUIIS project did not consider a stress-tested model to be applicable to the project. The project was designed without consideration of adaptability and sustainability beyond the value chains to the entire and current market systems. Furthermore, no full considerations were made in the business model for transfer of the project to suitable private sector players. This was deeply affected by the exit of strategic primary partners, leaving a vacuum potentially affecting sustainability; in this case, the transfer to a farmer organisation which was envisioned as the suitable eventual owner.

Project timeline

Agreeable to all participating partners, the 3-year period for MUIIS was not enough to achieve the expected impact. In spite of the presence of a well-planned timeline and roles to be played by partners, unforeseen challenges and stalemates were barely considered. MUIIS was an interconnected project whereby delays in delivery from different aspects affected the overall project execution. For a project that includes development of product, promotion of product, uptake and full deployment, a period of 6–7 years is more feasible.

Local context and partnership

Project build-up and design barely included local context and on-the-ground partnerships. While some local partners were brought on board, implementation strategies had already been put in place, some of which were not practical from the local partner point of view. This caused a clash between theoretical and practical strategies that affected implementation. It is vital that there is local talent that can be harnessed within Uganda.





Marketing and communication

MUIIS was designed as a product and service to be marketed to smallholder farmers and market actors; however, there was low penetration and reflection in the market. A public relations strategy was not considered in the design thereby neglecting engagement of the public, regulatory and private sector actors. Limited interest from mobile network operators was highlighted as a challenge.

Implementation, ownership, leadership

While MUIIS was carefully planned and involved many partners, minimal attention was given to implementation structure and strategy. A fully resourced core local implementation team was necessary to ensure each partner met their roles and objectives in a timely manner. Further to this, a team would have to keep key performance indicators tagged to their roles, hence making MUIIS a commercially feasible project.

Lessons learned at project implementation

Partner level

Project and process control

As a multi-stakeholder project with the intention of turning into a private sector entity, MUIIS was riddled with undefined processes and control measures. Critical elements in managing high to low level functions in both data-driven and financial service provision were neglected leading to frustration and mismanagement. Multiple suggestions have been given to improve participation that will still not be successful unless there is unity and a common way of working amid the varying intentions.

Market actor involvement

To ensure sustainability of MUIIS, market elements have been highlighted as an important driver for the project and the eventual business. To increase the chance of smallholder farmers

paying for services, linkages to off-takers and developed markets is key. Strategic partnerships with large market players and off-takers are paramount for the commercial success of MUIIS as bulking and farmer group formation or strengthening will occur. However, market actors must be carefully selected to ensure the core beneficiary remains the core of the business.

Commercial technical partner

Lessons from MAIL indicate that there is urgent need to engage commercial partners who will support business development services to build technical and operational capacity in SACCOs that are constituted mainly by farmers. These SACCOs need capacity building to strengthen their financial management, technical and managerial skills to serve farmers.



Beneficiary level

SACCO engagement

A notable insight is to use a bottom-up approach to provide insight into farmers' needs for finance and information. Furthermore, SACCOs can act as brokers in the acquisition of farmer inputs and purchase of harvest by off-takers. Through these linkages, market systems can be built that would establish a first-of-its-kind in agriculture in this region.

Strong and reliable agent network

While technology is a key component of the functionality of MUIIS, smallholder farmers still require a handholding approach. It was noted that farmers relate more to MSAs that they are familiar with right from the profiling

stage. To ensure reduced churn of these farmers and confidence in the product line, a primary lesson is having a strong, reliable and well-resourced MSA network catering to the farmers' needs to enable the adoption and uptake of ICT for agriculture.

Demonstration and sensitisation

Farming is a practical activity and with new technologies there is need to have sensitisation and demonstration runs. Smallholder farmers appreciate information; however, technical aspects have to be shared practically to ensure understanding. This was a key lesson to support development of the Knowledge Application meant to reinforce information dissemination.



RECOMMENDATIONS FOR MUIIS OPERATIONS

As MUIIS transitions to a business, an in-depth study of the MUIIS project has highlighted areas for improvement. Figure 2 shows a high-level structure that depicts the changes required to grow and sustain MUIIS. These options are described in detail.

To assess the viability of the recommendations, a business and financial model was developed to determine the most viable way of working with a focus on sustainability; here we looked at the key drivers of revenue generation, the correspondent costs of service, variable costs and the fixed costs that are incurred to run the business. With these insights, we were able to derive applicable recommendations as shown in the next sections.

Recommendations on structure and organisation

The MUIIS Consortium through the steering committee sets the targets and considerations for the next quarter or half-year. This is against project milestones as well as reporting from the previous period.

PPP at management level: the project is managed by an independent, private contractor responsible for data collection, technology, MSA supervision and the like. Their sole responsibility would be to report to the MUIIS Consortium against all project target deliverables as they are able to weigh and deliver priorities across all

15 partners without bias. They would also be responsible for creating strategic partnerships and linkages that might be hard to achieve by a not-for-profit organisation. This contractor would work with a technology partner to ensure that data regulations are being followed. Note that farmer mobilisation will still be done by farmer organisations.

This recommendation tallies very well with the need to transition to a business owned by a joint venture between a public and private organisation. Nevertheless, adaptations can be made once the type of organisation has been identified.

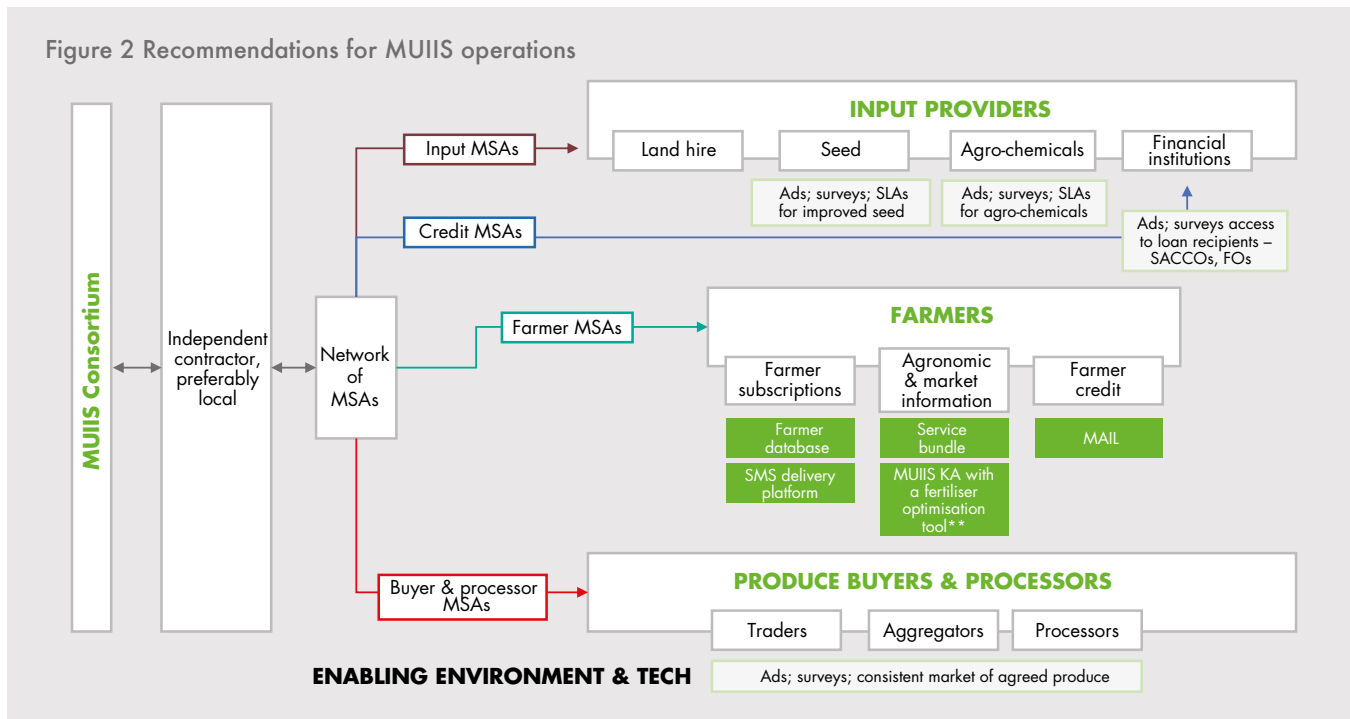
Recommendations for MSA network

Network of MSAs

Supervised by the independent private contractors. Different types of MSAs have different skills. Credit MSAs have loan or banking experience while processor or producer MSAs should have fast moving consumer goods experience. Farmer MSAs will remain as a supplement to the e-Extension services. Within the network of MSAs, they are arranged according to crop and region. Note that input MSAs and processor MSAs should be in sync to ensure quality, volume and demand is agreed prior to production. Set targets on number of trainings, demos, farmers, etc. Set service points,



Figure 2 Recommendations for MUIIS operations



preferably the facilities of the FOs. While linkages can be made via the MUIIS-KA, MSAs will be the human touch to B2C.

Remuneration and facilitation of MSAs

Remuneration is commission-based. As part of our recommended strategy, the original MSAs that spearheaded the project, the trained 125 MSAs, have already established relationships with the farmers they profiled. Therefore, to significantly increase the subscription rate, the current 30 MSAs and the 95 MSAs that dropped out after receiving training need to be incentivised, using a commission and referral-based marketing strategy; each earning commission of at least USh3,000 (€0.71) per farmer subscription.

This same financial and business model determined the maximum commission percentage that can be offered to each MSA while keeping the subscription price at USh20,000 (€4.76), for the business to realise net present value greater than zero; and this was found to be USh3,000. However, after Year 3, it assumed that all 125 MSAs would have been recruited and relationships with the farmers established through constant interaction. The commission earned would then be reduced to USh1,500 (€0.36), to encourage the MSAs to (a) push continuous subscriptions and (b) seek new farmers to be profiled and subscribed. Strict supervision and spot-checks on MSAs to maintain a goal-driven culture will be required. Also consider setting up





a team of problem-solving MSAs that are mobile to support the customisation for the farmers and their farmer groups.

Another recommendation is to use referrals from ACEs, farm group leaders and farmers. This is likely to aid the increase in subscription rate; referrals have been found to have the highest customer conversion rate. This, however, should be backed by a commission earning of about USh1,000 (€0.24) per successful referral, to be deducted from the USh3,000 (€0.71) earned by the MSA.

Recommendations for implementation

Farmer group strengthening

Work through groups. Inevitably, farmers require mutual support from MSAs. Through the support of MSAs, farmer groups should be identified, ranked and capacity built. Main focus should be on active FOs with offtake agreements, SACCOs with a substantial membership and continual agronomic training within these groups.

On the other hand, all members of these FOs and SACCOs should join MUIIS as part of their procedures. Offer tangible support alongside the service bundle at a fee paid by the B2C clients.

New farmer categories

Map out the commercial farms and use their subscriptions to cover the costs incurred by the smallholder farmers. Establish strategic

partnerships with SACCOs mainly constituted by farmers. This could be in the form of direct partnering with the SACCOs or through the agricultural technology companies, which offer financial services to both individuals and farmer groups. Such firms already have strong foundations in the sector; they would therefore be able to leverage their resources, such as their customer base, to increase the number of subscribers.

Partnering with the SACCOs and agricultural technology firms increases the subscription rates because the service bundle is simply incorporated into their already established systems; therefore, as part of the financial support, a farmer is also insured against drought and receives precise tips for best practice farming. Identify crops of interest and include them in MUIIS value chains.

Storytelling

Using mixed methods to reach and influence farmers, e.g., radio and TV to communicate MUIIS: sample random messages, advice, call for subscriptions at the start of the season that have a wider reach than only the agent network. Communicate new products such as MUIIS-KA. Capture or track farmers from 2015 for changes such as churn, change of number, change of land or interest.

Shareable and saleable insights

The business model also determined how much more revenue should be generated from the monetisation of the farmer database, in order to subsidise the MUIIS service bundle costs. This is because the current business model has



a high operating leverage; that is, the business has high fixed costs to incur, regardless of the total revenue generated. Therefore, with low subscriptions in a given year, the business would be making losses. For the project to realise net present value greater than zero, the farmer database needs to be monetised. An analysis was performed to determine the total amount that the database ought to generate while varying the subscription rates, to realise a net present value greater than zero.

To make these data more usable, the profiled farmers need to be re-engaged to supplement the captured information in the database with information that potential consumers would require so as to produce shareable insights for sale. Reports and surveys targeted to

development programmes with similar priorities such as the US\$248 million World Bank-funded Agricultural Cluster Development Project (ACDP) or the DFID-funded NU-TEC MD (Northern Uganda – Transforming the Economy through Climate Smart Agribusiness Market Development). Also, there may be interest in the financial sector; we may therefore share the success of MAIL with financial institutions. There may also be interest in the agricultural commercial industry, where information in the database can be used to enhance both traceability and modes of delivery of services to farmers such as digital payments and financing services. However, this revenue generation stream needs to be revisited, as this may not be applicable to the Ugandan economy.



Summary of the recommendations

Use of existing infrastructure and structures

This can be done through:

1 Using the existing database of over 250,000 farmers that MUIIS currently has at its disposal. This provides leverage for the business to engage these farmers through existing structures and technology to create revenue. This can be done through marketing of the MUIIS service bundle through its agent network. The business can strategically use the MSAs, farmer groups and cooperatives to convert the existing farmer numbers into subscribers, thereby earning sustainable revenue.

2 Rejuvenation of the agent network to meet the business targets and continuously maintain subscription of farmers. MUIIS benefits from a strongly motivated MSA network. Using a commission-based model through which MSAs' earnings are tagged to the number of subscriptions successfully made, the business will be assured of continuous revenue. Notably from profiling in the past three years, MSAs performed well due to the earning associated with profiling. This has been the basis for developing subscription commissions that will enable continuity of the business. A total of 125 MSAs can sustainably support MUIIS as a business across agro-ecological zones in Uganda.

3 Inclusions of other value chains.

MUIIS as a project concentrated on four value chains. However, it was noted that farmers in the project were producing in more than one value chain. Another concern is that different food and cash crops are grown in different agro-ecological zones. Using the existing structures and farmer organisations, the business can venture into lucrative value chains that will attract a diverse farmer base subscribing continuously. Notably this has to be done gradually, to ensure that services delivered remain of high quality and applicable to the respective value chains.

Introducing private sector rigour

For MUIIS to thrive, it must have a private sector mentality as it runs. This can be done through:

1 Adaptation of rigorous sales and marketing. MUIIS will have to adapt market sensitive techniques to sensitise and create awareness of its products. This can be achieved through advertisements on local community-based radio, community gatherings and print materials. It would need to create an agent network that solely works with input dealers, producers, distributors and financial institutions that are likely to increase the viability of the business.

2 Developing multiple revenue streams. MUIIS is heavily dependent on farmer subscriptions; the recommendation is to



monetise the data as a way to connect with B2C. While subscriptions will be the core revenue, alternative sources from the database have to be considered such as SMS advertising and ICT and database supply chain. These alternative sources provide a buffer for sustainability of the business. Note that a balance must be created; if subscription remains low then the monetisation of the database must be emphasised to assist in raising more revenue for the business.

3 Strategic PPPs. Development of partnerships is important to support the evolution of the business model. Ownership

is the best approach through a joint venture between public and private organisations. Public partners such as UNFFE, UCA, UNADA and UABA provide an opportunity for the business to engage in ecosystems surrounding the improvement of a nationwide agenda such as financial inclusion, data management and climate smart agriculture. Private sector players such as input dealers, financial institutions and developmental organisations will provide a significant amount of business through advertising, product enhancement and development. These partnerships will ably secure the business's interest and longevity.

ENDNOTES

- 1 Further details can be found in the excerpt of the business model in Box 1.
- 2 EAFF left the consortium with its activities implemented by CTA through UCA and UNFFE.
- 3 <https://www.mediacentre.go.ug/media/ministry-agriculture-media-release>

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Hollingsworth, S. (2018) 'Big data and smallholder farmers', 17 April 2018 [blog], Washington, DC: Grameen Foundation <<https://grameenfoundation.org/blog/big-data-and-smallholder-farmers>> [accessed 15 April 2019].



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