ACCORD

Advanced Coffee Crop Optimisation for Rural Development

A Case Study

UK Space Agency

The UK Space Agency leads the UK's efforts to explore and benefit from space. It works to ensure that our investments in science and technology bring about real benefit to the UK and to our everyday lives. The Agency is responsible for all strategic decisions on the UK civil space programme. As part of the Department for Business, Energy and Industrial Strategy, the UK Space Agency helps realise the government's ambition to grow UK industry's share of the global space market to 10% by 2030. The UK Space Agency:

- Supports the work of the UK space sector, raising the profile of space activities at home and abroad
- Helps increase understanding of our place in the universe, through science and exploration and its practical benefits
- Inspires the next generation of UK scientists and engineers
- Regulates and licenses the launch and operation of UK spacecraft, launch operators and spaceports
- Promotes cooperation and participation in the European Space Agency and with our international partners

International Partnership Programme

The International Partnership Programme (IPP) is a five-year, £30 million-per-year initiative run by the UK Space Agency. It focuses on using the UK space sector's research and innovation strengths to deliver sustainable economic, societal and/or environmental benefits to developing economies around the world. IPP is part of, and is funded from, the Department for Business, Energy and Industrial Strategy's Global Challenges Research Fund (GCRF). GCRF is a £1.5 billion fund announced by the UK Government which supports cutting-edge research and innovation on global issues affecting developing countries.

Executive Summary

This Case Study offers an overview of key successes and learnings of the Advanced Coffee Crop Optimisation for Rural Development (ACCORD) project at the midpoint of implementation. The case study outlines the context within which the project is being implemented, the problem being addressed, solutions to the problem, partners involved, the pathway to success and results achieved so far. It also provides initial evidence of the impact on smallholder coffee farmers in Rwanda and Kenya where the programme has been implemented.

- ACCORD aims to improve the livelihoods and incomes of smallholder coffee farmers in Rwanda and Kenya through the application of technology to reduce the impact of climate change.
- The ACCORD platform integrates GPS-based field mapping and satellite imagery with localised weather data to deliver weather alerts and agronomic advice direct to farmers via SMS text messaging.
- Kenya and Rwanda can grow more speciality coffee, and better quality, on a more sustainable basis, with better crop management practices based on these accurate mapping, crop health monitoring and regular localised weather alerts.
- The project started early in 2018 mapping the coffee farms, and messages to farmers and agronomists started in Rwanda in November 2018 and in May 2019 in Kenya.
- As of March 2020, more than 47,000 farms have been mapped and over 40,000 farmers are receiving regular weather alerts and agronomical advice via an SMS service.
- Feedback collected from farmers through quarterly surveys and focus group discussions during the midline showed that farmers reported being very satisfied with the ACCORD service.
- In the most recent survey the number of farmers who reported overall positive change in their farming practices through midline surveys was 99% of farmers against our target of 90%.
- 93% of farmers report taking the recommended action against our final target of 90%, and 98% report a positive impact on their crops.
- Farmers reported seeing a positive change in productivity and quality of the coffee, and their ability to manage their crops effectively was stated to be substantially improved thanks to the SMS alerts and advice service.
- Farmers stated that they appreciate the advice provided through the messages as SMS can reach everyone frequently whereas agronomists struggle to visit everyone regularly. In general, farmers seem to appreciate the complementarity between SMS and agronomist's visits: the SMS reminds them of what to do, and the agronomist can show them how to do it.
- The primary benefits delivered by the ACCORD project are related to improving crop quality and yield with the goal that this will feed through to improved farmer incomes.
- Coffee productivity also depends on many other influential factors and inputs that are not offered by ACCORD. For example, in order for farmers to fully apply recommendations and advice sent through SMS, they require funds to purchase recommended inputs and hire labour at the right time. These factors will also impact programme outcomes.
- The project is on track to improve farmers' good agricultural practices (GAP) and drive better crop outcomes. At the midpoint evaluation, the programme is:
- Well ahead of its target to map 50,000 smallholder coffee fields by endline
- Actively sending alerts and advice by SMS to over 40,000 farmers
- Achieving high adoption rates by farmers and better than 95% satisfaction
- Positively impacting good agricultural practices of circa 90% of farmers of both genders
- Awaiting first full season production data to validate results on quality of coffee and yields

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Project Origins

The UK Space Agency's International Partnership Programme (IPP) is a five year, £30m programme designed to partner UK space expertise with overseas governments and organisations. It is funded from the Department for Business, Energy and Industrial Strategy's Global Challenges Research Fund (GCRF).

UK Earth Observation and geospatial intelligence company Earth-i, formed a consortium to design and implement the 'Advanced Coffee Crop Optimisation for Rural Development' project – ACCORD. The consortium's bid for funding under IPP call 2 was successful in 2018, securing funding for a three-year programme to run until February 2021.

The project is led by Earth-i, working with a consortium of partners consisting of technology partner WeatherSafe from the UK, and Coffee Management Services (CMS), Kinini Coffee and San Francisco Bay Coffee in Kenya and Rwanda. The project delivers the timely, trusted insights needed to improve coffee yields and quality and, ultimately, the incomes of the smallholder farmers. Oxford Policy Management provides the monitoring and evaluation (M&E) services to the project.

ACCORD UK SPACE AGENCY

Addressing the Problem

Lack of competitiveness, the impact of climate change, and the decline in rural resilience pose major threats to the sustainability of African smallholder coffee farming. Furthermore, coffee farmers face the challenges of changing consumption patterns, resource scarcity, increasing traceability requirements, and price volatility in the global coffee market.

African Coffee Production is Losing Market Share

25 million smallholder farmers produce 80% of the world's coffee: 11 million of them are in Africa. Demand continues to rise in both traditional and new markets assuring continued and steadily increasing demand for this important global crop.

However, coffee production in Africa has been losing market share to big producers such as Brazil and Vietnam. Farms in South America and Asia are significantly more efficient. In 1990, Africa produced 13% of world coffee. By 2019, this had dropped to 10%. More specifically, Kenya produced 1,485,000 60kg bags of coffee beans in 1990, which reduced to 930,000 bags in 2019. Rwanda produced 535,000 bags reducing to 268,000 bags over the same period.

In Kenya and Rwanda combined, there are more than 1 million smallholder coffee farmers, organised around cooperatives and coffee washing stations. Their households depend on the performance of this cash crop for their income required, yet they generally:

- Produce relatively small volumes of export crops on very small plots of land
- Are far less well-resourced than commercial-scale farmers
- Usually depend on family labour and have very little mechanisation to drive efficiencies
- Are vulnerable in supply chains they have little influence over of price volatility in the markets

The Impact of Climate Change

Traditional farming methods for crop management decisions, are being increasingly undermined by the impact of unpredictable weather patterns caused by climate change.

Coffee farmers typically must make around 30 critical decisions per year, such as whether and when to apply inputs (fertilisers, pesticides or fungicides), or when and how to prune, mulch and pick coffee cherries. Receiving advice and support on good agricultural practices (GAPs), and the timeliness of that advice in light of changes in the weather, makes a significant difference to the effectiveness of their crop management decisions.

Yet the impact of climate change means that local weather patterns have become increasingly unpredictable. Using traditional coffee calendars (based on predictable weather) to plan activities has become far less effective. For example:

- Erratic rainfall can have a significantly detrimental effect on the crop growth cycle
- Rain may come when coffee is at the crucial flowering stage or prolonged drought occurs when cherries are forming and need a good water supply
- Unexpected rainfall after a farmer has sprayed their coffee trees, rendering the agro-inputs useless to the crop, and farmers have wasted limited financial resources
- Chemicals might also be washed into the local water supply and contaminate it.

How ACCORD Works

In addition, changing environmental conditions have increased the risk of pests and diseases affecting coffee crops. Over the last decade diseases such as Coffee Leaf Rust (CLR) and Coffee Berry Disease (CBD), and the pest Antestia bug, have become much more frequently reported problems. With incidences of such diseases and pests on the rise, productivity, quality and the sustainability of coffee as a cash crop for smallholder farmers is increasingly threatened.

In summary, the problem that ACCORD addresses is how to improve both the quality and productivity of this vital cash crop, and opportunities for increased income levels for smallholder farmers in the face of the impact of climate change. Smallholder farmers are ill-equipped to deal with this challenge. They have limited access to timely information on the weather and rely too much on out-dated agronomic practices in coffee farming. When they have access to agro-inputs to maintain their crop health and increase productivity, they lack the information and advice on how and when to apply them for best effect.

The ACCORD technology platform provides regular and frequent customised agronomic advice and weather alerts direct to farmers, and in support of agronomists on the ground, via SMS. The advice is based on the analysis of satellite images, ground observations, crop models, highly localised weather forecasts and agricultural best practice, to improve accuracy and timeliness of farmer decision-making. This data is integrated and analysed in a unique platform. The results of this advanced data analytics are used to provide farmers with a timely agronomic advice service delivered in a simple-to-access SMS format.

The intended result is that coffee farmers will implement effective and timely crop management practices leading to an improvement in quality and productivity. Better coffee quality and productivity could lead to an increase in incomes from coffee for ACCORD farmers. [1]

In the long run, the project will aid industry efforts to ensure coffee is sustainable as a cash crop for smallholder farmers and promote the adoption of the technology by new players as the service moves into the commercialisation phase.

1. Excepting for the fluctuations in the gate price for coffee cherries that are beyond the control of the programme.

To deliver these benefits the project utilises new and innovative technology.

- ACCORD technology provides the ability to map fields using GPS coordinates through mobile phones, satellite imagery provided by Earth-i and WeatherSafe platform analytics.
- Medium resolution earth observation imagery from satellites is overlaid on the shape files created from the GPS app, and updated approximately every ten days.
- Satellite imagery is analysed to monitor the health of the coffee trees in the mapped fields using NDVI (Non-Differentiated Vegetation Index) vegetation health analysis. It is therefore possible to monitor the status of crops in each individually mapped field and to provide effective crop management advice to farmers and their assigned agronomists.

Utilising the WeatherSafe platform architecture, ACCORD:

- Provides a portal for agronomists and farmers to access field health data
- Integrates weather forecasting data supported by local weather stations installed in proximity to the mapped fields
- Provides highly accurate and localised weather forecasts for each field integrated with agronomical advice on appropriate Good Agricultural Practices (GAP)
- Sends regular weather alerts and associated agronomic advice to farmers via simple-to-understand SMS texts.

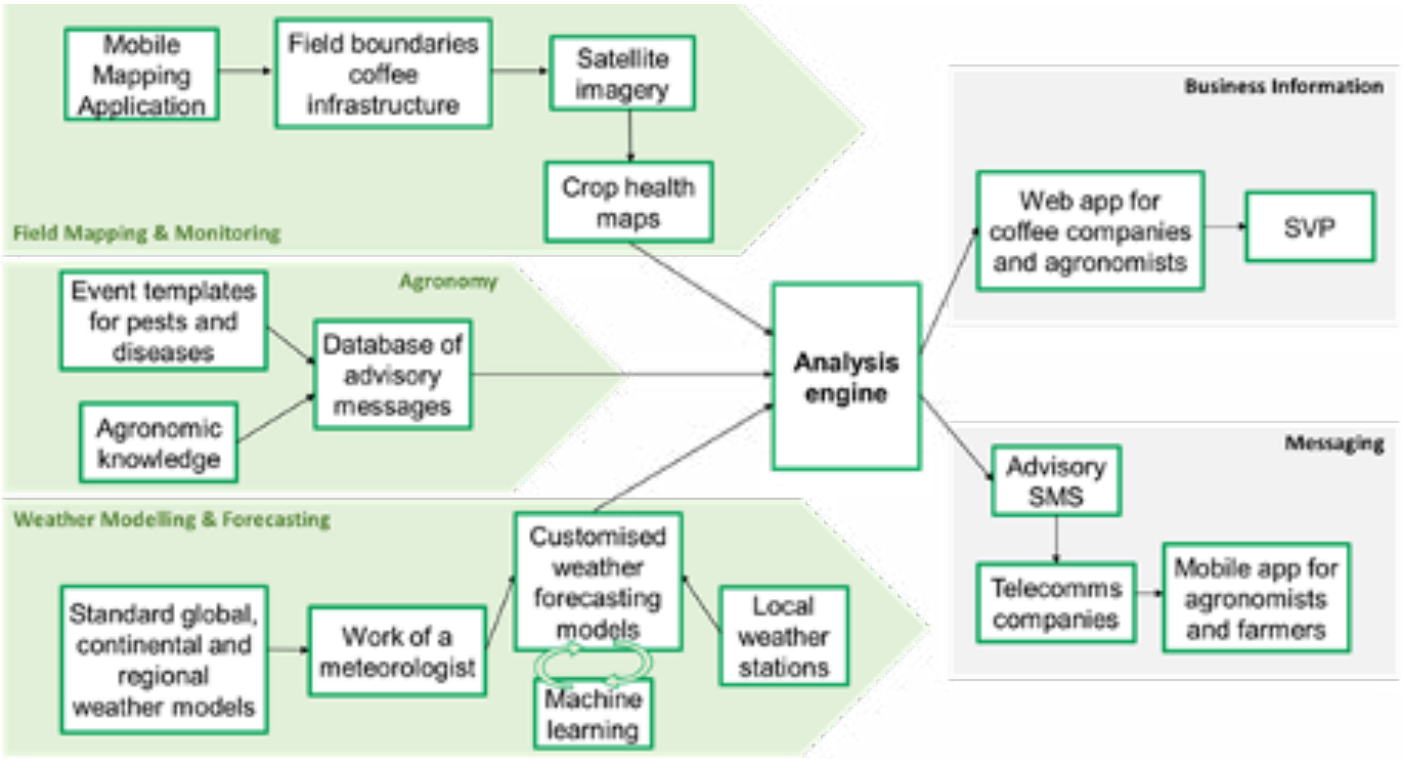


Figure 1: The WeatherSafe Platform Architecture

Consortium Partners

Earth-i is a geospatial intelligence company offering automated crop detection, mapping and health monitoring services to clients in the agriculture industry, with a particular focus on small holder farming worldwide.

For more information visit:
www.earthi.space/accord

WeatherSafe aims to help coffee WeatherSafe helps coffee producers protect and improve their farming operations with a unique platform that combines weather monitoring, agronomic data modelling, and satellite data to deliver a solution to farmers.

For more information visit:
www.weathersafe.co.uk

CMS provides farm extension services to coffee farmers to develop improved farm management practices, better quality coffee and higher yields, helping to build sustainability through modern crop management and technology.

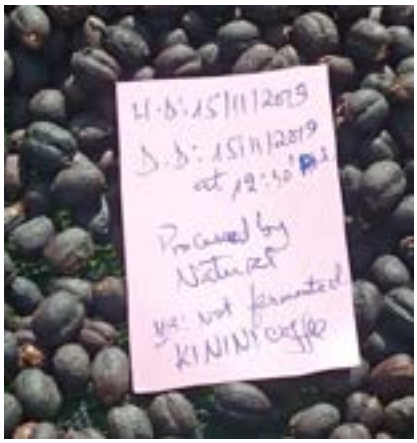
For more information visit:
www.coffeemanagement.co.ke

San Francisco Bay is a coffee company in Rwanda, striving to improve the quality of life and environment of their employees, farmers, and customers, through highly innovative coffee farming practices.

For more information visit:
www.sanfranciscobaycoffee.com

Kinini is a coffee cooperative from Rwanda, whose improved crop management practices has resulted in a big step change in coffee productivity, and in the incomes and livelihoods of farmers.

For more information visit:
www.kininicoffee.com



The Pathway to Impact

The primary benefits to be delivered by the ACCORD project are related to crop quality and yield, with the goal that this will feed through to improved farmer incomes:

- Improved yield is measured through annual data from coffee washing stations provided by CMS (above baseline levels, normalised to control group), and verified through self-reporting from a survey sample of interviewed farmers. The target is a doubling of yield over three years.
- Improved coffee quality is measured through coffee quality standards prescribed for Kenya and Rwanda defined as coffee parchment grades P1, P2 and P3 in Kenya and A1, A2 and A3 in Rwanda.
- Improved farmer coffee crop income as a result of improved yield and quality, is measured through annual data on changes in income provided by partners (above baseline levels, normalised to control group), and validated with through a sample of interviewed farmers. The ACCORD target is doubling of smallholder coffee income, attributable to the programme, by endline in February 2021.
- Secondary impacts of these improvements include the increased taxation revenues to Kenyan and Rwandan governments from the increased value of coffee production. We also expect to see secondary benefits to smallholder families and communities such as increased school attendance, resulting from the increased crop incomes if achieved.

A Theory of Change (ToC) approach was adopted as a method to articulate these goals, informing the programme design, implementation and performance monitoring.

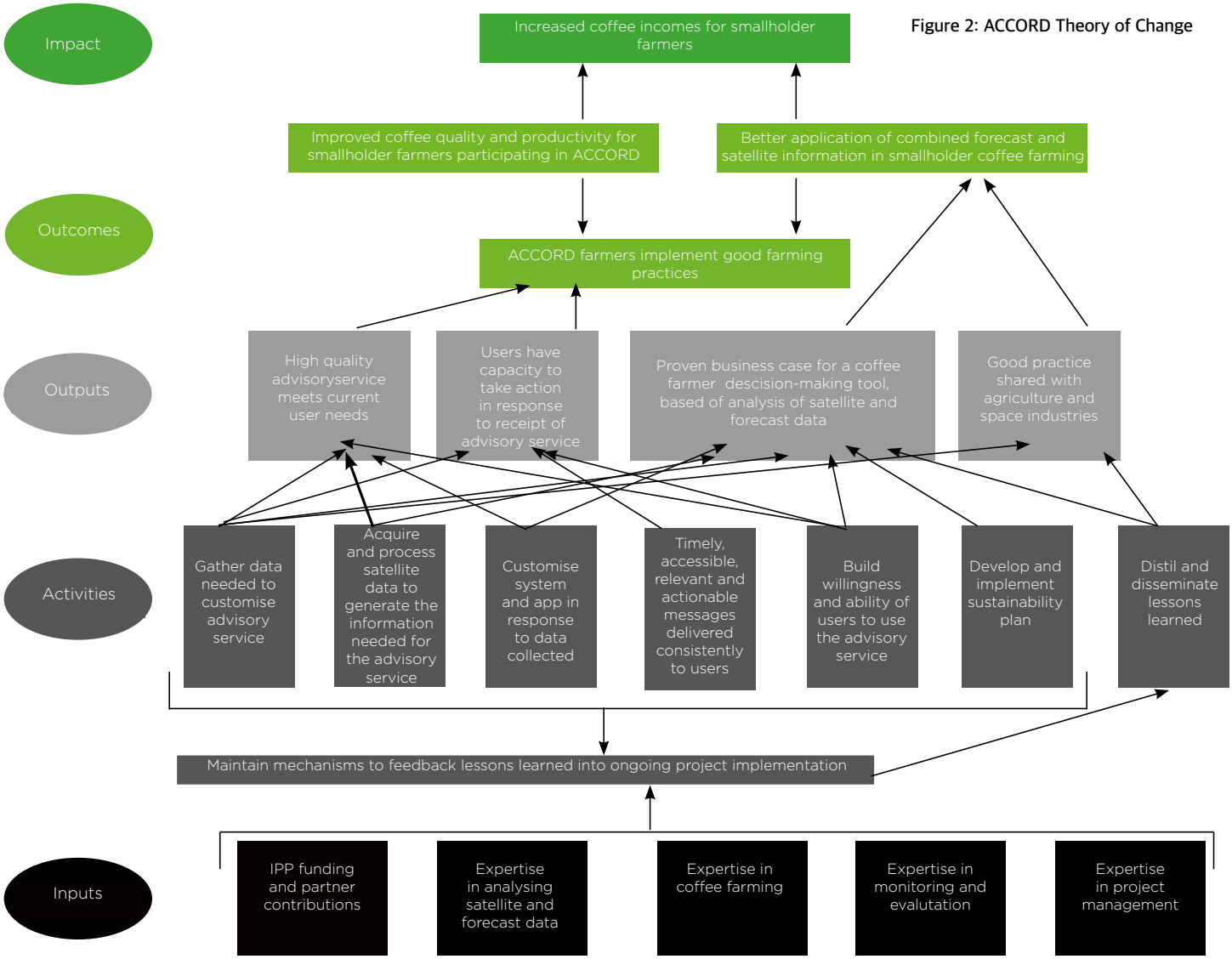


Figure 2: ACCORD Theory of Change

ACCORD and the SDGs

The project addresses a clear and specific development need and will enable measurable and sustainable outcomes towards the United Nations Sustainable Development Goals, specifically SDG #2 – Zero Hunger, and SDG #8 – Decent Work and Economic Growth.

ACCORD also contributes to SDG #1 by helping to raise incomes, build resilience and reduce poverty amongst smallholder coffee farmers, those relevant to SDG #5 through specific measures to encourage coffee cooperatives to include women farmers and also SDG #13 by contributing to combatting climate change and its impact.

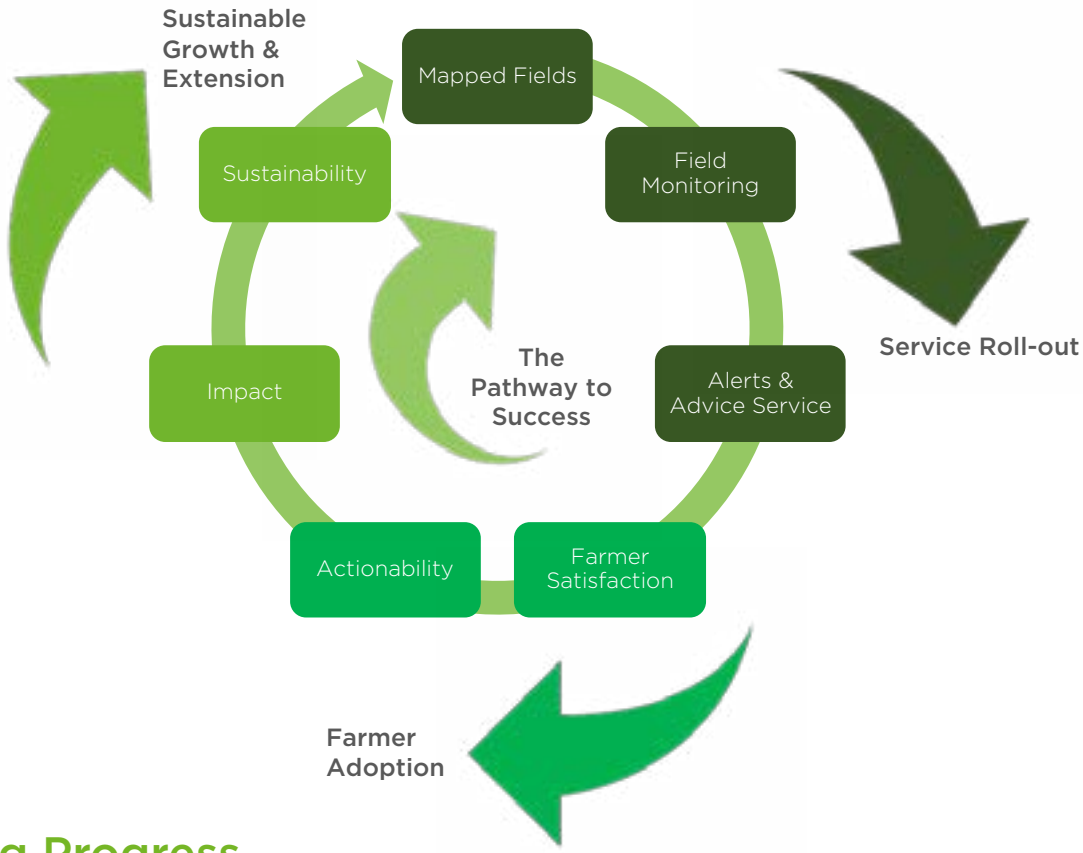
By working with the three coffee companies in Kenya and Rwanda as core project partners the ACCORD project has been able to engage directly with farmers and cooperatives within the existing bundle of farm extension services delivered by these companies. This process of engagement starts with the mapping of individual farmer's fields by the coffee partner's own agronomist teams. To date over 47,000 fields have been mapped using the WeatherSafe app, with the geo-location and the shape file uploaded to the WeatherSafe platform along with additional profiling data on the farm to create a rich database. Once mapped and logged in the database, satellite imagery is used to begin monitoring the crop health on an approximately weekly basis, and farmers are eligible to begin receiving the SMS service.

The pathway to success rests on a number of project deliverables generating the intended outcomes, therefore representing key factors for success for the ACCORD project:

- **Mapped Fields** - Accurate mapping and data collection by agronomists uploaded to the platform to create the farm and farmer database
- **Field Monitoring** - Effective satellite monitoring and NDVI analysis of mapped fields on a regular basis
- **Alerts and Advice Service** - Accurate localised weather forecasting integrated with timely and appropriate crop management advice to inform farmer decisions
- **Farmer Satisfaction** - Level of satisfaction from farmers with the accuracy and usefulness of weather alerts and crop management advice received by SMS
- **Actionability** - Positive actions taken by farmers in crop management based directly on this advice
- **Impact** - Impact on coffee quality and yields from improved agricultural practices and more timely crop management decisions
- **Sustainability** - Desire amongst farmers, their cooperatives and coffee extension services companies to continue the service beyond the IPP-funded period

A monitoring and evaluation work stream is the ongoing accompaniment to the project implementation to measure and evaluate progress against these key success factors.

Figure 3 - The ACCORD Pathway to Success



Measuring Progress

Following an initial baseline study completed in August 2018 progress against the path to success is formally monitored using various indicators derived from the Theory of Change. This includes regular qualitative and quantitative data collection such as a farmer surveys, focus group discussions, programme output metrics, and farmer production and income data.

The data and metrics collected enable a continuous monitoring and evaluation of the programmes progress against its key success factors, towards the ultimate goal of a commercially sustainable service for the long term. Mid-Line results of the key success factors are shown in the following table.

Key Success Factor	Measured by	Results Achieved at Midline Evaluation
Mapping Fields	Platform data	47,000 fields mapped at May 2020 against programme target of 50,000
Field Monitoring	Platform data	Updated with new imagery and analytics every 10 days
Alerts & Advice Service	Platform activity from programmed and automated messages	36,000+ farmers receiving regular messaging with close to 900,000 messages sent since June 2019 at the midline evaluation point
Farmer Satisfaction	Quarterly satisfaction surveys (results at May 2020) Farmer focus group discussions	84% of female and 93% of male farmers report an overall positive change in their farming practices as a result of receiving the SMSs
Actionability	Quarterly satisfaction surveys (results at May 2020) Farmer focus group discussions	93% of females and 97% of males report understanding the messages; 82% of females and 85% of males report taking the recommended action so far against a final programme target of 90% 71% of females and 78% of male farmers report improvement in crop health due to ACCORD
Impact	Production data analytics	Available production data to measure impact on quality and yield is limited at midline evaluation. There are good indicators that significant yield increases have been achieved in some cooperatives and washing stations.
Sustainability	Expressions of interest	Commitments to commercial service 23 expressions of interest, mainly from farmer cooperatives in East Africa One major corporate customer proposal in development

Cost Effectiveness Analysis

In addition to the ongoing monitoring and evaluation programme, the team also carried out an economic evaluation using cost-effectiveness analysis which compared using SMS to using drones or face-to-face advice from agronomists. The projected cost-effectiveness of ACCORD is excellent. The main driving factor behind the good CEA ratio is scale of impact. In summary, the costs of delivering a £1 increase in coffee yield during the 2018-2021 period is £0.022 for ACCORD, £0.028 for drones and £0.104 for face-to-face.

ACCORD in Action with Cooperatives

This section showcases how two selected Farmers' Cooperative Societies (FCS) in Kenya have successfully adopted ACCORD climate-smart services. Engagements with farmers through field validation visits have revealed early stage impact on farmers productivity, resilience and coffee quality. For example, in recent surveys 93% of women and 97% of men report understanding the messages; 82% of women and 85% of men report taking the recommended action.

Kenya - New Murarandia Farmers' Cooperative

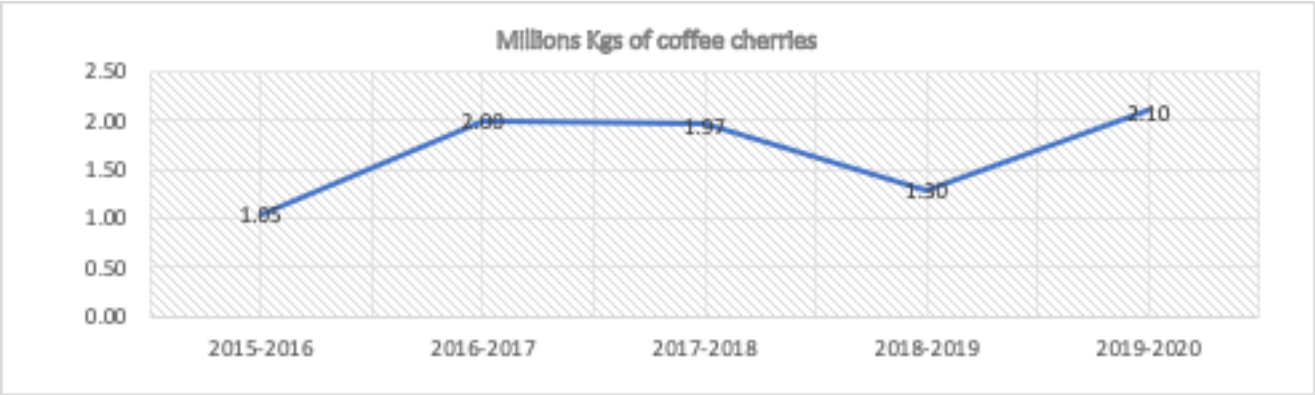
New Murarandia FCS has three coffee mills in Murang'a County serving 3,300 active members, 40% of which are women. The county is a major coffee producer with a total of 161 coffee washing stations and mills, the majority of which are largely managed by cooperatives. Each member farms an average of 0.3-0.5 hectares with an average of 130 coffee trees. ACCORD partner, Coffee Management Services (CMS) provides management services to the FCS and has been part of ACCORD from 2018.

Before then, farmers didn't have access to any form of precise weather and agronomic information and hence experienced low yields, crops were susceptible to diseases and pests and farmers made losses. Input companies and local radio stations provided farmers with generic agronomic information which is mostly linked with agro-inputs promotions campaigns. In a previous focus group discussions (FGD) with 24 farmers, the ACCORD team learned the following:

- Farmers prefer the ACCORD service because of the complementarity nature of SMS and agronomists. They value both SMS and agronomists support. "After receiving SMS, I can contact the agronomist for a visit or clarification of the message. I can also refer to old SMS on my phone if I forgot something" ~ Farmer
- Messages are timely, accurate and easy to understand. Farmers require minimal help to understand and some of them have established support groups where they meet regularly to discuss the messages and plan together. More than 95% of farmers find messages clear and ACCORD service very useful.
- 50% of farmers act on the ACCORD recommendations. The main limiting factor is lack of finances, especially in instances where the messages ask them to buy inputs- fertilisers, agro chemicals or pesticides.

As a result of ACCORD:

- 98% of the farmers are already mapped and receiving automated SMS alerts.
- The cooperative uses the SMS service to remind farmers of key events on their coffee calendar and what to plan for. They are able to anticipate when to stock inputs and also the type of inputs to stock and distribute to farmers on time.
- Farmers have acquired more knowledge on crop management through ACCORD agronomists provided by CMS. An agronomist follows up messages with regular visits to farmers to conduct training and demonstrations.
- More farmers have registered to become members of the Cooperative, in order to benefit from ACCORD service.
- As a result, timely application of inputs, improved pests and diseases management, application of agronomic practices like mulching, soil erosion prevention, pruning and timely cherry picking, have all improved.
- There is evidence of increasing coffee production for the cooperative from cherry production data received from all washing stations:



Kenya - Rumukia

Rumukia FCS is a collection of eight cooperative factories, or wet mills, where coffee is collected, pulped, fermented and dried. This FCS is in Nyeri County, also home to 22 other coffee FCS in this county.

The FCS has 6,300 active members. 90% of farmers have been mapped since June 2018 and receiving ACCORD support. The FCS has a bigger portion of aged farmers who have predominantly been involved in coffee farming since colonial years. This means that they need more attention and younger people need to be integrated in the coffee value chain activities in the county.

The FCS produced a total of 2.1m kgs of arabica coffee cherry, compared with 1.4m kgs in 2018, with a shift to newer coffee tree varieties which are pests and diseases resistant and higher yielding. In 2019, the yield has been on upward trend, reaching 1.6m kgs of cherry.

During a recent evaluation, a group of 24 farmers confirmed that:

- ACCORD messages are timely, accurate and very useful. Weather alerts have been accurate, enabling farmers to prepare for and manage the effects of changing climatic conditions.
- ACCORD crop management service (weather and agronomic message alerts) has enabled farmers to:
- Access useful information on when to spray, apply inputs, mulch or prune.
- Plan and adjust their weekly activities and save costs. For example, farmers are able to avoid spraying when rains are expected
- Identify common pests and diseases affecting their crops and apply pesticides at the right time
- Farmers have generally remarked on improved production and quality so far, and hope that the international coffee prices will keep increasing in order to achieve higher returns
- Coffee farming in the county contributes greatly to social protection. With large numbers of elderly farmers and households dependent on coffee farming for an income.
- Younger people are being attracted to work for FCS and it is hoped the application of technology like ACCORD will help boost this trend.
- Accurate and timely weather forecasting has enabled farmers to rationalise their spending on farm labour.

According to one farmer, the biggest burden a farmer bears is increased cost of agro-inputs (fertilisers, pesticides) and labour. They highly appreciate the role played by ACCORD-funded agronomists in helping farmers increase yield per tree. Some farmers are now experiencing an increase in yield per tree from 3- 7 kgs per year.

Future Sustainability

The project team have developed a business strategy for the continuance of the advisory service on a fully commercial basis delivering satellite monitoring and weather forecast data as an effective working tool to improve farmer decision-making.

The goal is a seamless transformation for ACCORD from being donor-funded into a self-supporting commercially sustainable business model. A key deliverable in current programme design is to show evidence of a sustainability plan in place and to develop a commercial proposition that can be adopted by current partners and / or other organisations within the coffee sector. This shall include recommendations of added value and enhanced services that can be included in the commercial version to create a robust business case for ongoing adoption.

ACCORD has participated in several global conferences, pitched the current model and early stage results, generating interest from coffee industry stakeholders in Africa and elsewhere. Evidence of the good practices and results achieved are being shared within the wider agricultural and the space industries, with a view to extending the application to other coffee producing countries and potentially to other crops.

Lessons and Final Phase Actions

From the lessons learned in implementing the project, the team is now focussed on a series of actions to implement in the last phase of the project:

- Collect more rich and accurate farmers' feedback. For example, ACCORD shall adjust the quarterly survey questionnaire to capture assess farmers attitudes towards a commercially funded service.
- Complete the mapping of the remaining farmers yet to be included to reach the target total of 50,000 mapped farms well in advance of end-line.
- Roll out the messaging service to all farmers managing those fields and generate qualitative feedback on the effectiveness of the service in positively influencing their crop management practices.
- Review coffee calendars with an aim of adjusting these calendars based on current weather information and trends in order to align with incremental effect of climate change.
- Collect and analyse enough production data to effectively evaluate the impact on crop quality, yields and farmer incomes.
- Develop an ACCORD commercial version and a business case for ACCORD partners in order to continue the service on a commercially viable basis. This will ensure sustainability of results and continuity of service beyond current funding.

ACCORD is delivered by a consortium led by Earth-i in association with the UK Space Agency's International Partnership Programme.

For further information please contact:
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For the ACCORD programme visit **www.earthi.space/accord**

For UK Space Agency and IPP visit **https://www.gov.uk/government/collections/international-partnership-programmes**