Digital Tools Assessment Report for:

BUILDING THE ADAPTIVE CAPACITY OF SUGARCANE FARMERS IN NORTHERN BELIZE (BAC-SUF)

Submitted to: Caribbean Community Climate Change Centre (CCCCC)

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Table of contents

ACRONYMS AND ABBREVIATIONS

BSCFA	Belize Sugar Cane Farmers Association
BSI	Belize Sugar Industries
CSCPA	Corozal Sugar Cane Producers Association
DFC	Development Finance Corporation
GCF	Green Climate Fund
NSCFA	Northern Sugar Cane Farmers Association
PMU	Project Management Unit
PSCPA	Progressive Sugar Cane Producers Association
SCPC	Sugar Cane Production Committee
SIRDI	Sugar Industry Research and Development Institute
SSC	Smart Sugar Cluster

1. Introduction and purpose

1.1 Technology in Agriculture

Historically, agriculture has relied on generational knowledge to inform practices, manage inputs, and ensure processes occur to send crop to the market. The operation of production has therefore been a laborious process, high risk to human error and delays, and highly inefficient.

Over the past 20 years, the agricultural sector has seen a significant increase in the use of digital systems. Activities and processes that need to occur to ensure the crops are produced and delivered to the market have been informed, facilitated, and made more efficient using digital systems. This is done using different types of digital systems, for example:

- **Mobile Monitoring**: Technologies such as mobile phones or tablets are used to collect in-field data. This data can generally be collected with or without internet connection and is the simplest and cost-effective way of collecting in-field data
- **Remote Sensing**: Remote data sends data collected in real-time to an online server via regular cellular signals. These sensors are bespoke and, including the software that runs these sensors, are generally quite expensive.
- **Big Data**: Data captured through 3rd party sources, such as climatic data which can be found freely online can form a critical component of a database when combined with in-field data.
- **Artificial Intelligence**: Having lots of data can be overwhelming. Therefore, systems have been developed that uses special algorithms to provide insights into your data based on a set of criteria. This could for example notify a farmer when to irrigate, based on soil moisture levels, expected rainfall and growth stage of the crop.

More so, having readily accessible data allows farmers, and the wider supply chain, to be more transparent while providing full traceability of the products produced. This has increased the ability of markets to source more responsibly and more sustainably while increasing effective communications between the various stakeholders within the supply chain. Digital systems therefore enable:

- **Real-time data**: Operations throughout the supply chain requires decisions to be made daily. Having real-time data can therefore inform decision and ensure that the best course of action is taken
- **Increased efficiency:** Technology and the ability to access and share data allows operations to increase their efficiency
- **Increased production:** Having access to data allows for performance reviews and ensures that supply chains are performing at the best
- **Increased use of sustainable practices:** Increased data collection and transparency has provided a view into the operations of the agricultural sector. This combined with increased market pressures to operate more sustainably and evidence showing the benefits of doing so, is leading to supply chains converting their operations into more resilient and sustainable supply chains.

1.2 Blockchain

A blockchain is, in the simplest of terms, a time-stamped series of immutable records of data that is managed by a cluster of computers not owned by any single entity. Each of these blocks of data is secured and bound to each other using a chain which are cryptographic links. The blockchain network has no central authority and is maintained by a peer-to-peer network. The network is a collection of nodes that are interconnected to one another. Nodes are individual computers that take in input and performs a function on them and gives an output. The entire workload is split between participants, who are all equally privileged, called "peers". There is no longer one central server, now there are several distributed and decentralized peers. Since it is a shared and immutable ledger, the information in it is open for anyone and everyone to see. Hence, anything that is built on the blockchain is by its very nature transparent and everyone involved is accountable for their actions.

A blockchain is therefore essentially a digital ledger of transactions and records that is duplicated and distributed across the entire network of users (That are given permission and access) to the specific records on blockchain. More importantly, Blockchain is a system of recording information in a way that makes it near impossible to change, hack, or cheat the system.

1.3 Purpose and methodology of report

Technology has been identified within the feasibility study as a key component to delivering a transformed sugar industry in Northern Belize. This report, therefore, provides in more detail the status of existing technologies within the sugar industry of Northern Belize and internationally.

The report will proceed to discuss the following technologies:

- SIMIS
- Smart Sugar Cluster
- Hello Tractor

The report conducts its literature review through reviewing a combination of existing assessments, existing tool reports and desk-based research. This collation of reports will serve as a digital tool library for the Project to revert on during implementation. Finally, the report provides recommendations on how the project will help capacitate and facilitate the introduction of these technologies within the sugar industry in Northern Belize.

2. SIMIS

2.1 History

The Sugar Management and Information System (SIMIS) was conceptualised to be the Belize sugar industry's central data management system. The project that initiated the development of SIMIS started in 2013.

The objectives for the project were to focus on building a financially sustainable solution tailored to deliver strategic and business value through consistent data to the Belize sugar industry. The proposal was developed using the following principles for the development of SIMIS:

1. Identification of priority and needs of the Belize sugar industry;
2. Strengthen SIMIS financial viability for service delivery to the Belize sugar industry;
3. Provide a well maintained and an appropriate system tailored to the Belize sugar industry needs;
4. Manage SIMIS with an eye to future needs

The development process of SIMIS therefore ensured to capture the needs of the industry and in doing so, ensure industry ownership to support it in becoming a sustainable system. Using the above-mentioned principles as guidance, the project aimed to deliver on three main components to ensure the sustainability of SIMIS:

1. **System Development**: Creation and maintenance of a functional sugar management and information system (SIMIS)
2. **System Governance**: Establishment of a Governance and Management framework for the SIMIS partnership. This is to ensure appropriate governance, strategic and project management, accountability and procedural oversight. A collaborative organisational framework will be established leading to improved trust and cooperation which is required for SIMIS to be successful, and links in with the objective of strengthening the institutions of the Belize sugar industry. This will also provide a strategic framework to put in place business and financial plans to support SIMIS after the funds are expended to ensure financial sustainability and viability
3. **Training and capacity building**: Given the role that the SIMIS will play in the region, it is vitally important to make a substantial commitment to the professional development of the technical staff. The professional development activities would include annual attendance at industry conferences/ seminars to maintain awareness of trends and other industry practices. In particular, ESRI training courses related to data development and management, desktop GIS, and spatial analysis should be considered. If the Farmer Identification system is developed in a SQL Server database training in this is recommended

Between 2014 and 2015, SIMIS was developed through consultation with the industry and support of a dedicated technical team based on the processes outlines in the project proposal. The specific activities completed during this period included:

1. Creation of the Cane Parcel Database
2. Development of the Farmer ID Database
3. Design and implement new cane estimate process through the Ticket Booth Database and integration of the Mill's Database
4. Establishment of a geospatial data library
5. Design, Develop and pilot the new Harvest Management System
6. Establishment of a governance and management framework
7. Capacity building and stakeholder awareness campaigns

In 2015, a proposal for the 2nd Phase development of SIMIS identified the need for improved database structures and increased accessibility to all stakeholders. Specifically, the report identified the need for the expansion of data within the developed databases:

1. Parcel Database

   a. Additional information to be collected on soil data, topography, and weather data
   b. Correlation between parcel data and environmental data, such as soil, drainage, and weather data
2. Farmer ID Database
   a. Farmer ID's need to be integrated with the other databases to provide the information required
3. Ticket Booth Database
   a. Remote access to data is required
   b. Introduction of barcodes for deliveries
   c. Update of current software environment used
4. Mill's Database
   a. GIS data required
   b. Remote sensing capacity to be increased

To this end, SIMIS has through the support of the industry, continued to develop the system and use of technologies within its operations.

2.2 Stakeholder Analysis

SIMIS has been a key component in supporting the continued collaboration and communication between industry stakeholders. The project proposed in 2013 identified that industry collaboration would be required, and the project allowed for just that. With BSI and SIRDI playing a crucial role in the process, the development included all major industry stakeholders through engagement, considering each stakeholder's inputs, requirements, and expectations.

Main project stakeholders' requirements identified for SIMIS during its development stages were as follows:

1. Farmer Associations

The farmers associations need a better access to information products such as annual productivity reports by association, test group, reaping group, and farmer. Additional information on soil conditions, meteorological parameters are necessary to advise the farmers on how to improve their agricultural practices. SIMIS should therefore enable the farmer associations to collect and view data as required.

It is also of utmost importance for farmers associations to have complete trust in the system for ownership to be achieved, which will be required for SIMIS (or any data collection system) to be successful. Therefore, data privacy is key when farmers and farmer associations are collecting and submitting data into a system.

When SIMIS was developed, BSCFA was the only farmers association in the industry. Since then, each of the newly formed farmer associations have participated in, and contributed to, the development and maintenance of SIMIS.

2. Farmers

The costs of reaping and delivering sugar cane to the mill amount to a significant portion of the farmers' total income from the cane. For the farmers, the variability in sugar prices

in combination with rising reaping and transport costs form a very significant threat to their livelihood. Without an enhanced productivity of the fields and an increase of efficiency of reaping and transport, many farmers will have to stop their business as it will become unviable.

To increase efficiency of reaping and transport, the farmers expect:

- An enhanced Harvest Management and Delivery System (HMDS) to be developed
- SIMIS to incorporate the HMDS giving recommendations to the reaping groups on the order in which the fields are to be reaped
- To receive recommendations and tools for better farm management including the farmer's personal production data by parcel and date; data visualisations of current and historic data; data overlay with precipitation and other climate data

3. BSI

In terms of data management, the mill is self-sustaining and efficient. The mill does not need any assistance for a better data management or an upgrade of the technical equipment. The mill however would benefit from a better system for harvest and delivery as it might help to increase the quality of the cane[1]. Likewise, better agricultural practices can help increasing the cane's quality. Thus, all efforts in better agricultural practices will also result in a higher quality of the cane which overlaps the interest of the Tower Hill management and the industry.

4. SIRDI

SIRDI's mission targets contribution to the development of a sugar cane industry that is efficient, globally competitive, and sustainable through transfer of improved technologies. This implies the necessity for being capable of monitoring the evolution of the sector's efficiency. Without having comprehensive information at its command, SIRDI would stab in the dark.

One of the main elements of SIRDI being efficient thus is the setup of a complete information system which will be the base layer for any decision support tool to be developed in future. SIRDI's expectation of SIMIS is therefore to become this information system.

These engagements during the development phases of SIMIS were essential to build trust in the system due to the data flows that the system will require to deliver its intended impact, as shown in Figure 1 in Section 2.3.

2.3 Data Base and Data Analysis

SIMIS has been developed by drawing on four sets of data from four databases. These four data bases come from the SIRDI and BSI data systems and are:

[1] Once cane is cut, it should be crushed by the mill as soon as possible to ensure sugar content is as high as possible. Therefore, efficient delivery systems is crucial to overall efficiency.

- SIRDI
  - Parcel layer Database
  - Farmer ID Database
- BSI
  - Mill Database
  - Ticket booth Database

Among the four databases, the Tower Hill mill database is the most dynamic information base: it is here where delivery values are updated during the crop season nearly in real-time. The parcel database and the farmer ID database are comparatively static databases – modifications are done in a comparably low frequency. Both these data bases should be updated yearly, just after the end of the harvest season and before the start of the new crop season.

The data drawn from each database is collated within the SIMIS database, is sorted and shared with the industry as required according to Figure 1 below.

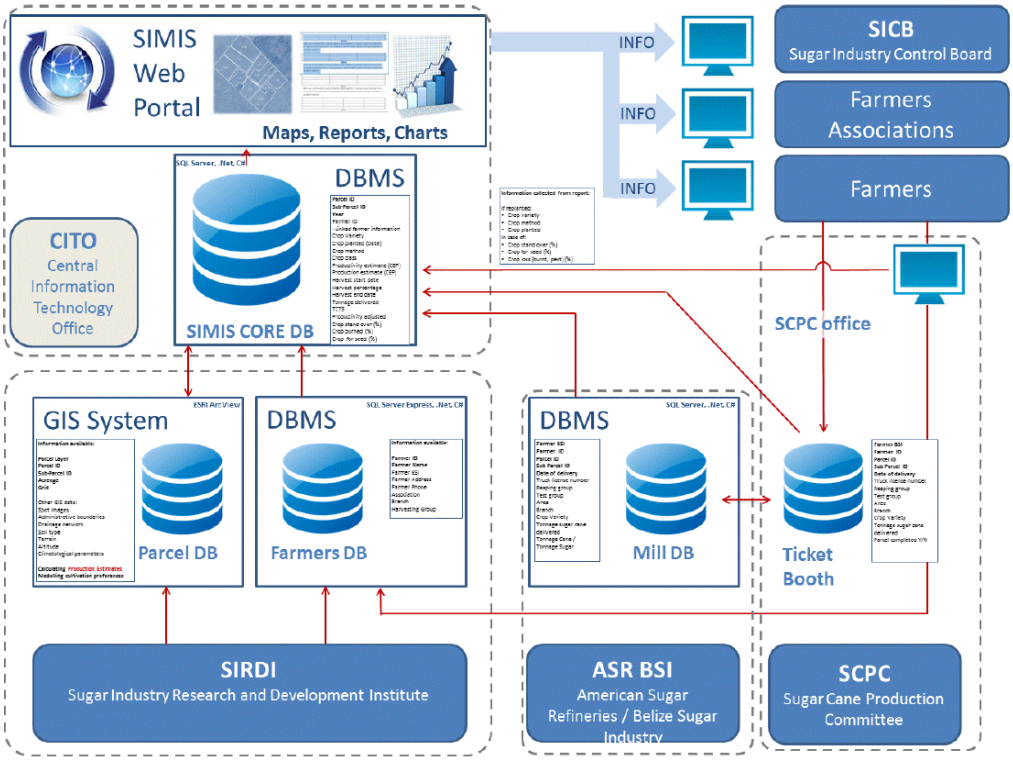

Figure 1: SIMIS data flows accessed from SIMIS evaluation report

The SIMIS database, which is therefore the all-encompassing database, is installed on a server at SIRDI. The user interface for data entry and ID card printing is a custom-tailored application which is installed on computers at SIRDI, at SICB, SCPC, at the mill and at the four farmers association offices. These installations outside SIRDI are linked to the network using software-based VPN technology to assure the necessary security. The VPN connections get administered and started on demand by SIRDI. Four permission levels are assigned to the users:

- Admin (all rights, can create 'Manager'-users)
- Manager (can create and modify 'Employee'-Users)
- Employee (can create and edit farmer data)

- Visitor

Data backups are done automatically locally and weekly on a manual system. There is no cloud backup which is a recommended solution to investigate.

The image below is taken from previous reports and depicts the database linkages via VPN as described above.

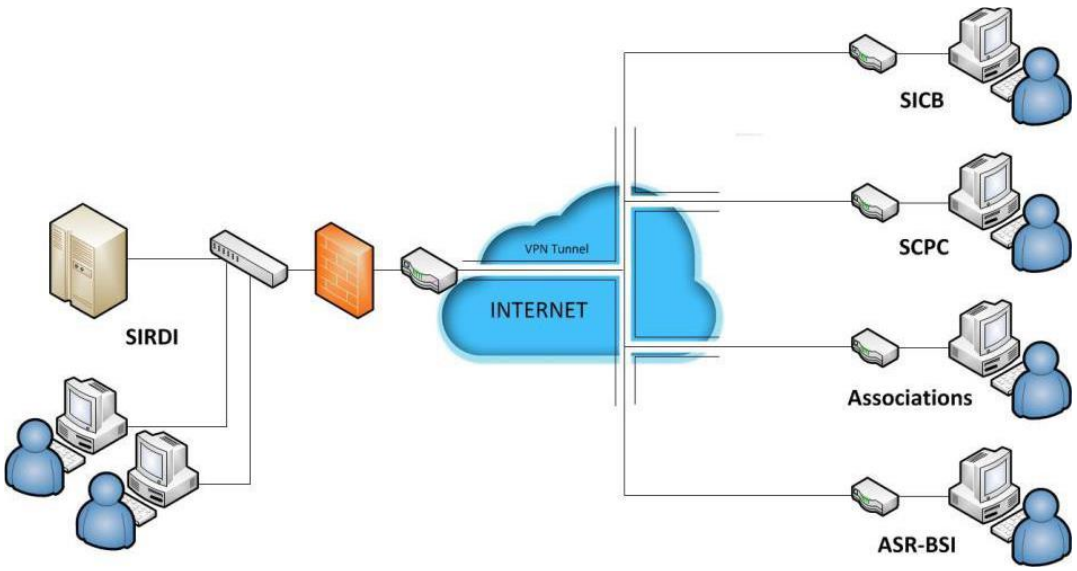

Figure 2: Data access architecture graphic accessed from SIMIS evaluation report

2.4 SIMIS Potential

SIMIS has been successful in that it has allowed the sugar industry in Belize to start the transition to a digital, more efficient future. It has the functionality to store field records and show historical records, collected from a range of sources, and has the capabilities to integrate additional datasets into its database. However, there has been little data added apart from production information collected through the four mentioned databases.

SIMIS has the potential to become a management tool that informs day-to-day decision making, in real-time. Information like: Fertilizer records; Chemical records; Labour records; and Machine records can provide the farmers with crucial information about the efficiencies and effectiveness of their farming operations. More so, it can provide the information required to identify inefficiencies, increasing profits.

At an industry level, SIMIS has the potential to unite the industry by having data to inform decision-making while allowing data to be shared among industry stakeholders, be it farmers-to-mill for operational purposes, or farmer-to-financiers for financing processes. Overall, as shown in Figure 3, data has the capability to connect all the nodes of the value chain in an efficient way, given the correct environment it provided. SIMIS has the potential to be this environment.

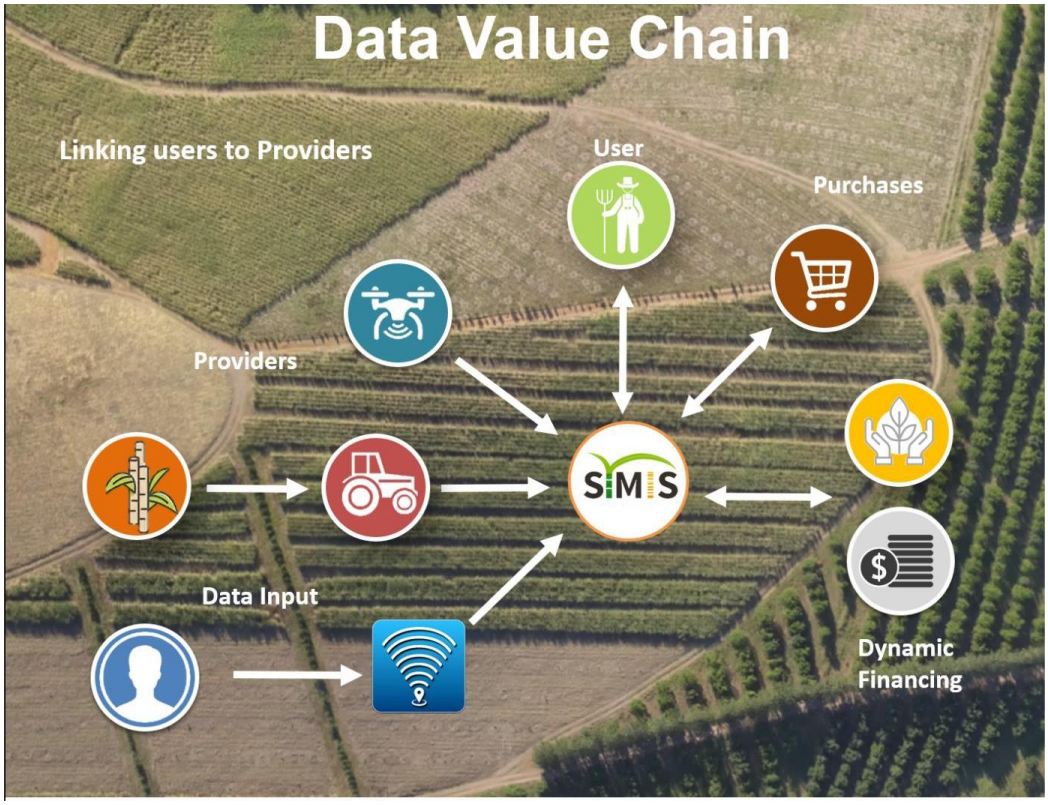

Figure 3: Data Linkages potential through SIMIS, accessed from Value Chain Opportunities and Climate Resiliency for Sugar Cane Farmers in Belize, Task 3

While the current data being collected and the existing system infrastructure is a big achievement for the industry, there are four further recommendations that will bring the SIMIS system into the 21st century. These are:

1. **Remote Sensing**: Start using remote sensing to monitor the Estate/cane supply. This will allow for a 'birds eye view' of what is happening on all the farms throughout allowing for verification on the harvesting of fields. There are various products that can be used as a standalone product and have API integration to work with SIMIS in the future.
2. **User Friendly Web Application**: Develop a web application that can be integrated with the SIMIS data base that will allow for seamless, user-friendly communication for all parties. There are products that allow API integration or even a white label option which can avoid expensive development costs.
3. **Traceability through Blockchain**: Incorporate Block Chain and peer to peer sharing of information. The block chain will probably need to be developed from the beginning as the workflows are project specific, however there are also some integrated web platforms that have peer to peer sharing that can be adapted and white labelled to this specific project.
4. **Industry Data Policy**: Develop a data policy that covers data integrity, data sharing and block chain and ensure that all stake holders are part of the development and implementation. This will be an intensive exercise where all stakeholders should participate and accept the policies set out.

3. Smart Sugar Cluster

3.1 History

The Smart Sugar Cluster (SSC) project started in 2019 through a collaboration between BSI, The Cluster Competitiveness Group INC and the various industry stakeholders. The project was developed in response to the need to improve the industry through improving its efficiencies with the use of data.

The project proposed the development of an innovative digital agro-processing-business platform integrating the cluster members to transform sugar cane cultivation and processing value chain into a modern, more efficient, competitive, and certifiable product for the Caribbean and European Market. The project would focus on financial inclusion of small-scale farmers in the value chain, with a key focus on women farmers, to improve management and productivity of their fields. It would create a direct interaction using "smart contracts" between their associations, the sugar cane miller and service providers to link agro-credit through service provision to increase competitiveness.

Furthermore, it would build trust among and between the members of the business cluster group by establishing verifiable, traceable, and transparent information for the financing sector.

The project, led by Belize Sugar Industries Ltd.-ASR Group (BSI) who owns and operates the sugar mill of the area, and also includes the following partners: Belagro Agriculture-Big Ceek Group, the largest agro-input provider of the country; Progressive Sugar Cane Producers Association, who groups 1,300 sugar cane farmers; Corozal Sugar Cane Producers Association, who groups more than 2,300 sugar cane farmers and the Development Finance Corporation, an entity from the Government.

In order to identify the areas of improvement in which to concentrate the work of the SSC, a gap analysis was conducted via the comparison of the ideal with the current value chain.

Table 1: Gap analysis found in Cluster Development Plan

	Ideal Value Chain	**Actual Value Chain**
Inputs and Service suppliers	Good quality seeds available Pesticides & fertilizers complying with required certification Quality, transparent	Good quality of suppliers, but not enough market share, due to farmer indebtedness and lack of access to affordable agro-credit
Sugar farmers	Good agricultural practices (soil treatment, integrated pest and weeds control, etc.) Sustainable farming techniques that improve climate resilience Constant communication with the mill to coordinate harvest	Low productivity per Ha due to inadequate agricultural practices. Agricultural practices that are not considering climate resilience as a variable

	Clarity and transparency in the Mill/Farmer Commercial Agreements and Contracts	
Mill	Sustainable and transparent process towards end consumers Constant good relations and communication with growers Clarity and transparency in the Mill/Farmer Commercial Agreements and Contracts	Mistrust between the miller and farmers due problems with verifying information. IT lacks the robust infrastructure necessary to provide secure and traceable information access to individual farmers continuously. Mistrust on cane payments due to a traceable system
Financial Institutions	Institutions understanding the industry, and the Agri risk behind it, hence providing affordable agro-credit to farmers, and collecting revenues in schemes directly related to the business.	More than 28,000 hectares of cane cultivation and harvesting activities rest on small-scale service providers and a few agro-input providers who have unsecured credit streams. Without adequate access to coordinated agro-inputs and services, farmers seek financing from commercial banks, with high interest rates, to obtain their own field equipment for small economies of scale. If and when the financing is provided in an untimely manner, it often misses important windows for fertilizing and weed control, resulting in low productivity and by extension a vicious cycle of indebtedness. Farmers who cannot access credit or financing abandon husbandry activities, severely affecting their yields and livelihoods in the following harvest season.

As a result of the Gap Analysis, and considering that, to compete successfully in the most attractive segment, it is vital to count with an ecosystem:

1. Traceable, vital to communicate the attributes of the product
2. Secure, to ensure a virtuous business relation among different clusters actors
3. Efficient, to increase productivity and remain competitive in terms of costs,

The Areas of Improvement defined are all related to the development and correct implementation of a Blockchain-based digital agro-processing-business platform integrating

the cluster to transform sugar cane cultivation and processing value chain into a modern, more efficient, competitive and certifiable product for the Caribbean and European Market.

The areas of Development and Improvement are the following:

1. **Platform Development**: Bring transparency and traceability to all the activities that the sugar cane has along the value chain. It will consist in a Blockchain-based platform that will improve the management, increase productivity and financial inclusion, by having a more efficient, traceable, and secure ecosystem. In order to implement this component, there are 4 activities that will be developed: (i) scope, (ii) blueprint, (iii) design and (iv) construction.
2. **Pilot of Implementation**: It entails two main activities: (i) initial implementation, in order to establish all the protocols to start using the platform, and (ii) testing and integration, to perform tests and validate the usability of the system.
3. **Training**: 2 main activities: (i) Train the Trainers, and (ii) Train the End Users. The reason of this double training is to ensure not only that the different users of the platform (farmers, agro-input provider, sugar cane processor and financial institution) learn how to use it, but also that there will be a pool of instructors trained, to ensure that future users will also be able to learn it.
4. **Social Marketing**: Use of social marketing techniques to transfer the technology to sugar cane farmers and their families. It will highlight the benefits of the platform, provide useful information about how to use it and support the development of the trainings. It includes 2 different activities: (i) definition of the social media campaign for the SSC, and (ii) its implementation and delivery.

The SSC's development still ongoing and although delayed by COVID-19, the main project partners (IDB and BSI) are determined to complete the project deliverables by the end of 2022. The system that is designed and communicated to the industry stakeholders has been well received and shows potential based on preliminary pilot results.

The SSC has the potential to digitize the Belize sugar industry. SIMIS provided the foundation that was necessary for the SSC to be so well received and given the risks are mitigated, especially in terms of data privacy, the industry is ready to onboard technology within its day-to-day operations.

3.2 Stakeholder Analysis

The SSC project has the intention to provide the framework and platform for the industry to collaborate and integrate. Therefore, the project's stakeholders are considered, at a high level, to be all industry stakeholders.

However, for the purposes of developing and piloting the SSC, the following organizations are considered project stakeholders:

1. Belize Sugar Industries (BSI)
2. Belagro- Agriculture - Big Creek Group
3. Progressive Sugar Cane Producers Association
4. Corozal Sugar Cane Producers Association
5. Development Finance Corporation (DFC)

These organizations together make up what is known as the cluster. The Cluster's profile and general information is provided below:

- 1,900 farmers (1,300 associated in Progressive Sugar Cane Producers Associations and 600 in Corozal Sugar Cane Producers Association)
- 4,205 jobs (2,315 permanent employees and 1,840 temporary employees)
- 68% of the total sales from cluster, come from exporting. The main markets are UK, USA, Canada, Caribbean and EU.
- The National Sugar Industry represents the 5% of the country's GDP.
- Belagro Agriculture-Big Creek Group supplies 70% of the currently used agro-inputs. While the market share seems high, Belagro only provides for 30% of the actual needs of the Sugar Cane fields due to farmer indebtedness and lack of access to affordable agro-credit.
- 257 farmer harvesting group leaders with over 3,000 cane cutters manually service 93% of 1.3 million tons.
- One farmer service provider mechanically service 7% of the total.
- The Development Finance Corporation (DFC), La Inmaculada Credit Union and St. Francis Xavier Credit Union provide lowest interests rate financing (6%) for re-planting and ratoon maintenance from an $11 million the EU-AMS revolving fund.

The stakeholders identified and those that participated in the pilot were part of a small group industry stakeholder to ensure the system can be moulded through an iterative process before rolling out to all industry stakeholders. This was important as the pilot participants would be required to actively engage in the development process.

Since the start of the SSC pilot, all the farmer associations have shown interest in the new system and have indicated that a digital system such as the SSC would be beneficial to the industry as a whole.

3.3 Database and Data Analysis

The SSC is developed within a blockchain environment that uses a digital ledger to track all data entries and data flows. The architecture of this environment, which will become the framework for the systems database, will draw on multiple sources, including existing databases. The following data sources, databases and data systems were reviewed during the development of the SSC:

Table 2: Data sources and systems reviewed

Industry	**External**	**BSI**
SIMIS: Each of the 4 databases within SIMIS	Weather Data (surface data)	BSI Ticket Booth
SCPC/CFR data	ARC GIS	BSI Scales
4 Associations	3 IOT Sensor Providers	BSI Production
7 Lenders / Financiers	1 Cloud Provider	BSI Finance
Fair Trade	1 Blockchain/DLT Provider	BSI Mill Schedule

	Truck Drivers	BSI NIR Quality Analysis
	Cane Cutters	BSI Quality Test Groups
	Cane Loaders	Harvest Group Leaders
		Farmers

Based on initial engagements and presentation of the SSC, additional feedback was provided by the industry showing their interest in the project and providing insight into the key areas of concern. These are:

1. Additional Data to be included
    i. Cane Price and history
    ii. Scale weight information
    iii. NIR analysis results
    iv. Digital maps of fields
    v. Burn, cut and transport dates during harvest
    vi. In-field treatment data
2. Workflow feedback
    i. Beginning of Season - approval of farmers and approval of any changes to farmer profile
    ii. Ensure the Administrator of the land is the individual being paid
    iii. Ensure the farmers have control of the sharing level of their data

The data collected[2] becomes the core of the system. The data collected by each user, will ultimately be the property of that user, and only they will be able to determine what happens to the data and who will be able to view the data.

Although the system is not fully developed yet, the system architecture will need to include several user levels with various data anchors to manage the data collected by each user in such a way that is accessible to the correct user(s) at the correct time.

The data will then need to be accessible through a user-friendly web portal that enables users to collect, share, view and analyse their data.

3.4 SSC Potential

The SSC is the next phase of what SIMIS needs to become. It has the potential to be the linkage system between all the industry supply chain nodes, allowing data to be transferred as required to make informed decisions.

The SSC, with its vision to be an improved data system, will ensure there is a high level of automation in terms of data collection through remote sensors and reporting through data management and reporting systems. By integrating the SSC into the daily lives of the industry,

[2] Sample data provided in Annex 1

it will help transform the industry into the 21st century by being the digital platform on which all future data systems can be developed.

4. Hello Tractor[3]

The world is busy transforming through the 4th industrial revolution. This is the introduction of digital solutions that communicate during operations to help improve efficiencies. The effects of this can be seen all over the world by the way we live our lives (mobile phones that are fully integrated with other smart devices), how we book hotels (for example Airbnb), how we move around (for example Uber), and how we buy things (for example Amazon).

Hello Tractor is the solution to a problem that is faced in emerging markets within the agricultural sector, supply of services. Hello Tractor has been designed to become a digital marketplace where farmers and service providers are able to connect and transact, in a fair and open market, through a transparent and traceable system - think Uber for farmers.

Hello Tractor provides its users the ability to be on either side of the transaction, either as a service provider or as the farmer. The system then goes one step further, providing the owners of the equipment the ability to manage their equipment through service providers. Below are the different solutions and descriptions:

1. **For Equipment Owners**
   Equipment owners are entrepreneurs or companies that have access to farming equipment such as tractors, who are interested in providing a service to farmers for a fee.

   Hello Tractor has identified three key areas of concern to equipment owners and built their app to address these concerns. Namely 1) the need to access customers and increase profits, 2) the need to be able to track and trace a fleet remotely, and 3) be able to generate detailed reporting for operational purposes and to access new financing to expand.

   The Hello Tractor app for Equipment Owners follows a simple 4-step process On the app to address the above-mentioned concerns. These steps are:

   1) Buy the Hello Tractor technology and download the app
   2) Add all your tractors and operators, and booking agents to your account
   3) Service farmers organized by your booking agent once the season starts
   4) Track tractor, operator, and booking agent performance to ensure maximum machine uptime, profits, and reduced fraud

[3] https://hellotractor.com/

2. **For Dealers**

   Hello Tractor has identified the need to incorporate equipment dealers onto their platform to complete their offering. This allows all nodes of the supply chain of delivering on farm services to be present on the platform.

   At the moment, Hello Tractor is piloting the Dealer solution on their app and believe the number of equipment owners and new entrepreneurs that are users of the platform will provide a natural market for equipment dealers. Additionally, by selling equipment with the Hello Tractor technology installed could allow the buyer could receive favourable financing terms and the dealer to provide improved after sales support based on the increased availability of data.

3. **For Farmers**

   The farmer users on the app is the market that creates the need for the app. Hello Tractor recognised that farmers, especially smallholder farmers, do not necessarily have the capital to buy equipment necessary to conduct the farming activities required to farm efficiently. Additionally, farmers that are located remotely are over charged when they requested local services from service providers in town, making these activities extremely difficult to conduct.

   Hello Tractor believed that the market existed for these small (and large) farmers and that if a competitive market with a logistical system is created to plan services, that these services could be offered at an affordable price.

   The application works as follows for any farmer:

   1) Download the Hello Tractor app and sign up as a farmer
   2) Select your country
   3) Set your farm location and book a tractor nearby
   4) If there are no tractors nearby, request service for a future date

4. **For Financing**

   For entrepreneurs or exiting entrepreneurs, Hello Tractor has recognised that financing is often a barrier to entry. The have responded to this barrier by developing a specific solution to support new entrant to the market.

   The solution works as follows:

   1) Receive Training: Entrepreneurs receive training on contracting business, driver recruitment, technology & booking farmers
   2) Book farmers: Entrepreneurs with 5% down payment and 500Ha of land pre-booked in the Hello Tractor app are vetted for financing
   3) Receive Tractor: Approved entrepreneurs receive JD 65HP (or similar) tractor wit implements, technology and dedicated account manager
   4) Earn & Repay: As tractor services pre-booked farmer, a small loan repayment of $20 is auto deducted to pay down loan

Like Uber, the data provided by the users of the platform, informs the platform and its users on its operation. Therefore, by integrating the platform and its data into a wholistic digital platform (like the SSC), Hello Tractor (or something similar) has the potential to provide a free and competitive market whilst supporting the development of new service providers.

5. GCF Project Intervention

5.1 Digital system's prospective under the project

Both SIMIS and SSC have been critical to the Belizean sugar industry's digitization journey. The GCF project design has recognised technology as an instrumental component to help ensure the development of project systems are sustainable, transparent, and efficient. It is therefore in the best interest of the project to provide support to these existing digital tools by catalysing the rollout of their use and further development through a specific allocation of grant funding.

The project will support the existing digital tools by identifying additional data points, training of project stakeholders on the system operation and support the increased adoption of technical tools by embedding the industry tools into the project's implementation process. The project will achieve this by using the data collected to inform actions, such as the allocation of resources through the bidding system and release of funds based on quality checks. Figure 4 shows the process flow envisaged for the development of the structures required to embed, for example, the SSC into the project and the actions the system could take to facilitate the implementation of the project.

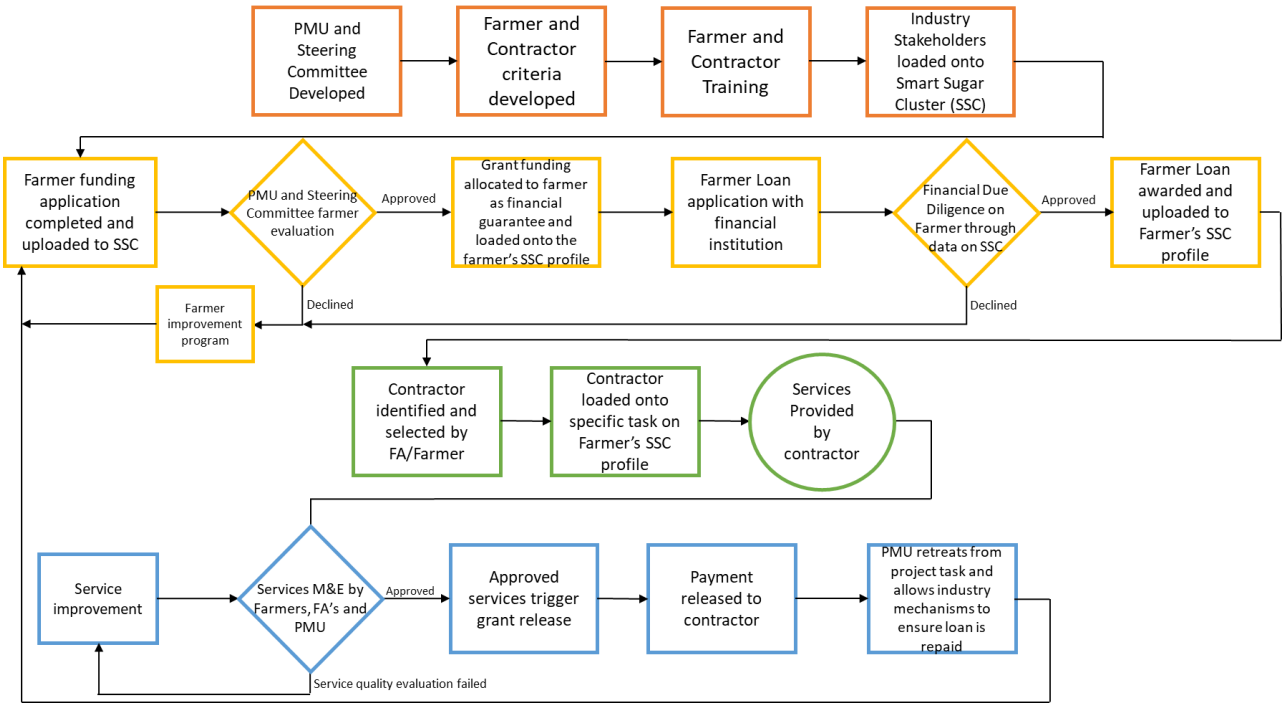

Figure 4: Project Process Flow Diagram

It is important to note that the digitization of the sugar industry needs to include all industry stakeholders in the design, development and deployment phases. The process flow diagram above describes how each phase of operation should be considered for the final design of the system. This includes the independence of the system, the data collection for operational and due diligence purposes, the free digital marketplace, to quality assurance.

Once the framework has achieved to allow for modularity, which to a degree has been achieved through the exiting tools, the industry will be able to expand on the data and systems that are contained within the platform as needed.

5.2 Stakeholder engagement

The process flow diagram in Figure 4 shows how the project could use the SSC as a wholistic digital tool to support the implementation of its interventions. Through the development of the project's process flow diagram, project stakeholders have been identified that will participate in the process flow and the diagram indicates how each of the stakeholders (through the various activities) could interact with the system, and finally what each stakeholder's responsibilities would be.

Table 3 provides more detail on the types of interactions that the various stakeholders might have with the system and shares potential barriers that each stakeholder might have to participate in using the system.

Table 3: Digital Tool Stakeholders System Interaction and Barriers

Stakeholder	**Type of interaction with system**	**Barrier to participation[4]**
Farmers	Data Collection; Data Analysis	Privacy of data
Farmer Associations	Data Collection; Data Analysis	Privacy of data
BSI	Data Collection; Data Analysis	Lack of industry uptake
Service Providers	Data Collection; Data Analysis	Increased quality assurance required; Financial barriers
Financiers	Data Analysis	Reliability and quantity of data
PMU	Data Collection; Data Analysis	Lack of industry uptake

It is important to note that the foundation of the system is the data that has been, and continuously gets, collected. The majority of this data will be collected by BSI, the farmers and the Farmer Associations and be used in various due diligence, quality assurance and operational activities. However, it is important to note that all stakeholders can (and will be required to) enter data into the system that becomes associated with their profile.

[4] Barriers to participate informed by stakeholder engagements conducted during site visit 2 and 3 in Belize as part of the principal contract to design the project proposal

The data users, are those users that analyse the data that they have access to, as provided by the data collectors. This process of reviewing data informs specific actions, such as providing access to a loan or allocating grant funding to a farmer association for a farmer based their proposal received for replanting fund during the replanting bidding process.

5.3 Data Mapping

The data generated through SIMIS and the SSC pilot, explained in Section 2 and 3, provides the foundation for additional data points to be collected. In order to ensure the project supports and builds sustainable systems, it must support and capacitate the industry tools that are in place or that exists, rather than developing a new system altogether.

Based on the data that has been collected through the existing systems, data points have been identified to integrate what has been developed into what is required by the project, and therefore what is required by the industry to build its resilience. The following data categories were identified:

1) Base Data

   Base data is the foundation data that allows all data users to identify themselves and establish their presence on the platform. Specifically for farmers in the case of obtaining finance, it allows the financiers to create an initial picture of the credit worthiness of the farmers, with evidence of fixed assets and a potential to repay any loans. In the case of farmer data for the industry, it allows industry entities such as SCPC and SIRDI to obtain critical data for planning purposes. This data is fixed, and only gets updated when fundamental changes are made to the farm or farming activities (for example, a larger area planted.).

2) Project Implementation Data

   The Project Implementation Data is data captured on the ground to verify that activities are required (for example replanting), to track the activities are being carried out, and to track and evaluate contractors that eventually carries out the service. This data may change from season to season and inform the financiers to release funds for activities to get carried out. This data also helps inform the industry (the farmers, the contractors, and the mill) on the status of transformation, the potential services required and the ultimate outcome of those services.

   The project implementation data can also be seen as operational data that helps inform the industry on activities that are required to sustain the sugar industry. For example, accessing replanting loans, determining production estimates, input procurement planning, etc..

3) Monitoring and Evaluation Data

   Finally, the monitoring and evaluation data will keep track of the industry at a high level. This data will indicate the change and the performance achieved by the activities.

Table 4 below provides specific data fields that could be collected within the three data categories. The table describes how the data point could be used within the system and how it will support the industry. It is important to note that the system's final design will be modular and therefore allow new and additional data points to be added as required by the industry. Therefore, these data points are simply an indication of what data could be included.

Table 4: Digital System Data Point(s) consideration

Data Categories	Description
Base Data	**Base data collected and identified once. This data is assumed to be available through SIMIS, Farmer Associations and the Banks**
Farmer name	-
Farm location	-
Farm polygon	-
Total area planted	-
Production estimate	The production estimate within the base data could be a rolling 5-year average for the entire farm, which considers different plots are on different ratoons.
Harvest group	An indication of the harvest group that the farmer belongs to will help the industry to develop a more sophisticated harvest management plan
Association name	Association members are to be linked to the association to allow for association-level planning, such as fertilizer procurement. This farmer-association connection will also ensure that project resources are equitably allocated.
Cane supply agreement	The tenure and quantity of the cane supply agreement will provide security for any existing or new loan
Farm asset registry	Any additional assets on the farm such as buildings, equipment, etc. can serve as collateral for a new loan. It also serves as a management tool for farmers to better understand their assets.
Farmer credit score	An indication of the existing credit score for the farmer will make the process of securing a new loan simpler and also ensure there is transparency with all lenders. If this is linked to the bank, it can probably be updated automatically based on the financier's due diligence.

Outstanding loan	For transparency purposes, to have an indication of the existing outstanding loans will ensure farmers are not over-burdening themselves. If this is linked to the bank, it can probably be updated automatically.
Project Implementation Data	**The project implementation data connects the Base data to the activities that need to be carried out by the contractors. This data is assumed to be identified and collected by the Blockchain project.**
Variety types planted	List of all varieties currently planted in the field, in the current harvest season. This data should be updated yearly according to any replanting.
Acres of each variety planted	The list of existing varieties with the acreage for each variety, updated yearly as fields are added and rested.
Land Prep - Land cleared of rocks and debris - Length of rows and row spacing - State of soil and land	An indication if the land has been transformed for mechanization and what activities are required to transform the land. This data will provide financiers an indication of the transformation that is happening on the farm and the quality of the fields (potential for good yields). The data will also allow farmers and farmer associations to plan replanting activities.
Replanting - Existing Cane Age - Field production estimate - Land and soil prep - Replant new cane varieties	Identify if replanting is necessary and how existing cane is performing. For a field with old cane that is performing poorly, replanting may be necessary. If replanting is necessary, land prep will be necessary. Data logic could ensure that replanting is only allowed if required.
Irrigation - Yes/No - Source of water	Does the farm have irrigation? What are the potential sources of water? The irrigation data could also help inform water management and planning at a watershed level and for training purposes.
Drainage - Yes/No - Near a river - Low lying area	Does the farm have drainage (sub-surface or surface)? Is the farm situated near a river or is the farm in a low-lying area which will make is more susceptible to flooding? This data can help inform the risk for financiers and allow the project to manage and plan resource allocation for developing new drainage systems.
Inputs - Fertilizer (quantity and date of	What inputs are being applied to the land, how much, and when? This will relate to the

application) - Chemicals (quantity and date of application) - Irrigation (Quantity and date of application)	performance of the cane production. Good levels in these indicators will also be a result of the training provided and provide and indication of good practice to the financiers. Keeping track of all these inputs will allow farmers to make informed decisions on their operations and show financiers of their good agricultural practices.
Pests and Diseases - Pest/Disease found in the field - Location of pest/disease in the field (polygon) - Size of P&D affected area (acres)	The pest and disease data will allow the industry to track any pest and diseases. The data will also allow the production estimates to be adjusted, while communicating with the harvesting teams to adjust their schedules for reduced tonnages. Finally, it provides an indication to notify contractors to come spray for pests and diseases while providing SIRDI with the data to address any pest outbreaks within the industry.
Harvesting & Haulage - Total production estimate (for the season) - Harvesting schedule (linked to land parcels) - Actual harvested cane quantity (linked to date and type of harvesting) - Data chain from harvest to mill (notifications at each check point – field, mill entrance, weighbridge) - Cane supply total to mill - Cane %pol -	The data for the harvesting and haulage connects the contracts to the specific land parcels and finally to the mill. This data will support the harvest and haulage process from field to mill and allow farmers access and traceability to see the tonnages delivered, which directly translates into their payment.
Contractor - Equipment - Price - Availability - Service delivery	Contractors identified and vetted by the project will each have specific services they can provide. This data will help determine the services delivered to the farmers, for activities that are activated by specific data point as noted above. Finally, once the service has been delivered, the completion of the task will trigger payment by the financier.
Monitoring and Evaluation Data	**The M&E data is to monitor performance of the project activities and are assumed to be industry standard metrics which are actively being monitored by either BSI, SIMIS or the Farmers Associations**
Total area planted - Per variety	This data works in combination with the project implementation data to provide an up-to-date

- Total	figure of cane planted, and per variety.
Tonnage cane per acre - Per variety - Total	This data works in combination with the project implementation data to provide an up-to-date figure of cane tonnages harvested, and per variety. Working with the other data fields in the project implementation data, an analysis could then be made to see the correlation between good climate smart agricultural practices and higher, more consistent yields
%pol for cane delivered	Similarly, to the tonnages delivered, the quality of the cane has an important role to play in the final payment to the farmer. This data could also be related back to the practices used on the farm to show the impact of the project activities
Total area irrigated	A project indicator, but also considered an industry management data point, to provide an indication of total irrigation levels within the industry
Total area mechanically green cane harvested	A project indicator, but also considered an industry management data point, to provide an indication of total mechanical green cane harvesting levels within the industry
Training attendance	This data could be disaggregated into males and females per training since that is an indicator for the project. Training attendance allows the industry to understand which farmers and farmer associations has been engaged on the newest practices. This data could also be analysed alongside the fields/farm performance to determine how effective the trainings were.

The data being collected by each user should be assigned to their specific profiles, be it a farmer, farmer association, the mill or financial institution. These individual profiles will have the capability to upload data according to their profile type and in that way, be able to share their data with other, specified, users. This system architecture is what has been designed within the SSC pilot and will ensure that the privacy of the user data is secure.

5.4 Project Support

The project design has allocated specific funds to support and catalyse the digital systems that exist in Belize, transforming the manual systems that dominates the industry. The project funds will ensure the necessary technical support, training and infrastructure is delivered to the project stakeholders to allow the system to be widely adopted and remain sustainable in the years to come.

The project design has identified specific digital solutions, including the SSC, SIMIS, and Hello Tractor as potential systems to be supported. These systems provide the foundation that is required and in SIMIS and the SSC, has the initial uptake that will help ensure the full rollout of the system is successful. However, there are other digital solutions that could provide the necessary functionality that the project and the industry require and therefore the project is not limited these systems.

Table 5 shows the breakdown of project funds for digital solutions with a short description of what each activity would consist of.

Table 5: Project Activities for Digital Solutions

Activity	**Description**	**Total Budget**
1.3.3: Establish digital marketplace for contractor to replant facilitated via technology-based solution(s) and systems	A digital marketplace, such as Hello Tractor, will be introduced and made bespoke for the sugar industry in Belize. Service Providers such as Hello Tractor can introduce the system with minimal financial support and by using the transformational officers to sensitize the farmers, financiers and the service providers, a digital marketplace could be established and sustained fairly inexpensively. It is important that within the implementation of the digital marketplace, the data is integrated with the wholistic data system, so data is shared where and as required.	$41 000
3.3.1: Equip and use industry tools to distribute climate related data for good farmer decision making	SIMIS has been identified as a key tool that introduced digital systems. It is important to keep those systems up to date as a wholistic solution is developed (which may or may not consume SIMIS and its databases). New datasets could be included to strengthen its offering, specifically in terms of climate data. Additionally, a simple web platform should be developed that will help distribute the weather data to the farmers and farmer associations.	$38 500
3.3.1: Integrate blockchain into industry tools	Blockchain has been identified to improve SIMIS, but to ensure full traceability to the industry. This activity is to provide the financial support to complete (or make bespoke) the SSC (or a similar project) to be suitable to the project and the industry based on the identified requirements. This activity will therefore help the development (and integration of other digital systems for this system to become an industry wholistic digital	$326 500

	solution), the training and the dissemination and rollout of the system to the industry stakeholders.	

6. Final Recommendations

Digital systems have been proven to be key in building efficient and effective agricultural industries. As a result, there has been many digital solutions developed throughout the world that can help the farmer manage their operations, in addition to helping increase the industry's transparency between the various nodes of the supply chain.

Based on the consultation, to introduce and successfully roll out a digital solution requires a high level of trust from the system's users. Only once the industry has full trust in the system, will there be ownership from the industry, which is required to participate in collecting data for the system.

It is therefore recommended that the digital solution that is used for the project is a system that has been introduced to the industry, to provide a sense of familiarity and trust. The systems described within this report, SIMIS and SSC, are therefore well-positioned to become the industry's digital system. Support from the GCF project will enable the development of additional measures to be implemented to ensure users have full trust in the system, especially that the data provided to the system is secure.

It is then also recommended that the industry works towards a centralised and wholistic system that can contain an integrated, and modular, database of all the industry data. This database should allow for blockchain to be used, where the users are the owners of the data and where the users help verify the data that is entered into the system. A wholistic integrated solution will ensure farmers and other industry stakeholders are not overwhelmed several systems, which often collect much of the same data.

Finally, it is recommended that an industry board is developed that will help manage the design and development of the final system. This board, which could be in the form of the GCF project steering committee, should consist of each of the industry stakeholders. This independent committee that will help define the system and build its requirements (especially in terms of data security and data sharing capabilities) will provide the comfort to the system users to build the trust that is required to scale the system across the industry.

7. References

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8. Annex 1: SSC Data sample from SIMIS

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