

LSC-IS Needs Assessment, Capacity Requirements and LSC-hub Design Requirements (Work Package 2): Rwanda Workshops and Key Informant Interviews Process Report

Deliverable 2.3

**PROJECT:** Land, Soil and Crop Information Services

to support Climate Smart Agriculture in

Ethiopia, Kenya and Rwanda







# LSC-IS Needs Assessment, Capacity Requirements and LSC-hub Design Requirements (Work Package 2): Rwanda Workshops and Key Informant Interviews Process Report

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# Abbreviations

| AGRITERRA |  |
| --- | --- |
| AKIS | Agriculture Knowledge and Innovation System |
| APTC |  |
| ASARECA | Association for Strengthening Agricultural Research in Eastern and Central Africa |
| CARAVAN |  |
| CGIAR | Consultative Group for International Agricultural Research |
| CNFA | Cultivating New Frontiers in Agriculture |
| CIAT | The International Center for Tropical Agriculture |
| CIP | International Potato Center |
| CO2 | Carbon Dioxide |
| CSA | Climate Smart Agriculture |
| DeSIRA | Development Smart Innovation through Research in Agriculture |
| E-SOKO |  |
| FAO  FFS | Food and Agriculture Organization of the United Nations |
| ICRAF | The International Council for Research in Agroforestry |
| ICT | Information and Communication Technology |
| IMBARAGA |  |
| INGABO |  |
| INES |  |
| IITA | The International Institute of Tropical Agriculture |
| IT | Information Technology |
| ISFM | Integrated Soil Fertility Management |
| IUCN | International Union for Conservation of Nature |
| KOICA |  |
| LAIS |  |
| LDSF |  |
| LSC-IS | Land Soil Crop Information Services |
| MINAGRI | Ministry of Agriculture |
| MINECOFIN |  |
| MINALOC |  |
| NAEB |  |
| NCCR |  |
| NCST |  |
| NGOs | Non-Governmental Organizations |
| NISR |  |
| NLA |  |
| OXFAM | Oxford Committee for Famine Relief |
| PSTA-4 |  |
| RAB | Rwanda Agriculture and Animal Resources Development Board |
| RAGA |  |
| RDO |  |
| REMA |  |
| RICA |  |
| RMA |  |
| RSA |  |
| RSB |  |
| RwaSIS | Rwanda Soil Information Services |
| RWARRI |  |
| RWB | Rwanda Water Board |
| RYAF | Rwanda Youth in Agribusiness Forum |
| SNS |  |
| SNV | Netherlands Development Organization |
| SPARK |  |
| SWC | Soil and Water Conservation |
| UNILAK |  |
| UTAB |  |
| UR | University of Rwanda |
| WFP | World Food Program |
| YEAN | Youth Engagement in Agriculture Network |

# 

# Executive Summary

Innovation in agriculture is a precondition for meeting the challenges of feeding the world’s growing population in the face of a changing climate and degrading natural resources (TAP, 2016). In east Africa climate change leads to a drastic reduction of the quality and resilience of the land, increased greenhouse gas emissions and food and nutrition insecurity for the growing urban and rural population. Innovation and access to reliable information is fundamental in achieving and promoting sustainable agriculture or Climate Smart Agriculture (CSA). Many countries are not fully exploiting their innovation potential in relation to CSA which includes amongst others sustainable intensification, increasing resilience against climate change, and contributing to climate change mitigation through reduced carbon emissions from land use and land use change and through sequestration of carbon in soils.

A capacity needs assessment workshop was carried out at the national and sub-national levels. The approaches and findings were:

1. Stakeholders were profiled in the agricultural sector and clustered into respective groups based on type of land, soil and crop data they use or provide. Stakeholder clustering revealed that most of the stakeholders are data users. A handful of the stakeholders are data providers at the national and sub-national level. Majority of the stakeholders either use or provide data and information on integrated soil fertility management and very few utilize or provide LSC information or data on soil-water conservation.
2. Assessing the data valorization process and evaluate the availability and accessibility of data related to land, soil, crops and cluster findings into integrated soil fertility management and soil - water conservation use cases. Identify the gaps and challenges in data gathering, processing, interpretation, application and usage. Identify the strengths, weaknesses, and gaps in the existing systems and infrastructure. Also, explore opportunities for integrating new technologies such as remote sensing satellite imagery, and land suitability maps.
3. Assess LSC data use and needs by assessing existing data integration and sharing mechanisms among stakeholders involved in LSC data collection and use. The barriers to effective data sharing and collaboration include lack of data availability, accessibility, incomplete and incomprehensible data among others. The needs assessment enabled the stakeholder clusters to explore opportunities for creating interoperability and data sharing platforms to improve the accessibility and usability of LSC information. In addition, shed light on stakeholders’ perspectives, needs, and challenges related to LSC information.
4. Capacity assessment of data users and providers

The participants assessed the capacity of stakeholders involved in the LSC data value chain and identified the technical and institutional gaps. Assess the capacities of institutions in relation to technical infrastructure, finance infrastructure, information technology (IT) and physical infrastructure, and existing internal standard operating procedures (SoPs), mandates and policies. Farmer and farmer cooperatives, the public sector, private actors, development organizations, and knowledge institutions independently contribute to the data valorization process in the agriculture sector. By leveraging the existing physical and technical infrastructure, combined with the expertise of human capital, stakeholders can unlock valuable insights, inform decision-making, and drive innovation in the agriculture sector. Collaborative efforts among these stakeholders hold the potential to revolutionize agriculture, leading to improved productivity, sustainability, and resilience in the face of evolving challenges.

1. Assess the existing policies and initiatives by listing existing climate-smart agriculture and LSC initiatives, projects, and programs implemented in Rwanda. State the objectives, targeted groups, and the responsible implementing agency. State existing all policies, regulations, and other legal frameworks that directly or indirectly relate to climate-smart agriculture and LSC information. The participants listed all the national agricultural policies, regulations act, environmental policies, climate change strategies, and other relevant legal framework documents. They also stated the key institutions and organizations responsible for implementing the policies as well as the objectives and the targeted people for the respective legal frameworks. Some of the policies and initiatives that have shaped the agricultural sector at the national and sub-national level include the Crop Intensification Program, Land Use Consolidation policy, Twigire Muhinzi, the National Agricultural Extension Strategy among others.

# Introduction

Agriculture has a dynamic role in the national economy of Rwanda (24.06%). Climate change and variability are having a short-term and long-term negative influence on Rwanda’s food systems and natural resources. It reduces crop and livestock production and productivity. This has led to yield gaps every year hence making it difficult to achieve SDG2 zero hunger in Rwanda. Currently, it is estimated that 18.7% of Rwandans are food insecure. Numerous agricultural stakeholders in Rwanda are implementing essential agricultural farming practices and innovations that are well-suited to assist a wider group of farmers (including smallholder farmers) in adapting to climate change and addressing the food insecurity gap. Some constraints prohibit stakeholders in Rwanda from adopting Climate Smart Agriculture (CSA) innovations and methods. The current legal frameworks, research and extension channels like Twigire Muhinzi which use farmer field facilitators and Farmer Field School (FFS) approaches to implement policies. However, the structures such as policies, strategies, regulations and government programs among others used to overcome food insecurity and climate change barriers have been insufficient thus far. The legal structures in place are weak in implementation and need to be strengthened.

It is critical to comprehend these hurdles and how they affect the scaling up of CSA practices in Rwanda. One of the proposed approaches to addressing barriers to scaling up CSA is knowledge and innovation generation and dissemination. Disseminating agricultural information and innovation through networks and platforms has been documented to be useful. The term Agricultural Knowledge and Innovation Systems (AKIS) is used to describe the whole knowledge exchange system: the ways people and organizations interact within a country or a region. AKIS can include farming practice, businesses, authorities, research, etc. and can vary a lot, depending on the country or sector. As part of AKIS, an effective instrument is the sharing of agricultural data and information through digital platforms. Examples include Evidence for Resilient Agriculture (ERA) and Sustainable Land Management. ERA is an online database managed by the research development organization, World Agroforestry ICRAF. The database reviews peer-reviewed agricultural work in Africa. The end user can explore the database. The derived data targets to influence agriculture in the public sector, private entities, development agencies, and NGOs. ERA has reviewed more than 75,000 data points using more than 50 indicators to develop and improve agricultural technologies.

The DeSIRA Land, Soil and Crop Information Services (LSC-IS) project aims to develop sustainable land, soil and crop information services (or hubs) in national agricultural research organisations to enhance the effectiveness of national Agricultural Knowledge and Innovation Systems (AKIS) and contribute to rural transformation and CSA in eastern Africa (Ethiopia, Kenya and Rwanda). Currently, LSC information is often not used effectively in decision-making, because it is not available in an organised and accessible form and is not seen as ‘owned’ by national organisations. Therefore, stakeholders at national and local levels, including smallholder farmers, are not well equipped with data and evidence to evaluate their policies, plans and farming practices; improve and transform these in a climate smart manner to make informed agricultural decisions. This project started therefore, with the assumption that soil, land and crop information services can help improve the efficacy of CSA related policies, plans and practices.

The aim of the project is to develop and embed a digital platform specifically on soil land and crop data and information (the LSC-hub) within the Rwanda AKIS (next to in Kenya and Ethiopia, see other parts of D2.3) that will allow a better adoption of CSA for rural transformation and resilience to climate variability/change. The specific objectives of output 2.3 include:

1. To assess the demand for LSC knowledge and information among stakeholders
2. Assess strategic, technical, operational and institutional requirements for LSC hubs
3. To assess the capacity for the use of the LSC hub

Based on methodologies on how to conduct these assessments (as described in D2.1 and D2.2) workshops were carried out in Kigali, Musanze and Rwamagana to understand the technical, institutional and operational LSC-data provision, use and valorization requirements of stakeholders who play a role in making the Rwandese agriculture more climate smart at national, as well as local (district) level. The needs assessment will help to identify the specific requirements and challenges associated with scaling CSA practices in Rwanda at the national and sub-national level. This assessment will inform the development of targeted strategies and interventions to enhance the sustainable provisioning, exchange and use of LSC Information Service and support the adoption of CSA practices at scale.

## Stakeholder Clusters and Their Roles

The stakeholder workshops held in Kigali, Musanze and Rwamagana aimed to profile Rwandese key stakeholders involved in the Land Soil Crop (LSC) information service and understand their roles in the valorization chain of LSC information. The participants included private actors, public/government authorities, development partners, knowledge institutions, and farmer organizations. Among these groups, most stakeholders from farmer organizations (10), private actors (19), development actors (22), and knowledge institutions (14) were classified under Use Case 1 (Integrated soil fertility management , as outlined in Annex 1. On the other hand, the public sector had fewer representatives in Use Case 1 (7) but a higher representation in Use Case 2 on xxxx Soil and Water Conservation (14). Use Case 2 had the least representation from private actors (4) and farmer organizations (2), as indicated in Annex 1.

In Rwamagana, Meteo Rwanda and the National Agricultural Export Development Board (NAEB) were identified as the sole data providers from the public sector. Similarly, in Musanze, NAEB served as the data provider. In both districts, there were more stakeholders identified as data users, followed by those who served as both data users and providers, as outlined in Annex 1.

Here are the findings of the stakeholders and their roles in the LSC data value chain.

## Farmer cooperatives and organizations

Farmer organizations and cooperatives in Rwanda are considered to be both data users and providers. The farmers groups are normally clustered into various groups such as Youth Engagement in Agriculture Network (YEAN), farmer cooperatives, farmer federations and syndicates, water user associations among others. All these clusters play a vital role in promoting and upscaling CSA such as advocating issues that affect farmers; provide extension services to farmers and training on good agronomic practices as well as technology transfer; linking farmers to lending facilities like banks as well as mobilizing resources; resolving conflicts over resources; and implementing government policies.

## Public sector

The public sector entails government parastatals, agencies and ministries, which are essential in enhancing and promoting CSA. The state entities share LSC information by advocating, lobbying and implementing policies and applying policy instruments. The public sector also provides extension services and does capacity building together with technology transfer. Through extension services, they ensure that farmers receive the necessary information and knowledge on CSA techniques that enable them to be resilient to extreme weather conditions like drought and erratic rainfall.

Government agencies and ministries provide guidelines, regulations, and frameworks that enable the adoption and scaling of CSA practices in Rwanda. They also create and develop policies, policy instruments and regulations that support directly and indirectly CSA (Annex 2).

Additionally, the public sector conducts research to improve on existing systems and approaches. Rwanda Agricultural Board (RAB) and University of Rwanda are public entities that do research around soil fertility. Such entities tend to provide information derived from their research inform of maps. RAB normally transfers new innovations in terms of technology to farmers. This enables farmers to properly manage natural resources such as land, water and water. In addition, RAB works closely with other institutions that oversee standards and/or the environment. Besides RAB, entities like NAEB and RICA monitor and coordinate agricultural activities.

The public sector has also embraced digital transformation as a means of disseminating agricultural services. For instance, RAB has collaborated with BK Techouse to provide agricultural services using digital platforms like Smart Nkunganire system (SNS).

In terms of resource mobilization and incentivizing, government-based facilities like SACCOs, NCST, FONERWA, BDF, and AMIR among others usually provide grants, loans and subsidies. The financial levers enable agricultural practitioners, farmers, entrepreneurs and organizations to access loans and grants that are used to invest in agricultural infrastructure and combat climate change.

Since the government works with several stakeholders, the public sector coordinates stakeholders by taking up the brokering role and ensures that stakeholders comply with the rules and regulations along the agricultural value chain.

## Private sector

Rwanda's private sector plays a crucial role in supporting CSA initiatives. The private sector present in the workshops consists of fertilizer companies, insurance companies, banks, and agro-input companies that deal with seeds, fertilizers, and pesticides. These private sector entities contribute to CSA in various ways. For instance, some private entities do field trials and research for market purposes. The field trials normally are for testing the efficacy of new products and technologies related to CSA.

In addition, the private sector disseminates technology and builds capacity. They train farmers and extension officers on the use of climate-smart practices and technologies. This enhances the knowledge and skills of farmers, leading to the uptake of climate-smart agricultural practices. A private company like Semarembo company is selling farm inputs to farmers. Other companies like BK Techouse offer agro-input recommendations through web-based platforms like the earlier mentioned SNS. Such advisory ensures that farmers have access to accurate and tailored information for effective decision-making.

Financial institutions like banks offer farmers loans and credits that are used to invest in climate-smart agricultural practices. Accordingly, farmers acquire inputs, invest in farm infrastructure that are climate-resilient and improve food production.

The private sector also does provide extension services. BK Techouse, for instance, offers extension services by providing accurate soil-related information to farmers. An organization like YEAN collaborates with other private actors to disseminate knowledge and provide technical assistance to farmers.

Another vital role played by the private sector is subsidy monitoring. Companies like BK Tech House, Twigire Muhinzi, and One Acre Fund are involved in the distribution of agricultural subsidies, ensuring that the right quantity of inputs reaches the specific sites. They also engage in follow-up activities to assess the impact and effectiveness of the subsidies provided.

Lastly, private sector organizations assist in linking farmers to markets. Through their networks and market connections, they help farmers in accessing markets for their agricultural products.

## Development partners

Development partners, both national and international organizations, play crucial roles in promoting agricultural development and food security. Their diverse functions include implementing projects aimed at enhancing food security and income diversity from agriculture. They offer valuable advice to farmers, guiding them on appropriate farming methods and the efficient use of farm inputs such as fertilizers and pesticides.

These development partners also focus on technology transfer and farmer training, equipping them with the necessary knowledge and skills through field manuals. This training helps farmers improve their agricultural practices. Additionally, these organizations engage in research and development, constantly working to improve existing farming techniques and develop new ones.

Capacity building is another important aspect in the work of development partners, with a focus on soil conservation and crop production. By providing training programs such as the Program for Capacity Development in Agriculture (P4CDA), they enhance farmers' abilities and promote sustainable agricultural practices.

Furthermore, development partners such as RDI contribute to market-related data, offering insights and information that help farmers make informed decisions. Additionally, RDI support farmers by providing seeds credit. In addition to their agricultural focus, development organizations actively participate in biodiversity protection, providing information on biodiversity conservation and collaborating with farmers' cooperatives.

Development partners also place importance on youth engagement in agriculture. For instance, RYAF gathers and maintains data and information about youth involved in agriculture and registration. They strive to increase the quality and quantity of goods and services produced by youth engaged in agriculture, ensuring their meaningful participation in the agricultural sector. By aligning their efforts with national policy goals, development partners contribute to the overall agricultural development agenda of Rwanda.

## Knowledge institutions

Knowledge institutions encompass both state and non-state agencies, playing vital roles in the agricultural sector. These institutions contribute to the development and implementation of national policies on agriculture development and animal husbandry. Their main objectives are to provide farmers and consumers of agricultural products with valuable information, techniques, and services that aim to enhance their profession and meet the local market's demand for increased and high-quality production, ultimately improving their agricultural and animal husbandry incomes.

Additionally, knowledge institutions conduct baseline surveys and research to address the identified challenges and develop innovative solutions in the field of agriculture and animal husbandry. They also assume the responsibility of monitoring and coordinating the activities of individuals engaged in agriculture, animal husbandry, research, and other stakeholders. Their focus includes identifying and disseminating new technologies to farmers for the effective management of land, water, and agricultural and animal husbandry mechanization.

Moreover, these institutions contribute to the establishment, promotion, and enforcement of laws and regulations that govern agriculture, animal husbandry, research, and related products. They actively collect both national and international innovations, appropriate technologies, and refine them to suit the specific needs of agriculture and animal husbandry in Rwanda.

Knowledge institutions are also responsible for providing agricultural extension services tailored to the specific needs of farmers. They coordinate activities related to agricultural extension and research plans and disseminate vital agricultural and animal husbandry knowledge. Furthermore, they foster partnerships and facilitate coordination among non-governmental organizations, private operators, and relevant entities involved in implementing agricultural and animal husbandry programs.

## Data Valorization

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## Data gathering

Organizations in the public sector that do data gathering include RAB, REMA, LODA, NAEB, NLA, and RWCA. All the mentioned government agencies and initiatives gather various types of data. For instance, RAB gathers data on soil erosion. REMA gathers information on marshland. NAEB gathers data on crops, soil, and agricultural market. NLA collects data on land location whereas LODA gathers data on soil conservation. The data is usually collected through field surveys. Rwanda Space Agency (RSA) gathers data using satellite images that are used in monitoring crop health and soil status. Rwanda Meteorology Agency (Meteo Rwanda) gathers data on weather like wind, precipitation, temperature and humidity.

Knowledge institutes involved in data collection include Muhabura Integrated Polytechnic College (MIPC), AgriResearch, World Research Institute, INES, ICRAF, and the University of Rwanda (UR/CAVM). The collected data revolves around soil, remote sensing and adaptability trials of agroforestry trees. Most knowledge institutions gather data through surveys. A well-endorsed research institute like IITA-CGIAR does research on banana and cassava cropping systems and compares various varieties of banana species' response to fertilizers as well as other agronomic practices like intercropping and crop rotation systems and resistance to diseases. Also, IITA assesses market access and post-harvest handling. The research institute also conducts nutritional research and evaluation of consumer diets and preferences. ICRAF, collects data revolving around trees and crops as well as socio-economic data.

Development agencies like Agrittera and Food and Agriculture Organization (FAO), USAID Hinga Weze gather various types of data. Agriterra collects soil samples and has demonstration plots which they also monitor. FAO gathers data through surveys and through monitoring and evaluation of projects they are implementing. USAID Hinga Weze gathers data on soil, climate and water. Private entities like One Acre Fund (OAF) gather data from their demonstration plots, adapted tree species. Accordingly, OAF also collects data on soil and crop. Soil and crop parameters that OAF is keen on includes slope, physio-chemical properties, crop diseases, and tree related measurements. Farmer cooperatives such as Imbaraga Farmers and COMIXBU also take part in agricultural surveys to gather data.

## Data Processing

The collected data by public entities is first arranged and sorted before it is processed. However, it is unclear which methods and standards are used to process the gathered information to obtain trends or patterns. Gathered data by knowledge institutions is first organized before processing. Types of data processed include topographic data as well as soil and water data.

Knowledge institutes like IITA and ICRAF use an assortment of approaches to process gathered data such as GIS and remote sensing, STATA, R Software, Excel, and crop models (QUEFT and APSIM).

Development agencies like Cultivating New Frontiers in Agriculture (CNFA) process yield and GIS data.

## Data Interpretation

Data on soil, crop and land cover are normally subjected to analysis by a government agency like RAB and MIPC (knowledge institution). At times, the processed data is interpreted to produce land maps (NLA), crop suitability information (NAEB), and to assess water quality (REMA and INES). The data is usually processed to address current situations at the field level such as rainfall availability. For instance, NAEB does market analysis to ensure that it provides adequate and reliable market intelligence to Rwanda companies that want to explore local and international markets. Another government agency, LODA, does budget analysis to derive crucial information for decision-making on resource allocation and strategic financial planning. RWB uses the data to identify hotspots prone to soil erosion, estimate available water, predict floods and water scarcity; develop water models for water quality and laboratory analysis

On the other hand, a research institute like IITA derives maps for soil fertility and crop performance to visualize trends and patterns. The interpreted data is usually published in peer-reviewed journals and technical reports are shared to provide insight. Additionally, the information is used to carry out capacity building of technical staff.

## Data application

Besides applying LSC information to create maps, the public sector, REMA, LODA, and NAEB, applies the interpreted data to provide services. Government entities like LODA, REMA and NAEB use the LSC information to create training manuals and formulate policies. An institution like RAB uses the LSC information to create maps, develop websites, share stories using videos, and develop fertilizer and lime recommendations for different agro-ecological zones. Ministry of Agriculture (MINAGRI) Uses the processed information in formulating policies related to subsidies on crops, fertilizer usage and insurance. Additionally, MINAGRI develops farmer advisories from generated data and information.

On the other hand, private companies like Holland Greentech apply irrigation information since one of the services they provide is to build and install an effective irrigation system. Hence irrigation information is applied to developing suitable irrigation systems and utilizing water efficiently to meet their customers' preferences.

Partners For Conservation (PFC) focuses on creating equal opportunities for everyone including farmers. To enhance its efforts on biodiversity conservation, the NGO applies LSC data to come up with efficient knowledge that they use to train farmers. Also, knowledge institutions like INES and UR/CAVM use the LSC information to provide technical training to their clients.

IITA-CGIAR, which is in the knowledge institution cluster, besides providing technical notes in terms of reports and published scientific papers, the data is applied in up-scaling existing and new projects. ICRAF, applies the data to publish research findings such as policy briefs. Accordingly, the generated knowledge is also used to develop extension materials in terms of manuals and reference materials that are used in providing extension services.

## Data Use

Public entities like RAB and RWCA use LSC information to train or teach on the market, write reports and offer extension services. At the same time, RWCA utilizes LSC information on reforestation activities, constructing terraces and installing water systems. When it comes to land issues, NLA and MINAGRI utilize data in decision-making on issuing land titles, land use plans consolidation, and guidelines. The data is also used by MINAGRI to guide decision-making on fertilizer usage and assist farmers to access finances.

The private entity MoneyPhone, a digital fintech company, offers digital loan origination to farmers for input acquisition. To improve service delivery, MoneyPhone utilizes data to enhance digital service provision, identify opportunities, mitigate any emerging risks, and enhance the overall performance of the platform. YEAN on the other hand utilizes data to mobilize farmers while VUP uses data to generate soil and water conservation methods.

Knowledge institutions like MIPC and AgriResearch use data to come up with soil and water conservation measures. INES particularly uses the data to come up with soil and water measures, particularly for Irish potato and wheat production. The University of Rwanda focuses on soil and water measures for seed production. IITA-CGIAR uses the information to do capacity development, support decision making and provide policy recommendations. At the

Farmer organizations such as HORECO utilize LSC data to mobilize farmers. Other mentioned farmer cooperatives that utilize data include COMIXBU and Imbaraga Farmers.

## Data Valorization Challenges

Some of the key challenges mentioned on data valorization during the workshops are:

1. Inadequate data validation and poor quality assurance of crop harvest and soil control
2. Lack of affordable tools/software to analyze data, and (combined) databases to store processed data
3. Lack of coordination and silos between the various AKIS organizations create issues of data accessibility, and duplication of databases and data tools across organizations. E.g. most of RAB’s info is only available at the national level and isn’t open access. It can only be accessed by key people upon request.
4. Data providers use poor methods or channels to disseminate and share agricultural knowledge.

## Data use and needs

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## 

## Overall

Most LSC data users utilize the provided information in 5 key areas namely:

1. Natural disaster management
   1. Soil erosion and land slides
   2. Floods management and weather forecasting
   3. Catchment protection,
   4. Soil conservation coverage
2. Farm inputs application and efficiency
   1. Fertilizer and lime recommendation (type and application rate)
   2. Pest and disease control
   3. Improved seeds with high yield potential and resistance/tolerance to diseases traits
3. Agricultural practices
   1. Appropriate irrigation systems
   2. Agroforestry practices
   3. Climate-smart agriculture
   4. Irrigation water use efficiency
   5. Harvesting techniques/practices and post-harvest management
   6. Pesticides and fertilizer use
4. Decision-making support tools
   1. Maps
   2. Scientific models/softwares/applications
5. Markets and Finance
   1. Market prices
   2. Business models
   3. Budget allocation
   4. Import and export data

## ISFM Data Users

The main LSC data users for the Integrated Soil Fertility Management (ISFM) at the national and district levels are private (BK Techouse, APTC, API), knowledge institutions (RAB, IITA), farmers, and the public sector (RYAF, RSA). Data users use different types of ISFM data. The LSC information is used to come up with specific fertilizer recommendations, develop soil maps, recommend suitable crops or varieties to breed, establish good agricultural practices that boost productivity, and develop agricultural policies. For the stakeholders to be able to utilize the LSC information on ISFM, they need an assorted set of LSC data such as soil pH, soil nutrient characterization, soil pedological characteristics e.g. soil type, texture, water holding capacity. Some of the needed LSC data sets are available while others are not. Besides being unavailable, other challenges that LSC data users face include: data is inaccessible; the data is not digitized; poor data quality and unharmonized; and poor data storage and safety measures not applied. Data that is available sometimes can be accessed through organizations or through open access portals. The portals are normally user friendly hence end users can easily navigate and get information they desire.

It should be noted that there are LSC data gaps that need to be addressed to meet the data users’ demands and needs. The identified data gaps that data users need to be addressed are:

* Harmonization in soil input application. Organizations need to come up with a standardized fertilizer and lime application. This will ensure farmers are applying the right amount and type of fertilizer when planting crops and top dressing during mid-season.
* Organizations tend to have siloed data sets. There is a need to combine datasets to fill in the loop holes and make decisions with adequate evidence. Combining efforts to share different datasets will help to maximize on limited resources.

The stakeholders in the workshop named the Caravan project as an example of a successful ISFM initiative by the public sector. The Caravan project is a portable soil-testing laboratory that does soil testing using the latest technology. The objectives of the project are to collect soil samples, conduct soil analysis and develop a soil fertility map for 4 key areas in Rwanda. The mobile soil lab also intends to sensitize farmers on good agricultural practices such as appropriate fertilizer application depending on the nature of soil and crop requirements. The Caravan project is a collaboration between the government of Rwanda and the Kingdom of Morocco.

Another example of a successful ISFM initiative is Rwanda Soil Information Service (RwaSIS). The RwaSIS initiative is considered a success because it will address issues on soil erosion and degradation in Rwanda. It will provide soil information up to the local context. In addition, the platform provides real-time soil and agronomic information that is reliable and can be used to advise farmers.

From a knowledge institution, Land Degradation Surveillance Framework (LDSF) is another successful approach to assessing systematically the health of the ecosystem and soil at the landscape level. The framework monitors and evaluates the process of land degradation which then provides a biophysical baseline of the landscape.

Open source data processors like python, java, QGIS among others are used to analysis data sets when processing biophysical indicators. Accordingly, data collected in the field and labs are stored in ICRAF’s open source databases namely MySQL and PostgreSGL.

## SWC Data Users

Stakeholders that use the soil and water conservation (SWC) data utilise it for example to develop policies on land use and management. A good example is the Land Use Consolidation (LUC) Policy that the Crop Intensification Program has been implementing for 6 major crops namely maize, beans, cassava, wheat, rice, and Irish potatoes. The LUC policy is used to address land fragmentation in Rwanda and promote land use intensification. Another goal of utilizing LSC information on SWC is to create reference materials and tools like manuals and training materials for extension providers. To create the reference materials and tools, various data sets are needed such as soil data on slope, texture, infiltration rate; land use practices and land cover types; and weather data e.g. rainfall.

Unfortunately, not all LSC data that data users require is available. Accordingly, other challenges that SWC data users face include:

* Accessibility
* Not digitized
* Data quality and harmonization
* Data storage and safety

These hurdles prevent development of useful information that extension service providers and other agricultural practitioners can use to advise farmers on improving crop production. Some of the SWC data that is available can be accessed through website portals that are user friendly.

Consequently, there are data gaps that do exist that data users need. The existing SWC data gaps are insufficient accurate data and lack of combined data portals.

## Data Provision and needs

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### ISFM Data provision

The various groups of stakeholders have different types of LSC information available. Public sector organizations that are identified as main LSC data providers at the national level include RICA, Rwanda Meteo, RIC, REMA, MOE, RCA, RYAF, and National Land Authority (NLA), NISR (socio-economic data), and RWB. LSC information that is available from RAB includes:

1. Maps – crop suitability map, crop varieties,
2. Legacy data on soil status, irrigation master plan
3. Soil nutrients content and soil fertility management data e.g. soil pH, soil type and texture (sandy, clay, or silt), slope, fertilizer recommendation, infiltration rate
4. Land use practices and cover e.g. pasture land, good agricultural practices (terracing), agroforestry etc.

Available data sets from Meteo Rwanda are wind velocity, temperature and rainfall. The weather data is useful to RAB because it helps them to make informed decisions and advise farmers accordingly.

Private entities like fertilizer companies conduct soil sampling and field trials and have services like the provision of accurate soil-related information to farmers through the support of YEAN, a youth network. The knowledge entities such as RICA, IITA, ISRIC and UNILAK have soil information such as soil pH and soil type. The data is used to make soil maps and suitable measures on soil and water conservation measures. development agencies share socio-economic data that focuses on market related data, youth involved in agriculture and registration. Farmer cooperatives such as Horeco also provide LSC data. Knowledge institutes like RAB and ICRAF are also sources of LSC data. RAB relies on Rwanda Meteo for weather and climate data. Organizations that work and share information with RAB include NLA (land ownership data), Meteo Rwanda (weather data), NISR (socio-economic data), and RWB.

The ISFM data providers supply data that is used in policy development by government agencies, create investment plans for the private sector, improve products and service delivery of on-going projects or programs, enhance natural resource management, carry out awareness campaigns, market development and industry crop promotion. However, the data is unavailable and only available to a few organizations. The ISFM data is accessible in form of reports and in most scenarios the data is either partially accessible or accessible upon request. A few can access a full report.

Besides LSC data being unavailable and inaccessible, there are other challenges that stakeholders encounter when using LSC data. Examples of challenges include poor resolution of satellite images and data is presented in a non-standard format. This makes it difficult to extract useful data and process it.

### SWC Data Provision

There are several stakeholders that provide Soil and Water Conservation (SWC data). These include the public sector (MINAGRI, Statistics, local government), knowledge institutions (RAB, ICRAF, UR), and development agencies (FAO, World Vision), private entities (One Acre Fund, fertilizer companies). The SWC data providers supply an assortment of datasets like fertilizer dosage, pH, crop variety, integrated pest management, crop suitability, and good agricultural practices.

At the district level, knowledge institutions like RAB, Universities (UNILAK, RICA) and ICRAF have various LSC data types comprising of:

1. Agroforestry trees data, (adaptability),
2. soil conservation practices
3. Soil data e.g. soil texture (sandy, clay, silt), soil type, moisture content, slope, soil pH, nutrient deficient soil, inflation rate, soil nutrient content, and fertilizer recommendation (fertilization rate).

Government agencies e.g. Meteo Rwanda and REMA have LSC data types on:

1. Weather data e.g. wind velocity, precipitation, temperature
2. Land degradation
3. water level (increasing or decreasing)

Private entities such as One Acre Fund have data on tree survival rate.

The supplied SWC data is usually used to enhance crop productivity, identify research gaps, and develop tools e.g. extension material, training/teaching module, community outreach program. At the district level, the rationale provided by the various stakeholders on using LSC data include:

* Improving productivity, soil health, soil conservation measures, guidance on soil conservation method, the use of provided data, erosion control
* weather forecasting and warning
* Water conservation and forest restoration
* policy making
* Guidance on soil and water conservation, develop soil maps

However, the SWC that are not readily available such as: soil nutrient type, pH and fertility maps, and soil fertility variation trends. In addition, available data that is digitally disseminated is outdated and methods used by data providers to supply data is poor. Some of the channels used to distribute and disseminate SWC related data are websites, short messaging services (SMS), and extension materials in terms of modules and manuals. Some of the needs that the stakeholders need is that SWC data be disseminated to extension agents, or via prescription by agro-dealers.

The stakeholders cited several challenges that are hindering the effective use of the SWC related data that comprise of:

* Language barrier prevents maximum usage and interpretation of data.
* Lack of technical expertise to interpret data
* Reliance on outdated data
* Data sharing policy
* Financial limitation
* No collaboration framework with data providers
* Insufficient data
* Data is fragmented and scattered
* There is no universal database that gathers needed LSC data

At the district level there are several SWC data gaps that need to be addressed which include:

* Low dissemination of adapted agro species to local area
* There is inadequate knowledge and awareness of available weather data
* Language barrier
* Incomplete data (micro and micronutrient) and incomprehensive data (meteo data, temperature, precipitation, wind velocity)

Data on appropriate infrastructures, site-specific soil nutrient content, landscape-level data (slope, crops, water management, etc.), site-specific fertilizer and pesticide application rate are all missing. In addition, datasets that were stated as incomprehensive and incomplete include: weather and climatic data are abroad; there is low awareness and promotion of new technologies; limited access to research data and interpretation; data on protected area is unknown; there is low cohesion and coordination of land conservation practices

The stakeholders are ready to explore opportunities by addressing some of the challenges especially on data accessibility and hopefully it will lead to creation of businesses. There are successful case studies that are recognized at the national and sub-national level.

At the national level, Twigire Muhinzi National Extension System is an example of a successful initiative by the Rwandan Government. The initiative has decentralized extension services up to the local level using farmer field schools and farmer-to-farmer extension approach is aligned with the national agricultural extension strategy whose broad objective is to achieve food security, alleviate poverty and a pillar of the national economy. Additionally, the initiative fosters the development of farmer cooperatives and organizations that will generally enhance farmers' way of farming. In the long run, farmers will be able to access resources, agricultural information and markets efficiently thus boosting their income and trading power.

Smart Nkunganire System, Regreening App, and Tearfund are examples of successful initiatives that stakeholders are familiar with at the sub-national level.

## Capacities data valorization process

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### Existing physical and technical infrastructure and human capital for data valorization

### Farmer and farmer cooperatives

Farmer cooperatives play a crucial role in supporting extension service providers and agricultural practitioners by providing valuable assistance in the implementation of data-driven practices. They bridge the gap between farmers and agricultural practitioners. This accelerates the adoption of data-driven climate smart-agriculture at the grassroots level. Moreover, farmer cooperatives at the national and sub-national level have well-structured administration with skilled personnel. The farmer cooperatives often use community-based radios as a powerful communication channel, disseminating agricultural information and data-driven insights to farmers and rural communities. This enhances farmers' knowledge and decision-making capabilities.

**Public sector**

Public entities have various existing physical and technical infrastructure essential for an AKIS. For instance, LSC field tools or equipment are used for data collection in the field, allowing for the measurement of crucial parameters like crop yields, soil conditions, and pest infestations. These tools enable real-time data acquisition, providing valuable inputs for decision-making processes. Computers are used in data processing and analysis, facilitating the storage and computation of large agricultural datasets. Soil and crop laboratories equipped with equipment enable lab technicians to analyze crop and soil samples. The data generated is valuable for research and support decision making. The expertise of crop and soil scientists further enhances the data valorization process by providing domain-specific knowledge and recommendations based on data analysis. Mechanization machines employed in agricultural operations generate data on productivity and efficiency, offering insights for process optimization. Finally, data specialists ensure the effective management, quality, and utilization of agricultural data, contributing to informed decision-making.

**Private actors**

Data scientists in the private sector come in handy in the entire data value chain. Their vast experience with data management enables them to process data and identify trends and patterns. Accordingly, they interpret data so that various audiences can understand and make informed decisions.

**Development organizations**

Development agencies have invested in data processing tools like CNFA. CNFA uses a GIS model called CROM DSS and is used to identify hotspots of land degradation and soil erosion. This enables experts to make informed decisions on catchment restoration in Rwanda. Collaboration between experts such as botanists and environmentalists also enhance their knowledge in plant biology, ecology, and environmental factors contributes to a comprehensive understanding of agricultural systems and how to manage them sustainably through innovations.

**Knowledge institutions**

Knowledge institutes such as IITA normally s have well-staffed IT departments and data analyst scientists. Also, crop and animal scientist, are at the forefront of agricultural research and innovation. They conduct experiments, analyze data, and provide evidence-based recommendations for agricultural development. Research findings help to shape agricultural practices and policies, driving sustainable and efficient data-driven decision-making.

## AKIS Initiatives and Policies

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### National Policy environment regarding AKIS/ Agricultural R&D / Digital & spatial decision support tools

At the national level, there have been many agriculture- and data-related policies (Annex 2), initiatives (Annex 3), and programs implemented by, and/or in association with, the Rwandan Government. Many of these policies suggest the likely success of creating an AKIS in the nation.

The Public Investment Principles of the 2018 Rwandan National Agriculture Policy (NAP) reports that the focus of public investments will be towards projects that are societally desirable, but not necessarily profitable. This bodes well for the implementation of the Land Soil and Crops (LSC) hubs to support the Agriculture Knowledge and Innovation System (AKIS) in Rwanda which fits within this category. The LSC hub supporting the AKIS in Rwanda is highly desirable and it assumed to improve the lives of many small-scale Rwandan farmers. However, it is not likely to generate revenues for stakeholders who invest in its implementation. And in that sense can be considered to be a public service.

One of the pillars of the Rwandan NAP is Technological Upgrading and Skills Development.[[1]](#footnote-0) Taking this into consideration, the LSC hub should be considered a high priority by the Rwandan Government; since it perfectly exemplifies digital upgrades and will enhance the knowledge of Rwandan farmers by providing accurate advisories that are context specific and based on accurate data and information. For instance, extension service providers will advise farmers on the right fertilizer application based on the type of soil and crop requirements. Under this pillar of the NAPmultiple types of research, both crop and soil system research are listed by name (see footnote 1). The fact that two-thirds of the LSC (land, soil and crops) name are directly addressed once again shows how Rwandese Governmental policies support the implementation of this initiative.

The Land Use Consolidation Act (LUC) showcases the Rwandan Government’s interest and commitment both to increasing the productivity of farmland and encouraging farmers to grow the crops best suited to their region and local soil conditions. The LUC creates consolidated farmland by connecting the lands of multiple farmers in the same area while maintaining the lands’s original owners. This makes improved farming practices more effective and economical as it introduces an economy of scale, reducing the average costs of goods. In terms of the nation's interest in facilitating informed crop selection, the Ministry of Agriculture (MINAGRI) compels LUC farmers to grow a single-priority crop based on local conditions[[2]](#footnote-1). One possible problem is that this creates a risk of conflicting instructions. This is because the Government of Rwanda may believe a farmer should grow a different crop than what the LSC-IS suggests. In this scenario, the farmer would struggle in deciding what to plant. Another problem is that the Rwandan Government’s priority crop system means that farmers only grow one crop in a field. The issue is that the practice of monocropping is not ideal as it is better for not only yields but also soil quality if a farmer practices intercropping and/or crop rotations i.e. growing alternating rows of maize and groundnuts.

The Crop Intensification Program (CIP) in Rwanda is another example of a policy with goals that coincide with the implementation of the LCS AKIS. The main goal of the CIP is to enhance crop production using farm inputs such as improved seed varieties and fertilizer. Furthermore, the program implements the LUC policy. At the sub-national level, Rwamagana is one of the CIP-intensive zones for bean production whereas Musanze is a maize production zone that CIP intensively promotes (Nsabimana *et al.,* 2021)[[3]](#footnote-2). Following the implementation of this program, fertilizer usage significantly increased between 2007 and 2010 from 8 Kg/Ha to 23 Kg/Ha. Accordingly, the percentage use of improved seeds by farmers improved from 3% to 40%. Therefore, the availability and accessibility to farm inputs have improved in Rwanda and improved crop production of the six major staple crops namely maize, wheat, Irish potatoes, and cassava root. In t/Ha these crops rose from 0.61 to 1.8, 0.55 to 1.57, 7.7 to 10.1, and 5.3 to 11.0 respectively[[4]](#footnote-3). The increased availability of improved crops means that farmers will be better able to adhere to the advice given to them through the newly implemented LSC AKIS as they have a selection of improved seeds and fertilizers to choose from. This same report on crop production in Rwanda shows the distribution of 6 major crops: maize, wheat, rice, Irish potato, cassava, and beans between 2007 and 2011. In 2011, beans contributed to nearly 50% of all farmland for one of the major crops. Maize made up the second largest portion being just over 20% of these crops (see footnote 3). This high percentage of beans implies that many farmers are likely familiar with the benefits of using beans for their nitrogen-fixing properties, and therefore will need less training to implement this into practice. In recent years, however, these improvements have either been slowed or reversed. Each year from 2011 to 2015 all crop yields save for cassava and Irish potato saw a decline. Seemingly in contradiction to this, all have significant gaps between their potential and real yields. The two highest gaps are Irish potatoes and beans, which are 76.40% and 71.68% below potential yields respectively[[5]](#footnote-4). It is believed, however, that increasing the use of nitrogen fertilizers in the country to >80-100 kg N Ha-1 will increase the maize yields threefold and therefore close the yield gap significantly[[6]](#footnote-5). To mitigate nitrous oxide emissions from the high application of N fertilizer, innovations like slow-release fertilizers should be adopted. One can also assume a similar effect would be had on other crops, it is only a question of how close the effect would be. Therefore, the implementation of the LSC-IS is more relevant now than ever. Now that these farmers have access to the proper seeds and fertilizers, but suffer from a lack of the necessary information on how to implement these improvements.

Considering the scale of the increase of N fertilizer as suggested by Leitner *et al.,* (2020), some level of change would be required for farmers to be able to increase their fertilizer usage to such a level. Fortunately, in June 2014, the Rwandan Ministry of Agriculture and Animal Resources introduced a policy called the National Fertilizer Policy. The policy was introduced to increase the usage of fertilizers by farmers in 2013 from 30 kg/Ha to at least 45 kg/Ha by 2017[[7]](#footnote-6). While this is still less than the ideal quantity previously mentioned, it is an important sign of improvement. The policy will increase the prioritization of research and development of site and crop-specific recommendations for farmers. Another goal of the policy is to improve knowledge of advanced agricultural techniques that improve the efficiency, effectiveness, and environmental sustainability of using fertilizer (see footnote 6). Both goals align with those of the LSC-IS, which will provide location- and crop-specific advice as well as advanced techniques for fertilizer application.

With proper implementation of the LSC hub, the Rwandan National Data Revolution Policy 2017 will be used to address issues on data accessibility, sharing, and security among others. This is because the LSC hub embodies several goals of the policy. The policy states that the implementation of “Open Data” practices is a significant priority for Rwanda. Meaning the Rwandan Government has already made clear its intent to make as much data available to the public as possible. Bearing this in mind, LSC information services provided through an hub would perfectly exemplify this part of DRP, as its goal is to share agricultural knowledge and skills through data and digital innovations. Accordingly, MINICT advocates for “opening data and derived insights” to researchers, further showing how this policy will aid in data collection for the LSC hub[[8]](#footnote-7). On page 8 it is written that another principle of the data revolution is for data to be “Easily Accessible & Usable.” The LSC hub aims to be both. The DRP policy further provides key rules and regulations on all data including:

1. Data that is non-sensitive will be consolidated and published on a central national data portal or other visible portals
2. Participation of all stakeholders is essential to build a sustainable data industry
3. Promote public-private partnership by creating a national data portal that will provide data from all government and private sector agencies
4. Foster collaboration with international organizations to develop national geospatial data infrastructure

The DRP policy makes it difficult for the private sector to keep data for itself. The only issue with the DRP policy is that repeatedly throughout the document it states that the Government of Rwanda wishes to change the economy from “an agriculture-based economy to a digital one” (see footnote 5). This desire for the country to distance itself from its agrarian past could potentially lead to suboptimal interest and participation on the part of the Rwandan Government in funding and otherwise facilitating the implementation of the LSC hub.

Another program that has been created in the country is the Smart Kungahara System (SKS). It is a Public-Private Partnership between BK Techouse and the Rwandan National Agricultural Export Development Board (NAEB). This system is used through an app by farmers of cash crops, primarily coffee but tea as well. The system is used to track coffee and tea yields, the estimated value of their yields, and much more data related to their crops, including what washing station the coffee is sent to and other similar updates

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Figure 1: SKS Coffee app on google play store (Source: images of the user interface are available on the app’s Google Play description)[[9]](#footnote-8),[[10]](#footnote-9).

While this system is different from other information services in several ways, it is a good example of a successfully implemented live information database in the nation. The SKS serves as evidence that the LSC hub may garner the same success. Another benefit of the SKS program is that its usage shows that many farmers now are familiar with using an app or website to log their yields and other information digitally, this will translate into proficient usage of the LSC information services.

The Rwandan Government has also demonstrated how the LSC-IS would be in their best interests through the existence of the Catchments Restoration and Erosion Control Division. The goal of this division of the Water Resources Board is to utilize Catchment Restoration Opportunity Mapping (CROM-DSS) to take steps towards preventing soil erosion and degradation in the country[[11]](#footnote-10). Both problems can be mitigated by the implementation of the LSC AKIS in the country by educating farmers on what crops preserve soil quality and reduce silt runoff (listed as a major concern of the division) into catchments by securing soil in place. Not only this, but the CROM-DSS program utilizes a “spatial data infrastructure/geodatabase” using highly detailed maps of the nation. The data used in the creation of this geodatabase could also be used to benefit the LSC-IS as it includes the following: land use, land cover, administrative boundaries, river networks, lakes, reservoirs, wetlands, DEM, rainfall intensity, geology, soil types, soil depth, road networks, landslide locations, population density, poverty, livestock and more (see footnote 8).

Two more highly relevant initiatives in Rwanda are the RwaSIS (Rwandan Soil Information Services) and the Maproom. The RwaSIS is a perfect fit for working side by side with the LSC-IS as it is focused on creating localized information about the state of soil erosion and other qualities related to the soil such as crop yields. This information will be used to give stakeholders (ministries, soil scientists, and fertilizer companies) data-informed advice on the soil-specific fertilizers they should use as well as what crops to grow[[12]](#footnote-11). This data will be updated and provided to users in the timeliest way possible. The only downside to the RwaSIS system is that it does not prioritize giving information to the farmers directly. Instead, RwaSIS intends to provide information largely to private entities who will use it to inform their own decisions.

Currently, CABI is leading in the development of the RwaSIS. A partnership with CABI will be useful in co-designing the LSC AKIS to avoid duplication of efforts and enhance synergy. If this happens the LSC hub can solve this problem by sharing the information with the farmers themselves. The Maproom is domiciled at Meteo Rwanda, a government agency. The Maproom is an open-source website and has no such limitations compared to RwaSIS. It is a collection of maps related to climate, agriculture, and other variables that is open to the public[[13]](#footnote-12). Once again, the data supplied by Maproom could be beneficial to the LSC hub.

One could learn from already existing initiatives that are sharing information with various stakeholders that embraces public-private partnership approach. The most common initiatives both at the national and district levels that have been developed by a knowledge institute (RAB) include the Smart Nkunganire System (SNS), e-Soko, and Smart Kungahara System (SKS). SNS and SKS are service products of BK Techouse. The two products have been developed through a private-public partnership with RAB and NAEB respectively. The SNS relies on RAB for data and the objectives of the program are to monitor the distribution of subsidized inputs and manage input subsidy. Other stakeholders involved in SNS include farmers, farmer organizations, agro-dealers, fertilizer companies, local governments, OAF and MINALOC. The main objective of SKS is to digitalize cash crop value chains such as tea, coffee, and horticultural crops. The targeted stakeholders include farmers, farmer organizations, agro-dealers, fertilizer companies, and local governments. E-Soko is an initiative that is implemented by MINAGRI and MINICOM. Its main goal is to make agricultural product information on market prices available to agro-dealers and farmers.

Stakeholders also identified some policies that will be useful to enhance food security and livelihoods. The missing policies are:

* Policy to promote indigenous crops like pumpkin, sorghum, cowpea, etc.
* Policy to initiate participation of farmers in agriculture research
* Farmer policy
* Agrochemical revalidation

Moving forward with the LSC-IS development the following need to be addressed:

* Map out overlapping policies and dormant policies
* Policies that are pending approval and are important to the LSC-IS
* Engaging farmers in policy development
* Awareness campaigns to sensitize stakeholders such as farmers on the objectives and goals of policies
* Validation of non-conforming products
* Regulation of stakeholder bodies responsible for implementing policies in Rwanda
* Farmers experience a language barrier hence they don’t understand the purpose of the initiatives and utilizing available agricultural information.
* Most disseminated LSC data revolves around maize and green grams. Therefore, the AKIS should promote crop diversity.
* The initiatives that provide information services have limited coverage hence leaving behind some groups.

## Key Informant Interviews

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### Data Providers

Data providers supply various types of LSC data, services and or advisories. These include:

* Soil nutrient management e.g. soil testing, soil amendments applications, compost making, mulching,
* Soil management e.g. tillage practices, mechanization techniques
* Water management e.g. harvesting methods, irrigation systems
* Good agricultural practices e.g. kitchen gardening
* Integrated farming systems e.g. agroforestry
* Product marketing
* Climate information e.g. advisory services on crops and soils
* Agro-ecological maps

The LSC data which they use for these services is usually stored using various formats. Some of the formats used to store data include:

* vectorized ( point data, polygons) geospatial data in shapefiles and GEOTIFF
* rasterized geospatial data like in ESRI raster,
* tabular data likecin MS Excel (plain tables),
* analogue maps, geopackage,

Some data providers do have metadata however, it is scattered.

The dissemination of the agricultural knowledge and information (AKI) is through trainings, community outreach programs, websites, Scientific Journals, analogue methods (hard copies), emails, external storage devices, web-based platforms, school platforms, Management information system (MIS) and GIS center. The AKI on LSC data is preferably presented to end-users using MS Excel tables via portals like web-based platforms and mobile apps.

Public entities like MINAGRI and Meteo Rwanda have digital data repositories of LSC and climate related datasets. For example, Meteo Rwanda has developed Maproom: an open-source portal where end users can access climate and agricultural maps. On the other hand, MINAGRI has an LSC data warehouse, an MIS accessible to internal users only.

Other repositories used include API. An example of an open source web-based platform is the Sprout ([sproutopencontent.com](https://sproutopencontent.com/about)). knowledge institute International Potato Centre has an assortment of open-access repositories like Dataverse, CGSpace, and Toolkit.

Skilled labour and ICT infrastructure are critical cost implications when hosting and maintaining an LSC hub. The hosting and maintenance of the LSC hub requires skilled professionals such as software developers, data analysts, system administrators, and technical support staff. The costs will involve salaries, training, and potentially hiring external consultants or IT service providers for specialized expertise. In addition, the LSC hub will require robust hardware and software infrastructure, including servers, networking equipment, storage systems, and backup solutions. The cost includes the initial investment in acquiring the equipment and the ongoing expenses for maintenance, upgrades, and replacements.

Obviously content quality management (including the formulation of standardised meta-information of the various dataset and data layers) of the, to be shared, LSC data and information also needs the involvement of LSC content experts.

Data providers that are simultaneously also using data themselves are willing to pay a small fee to access LSC data and download files. Therefore, types of LSC information, services, or advisories that end users need to address soil fertility and soil and water conservation challenges include

1. Soil Fertility and Nutrient Management

* Soil properties and fertilization methods
* Soil nutrients status based on specific regions
* Crop suitability to a given soil type

1. Technological Demonstrations and Field Crops

* Technological demonstrations on field crops
* Georeferencing

1. Climate Data and Weather Forecasting

* Climate data (Historical and forecast)
* Weather prediction/forecast

In fulfilling the following functionality expectations, the LSC hub can effectively serve its users, enhance user experience, and provide valuable information and services for soil fertility, soil-water conservation, and agricultural practices.

1. Data visualization and interpretation
   * Graphics and their interpretations
   * Videos
   * Figures or pictures relating to the texts
   * Friendly design facilitating everyone
2. Information access and response
   * Ability to respond to questions from farmers on LSC and weather
   * Offering advisory services
   * Filtering options for getting site-specific data
3. information delivery and communication
   * Catalogues
   * An understandable language to all
   * Warnings for upcoming hazards farmers might face in agriculture

Data providers that are simultaneously also data users would like to access the LSC hub via phones, and other electronic devices such as tablets, desktops, computers. Key security and privacy data requirements that the LSC hub should consider in its design and understanding security and privacy requirements include:

* Implement robust backup mechanisms, including cloud-based solutions, to ensure data availability and protect against data loss. Apply appropriate security measures to safeguard the stored data from unauthorized access, data breaches, and data corruption.
* Implement measures to protect user privacy, such as allowing users to sign up with minimal personal information and providing clear privacy policies. Ensure that user data is collected, stored, and used in compliance with applicable data protection regulations.
* Establish a hierarchical system architecture that limits access to sensitive data based on user roles and responsibilities. Implement access control mechanisms to ensure that only authorized users can access and modify specific data and functionalities within the LSC hub.
* Implement mechanisms to track user activities within the LSC hub, including user logins, data access, and modifications. Maintain audit logs that capture relevant information for monitoring and investigating any potential security breaches or data misuse.
* Implement a secure user authentication system, such as creating login accounts with strong passwords or using multi-factor authentication, to verify the identity of users accessing the LSC hub.

By considering these security and privacy data requirements, the LSC hub can protect user privacy, secure sensitive data, control access to information, track user activities, and comply with data protection regulations, fostering trust among users and stakeholders.

These recommendations are clustered based on their related aspects. The data providers’ suggestions focus on ensuring the availability of skilled human resources and necessary equipment, maintaining data quality and accuracy, providing market-related information and linkages, organizing validation sessions, and establishing a sustainable hosting arrangement for the LSC hub.

By implementing the following recommendations, the LSC hub can be effectively sustained and continue to serve its users in the long term:

1. Skilled Labor and Equipment

* Skilled labour
* Equipment to maintain the hub

1. Data Quality and Accuracy

* The hub should provide useful/accurate information accompanied with meta-information and generated and processes using international data standards
* Update information

1. Market Information and Linkages

* Avail information for Agribusiness: prices of different crops, production cost of different crops, forecasting the market price
* Market linkage between farmers and traders
* Cost of production of major crops
* Postharvest handling

1. Validation and Collaboration

* Organizing validation sessions of LSC data to be uploaded in the hub
* After the project, the hub should be hosted by an ICT unit of a public institution with a specific budget and staff.

### Data Users

Stakeholders in the agricultural sector use various CSA interventions on soil fertility and soil-water conservation measures. The following CSA clusters group together related practices and techniques that address specific aspects of farming, such as soil conservation, fertility management, water management, and sustainable farming practices.

1. Soil Conservation and Erosion Control

* Erosion control and management
* Soil water conservation
* Avoiding erosions by terraces and trenches
* Mulching
* Marshland drainage

1. Soil Fertility Management

* Integrated soil fertility management
* Organic fertilizers (compost)
* Practices to renew soil fertility through conventional tillage
* Liming and composting
* Lime application to stabilize the soil pH
* Fertilizer recommendations

1. Water Management

* Water harvesting
* Minimizing water usage by automatic irrigation
* Rainwater harvesting
* Provision of Small-scale irrigation technology (SSIT) Kits

1. Sustainable Farming Practices

* Mitigation measures by limiting the emission of greenhouse gases
* Vertical farming through Plasticulture
* Land husbandry technologies
* Agroforestry tree planting
* Pasture management

Data users need LSC data or derived information to make decisions or foster decision-support processes or for use case development on soil fertility and soil-water conservation. These categories encompass a range of data and derived information that include:

1. Soil Characteristics and Fertility

* Soil organic matter content
* Soil pH
* Soil CEC (Cation Exchange Capacity)
* Soil texture
* Soil nutrient content
* Soil moisture content
* Soil infiltration rate
* Soil erodibility

1. Crop Management and Suitability

* Improved seeds
* Pest and diseases types and their corresponding control measures
* Cropping calendar
* Soil pests and soil-borne diseases
* Fertilizer recommendation for different crops
* Crop suitability assessment
* Crop response to different rates of fertilizers

1. Water Management

* Rainfall erosivity
* Floods management and reducing hillside runoff
* How to keep toxic and unclean water from reaching the wetlands
* Buffer zone creation around lakes and wetlands

1. Climate and Weather

* Weather forecast
* Climate change future effects on the weather

1. Economic Factors

* Cost of production of most cultivated crops in Rwanda
* Expected income

1. Planning and Demonstrations

* Demonstration and adaptability plots for crop production
* Crop suitability in every region

Generally, while the mentioned use cases on soil fertility and soil-water conservation have the potential to contribute to improved crop productivity, climate resilience and mitigation of GHG emissions, their adequacy may be influenced by the availability of resources, contextual relevance, accessibility, and the need for comprehensive guidance and support for farmers. The use cases on soil fertility and soil-water conservation mentioned have different levels of adequacy and potential gaps.

* Development of extension materials are essential for disseminating knowledge and best practices to farmers. They can provide guidance on soil fertility management and soil-water conservation techniques. However, the adequacy of extension materials depends on their quality, accessibility, and relevance to local contexts. There may be gaps in terms of translating technical information into easily understandable content for farmers.
* Development of training manuals can be valuable resources for capacity building and promoting proper soil fertility and soil-water conservation practices. But the effectiveness of training manuals depends on their clarity, comprehensiveness, and alignment with local conditions. Gaps may exist if the manuals lack practical demonstrations or fail to address specific challenges faced by farmers.
* Compost making is an invaluable practice for improving soil fertility and organic matter content. Adequate guidance on composting techniques can support farmers in adopting sustainable soil management practices. On the flip side, gaps may exist in terms of accessibility to training or information on composting methods and sources of raw materials, especially for resource-limited farmers. Lack of awareness or technical knowledge may hinder the widespread adoption of composting.
* Increasing resilience to climate change impacts distinguishes the importance of adapting agricultural practices to climate change and promoting resilient farming systems. Unfortunately, this depends on the availability of specific strategies and techniques to enhance resilience. Gaps may exist in terms of practical guidance or resources for farmers to implement climate-smart practices.
* Promoting good agricultural practices can contribute to soil fertility and soil-water conservation. Valuable guidelines and training on these practices can support sustainable farming. Gaps may exist if the information on good agricultural practices is not context-specific or if there is a lack of resources for farmers to implement these practices effectively.
* Demonstration plots serve as learning platforms for farmers to observe and adopt soil fertility and soil-water conservation practices. This depends on the availability and accessibility of demonstration plots. If there is limited access to demonstration sites or if the demonstrations do not cover a wide range of practices and techniques less learning will take place. For instance, model farms can be used to develop trenches as a strategy for soil water conservation. Developing trenches for soil water conservation can be an effective technique for managing soil moisture. Model farms can showcase these techniques and serve as learning hubs for farmers. These model farms should be easily accessible to other farmers and showcase soil conservation measures. But if there are limited resources or support for establishing model farms or if the models do not address the diverse needs and challenges of farmers.

The outputs that require LSC data/information as an input encompass a range of communication materials, tools, and initiatives that aim to educate, inform, and support farmers and other stakeholders in making informed decisions about soil, land, and crop management. The outputs that require Land Soil Crop (LSC) data/information as an input can be categorized as follows:

1. Training manuals are developed to provide comprehensive guidance on various aspects of soil, land, and crop management. LSC data/information is crucial for incorporating accurate and relevant content into these manuals.
2. Extension materials, such as leaflets, booklets, radio programs, and short videos, are created to disseminate information to farmers and other stakeholders. LSC data/information is used as a basis to develop content that educates and raises awareness about soil, land, and crop-related topics.
3. Communication platforms, including websites, mobile applications, and online forums, require LSC data/information to provide accurate and up-to-date content for users. This can include sharing data on soil fertility, soil-water conservation techniques, crop recommendations, and sustainable farming practices.
4. Technical advice provided by agricultural experts and extension agents relies on LSC data/information. It enables them to offer tailored recommendations and solutions to farmers regarding soil management, crop selection, pest control, and other agricultural practices.
5. Digital tools such as agricultural software applications, decision support systems, and online calculators, use LSC data/information to provide users with insights, recommendations, and predictions related to soil, land, and crop management. These tools can assist farmers in making informed decisions and optimizing their agricultural practices.
6. Demonstration plots serve as physical spaces where farmers can observe and learn about various agricultural techniques. LSC data/information is utilized to design and implement these plots, showcasing best practices in soil fertility management, soil-water conservation, and crop cultivation.
7. Mobilization campaigns aimed at raising awareness and promoting sustainable agricultural practices rely on LSC data/information. These campaigns may involve workshops, training sessions, field visits, and community engagement activities to encourage the adoption of soil, land, and crop management strategies based on accurate data and information.

The LSC data users develop or provide products, services, or advisories for various categories users or target groups. These users or target groups reflect the diverse stakeholders involved in agriculture, ranging from individual farmers to cooperative organizations, investors, facilitators, and local NGOs. By providing relevant LSC data products, services, or advisories, data users aim to support these groups in improving agricultural practices, enhancing productivity, and promoting sustainable farming approaches. The targeted groups include individual farmers, farmers’ cooperatives, investors, farmer field school facilitators, and local NGO’s. The scale or level of application of the mentioned use cases can vary, and they can be applied at different levels, including: sector level, province level, district level, and countrywide.

The range of applications, models, and tools used in the LSC use cases, including soil fertility and soil-water conservation, include:

* AquaCrop is a crop-water productivity model developed by the Food and Agriculture Organization (FAO). It simulates crop growth, yield, and water use under different environmental conditions. AquaCrop is used to optimize irrigation scheduling and improve water management practices.
* CropWat is another model developed by the FAO that estimates crop water requirements and irrigation scheduling. It considers factors such as climate data, crop characteristics, and soil properties to provide recommendations for efficient water use in agriculture.
* Geographic Information System (GIS) software, such as ARCMAP, ARCVIEW, and ARC catalogue, is utilized to analyze and visualize spatial data related to soil, land, and crop management. GIS tools can help in mapping soil fertility, soil erosion, crop suitability, and other relevant information.
* Statistical Analysis System (SAS) is a software suite used for advanced statistical analysis. It is employed to analyze large datasets related to LSC data, enabling data users to derive insights, identify patterns, and make data-driven decisions.
* Microsoft Excel is a commonly used tool for data management, analysis, and visualization. It is utilized to organize and analyze LSC data, generate reports, and create charts or graphs for better understanding and communication of findings.
* Statistical Package for the Social Sciences (SPSS) is a software package widely used for statistical analysis in social sciences. It can be applied to analyze LSC data, perform data mining, conduct regression analysis, and generate statistical reports.
* AutoCAD is a computer-aided design (CAD) software used in various fields, including agriculture. It is used to create and analyze designs related to land management, irrigation systems, and farm layouts.
* Weather stations are used to collect real-time weather data, including temperature, rainfall, humidity, wind speed, and solar radiation. This data is essential for understanding climate patterns, predicting weather conditions, and informing agricultural decisions related to irrigation, planting, and crop management.
* The Africa Soil Information Service is an online platform that provides access to soil-related data and information across Africa. It offers soil maps, soil profiles, and other soil-related resources to support soil fertility and soil-water conservation efforts.
* SoilGrids250m 2.0 is a global soil information database that provides high-resolution soil property maps, including soil organic carbon, pH, and texture. It is normally used to assess soil fertility, variability, and make informed decisions regarding soil management practices.
* The Akilimo app is a digital tool developed for smallholder farmers in Africa. It provides personalized recommendations and advice for crop management, including soil fertility and water conservation practices, based on real-time data, local conditions, and farmer inputs.

The main sources of readily available data for LSC purposes on soil fertility and soil-water conservation include Schools/Education centres, RAB, published documents, scientific research and publications, NISR, Meteo Rwanda, RWB and FAO. These sources of data contribute to the availability of information and insights related to soil fertility, soil-water conservation, and other aspects of LSC practices. Data users can access and utilize these sources to enhance their understanding and decision-making processes in agricultural management.

Nevertheless, there are constraints in accessing LSC data for targeted users/groups, use cases, or services. Some of the mentioned constraints include:

* One of the primary constraints is the unavailability of certain LSC data. Some data may not have been collected or documented, limiting the information that can be accessed by users. This can be due to resource constraints, lack of data collection initiatives, or gaps in data sharing.
* Accessing and interpreting LSC data may require specialized technical knowledge and skills. The shortage of technical experts in the field of soil, land, and crop management can hinder the effective utilization of available data. This constraint may limit the ability of users to extract meaningful insights and apply them to decision-making processes.
* Inconsistencies in LSC datasets, such as variations in data collection methods, formats, or quality, can pose challenges for users trying to access and integrate different data sources. Inconsistent datasets may require additional effort and resources to reconcile and align, affecting the accuracy and reliability of the information obtained.
* Even if the data exists, it may not be easily accessible to users. Data may be held by specific institutions or organizations without proper mechanisms for sharing or dissemination. Lack of data sharing platforms or open data policies can limit the availability of LSC data to targeted users or groups.
* LSC data may be scattered across multiple sources, making it difficult for users to locate and access the relevant information they need. Data fragmentation can arise due to various factors, including multiple data providers, different data formats, and lack of centralized data repositories.
* Outdated LSC data can present a constraint to users, as it may not accurately reflect the current soil fertility, water availability, or crop management conditions. Timely updates and maintenance of data are crucial to ensure the relevance and reliability of the information for decision-making processes.
* Lack of coordination among the organizations or institutions responsible for collecting and managing LSC data can result in fragmented data systems and duplication of efforts. Inadequate coordination can lead to inefficiencies in data sharing, limited interoperability, and challenges in accessing comprehensive and integrated datasets.

Users of LSC data may require various formats of data and information to effectively utilize and analyze the data. The formats commonly required by users are figures (charts, graphs, and diagrams), maps, shapefiles and metadata. Thus, users may require LSC data at different scales and resolutions to match their specific requirements, such as national-scale data for policy planning or high-resolution data for site-specific agricultural management. By providing LSC data in formats like shapefiles, figures, maps, and with accompanying metadata, data providers can cater to the diverse needs of users and enhance the accessibility and usability of the data. Additionally, offering data at different scale levels and resolutions allows users to analyze and apply the data effectively for decision-making processes. For instance, when working with georeferenced LSC data, understanding the coordinate system, including the UTM zone, is essential for proper integration and analysis.

Most LSC data users and providers like to access LSC data or information either as a downloadable file, SMS, and API. Therefore, LSC hub should have data that is readily available, accessible, information available in various languages i.e. French, Kinyarwanda and English.

#### **Hub Design**

The LSC hub should aim to provide comprehensive information services and advisories related to soil fertility and soil-water conservation. Based on the mentioned requirements, the following LSC information services and advisories should be developed:

1. Crop Management and Varieties
   * Information on pests and diseases and their specific control measures
   * Improved varieties (Yield and tolerance to pests and diseases, drought and salinity)
2. Water Management and Irrigation

* Crop water requirements
* Irrigation scheduling
* Water infiltration rate of each region
* Irrigation guidelines

1. Soil Management

* Soil texture
* Soil nutrient status and suitable crops of every region

1. Climate and Environmental Data

* Climate data

1. Pesticides and Chemical Management

* Data on pesticides

The functionality of the LSC hub should aim to enhance data accessibility, usability, and user engagement. By providing features such as data download, interactive dashboards, user feedback mechanisms, data viewers, and multilingual support, the LSC hub can effectively serve the needs of users in accessing, analyzing, and applying LSC data for decision-making and sustainable agricultural practices.

The preferred way of accessing LSC information can vary among users and regions. two common methods for accessing LSC information are mobile phones and mobile apps or SMS. Mobile phones have become increasingly popular and widely accessible, making them a convenient tool for accessing LSC information. With internet connectivity, users can browse websites, access online platforms, and download LSC-related resources. Mobile phones provide flexibility and convenience, allowing users to access information anytime and anywhere. Mobile apps and SMS-based services can be developed specifically for delivering LSC information. Mobile apps provide a user-friendly interface, interactive features, and personalized content. Users can download the app and access LSC information, including advisories, weather updates, and crop management recommendations. SMS-based services can deliver LSC information through text messages, reaching users who may have limited internet access or smartphones. The two approaches offer advantages in terms of accessibility, scalability, and user engagement. They leverage the widespread use of mobile technology and provide a direct and personalized communication channel for delivering LSC information to farmers, extension workers, and other stakeholders in the agricultural sector. Moreover, users are willing to pay a low fee to access agricultural advisories and information.

Implementing the following recommendations can help ensure the effectiveness, scalability, and sustainability of the LSC hub, enabling it to serve as a valuable resource for agricultural stakeholders and contribute to improved soil fertility and soil-water conservation practices:

1. Data quality and presentation

* Provide accurate information
* Well presentation of the data
* Provide data that meets the needs of farmers
* Should have updated data

1. Awareness and promotion

* Awareness/promotion of the hub
* Awareness creation of the LSC hub

1. Resources and collaboration

* Human and financial resources
* Continuous collaboration/consultation between public and private stakeholders

1. Data quality and presentation

* Provide accurate information
* Well presentation of the data
* Provide data that meets the needs of farmers
* Should have updated data

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## Conclusions

1. Most of the stakeholders are data users both at the national and district level. They rely on government agencies to provide them with agricultural data to develop programs that are implemented at the grassroots level.
2. Stakeholders often tend to work in silos hence there is less synergy. This may lead to duplication of efforts and hurdle efforts used to combat climate change and food insecurity.
3. Stakeholders lack technical expertise, tools and organizational policies to do proper data valorization. Most data users rely on data providers' processed data. On the other hand, data providers lack the resources and tools to ensure they have authentic data sets.
4. Public institutes lack the technical capacity in IT for them to handle data and disseminate it through various channels such as digital platforms, training, field schools, publications, manuals etc.
5. There is a need to harmonize existing policies and mandates to avoid stakeholder rivalry. In addition, organizations need to sensitize their staff about the existing legal frameworks.
6. There is a need for a universal platform where each stakeholder can share data, and access data whenever required. For this to be successful, data providers need to have a clear protocol for data gathering, processing, and interpretation and dissemination. Such protocol includes agreements on technical details like of the data valorization like international data standards and formats, on aspects of quality assurance as well on aspects of the rights to use data and obligations for data sharing. This will help to develop the LSC-IS based on authentic data and develop decision-supporting tools based on valid primary and secondary data.
7. Most initiatives are recognized at the national level. Hence, theLSC-hub should be devolved to the sub-national (district to local) levels and in a simple format and language that the implementing officers can understand easily.
8. Farmer representatives and farmer cooperatives would like to be engaged in the development of the LSC hub to be able to provide informed advice to farmers. Based on the recommendations they provided during the FGD, the farmer representatives would like to have weather forecast information. This will enable them to advise farmers on the appropriate time to plant and harvest.
9. Most of the initiatives focus on the major staple crops like maize, beans, Irish potatoes, rice, wheat, and cassava as well as cash crops such as tea, coffee, and horticultural crops. Most farmers would like to have information on other value chains like orphan crops.

## Recommendation

### Opportunities for data valorization

1. Capacity development
2. Training of farmers by institutions by introducing training programs to farmers, that focus on sustainable agricultural practices, improved crop management techniques, pest and disease management, post-harvest handling, and market-oriented strategies. These training programs should be tailored to the specific needs and contexts of farmers, promoting knowledge and skills development. The LSC hub can be embed on CIP’s network blueprint.
3. Create a data-driven policy environment that is politically supported. Data revolution policy can be used as the base to harmonize and coordinate data sharing between stakeholders. Additionally, the CIP program can be used to enhance the 6 major staple crops of Rwanda by embracing cropping systems such as crop rotation and intercropping. Cropping systems that promote crop diversity will enhance on-farm diversity, enhance soil health, improve household diets as well as income among other benefits.
4. Organizations need a central structure with clear guidelines such as a data governance framework stating the role of each organization and the objective of the platform. That way, the framework defines the roles and responsibilities of each organization involved in data sharing and sets out the objectives and principles of the platform. It ensures effective coordination, collaboration, and data sharing among stakeholders, leading to a more efficient and integrated AKIS.
5. To effectively manage and maintain the AKIS and the AKIS hub, there is a need for capacity building in both technical and physical infrastructure. Staff members of the host institution should receive training on the management and maintenance of the AKIS hub and related systems. This includes technical skills in data management, database administration, and platform maintenance. Additionally, organizations should invest in the necessary physical infrastructure, such as reliable internet connectivity, hardware, and software, to support the smooth functioning of the AKIS hub.
6. LSC-hub design
   1. Tools and Equipment

The LSC hub should be equipped with the necessary tools and equipment to facilitate knowledge sharing, collaboration, and innovation. This may include physical resources such research facilities and demonstration plots. Additionally, technology tools like computers, internet access, audiovisual equipment, and software applications should be available to support communication and data management.

* 1. Affordable and User-Friendly Digital Database

A crucial component of an LSC hub is an affordable and user-friendly digital database or platform. This database should allow stakeholders, including farmers, researchers, extension workers, and policymakers, to access and contribute to AKI remotely. The database can include resources such as research findings, CSA practices, case studies, training materials/modules, and market information. It should be built using the FAIR data principles i.e. findable, accessible, interoperable and reusable. The database ought to be regularly updated to ensure relevance and reliability. Additional recommendations include:

* Design the hub in multiple languages so that all stakeholders can use it.
* Connect the hub to weather forecast data
* The hub should have a functionality where everyone can share data. To do so, there must be a quality check in place.
* The hub can think about functionality that also people without smartphones can access the info.
* The hub shouldn't limit its coverage to make sure more people can use it. Or start small, but then extend it.
  1. Feedback Loop

A feedback loop is essential for continuous improvement and adaptation within the LSC hub. It involves gathering feedback from stakeholders and using it to refine and enhance the hub's activities and services. Feedback can be collected through surveys, focus groups, workshops, or online platforms. Regular communication channels should be established to encourage stakeholders to share their experiences, suggestions, and challenges. This feedback loop helps identify gaps, address emerging needs, and ensure that the AKIS hub remains responsive to stakeholders' requirements.

* 1. Monitoring and Evaluation

Implementing a monitoring and evaluation system helps assess the performance and impact of the LSC AKIS hub. This will entail tracking the usage, engagement, and outcomes of the hub to measure its effectiveness and identify areas for improvement. Feedback from users, data analytics, and periodic evaluations can inform decision-making and ensure the hub remains relevant and responsive to user needs.

* 1. Co-designing and co-creation

All stakeholder clusters ought to be represented in the co-design and co-creation of the LSC hub. This can be done through participatory workshops, focus group discussions, and iterative feedback sessions where stakeholders contribute to defining the hub's goals, features, and content. Such collaborative approaches facilitate ownership, engagement, and sustainability of the LSC hub.

* 1. Joint Learning

A collaborative approach to knowledge generation and sharing within the LSC hub is essential. It involves creating opportunities for stakeholders to learn from each other's experiences, exchange ideas, and co-create innovative solutions. Joint learning activities can include workshops, field visits, study tours, seminars, and networking events. These activities facilitate the sharing of practical knowledge, research findings, and lessons learned, fostering a culture of continuous learning and improvement.

1. Financial leverage
   1. Develop financial investment plans and strategies that encourage partnership locally and internationally. The private-public partnership model has shown to be an effective strategy for web-based platforms like SKS and SNS. The PPPs model permits for the sharing of resources, expertise, and infrastructure between public and private entities. Public institutions, such as NAEB or knowledge institutions like RAB and IITA, possess valuable knowledge and research capabilities, while private companies like Bk Techouse bring market-oriented approaches and technology. By stakeholders pooling their resources, both stakeholder clusters can leverage each other's strengths and develop a more robust agricultural knowledge and innovation system.
   2. Mobilization of funds

Mobilizing funds is crucial to support the implementation and sustainability of the LSChub. Hence the need- for a buy-in by various clusters of stakeholders. Government of Rwanda can allocate financial resources through national agricultural budgets, grants, or targeted funding programs that promote agricultural research, extension services, and innovation. International development agencies and donors can provide financial assistance through grants, loans, and technical assistance programs specifically aimed at strengthening the LSC-hub and at the same time promoting CSA interventions that enhance food security. The private sector, including agribusinesses, financial institutions, insurance companies and technology companies, can support the LSC hub by investing. This can be through funding research projects, supporting innovation and technology development, and investing in infrastructure and services that enhance the functioning of the hub. Also, coordinated efforts by stakeholders pooling their financial resources and leveraging external funding opportunities will support the development of the LSC hub and its activities.

1. Knowledge generation through research for development of the LSC hub. The research will generate evidence that informs decision-making processes within the AKIS. Evidence generated will identify the needs and challenges faced by farmers, extension workers, and other stakeholders, and provides data-driven insights into potential solutions. This evidence-based approach improves the effectiveness and efficiency of CSA interventions and ensures that resources are targeted towards the most pressing issues. Moreover, identifying and testing new technologies, practices, and approaches will enhance crop productivity, sustainability, and resilience. Through research, new crop varieties, farming techniques, pest management strategies, and value chain innovations can be developed, adapted, and disseminated within the LSC AKIS.

Accordingly, research for development will revolve on generating context-specific knowledge and solutions such as crop-specific and soil-specific fertilizers. It recognizes the diversity of agroecological conditions, socio-economic contexts, and cultural practices within the AKIS. By conducting research within local contexts, agricultural practitioners can better understand the unique challenges and opportunities faced by farmers and develop appropriate, locally adapted solutions. This ensures that interventions are relevant, acceptable, and effective in addressing the specific needs of the target audience.

# Annexes

## Annexe 1: Stakeholder data providers, users or both (data providers and users)

List of Stakeholders at the national level - Kigali (Use case 1 - Integrated soil fertility management)

| **Farmer Organisations** | **Private actors** | **Development partners** | **Knowledge Institutions** | **Public** |
| --- | --- | --- | --- | --- |
| Rwandan Farmer Organizations, National Confederation for Cooperation in Rwanda (NCCR), IMBARAGA, INGABO, Rwandan Youth in Agribusiness Forum (RYAF), Urugaga Imbaraga, Syndicat Ingabo, RYAF, HORECO | Western Seed Company; Farming insurance; SNS; BK Tech House; SANLAM; RADIANT; SONARWA; Prime Insurance; Old Mutual; YARA fertilizer; Agro-Processing Trust Corporation (APTC)ltd; Bank of Kigali; Chambers of agriculture commerce; RFC; ETG input ltd; Rwanda fertilizer company ltd; Agro-dealers at different levels; YEAN; One Acre Fund | CNFA, RWARRI, RDO, SPARK, SNV, ISRIC, KOICA, OXFAM, FAO, WFP, PLAN International, AGRA, WVR, USAID, CRS  VILife/Agroforestry, World Bank, | ICRAF; ISRIC; RAB; Rwanda Polytechnic; RICA; UNILAK; NCST; INES; UR; NISR; IITA; CIP; Rwanda Meteorological Agency; CIAT; UTAB; ICRAF; IUCN; CGIAR (IITA); CGIAR | RAB; NLA; MINAGRI; RICA; RSA; RWB; NAEB |

List of Stakeholders at the national level - Kigali (Use case 2: Soil/Land suitability and land use management)

| **Public** | **Private** | **Development partners** | **Knowledge institutions** | **Farmer representatives** |
| --- | --- | --- | --- | --- |
| MINAGRI; RAB; RWB; MoE; RFA; REMA; MININFRA; WASAC; NLA; LODA; REG; Districts; FONERWA;  Rwanda mining authority | APTC; Mining companies; OAF  Construction companies (constructors) | CNFA; RWARRI; ARCOS; IUCN; FAO; WFP; GGGI; WUR; CGIAR (ICRAF, IITA, CIAT, CIP); CARE; SNV; JAICA; KOICA | RAB  Universities (UR, RICA, RP, UNILAK, INES, UTAB); RWB; RFA; CGIAR (ICRAF, IITA, CIP, CIAT) | Farmers’ cooperatives and unions; Farmers’ federations like Urugaga Imbaraga |

**Stakeholder identification of key data providers and users at the district level (Musanze and Rwamagana)**

| Location | Category | Farmer Organizations | Private actors | Development partners | Knowledge Institutions | Public | NGO |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Rwamagana | Providers |  |  |  |  | Meteo Rwanda |  |
| Users | KOKIKU cooperative; Gwiza RW.34; Hirwa RW.35; Ejo Heza Rugende; COCURIBU; COCURICYI; Rwamagana Maize Crop Cooperative; COCURIGA; Cooperative Twite ku bidukikije; COOPAGA; CO.FK Ejo Heza; Akabando k’Iminsi cooperative; CORICYA; Isuka Irakiza cooperative; Wisigara Nsinda;  COCUMAKI; Gishari Farmer Cooperative; Terimbere Gishari; COHUNYA; COCURIMU; Jya mbere muhinzi; Urumuri rwa Musha; Urumuri Mwurire; Abishyize hamwe Cyabitana; Jya mbere Muhazi; ADECOR; COPAKAKA; KABOKU; RRGC; Muvumba P8RGC; COODAEGA; COOPALEG; Abanyamurava Cooperative; Koperative Kirehe; COOPRIKI; COACMU; Mushikiri Rice Growers; Twisungane; Duterimbere; COAIGA | EJO HEZA Greenhills; HORECO; Rwanda Farmers’ Organization; Vision company (seeds), Urwego Bank; Ishimwe Farm ltd; Individual Farmer (apples, figs) – PPCAE; Agro-dealers, TRI-SEEDS Co. Ltd; YEAN; RYAF; Vision Garden Co. Ltd; MNG supply Ltd; AIF ltd; EAX ltd; Sarura ltd; RGCC; MINIMEX; Agri-seed Co ltd; NV General Supply Co ltd; Seed of Trust Co. Ltd; Priders Farmers; Gabiro Agri-Hub | AEE; Rwanda Tearfund; CDI; World Vision/regreening Africa; EUCOD/Rwamagana – European cooperative for rural development; Land O’ Lakes V37 | WUR; UNILAK | Rwamagana district; MINAGRI/District; SAIP; Nyagatare District; | AGRITERRA; MYI; Better World; Uyisenga ni Imanzi; Oxfam |
| Both |  | One Acre Fund |  | ICRAF; RICA – Rwanda Institute of Conservation Agriculture; UR/CAVM Nyagatare campus; Gishari IPRC | KARLO; RAB/Rubilizi station; REMA – Rwanda environment management authority; NICO |  |
| Musanze | Providers |  |  |  |  | NAEB |  |
| Users | Igitega cy’ubuzima ltd; Cooperative KABUKA – cooperative of farmers of Kabeza; KOTTUBUMU; Cooperative Intwari; COMIXBU; KOTEMUSHI; CAPSNI cooperative; KOTIMURWE | YEAN – youth engagement in agriculture network; EGSP – early generation seed potatoes; HORECO Rwanda – horticulture reality in cooperation; Delphy; [Money phone](https://www.money-phone.com/post/moneyphone-launches-in-rwanda); ENCOR Ltd; Aenerls and kernels company; Chia seed; VUP – Vision Umurenge Program; Burera Semarembo Family ltd; Savannah Musanze ltd | Seed Potato fund |  | Musanze district; Nyabihu district; Rubavu district; Rutsiro district | Verdure (based in Rubavu); DERN; Rural Development Initiative; AGRITERRA; PFC; ESF; World Vision; Rwanda wildlife conservation association; CPPA Kisaro; CPPAK; MIPC |
| Both | Imbaraga farmers organization | AGRI-Research (have smart inputs system, climate-smart agriculture practices); Holland FairFoods; Holland greentech; One Acre Fund | World resource institute; | ICRAF; Muhabura Integrated Polytechnic college; INES Ruhengeri; UR-CAVM; CIP; CoEB; | RAB- Musanze; REMA; LODA; Rwanda land management and use authority; MINAGRI | Imbaraga Farmers’ organisation |

## Annexe 2: Policies

List of Rwanda’s agricultural legal frameworks

| **No.** | **Policy/Framework** | **Objectives** | **Implementing organization** | **Targeted stakeholders** | **Link** |
| --- | --- | --- | --- | --- | --- |
|  | National Agriculture policy | - Increased contribution to wealth creation  - Economic opportunities & prosperity  - Improved food security and nutrition  - Increased resilience | RAB | NAEB | [NAP](https://www.minagri.gov.rw/fileadmin/user_upload/Minagri/Publications/Policies_and_strategies/National_Agriculture_Policy_-_2018___Approved_by_Cabinet.pdf) |
|  | Land consolidation policy | - Land ownership and tenure security  - Equitable allocation  - Increase productivity per unit area  - Effective use of inputs | MINAGRI, Ministry of Environment, Local government, RAB, NAEB |  | [Land Use Consolidation Act (LUC)](https://www.landportal.org/library/resources/rwanda-land-research-136/final-report-land-use-consolidation-and-crop) |
|  | National data revolution policy | - Establish stand and principles for data management  - Establish a framework to develop human resources  - Establish a framework for data creation, realization  - Derive development  - Establish a data framework |  |  | [Data Revolution](https://statistics.gov.rw/file/5410/download?token=r0nXaTAv) |
|  | Biodiversity conservation policy |  |  |  | [Rwanda Biodiversity Policy](https://rema.gov.rw/rema_doc/pab/RWANDA%20BIODIVERSITY%20POLICY.pdf) |
|  | Fertilizer use guidelines | - Increase productivity  - Effectiveness and national fertiliser use | MINAGRI, RAB |  | [National Fertilizer Policy](https://faolex.fao.org/docs/pdf/rwa174364.pdf) |
|  | Agricultural extension policy |  |  |  | [National Agricultural Extension Strategy](https://faolex.fao.org/docs/pdf/rwa149678.pdf) |
|  | Irrigation guidelines |  |  |  | [Irrigation Master Plan](https://www.minagri.gov.rw/fileadmin/user_upload/Minagri/Publications/Policies_and_strategies/Rwanda_Irrigation_Master_Plan.pdf) |
|  | National Environmental and Climate Change Policy | - To protect national resources from environmental hazards and weather  - Resilience to climate change | RAB, MoE, FONERWA, REMA |  | [NECCP](https://plasticsdb.surrey.ac.uk/documents/Rwanda/Ministry%20of%20Enviornment%20(2019)%20Rwanda%20National%20Environment%20and%20Climate%20Change%20Policy,%20Rwanda.pdf) |
|  | PST4 | - Sustainable productivity  - Market-oriented agriculture  - Improved technical innovations in Agriculture  - Smart agriculture | MINAGRI; RAB | Farmers; private sector; |  |
|  | National Forestry Policy | Conservation, protection, management and utilisation of national forest resources |  |  | [Rwanda National Forestry Policy](https://www.environment.gov.rw/fileadmin/user_upload/Moe/Publications/Policies/Rwanda_National_Forestry_Policy_2018__1_.pdf) |
|  | Rwanda water policy | - Effective use of water | Rwanda Water Board, RAB, MoE | All farmers, Private sector |  |
|  | Mining policy | - Sustainable use of available mining | REMA, MoE, Rwanda mining petroleum and Gas | All farmers, private sector |  |
|  | Crop intensification program | - Increase productivity per unit area  - Effective use of inputs | RAB, MINAGRI | Farmers, agro-dealers | [CIP](http://197.243.22.137/gakenke/fileadmin/templates/DOCUMENT_Z_ABAKOZI/abakozi/MORE_INFORMATION_ABOUT_CROP_INTENSIFICATION_PROGRAM.pdf) |
|  | Quality and food safety policy |  |  |  |  |
|  | Seed multiplication policy |  |  |  |  |
|  | Paddy Rice Policy |  |  |  | [National Rice Development Strategy](https://riceforafrica.net/wp-content/uploads/2021/09/rwanda_en.pdf)  [Rice Strategy 2021-2030](https://riceforafrica.net/wp-content/uploads/2022/02/nigeria_nrds2.pdf) |
|  | Inspection policy |  |  |  | [Rwanda Quality Policy](https://rwandatrade.rw/media/2010%20MINICOM%20National%20Quality%20Policy.pdf) |
|  | Livestock policy |  |  |  |  |
|  | Nutrition-sensitive agriculture mainstreaming guideline | Innovation and extension, productivity and market value chain, enabling government and responsible institution | RAB, NAEB, RICA, RSB | RAB, NAEB, RSB, RICA, NIRDA, Local Government, Research institution, Private sector, NGO |  |

## Annexe 3: Initiatives

List of AKIS initiatives in Rwanda

| **No.** | **Initiative** | **Objective** | **Implementing organization** | **Targeted stakeholders** | **Link** |
| --- | --- | --- | --- | --- | --- |
|  | Smart Nkunganire system | - Input subsidy management  - monitor the distribution of subsidised inputs | BK tech house | Farmers; Farmer organization; agro-dealers; fertiliser companies; local government; BK Tech House; RAB; OAF; MINALOC | [SNS](https://www.minagri.gov.rw/updates/news-details/smart-nkunganire-system-to-enhance-access-to-agriculture-inputs) |
|  | Smart Kungahara System | Digitise cash crop value chain (coffee, tea, horticultural crops | NAEB | Farmers; Farmer organization; agro-dealers; fertiliser companies; local government | [SKS](https://smartkungahara.rw/#/) |
|  | Land ownership through the land administration information system (LAIS) |  |  |  | [Land administration](https://landportal.org/node/38457) |
|  | CROM-DSS (catchment-based land restoration opportunity mapping decision support system) | Tools to help field operators to identify priority sites for soil erosion and landslide mitigation  Restoration measures | Rwanda water board | RAB; Local government | [CROM DSS](https://docplayer.net/203761268-Catchment-restoration-in-rwanda-crom-dss-a-gis-model-to-support-decision-making-on-catchment-restoration-africagis-2019.html) |
|  | YEAN platform | Providing technical information on crop and livestock | YEAN | Value chain actors; RAB; MINAGRI | [YEAN](https://yeanagro.org/) |
|  | RwaSIS | - To provide information on soil erosion hot spots  - To develop a tool where the information can be channelled  - To develop lime and fertilizer site-specific recommendations | RAB | Farmers; National land authority; Financial institutions; RISA; Water use associations; Investors; Exporters; Producers; Processors |  |
|  | E-soko | To provide market information for different commodities | MINAGRI and MINICOM | Farmers; Financial institutions; Water use associations; Investors  Exporters; Producers; Processors | [e-Soko](https://esoko.com/) |
|  | Maproom | To collect maps and data for climate and environmental monitoring | Meteo Rwanda | Decision makers; Agricultural extensionists; Health institutions; Disaster management entities; Academics | [Meteo Rwanda Map Room](http://maproom.meteorwanda.gov.rw/maproom/index.html) |
|  | Carbon footprint | Carbon credit calculation to reduce CO2 emissions | REMA | RICA; REMA; RSB; Manufacturers; NGOs |  |
|  | National agriculture uses insurance | - Decrease the risk in agriculture  - To develop farmers to access loans. | MINAGRI, BK Company Insurance |  |  |
|  | MOPA System |  |  | SAIP |  |
|  | Tekana Muhinzi Mworozi |  |  |  |  |

## Annex 4: Workshop Program

**NATIONAL AND SUB-NATIONAL WORKSHOPS AGENDA (Kigali)**

| TIME | | TOPICS/ACTIVITIES |  | RESPONSIBLE |
| --- | --- | --- | --- | --- |
|  | **DAY ONE –10 November 2022** | | | |
| 8:00 - 8:30 am | | Arrival and Registration |  | RAB-Adm |
| 8:30 - 9:00 am | | * Welcome Remarks. Objectives of the Workshop and overview of the agenda * RwaSIS system development | Jules | RAB |
| Introduction of the participants | Jules |
| 9:00 - 9:45 am | | Opening remarks:   * Opening Remarks | DDG | RAB |
| 9:45 - 10:00 am | | Overview of the DeSIRA LSC-IS project | Frank/ Recha | WCDI, ISRIC |
| 10:00 - 10:30 am | | **Activity 1.** Presentations to provide a background of the project   * Overview of current state of LSC-AKIS- ICT/LSC adoption * Use cases and examples from established systems * Presentation on the draft sketched AKIS – specifying the configuration for the two identified use cases | Recha and Jules | RAB |
| **10:30-11.00** | | **HEALTH BREAK** |  | **All** |
| 11:00am -12:30 pm | | **Activity 2.1** Group work on Identification of key stakeholders/partners, their roles (users, suppliers, or both -intermediaries), and challenges and opportunities in producing or use of LCS information | Celestin and Recha | Facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF & ASARECA) |
| 12:30- 1.00 pm | | **Activity 2.2** Session Reflection activity and Group plenary presentations | Celestin |
| **1.00-2.00 pm** | | **LUNCH** |  | **All** |
| 2.00-4.00 pm | | **Activity 3**. Group work - Specifying LSC-information needs and LSC-information users- identify data sets for specified use cases: (Template 4,5, 6 and 7: Used to guide the group discussions) | Olivier | Facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 4.00-4.30 pm | | Wrap-up and closure of the day:   * Review, summary, and capture emerging questions | Recha | WCDI |
| * Announcements | Jules | RAB |
| **4.30-5.00** | | **Health Break and end of day 1** |  |  |
| **5.00-6.00** | | **Core-team reflections** |  |  |
|  | **DAY TWO – 11 November 2022** | | | |
| 8:00 – 8:30 am | | Registration and Day - 2 Agenda Overview | Chantal | DG-Adm |
| 8:30 – 8:45 am | | Recap of Day-1 | Blaise | ASARECA |
| 8:45 - 10:00 am | | **Activity 3.1** Session Reflection activity and Group plenary presentations | ISRIC | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 10.00-10.30 am | | **Activity 4.** Group work - Identifying capacity requirements for LSC-information use and users to inform hub development: (Use template 9 to guide the discussion) | Ermias and Eric | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| **10:30 -11.00** | | **HEALTH BREAK** |  |  |
| 11:00-12.30 pm | | **Activity 4** continues Group work - Identifying capacity requirements for LSC-information use and users to inform hub development (Use template 9 to guide the discussion) | Ermias and Eric | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA |
| 12.30 -1.10 pm | | **Activity 4.1** Group plenary presentations and Reflection Activity | Ermias and Eric | All groups |
| **1.15-2.15 pm** | | **LUNCH** |  |  |
| 2.15-3.15 pm | | **Activity 5**: Participants identify AKIS policies/initiatives related to the use cases (using template 3) | John and Jules | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 3.00-3.30 pm | | **Activity 5.1** Group plenary presentations and Reflection Activity | John and Jules | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 3.30-4.00 pm | | **Activity 6:** Expand/unpack the outputs to clarify, and linkages to other Work-Packages:   * Work-Package 3- LSC-hub development * Work-Package 4- LSC-hub use at national level * Work Package 5- LSC-hub use at local level | John and Jules | RAB-ILRI |
| 4.00-4.30 pm | | Summary, next steps, and meeting closure | John | ILRI |
| 4:30-4:40 pm | | Workshop evaluation | Jules | RAB |
| **4.40-5.00 pm** | | **Health Break and departure** |  |  |
|  | | **Core-team reflections** |  |  |

**SUB-NATIONAL WORKSHOPS AGENDA (Musanze)**

| TIME | TOPICS/ACTIVITIES |  | RESPONSIBLE |
| --- | --- | --- | --- |
|  | **DAY ONE –Monday 14 November 2022** | | |
| 8:00 - 8:30 am | Arrival and Registration |  | ILRI |
| 8:30 - 9:15 am | · Welcome Remarks. Objectives of the Workshop and overview of the agenda  · RwaSIS system development | Jules | RAB |
| Introduction of the participants | Jules |
| Participants Expectations, Questions and Comments | Blaise | ASARECA |
| 9:15 - 9:45 am | Overview of the DeSIRA LSC-IS project | Frank/ Recha | WCDI, ISRIC |
| 9:45 - 10:30 am | **Activity 1.** Presentations to provide a background of the project  · Overview of current state of LSC-AKIS- ICT/LSC adoption  · Use cases and examples from established systems  · Presentation on the draft sketched AKIS – specifying the configuration for the two identified use cases | Recha and Jules | RAB |
| **10:30-11.00** | **HEALTH BREAK** |  | **All** |
| 11:00am -12:30 pm | **Activity 2.1** Group work on Identification of key stakeholders/partners, their roles (users, suppliers, or both -intermediaries), and challenges and opportunities in producing or use of LCS information | Recha, Kennedy, Blaise | Facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF & ASARECA) |
| 12:30- 1.00 pm | **Activity 2.2** Session Reflection activity and Group plenary presentations | Recha, Kennedy, Blaise |
| **1.00-2.00 pm** | **LUNCH** |  | **All** |
| 2.00-4.00 pm | **Activity 3.1** Group work - Specifying LSC-information needs and LSC-information users- identify data sets for specific use cases: (Template 4,5, 6 and 7: Used to guide the group discussions) | Recha, Kennedy, Blaise | Facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 4.00-4.30 pm | Wrap-up and closure of the day:   * Review, summary, and capture emerging questions | Recha | ILRI |
| * Announcements | Jules | RAB |
| **4.30-5.00** | **Health Break and end of day 1** |  |  |
| **5.00-6.00** | **Core-team reflections** |  |  |
|  | **DAY TWO – Tuesday 15 November 2022** | | |
| 8:00 – 8:30 am | Registration and Day - 2 Agenda Overview | Chantal | DG-Adm |
| 8:30 – 8:45 am | Recap of Day-1 | Blaise | ASARECA |
| 8:45 - 10:00 am | **Activity 3.2** Session Reflection activity and Group plenary presentations | Recha, Kennedy, Blaise | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 10.00-10.15 am | Expand/unpack the outputs to clarify, and linkages to other Work-Packages:  · Work-Package 3- LSC-hub development  · Work-Package 4- LSC-hub use at national level  · Work Package 5- LSC-hub use at local level | Recha and Thaisa | ISRIC-ILRI |
| **10:15 -10.45** | **HEALTH BREAK** |  |  |
| 10:45-12:30 | **Activity 4.1** Group work - Identifying capacity requirements for LSC-information use and users to inform hub development: (Use template 9 to guide the discussion) | Ermias and Eric | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 12.30-1.30 pm | **Activity 4.2** Group plenary presentations and Reflection Activity | Ermias and Eric | All groups |
| **1.30-2.30 pm** | **LUNCH** |  |  |
| 2.30-3.30 pm | **Activity 5.1** Participants identify AKIS policies/initiatives related to the use cases (using template 3) | Recha, Kennedy, Blaise | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 3.30-4.00 pm | **Activity 5.2** Group plenary presentations and Reflection Activity | Recha, Kennedy, Blaise | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 4.00-4.30 pm | Summary, next steps, and meeting closure | Recha | ILRI |
| 4:30-5:00 pm | Workshop evaluation | Recha | ILRI |
| **5.00 pm** | **Departure** |  |  |
|  | **Core-team reflections** |  |  |

**SUB-NATIONAL WORKSHOPS AGENDA (Rwamagana)**

| TIME | | TOPICS/ACTIVITIES |  | RESPONSIBLE |
| --- | --- | --- | --- | --- |
|  | **DAY ONE –17 November 2022** | | | |
| 8:00 - 8:30 am | | Arrival and Registration |  | RAB-Adm |
| 8:30 - 9:00 am | | · Welcome Remarks. Objectives of the Workshop and overview of the agenda  · RwaSIS system development | Jules | RAB |
| Introduction of the participants | Jules |
| 9:00 - 9:45 am | | Opening remarks:  · Opening Remarks by Taita-Taveta County Government | DDG | RAB |
| 9:45 - 10:00 am | | Overview of the DeSIRA LSC-IS project | John | WCDI, ISRIC |
| 10:00 - 10:30 am | | **Activity 1.** Presentations to provide a background of the project  · Overview of current state of LSC-AKIS- ICT/LSC adoption  · Use cases and examples from established systems  · Presentation on the draft sketched AKIS – specifying the configuration for the two identified use cases | John and Jules | RAB |
| **10:30-11.00** | | **HEALTH BREAK** |  | **All** |
| 11:00am -12:30 pm | | **Activity 2.1** Group work on Identification of key stakeholders/partners, their roles (users, suppliers, or both -intermediaries), and challenges and opportunities in producing or use of LCS information | Celestin and John | Facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF & ASARECA) |
| 12:30- 1.00 pm | | **Activity 2.2** Session Reflection activity and Group plenary presentations | Celestin |
| **1.00-2.00 pm** | | **LUNCH** |  | **All** |
| 2.00-4.00 pm | | **Activity 3**. Group work - Specifying LSC-information needs and LSC-information users- identify data sets for specific use cases: (Template 4,5, 6 and 7: Used to guide the group discussions) | Olivier | Facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 4.00-4.30 pm | | Wrap-up and closure of the day:  · Review, summary, and capture emerging questions | John | WCDI |
| · Announcements | Jules | RAB |
| **4.30-5.00** | | **Health Break and end of day 1** |  |  |
| **5.00-6.00** | | **Core-team reflections** |  |  |
|  | **DAY TWO – 18 November 2022** | | | |
| 8:00 – 8:30 am | | Registration and Day - 2 Agenda Overview | Chantal | DG-Adm |
| 8:30 – 8:45 am | | Recap of Day-1 | Blaise | ASARECA |
| 8:45 - 10:00 am | | **Activity 3.1** Session Reflection activity and Group plenary presentations | Likoko | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 10.00-10.30 am | | **Activity 4.** Group work - Identifying capacity requirements for LSC-information use and users to inform hub development: (Use template 9 to guide the discussion) | Ermias and Eric | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| **10:30 -11.00** | | **HEALTH BREAK** |  |  |
| 11:00-12.30 pm | | **Activity 4** continues Group work - Identifying capacity requirements for LSC-information use and users to inform hub development (Use template 9 to guide the discussion) | Ermias and Eric | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA |
| 12.30 -1.10 pm | | **Activity 4.1** Group plenary presentations and Reflection Activity | Ermias and Eric | All groups |
| **1.15-2.15 pm** | | **LUNCH** |  |  |
| 2.15-3.15 pm | | **Activity 5**: Participants identify AKIS policies/initiatives related to the use cases (using template 3) | John and Jules | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 3.00-3.30 pm | | **Activity 5.1** Group plenary presentations and Reflection Activity | John and Jules | Co-facilitators (RAB, ILRI, ISRIC, WCDI, ICRAF, ASARECA) |
| 3.30-4.00 pm | | **Activity 6:** Expand/unpack the outputs to clarify, and linkages to other Work-Packages:  · Work-Package 3- LSC-hub development  · Work-Package 4- LSC-hub use at national level  · Work Package 5- LSC-hub use at local level | John and Jules | RAB-ILRI |
| 4.00-4.30 pm | | Summary, next steps, and meeting closure | John | ILRI |
| 4:30-4:40 pm | | Workshop evaluation | Jules | RAB |
| **4.40-5.00 pm** | | **Health Break and departure** |  |  |
|  | | **Core-team reflections** |  |  |

## 

## Annex 5: Workshop Participants

**List of participants for the national workshop in Kigali**

| **No** | **GOVERNMENT OFFICERS CATEGORY** | **Organisation** | **Position** | **Email Address** | **Telephone** |
| --- | --- | --- | --- | --- | --- |
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| 30 | Mujawamariya Providence | ICRAF Rwanda | Country Representative | [a.mukuralinda@cgiar.org](mailto:a.mukuralinda@cgiar.org) |  |
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| 32 | Alexis Mugayi | World Vision | Officer | [infowvrwanda@wvi.org, alex.qmw@gmail.com](about:blank) |  |
| 33 | Aurore Regine Ingabire | CNFA | Agronomist | [aingabire@cnfarwanda.org](mailto:aingabire@cnfarwanda.org) |  |
| 34 | Milly Mbuliro | Nile Basin Initiative | Water Resources Officer (GIS/modeller) | Mmbuliro@nilebasin.org |  |
| 35 | Ulan TURDUKULOV | ISRIC | Senior Expert Spatial Data Infrastructures | ulan.turdukulov@wur.nl |  |
| 36 | Thaïsa van der Woude | ISRIC | Project manager | [thaisa.vanderwoude@isric.org](mailto:thaisa.vanderwoude@isric.org) |  |
| 37 | Representative | IUCN Kigali | Program officer |  |  |
| **AGRICULTURAL KNOWLEDGE INSTITUTIONS CATEGORY** | | | | | |
| 38 | Mugisha John baptiste | MINAGRI | Digital System Administration Specialist | [jbmugisha@minagri.gov.rw](mailto:jbmugisha@minagri.gov.rw) |  |
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