A Roadmap Towards a Sustainable Soil Information System in Ghana

Application of the Framework for Sustainable National Soil Information Systems

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Executive Summary

This roadmap outlines the strategic steps for strengthening Ghana's Soil Information System (GhaSIS) to enhance agricultural productivity, soil health, and informed decision-making for sustainable soil management. It builds on insights from the "Ghana Soil Information System: Roadmap Development Workshop" held in October 2024 in Koforidua, co-hosted by CABI, ISRIC-World Soil Information, and CSIR-SRI. Participants from various sectors addressed common data and capacity challenges and discussed long-term financial sustainability options for GhaSIS.

The workshop reviewed seven components of the SIS framework, crucial for GhaSIS's success: 1) envisioning the SIS, 2) enabling environment, 3) needs assessment, 4) SIS design, 5) partnership development and sustainability plan, 6) data strategy, and 7) organizational and financial sustainability plan. The roadmap includes an overview of each component, addressing available information, gaps, and recommendations, which are optional for the GhaSIS project team to consider.

The **key potential next steps** for SRI to consider include:

1. Draft a comprehensive concept note for GhaSIS development for the West Africa Hub meeting in November, using CABI and ISRIC's outline (Annex VI).
2. Establish steering and technical committees to define roles, responsibilities, and activities.
3. Finalize the financial sustainability plan with input from all partners.
4. Organize a validation workshop with broader stakeholder participation once design and work plans are prepared and next steps are consolidated.

Acknowledgments

More information, supporting resources and useful tools for each of the components available in the online SIS framework, hosted on ISRIC's Resource Library (https://resources.isric.org/sis-framework/). If there are any questions or aspects of the roadmap that require further support or input from CABI and ISRIC, kindly contact fair@cabi.org or thaisa.vanderwoude@isric.org.

Acronyms and abbreviations

AFSIS: Africa Soil Information Service
ANSIS: Australian National Soil Information System
APNI: African Plant Nutrition Institute
ATCS: Africa Targeted Climate-Smart Agriculture Solutions
CABI: CAB International
CADER: Centre for Agricultural Development and Extension Research
CSIR-SRI: Council for Scientific and Industrial Research - Soil Research Institute
DAES: Directorate of Agricultural Extension Services
DMAP: Data Management Access Plan
FAIR: Findable, Accessible, Interoperable, and Reusable (data principles)
FERARI: Fertilizer Research and Responsible Innovation Project (IFDC-led)
GIDA: Ghana Irrigation Development Authority
GIS: Geographic Information System
GhaSIS: Ghana Soil Information System
INSTI: Institute for Scientific and Technological Information
ISRIC: International Soil Reference and Information Centre
iSDA: Innovative Solutions for Decision Agriculture
LT-LEDS: Long-Term Low Emission Development Strategies
MAG: Modernizing Agriculture in Ghana
MESTI: Ministry of Environment, Science, Technology, and Innovation
MoFA: Ministry of Food and Agriculture
MRV: Monitoring, Reporting, and Verification
NDC: Nationally Determined Contributions
NITA: National Information Technology Agency
OFRA: Optimizing Fertilizer Recommendations in Africa
PFJ 2.0: Planting for Food and Jobs Phase 2
SAPIP: Savannah Agricultural Productivity Improvement Project
SIA: Soil Initiatives for Africa
SIS: Soil Information System
SRID: Statistics, Research, and Information Directorate (MoFA)
UM6P: Mohammed VI Polytechnic University
USAID: United States Agency for International Development

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1   Introduction

A Soil Information System (SIS) is not just a digital platform but a collaborative tool that engages stakeholders—from government agencies to farmers—to improve data access, soil health management, and informed decision-making in Ghana's agriculture sector. Understanding how these people and institutions should work together, and aligning on who is responsible for what, is a critical step to ensuring the progress of the SIS. There are three levels to consider: the individual (suitable skills, knowledge, competencies, and attitudes), the organizational (efficient structures, processes, and procedures), and the governmental level (establishment of adequate institutions, laws, and regulations).

The project *A Process Toward Strengthening National Soil Information Services,* led by CAB-International and ISRIC – World Soil Information, supported by the Bill & Melinda Gates Foundation, has created a framework for SIS development, assessing these levels at the start of a SIS intervention. The SIS Framework can help identify activities needed to fulfil the SIS objectives, deciding also on the sequence in which these activities are best

performed, who is going to do them, and identifying potential risks, with each specifically tailored to the country context.

In October 2024, the framework was further refined during the "Ghana Soil Information System: Roadmap Development Workshop". This document gathers the information collected and validated during the workshop and proposes a suggested roadmap for implementing GhaSIS. A roadmap is a strategic plan that details the steps required to achieve a specific goal. In this instance, the goal is a sustainable national SIS in Ghana that will last beyond the initial phases of project funding, be built on best practices, and will continue to meet the needs of users.

The intention is that the SIS owner and SIS operator (MoFA/SRI – Soil Research Institute) and members of the newly formulated temporary governance and technical steering committees will be able to refer to the roadmap throughout the strengthening process of GhaSIS to ensure continued alignment with the stated purpose of the SIS.

2 Preparation activities for the roadmap

2.1 The SIS framework

CABI has identified patterns of success factors and common limitations across SIS development and maintenance based on comprehensive review and analysis of existing and past SIS. Accompanied by ISRIC's findings on best practice methods, standards, and tools for SIS development, both technological and socio-institutional considerations were integrated to develop the SIS framework.

An important aspect of this framework is that it seeks to adopt the FAIR data principles. This means that soil data will be Findable, Accessible, Interoperable and Reusable. FAIR data is important for SIS, because it ensures the highest value and usability of data. Throughout the SIS framework's supporting resources, you will see references to "FAIR Process Framework" steps, developed by CABI, that will enable the implementation of best data practices throughout the development and lifecycle of a SIS.

The SIS framework follows a multi-stakeholder engagement approach and is for anyone in the soil community who is interested in developing or funding a SIS, or anyone who would like to improve their existing SIS. It also provides guidance for SIS owners, system developers, funders, implementing partners, and research institutions involved to ensure their investments lead to sustainable outcomes.

The framework has four phases: initiation, planning and design, implementation and operational. Within each phase, there are "components", which contain suggested activities, accompanied by guiding questions, recommended tools, and supporting resources to make the process as practical and easily usable as possible. The activities within each component are intended as optional and the SIS project team decides which ones to execute. The SIS framework is used as the foundation for the development of the GhaSIS roadmap.

2.2 Component 0: the checklist

In preparation for the roadmap development workshop, the CABI and ISRIC team conducted an online interview with SRI to go through component 0: the checklist, to help identify which key activities have already been completed, which are in progress, and which activities have not been started. Together with CSIR-SRI, priority activities were selected to guide the focus of the workshop (the complete checklist for GhaSIS can be found in Annex II). These were:

- Align with stakeholders on the mission, definition, and goals of the SIS.

- Develop a clear financial sustainability plan for the SIS.
- Discuss the challenges around data sharing with the stakeholders and identify possible solutions, including aligning on FAIR data principles for the SIS.
- Clearly understand and define the roles, responsibilities, and data/value exchanges between stakeholders.
- Clearly define the needs of end-users to inform the design of the SIS.

2.3 The workshop

The Ghana Soil Information System (GhaSIS) Roadmap Development Workshop was held on October 8-9, 2024, in Koforidua, Ghana. The event was organised by CABI and ISRIC – World Soil Information, in collaboration with the CSIR-SRI, and co-funded by the Bill & Melinda Gates Foundation and ISRIC – World Soil Information. The workshop aimed to apply the SIS framework and design a roadmap to strengthen GhaSIS, ensure its long-term operation and sustainability, and enhance access to soil data for decision-makers, farmers, and other stakeholders in Ghana's agricultural sector.

The workshop attracted a diverse range of 35 participants from across the agricultural value chain (a complete list is available in Annex III). Over the course of two days, the sessions included presentations, group discussions, and breakout activities to understand common challenges, identify stakeholders' requirements for data and the system itself, brainstorm issues pertaining to financial sustainability, and develop strong partnerships to drive the improvements of GhaSIS forward (the full agenda is available in Annex III). An overview of the workshop, including interviews with key stakeholders, can be viewed here.

Commented [MA1]: The team is currently working on putting together a short YouTube video that gives an overview of the workshop and includes some interviews from key stakeholders who attended the workshop. We will add the link to that here, once it is uploaded.

3 The roadmap for strengthening GhaSIS

3.1 Component 1: Envisioning

The first component in the SIS framework is "envisioning", which seeks to guide decision-making, strategic planning, and obtain national government buy-in from the very beginning. It does this by setting clear definitions, objectives, long-term goals, and desired outcomes of the SIS. Generally, goals are broad, general intentions that guide the direction of the SIS towards the intended future state, whereas the objectives are specific, measurable actions that must be taken to achieve the goals. The output of envisioning is intended to be revised and aligned later in the framework, after more detailed assessment and information-gathering.

3.1.1 Define the problem, mission statement, and SIS definition.

Workshop findings:

- SRI outlined an initial mission for GhaSIS, focusing on three core objectives:
    - **Provide essential soil data**: Deliver comprehensive soil data to support agriculture, environmental management, and infrastructure development.
    - **Support decision-making**: Enable informed decisions on soil health, land use, and policy development.
    - **Monitor soil health**: Enhance monitoring of soil degradation, fertility, and moisture content to guide sustainable land use.
- SRI vision for GhaSIS capabilities:
    - **Support national goals**: Guide the national government's decisions on the low emission strategy (NDC/LT-LEDS) with relevant soil and environmental data.
    - **Contribute to PFJ 2.0**: Support MoFA's Planting for Food and Jobs program (PFJ 2.0) by providing soil data to increase the yield of the target crops.
    - **Leverage historical data**: Analyse soil data trends dating back to 1984 to inform crop nutrient management and policy decisions.
- SRI also referenced the existing mission statement on the CSIR Soil Information hub, which will be shared with stakeholders for alignment and feedback
- Key considerations
    - **Align with stakeholder agendas**: SRI have a working document on the mission and definition of GhaSIS that they will share with the wider stakeholder group for their input.
    - **Align on the focus of GhaSIS**: There is a need to strategically align the SIS with key stakeholders' agendas. It was discussed that initially, the SIS should

focus on agricultural users only, and once it is online and meeting initial target users' needs, then it can be expanded to other relevant areas such as mining, land planning, and public health. However, it was also discussed that the SIS should start by addressing in-demand emerging topics, such as soil pollution, emission factors, and mining, which were highlighted during breakout sessions.

Recommended additional next steps:

- **Align on the target users and the use cases** for the initial launch of GhaSIS, considering a phased approach for including a smaller target group first, then to widen the scope to more users and use cases.
    - o Other questions to consider addressing in SRI's working document:
        - When defining the SIS, is it considered only as the digital platform itself? Or does the SIS also include the larger context of stakeholders and activities that enable and support the digital platform, as well as the use cases it seeks to serve?
        - What are the desired outcomes from the creation of the SIS?
- **Review the example SIS mission** statement from a convening of key SIS stakeholders in Nairobi, March 2024: *"A multi-stakeholder, demand driven public good platform that collects, stores and serves soil data and enables decision and policy support to address food and nutrition security, land conservation and rehabilitation, climate change resilience."*
- *More guidance can be found on the SIS framework platform* [here](#).

3.1.2   Articulate the value proposition and business case for government support.

Workshop findings:

MoFA representatives, including the Director of Crop Services and Deputy Directors, voiced strong support for GhaSIS, emphasizing its importance in advancing government initiatives to improve advisory services and promote food security. GhaSIS is well-positioned to support MoFA's Planting for Food and Jobs (PFJ 2.0) initiative.

Private sector representatives expressed interest in accessing high-quality, tailored soil data and indicated a willingness to pay for such information. Identifying and engaging these potential paying users will strengthen the business case and help demonstrate GhaSIS's value across sectors.

Recommended additional next steps:

- **Align GhaSIS objectives with MoFA's priorities**: Identify aligned objectives (current and upcoming), between MoFA initiatives and GhaSIS activities- this could be done by the SRI lead and the relevant representatives of the different MoFA department.
- **Document benefits for stakeholders**: Consider clearly documenting the benefits of GhaSIS to the different stakeholder groups, beyond the high-level benefits. Consider how the SIS brings value to private sector, public sector, NGO, and development community actors.
  - Review this example of the benefits documented by Australia's National SIS (ANSIS).
- **Assess market demand**: Consider engaging with more potential users of GhaSIS to assess their willingness and readiness to pay for soil data, finding out what each stakeholder's interests are and how the SIS can benefit them.
  - Review the use case of New Zealand SIS on the pay model for their SIS.
- **Implement a phased payment model**: Establish GhaSIS with high-quality data to demonstrate its value to users. Consider introducing payment options once the system has proven its benefits to stakeholders.
- *More guidance can be found on the SIS framework platform here.*

3.1.3 Discuss potential roles, ownership and funding.

Workshop findings:

Feedback from the workshop highlighted the need for clear definitions of SIS ownership and operation. It was discussed that MoFA could be the overall owner, responsible for securing long-term funding and ensuring GhaSIS aligns with national priorities. Whereas SRI is also seen to be the operational owner, overseeing development, governance, and maintenance.

A steering committee and technical committee were initially formed with representatives from key stakeholder groups. SRI will draft Terms of Reference (ToR) for both committees and seek input from all participants.

- *Recommended additional next steps:*

- **Clarify MoFA's role**: Ensure clear alignment on the role of MoFA and what the expectations of them are as being responsible for GhaSIS receiving adequate, continuous funding.
- **Establish a Terms of Reference (ToR)**: Develop ToRs for both the steering and technical committees.
  - Review the draft ToR for that was developed for the Kenya SIS steering committee in Annex VII.

- **Define key roles and responsibilities:** Consider reviewing the list of roles required for SIS development in Appendix 2 of A Process Towards Strengthening National Soil Information Services: New Evidence for a SIS Development Framework and the report on the Landscape of key stakeholders for the development of SIS.
- *More guidance can be found on the SIS framework platform here.*

3.1.4 Set short-, medium-, and long-term goals

Workshop findings:

To ensure a focused approach, it is recommended to define GhaSIS's scope and target users early on. The initial launch should address the needs of primary users, allowing for system expansion as it matures.

Recommended additional next steps:

- **Set up specific goals:** Once key stakeholders have agreed on the problem statement, mission, and SIS definition, then specific goals can be set and agreed upon by the SIS owner, SIS operator and the steering committee.
- **Goal structure**:
    - Short-term goals might include, for example: establish a simple, functional SIS that is accessible and serves some of the needs of some of the identified user groups.
    - Medium-term goals might include, for example: add specific functionalities for additional users, or expand data collection / sampling schemes for increased spatial coverage.
    - Long-term goals might include, for example: providing data, information, and related services to policymakers to support updates to specific agricultural and soil policies, and to help decision-makers in other sectors.
- *More guidance can be found on the SIS framework platform here.*

3.2 Component 2: Enabling environment assessment

The second component of the SIS framework is "enabling environment assessment". This entails developing a detailed description of the existing "system" of stakeholders, institutions, policies, and resources surrounding soil data and information, and identifying the gaps to support the planning and development of the new SIS effort or initiative.

3.2.1 Develop stakeholder and data ecosystem map.

Workshop findings:

Using the workshop invitee list, a stakeholder and data ecosystem map was created on the platform kumu. The group categorised each stakeholder as one of the following:

- Policy makers
- Data users
- Regulators
- Contributors (data providers, advisory, and financial contributions)
- Beneficiaries
- Data stewards
- Intermediaries

This ecosystem map serves as a strategic visual tool that depicts the collection, sharing, and utilization of data across a network of your specific digital ecosystem, considering stakeholders, data, and processes relevant to the development of the SIS. It lays out the roles of various stakeholders and the dynamic interrelations in this space, including Value Exchanges. The map visualizes the flow of your digital solutions data, identifying components of value creation, and highlighting the integration of digital tools and data in achieving your project's ultimate goals and activities.

Recommended additional next steps:

- **Foster collaboration and data sharing:** Continue to collaborate with pre-existing efforts and encourage a culture of responsible data sharing.
- **Identify collaboration opportunities:** Draw upon the GhaSIS Data Ecosystem Map, to identify opportunities for data sharing and collaboration.
- **Expand to other domains:** When GhaSIS is ready to broaden its scope to a wider audience of end users, consider reviewing the list of other domains that use soil data on page 3 of the Guide for an Assessment of the Enabling Environment.
- *More guidance can be found on the SIS framework platform here.*

3.2.2 Conduct enabling environment assessment

Workshop findings:

- Social/cultural:
  - **Data sharing concerns:** Stakeholders expressed hesitancy in sharing data due to concerns over what their data could be used for and lack of attribution.
  - **Incentives for data producers:** Data providers emphasized the need for clear incentives from SRI to support data-sharing efforts.
- Political:
  - **Election Impact**: Anticipate potential effects of the upcoming December 2024 elections on project continuity.
  - **Data Protection Act**: Ensure GhaSIS compliance with the Data Protection Act to safeguard privacy and data integrity.
- Institutional:
  - **SRI mandate:** SRI is mandated "to undertake scientific research to generate technologies (information), commercialize these technologies and build capacity in sustainable management of Ghana's soil resources for increased agriculture, environmental quality and improved livelihood", but those who need soil data are mostly contacting universities instead of SRI.

  - **Data Access Structures**: CSIR's existing approval processes for data sharing should be clearly communicated to all stakeholders.

- Existing in-country initiatives and legislation:

  - **Relevant legislation**: Plants and Fertilizer Act, 2010 (No. 803). (PFJ 2.0)
  - **Ongoing Initiatives:** AGRA PIATA, RECSOIL, APNI ATCS, SoilFER, EJP Soil C-arouNd, Soils4Africa, AfSIS, SAPIP, OCP-SRI, MAG, SOILS Space-to-Place, FERARI- IFDC
- Technical:
  - **Data Protection Compliance**: GhaSIS must comply with the Data Protection Act and maintain SRI's ISO certification.

  - **Digitalisation requirements:** GhaSIS will need infrastructure support for data hosting, including servers, workstations and potentially cloud storage for big data.

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- o **Human resources and partnerships:** Expanding partnerships and enlisting technical expertise are essential for ongoing data updates and solutions development.
- o **Existing resources**:
  - Esoko – provide information for smallholder farmers. This is also what Farmerline uses.
  - NITA – creates the enabling environment for effective deployment and use of ICT by all sectors in Ghana.
  - UM6P provide access to high computation operations and clusters analysis.
  - iSDA – provide field-level soil maps for Africa and offered to assist with technical aspects of the development of the SIS.

Recommended additional next steps:

- **Review budget and financial needs:** Consider whether there is someone within SRI that has the relevant financial/business analyst expertise to review existing budget and cost recovery structures.
- **Address data gaps:** Review existing data inventories and identify what data are missing and how will that gap be addressed?
- **Standardise data across GhaSIS:** Consider how you can ensure the same data standards are used across the GhaSIS ecosystem.
- **Investigate existing resources:** Which organisations already exist that can help with developing GhaSIS, collecting soil information, creating soil maps and support computational efforts for GhaSIS?
- *More guidance can be found on the SIS framework platform here.*

3.3 Component 3: Needs assessment

The third component of the SIS framework is the needs assessment. The goal is to understand *who* the data users and producers are, *how* they interact with soil data, and *what* are their challenges, needs, and priorities. This will support the planning and development of the new SIS effort or initiative by focusing activities on the people, institutions, and areas of greatest need.

3.3.1 Conduct needs assessment

Workshop findings:

- SRI identified key end-user groups who require data from GhaSIS: including:
  - **Farmers and agricultural organisations.**

- o **Environmental agencies and land-use planners.**
  - o **Researchers and academic institutions.**
  - o **Government and policy-making bodies.**
  - o **NGOs focused on sustainability.**
- SRI also outlined the types of data these end users need:
  - o **Soil properties**: nutrients, pH levels, moisture, texture, soil pollution hotspots.
  - o **Spatial data:** geographic distribution of soil types.
  - o **Temporal data:** seasonal changes and historical trends.
  - o **Environmental data:** climate, topography, and land use patterns.
- An initial stakeholder list of specific contributors, beneficiaries, and end users has been documented in the GhaSIS Data Ecosystem Map. Key identified end users include organisations such as:

  - o YARA
  - o OCP
  - o CADER
  - o Mining companies
  - o IFDC
  - o University of Cape Coast
  - o FAO
  - o iSDA
- **Private Sector Needs**: SRI emphasized that assessing the private sector's data needs is crucial, as many potential users in this sector may also be data contributors or funders.

Recommended additional next steps:

- **Review existing use cases:** Review the list of current use cases, key issues to address and key applications of soil data on page 4 of this case study.
- **Engage with stakeholders:** Refer to the stakeholders and end users identified in the GhaSIS Data Ecosystem Map, as a starting point for who to engage with to assess their needs (but it is encouraged to build on this further).
- **Consult SIS development resources:**
  - o Refer to Chapter 2 of Development options for a Soil Information Workflow and System for guidance on conducting needs assessment.
  - o Refer to Annex I in Development options for a Soil Information Workflow and System for guidance on assessing technical capacities.

3.4 Component 4: Idealized system design

The fourth component is the idealized system design. The goal is to develop a comprehensive description of how the ideal SIS would look, operate, function, and/or deliver information to its users if there were no resource limitations. Then, prioritise what can be done now and what could be done with some additional resources. This "wish list" description merges the insights from the envisioning (component 1), enabling environment assessment (component 2), and needs assessment (component 3). It then expands upon those insights by defining the details of the SIS, such as data, embedded tools, functionalities, and other characteristics that respond to the needs and constraints identified in earlier steps.

3.4.1   Identify what information the ideal SIS would contain

Workshop findings:

- **Metadata:** Include metadata with clear data conversions (variables and components), indicating sources for user reference and ownership.
- **Soil maps:** Soil maps that can be used by farmers, policy makers – crop suitability maps.
- **Fertilizer Recommendations**: Enable data on which fertilizers to use for specific soil types.
- **Multilingual Support**: Offer translations and audio options in multiple languages to enhance accessibility.
- **Weather Data Integration**: Link with weather data to inform agricultural decision-making.
- **Advisory Services**: Investigate possibility to include access to call centres for additional support, with options for region-specific and translatable information.
- **Policy Mapping**: Include maps highlighting vulnerable areas (e.g., swamps, steep slopes) where farming is not advised.

Recommended additional next steps:

> You can refer to ISRIC's technical guidance report to support this: <u>Development options for a Soil Information workflow and System.</u>
>   - o **Important Note:** Incorporate phased development into the architectural design. It is advisable to implement functionalities incrementally, ensuring that each one is fully operational before introducing the next.
>   - o **Review** who within the technical committee has the required expertise and capacity to take on this activity.
> - **Review the example metadata template** from the <u>LSC hub project</u>, which is available in an <u>online ODK form.</u>
> - *More guidance can be found on the SIS framework platform <u>here</u>.*

3.4.2 Develop high-level FAIR aligning principles

Workshop findings:

Stakeholders agreed that FAIR data principles are useful and can strengthen data sharing to have an effective SIS, and as such SRI agreed to build the data sharing template on the FAIR data principles.

Recommended additional next steps:

> - **Review the example FAIR aligning principles in Annex V** and consider developing GhaSIS's own FAIR aligning principles with key stakeholders to create a common vision for data management for improved sharing, which encourages collaborative working that can aid alignment and help develop buy-in.
>   - o Whilst there was a general acknowledgement of the importance of the FAIR data principles, it was not clear from the workshop which institutions have already implemented FAIR into their existing data practices.
>   - o Bringing these stakeholders together again to develop FAIR aligning principles may also bring clarity into how far along each stakeholder is in their "FAIR journey".
>   - o This activity will improve awareness about the importance of FAIR, support building trust between stakeholders, and in turn could improve the "FAIR-ness" of the wider ecosystem GhaSIS operates within.
>   - o If this activity is of interest and you would like to find out more, please contact fair@cabi.org
> - *More guidance can be found on the SIS framework platform <u>here</u>.*

3.4.3 Brainstorm data plan

Workshop findings:

- GhaSIS will be aligned with Ghana's <u>Data Protection Act</u> and ensure GhaSIS's data plan fits within this framework.
- GhaSIS is to be registered with the data protection commission to ensure the correct procedures are followed.

- There is need for GhaSIS to have restrictions on uploads, usage, sharing, accessibility, data format e.g. it will not share raw data, but products such as maps would be made open access. This also gives the opportunity in the future to elicit small fees for more processed data to keep GhaSIS sustainable.
- The design of database template must have key data variables.
- For data capture, the sampling points should be georeferenced and use the same standards. It would be ideal if in the future all soil samplings are obliged to use the same standards to be uploaded in GhaSIS.
- Implement security measures to prevent hacking and consider hosting with (for example) Google to implement multiple encryptions that can be provided (cloud storage).
    - NITA or the Institute for Scientific and Technological Information (INSTI) of CSIR could assist with the data storage. INSTI could lead on the development of design.
- GhaSIS should provide protocols for data producers (field and lab analysis).
    - Technical committee should agree on the protocols.
- The idea is to plan for a self-sustaining GhaSIS containing high quality data.

Recommended additional next steps:

> - **Contact NITA and INSTI** for discussing hosting the data for GhaSIS and their storage opportunities.
> - **Review the example of the law in the Netherlands**: obligation to upload any new soil information to the soil information system – the National Key Registry of the Subsurface Act.
> - **Review the case study of developing** a soil and agronomy data sharing policy in Ethiopia.
> - **Review Ethiopia's Coalition of the Willing guideline** on data collection.
> - **Identify** who within the technical committee will develop the data strategy for GhaSIS and what expertise are missing to formulate this (more information on this is provided in Chapter 3.6).
> - *More guidance can be found on the SIS framework platform here.*

3.4.4   Brainstorm SIS functionalities

Workshop findings:

- During the workshop, various functionalities were mentioned as requests for GhaSIS. GhaSIS should ideally provide:
    - **Algorithms** to upload data in a standardize format.
    - **Soil classification maps**.
    - **A login function** to serve various users.
    - **Guidance for fertilizer recommendations**.

- o **A user-friendly platform** for different users.
- o **A dashboard** showing the traffic of SIS users.
- o **A repository**: GhaSIS doesn't need to store all data itself; instead, it can connect to existing resources via a repository, serving as a centralized access point for information. For instance, while weather data is crucial for understanding soil and crops, it's more effectively maintained by meteorological institutes that continuously update this information. The repository ideally should link to:
  - ▪ Workflows/methodologies used to create soil maps - for researchers.
  - ▪ Crop and geology models that can be used to further process soil data, e.g. FAO's AguaCrop or SWAP (Soil, Water, Atmosphere and Plat) or the crop module of the Soil Water Assessment Tool (SWAT) – for researchers.
  - ▪ OFRA ˗ Fertilizer Optimisation Tool (FOT) – for advisory services.
  - ▪ FERARI- IFDC project which focus on fertilizer research and responsible implementation.
  - ▪ Ghana meteorological Agency (GMet) for weather data.
- The technical committee should be included in the design process and can ensure that end users are also involved in the process to meet their needs (e.g. private sector, farmers, and other service providers).
- There is a need to investigate and plan for the role of generative artificial intelligence (GenAI).
- There may be lessons to be learned from the CSIR space repository.

Recommended additional next steps:

- **Website designer**: considering hiring a website designer to the GhaSIS project team to ensure GhaSIS has a user-friendly design for various users.
- **Review the example** of the Land, Soil, Crop information hub Kenya which uses Terria.JS to visualise spatial information.
- **Review the AI4SoilHealth** project website to investigate the possibilities for AI. There is a free, online conference on **4 December 2024**, also covering GenAI. More info here and register here.
- **Review functionalities** of other existing SISs, e.g. login options.
- *More guidance can be found on the SIS framework platform here.*

3.4.5 Brainstorm feedback and communication plan.

Workshop findings:

- **Feedback mechanisms:** There is a desire for an interactive platform, and so the option of adding a chat box to GhaSIS was discussed.
- **User engagement**:
  - o If accessibility (traffic) is monitored through a dashboard, then these users can be followed up with.

- GhaSIS could examine serving different users with different languages.
  - Audio options in multiple languages was preferred to enhance accessibility, especially if farmers are the end-users.
- **Monitoring plans**: Developing a monitoring and improvement strategy with clear KPIs and reporting was discussed as key for GhaSIS.

Recommended additional next steps:

- **Monitoring plans**: For further guidance specifically on monitoring the system, view the operational phase here.
- **User feedback:** Review the Land, Soil, Crop information hub for Kenya that uses GIT for user feedback collection and review their documentation for different users.
- **Consider the following questions:**
  - Will you provide a platform for data users and data providers to communicate?
  - Do you want to foster an online community through the SIS to ask and answer questions within the community rather than contacting the SIS operators directly?
  - How will the users or operators know how to use the SIS? E.g. through guidelines, chatbot, videos etc?
- *More guidance can be found on the SIS framework platform here.*

3.5 Component 5: Partnership development and high-level financial sustainability plan

Component five of the SIS framework focuses on partnership-building among the institutions and individuals involved in SIS development. A SIS is, besides a technological output, also a process by which people and institutions must collaborate, explore, iteratively refine, and implement plans for data development, all while balancing multiple evolving sets of needs, setbacks, resources, and priorities. Understanding how these people and institutions should work together, and aligning on who is responsible for what, is a critical step to ensuring the progress of the SIS. Initial thinking on the partnership development and the financial sustainability of the SIS is given. During the workshop, initial perspectives from key stakeholders were gathered on this topic which are detailed below. It is important to understand how people and institutions should work together and align on who is responsible for what. This is a critical step to ensuring the progress of SIS development.

3.5.1 Develop partnerships.

Workshop findings:

- **A 5-member temporary steering committee was discussed.**
- Purpose of this committee is to provide governance, strategy direction, review progress, resource allocation and outreach.
- The committee is a temporary structure for 3-6 months, to oversee the establishment of the system.
- It was discussed there would be co-chairs, and once a formal committee is established there could be bi-annual rotations.
- There will also be a secretary with the role of coordination.
- Members of the committee:
    - Private sector- YARA/OCP (local representative)
    - Research institutes- CSIR-SRI (co-chair)
    - Public sector- MoFA (co-chair)
    - Funders- AGRA (to be discussed)
    - NGOs/CSO- Fertilizer platform Ghana
- **A 7-member technical committee was discussed that will report to the steering committee.**
- Members of the technical committee:
    - Director SRI (data analysts)
    - Fertiliser companies (international and local)- e.g. Chemico
    - President of the soil science society
    - IT experts- Director INSTII (GIS expertise)
    - Soil experts- Universities representatives

- o MoFA- extension directorate (DAES)
- **The following activities were discussed for the partnership:**
  - o SRI will lead on developing a first draft Terms of Reference (ToR) for the steering and technical committees and will share with the representatives by the end of the year.
  - o It will need to be discussed which individuals are the best representatives from their respective organisations which best meet the required needs for the committees.
  - o The steering committee will develop a legal framework that guides the committee (detailing e.g. process of selection, duration of membership etc.).
  - o A kick off meeting will be needed to agree on timelines, and then the committee will meet quarterly.
  - o The committee will conduct a comprehensive review of the gaps in the current state of GhaSIS and capacity gaps and develop a review report.
  - o Data sharing agreements will be made between committee stakeholders.
  - o The checklist (in Annex II) will be shared with the stakeholders.
  - o Steering and technical committees will put together a concept note, aligning with funders strategies, including consideration of long-term funding needs, to kick-start the next steps for improving GhaSIS.
  - o The steering committee will set timeline, milestones, target activities and budgets so that next steps are actionable.
- **Representation of the full value chain at national level** in the GhaSIS partnership was discussed as neccessary.
- **The key role of the partnership** is to ensure financial sustainability of the SIS.
- It was agreed that everyone on the steering committee will have the same level of approval.
- **Additional expertise required**: A business model expert is required to look at the scope and services in the partnership agreement, as are legal experts to participate in the partnership to support responsible data sharing.
- **The partnership should enhance collaboration** between the different stakeholders- even beyond the stakeholders in the partnership, e.g. extension services, policy & advocacy actors.
- **Other capacities needed** for the partnership are, for example:
  - o INSTI responsible for information dissemination, app & platform development.
  - o Universities should represent both soil science and ICT.
  - o Ministry of Finance to be included in financial sustainability, costs, and revenue generation decisions.
  - o CSIR for policy issues.
  - o Ghana Meteorological Agency, as weather data input is required.

- Software developers.
- Advocacy group to maintain government buy-in and articulate the value of soil for society and how soil data can address government needs.
- **Future stakeholder engagement**: SRI suggested other institutes not at the workshop that could be considered for future engagement or for the partnership:
  - CSIR-INSTI
  - CSIR-STEPRI
  - MESTI
  - GIDA
  - Land Commission
  - Local Blending Companies, e.g. AMG, Omnifert, Glofert
  - MoFA (SRID)
  - Statistical service
  - Software developers
  - Farmerline
  - Esoko
  - Farm Radio
  - Soil Science Society of Ghana
  - NITA
  - Small holder farmer associations
  - Cocoa board
  - Ministry of Lands and Natural Resources

Recommended additional next steps:

- **Co-develop a theory of change**: consider conducting this exercise with the partnership/committee members to help visualise what GhaSIS is trying to achieve, why, and how. See guidance on this from USAID here.
- **Review the example draft ToR** provided by CABI for the KenSIS steering committee in Annex VII, to guide the development of the ToR for GhaSIS.
- **Transitioning to a permanent committee**: Consider a plan for when the 3-6 months of the temporary committee is over, and include plans for this in the temporary committees activities, such as handovers to the permanent members, if necessary.
- **Decision-making responsibilities**: Although it was discussed in the workshop that all steering committee members would have the same level of approval on decisions, SRI may consider taking on the final decision-making responsibilities as the SIS operator, reporting to MoFA, and this could be reflected in the organogram that was agreed as a useful tool for stakeholders involved in GhaSIS.
- **Core partnership for GhaSIS**: Many institutions have been listed for partnership engagement. In its initial stages, consider a focused core partnership for GhaSIS

with clear goals, roles, and tasks with the required capacities and buy-in to address the agreed target users' needs. The scope of the partnership could then be expanded once initial structures and strategies are in place to streamline efforts further.
- **A RACI matrix** may be useful for identifying which stakeholders are essential in the partnership, and which need only be part of broader stakeholder engagements.
- *More guidance can be found on the SIS framework platform here.*

3.5.2 Brainstorm marketing of the SIS

Workshop findings:

There was acknowledgement of the need to create awareness about GhaSIS to ensure users know about GhaSIS and are reminded to use it. Social media can be useful for dissemination of information and creating awareness on GhaSIS (e.g. through Esoko, Farmerline, and communications personnel from CSIR).

When it came to discussing how GhaSIS would measure its impact on the end-users, multiple options were explored to measure the impact:

- Traffic of users of GhaSIS via a dashboard.
- Seek continuous feedback from a range of users.
- Real impact is only achieved once policy makers use soil information of SIS. When this happens, it should be captured and documented.
- Agronomic nutrient efficiency – by measuring the yield of crops or the soil properties over time, impact of GhaSIS can be measured.

Recommended additional next steps:

- **Develop a clear communications plan** for GhaSIS that targets both potential funders and potential end users.
- **Consider adding a communication person** to the GhaSIS project team to take responsibility for awareness creation through the social media channels.
- **Consider contacting a youth organisation** to connect with young professionals in agriculture, such as YPARD.
- *More guidance can be found on the SIS framework platform here.*

3.6 Component 7: Develop data strategy

Component seven of the SIS framework focuses on the Data Strategy. The data strategy for the SIS intends to develop a description of the data to be collated from pre-existing sources, newly collected in the field, and delivered by the SIS that ensures data is comprehensive, consistent, high quality, and FAIR-compliant. This includes consideration of who will be involved in which aspects of data management (**people**), what **processes** will be used to develop and manage data assets, and what systems and technologies will be employed to manage data (**platform**).

'People' here are best defined as those within the organizational structure of the key participating agencies involved in data governance. It includes due consideration of the roles and responsibilities of those who own, collect, store, manage, and use data. '**Processes'** refers to guidelines for using, protecting, and managing data, ensuring consistency and compliance. **'Platforms'** (or technology) are the tools and systems that support data governance and can include security protocols or data management platforms. For an effective data strategy to be put into practice, all these components must be considered.

3.6.1 Develop data plan for 'people'

Workshop findings:

The discussions on data plans for 'people' revolved mostly around capacity building needs, such as needing to strengthen the capacity of data generators and technical staff to ensure the production of high-quality data, and that there is currently a lack of technical expertise for advanced stages of data development, including modelling, creating data-driven products, and data delivery.

Additionally, improving communication and transparency around data between stakeholders was also discussed. It was agreed that for the improvement plans for GhaSIS to move effectively, it is essential to clearly identify the appropriate contacts for accessing soil data from the various institutions. Also making clear the ownership of the data is important as it is currently ambiguous and data providers for GhaSIS would like to see their contributions recognized and acknowledged.

Recommended additional next steps:

- **Develop a data governance policy** as part of the data strategy, which will make clear what roles are needed for data ownership and management, and what their responsibilities will be. For example, are there existing data managers or data

stewards for GhaSIS, or is there scope for this role to be created? And is there short-term and long-term budget for these roles?

- **Develop capacity building /succession plans** and, where relevant, identify key person risks, so that responsible data management and governance is maintained throughout the lifespan of GhaSIS.
- **Consider regular training and awareness on each stakeholder's role in data governance**, ensuring they understand their roles and responsibilities and are equipped with the knowledge to maintain high standards in data governance.
- Review this **NSW Data Governance Toolkit.**
- *More guidance can be found on the SIS framework platform here- please note, the "FAIR Process Framework" that contains all resources and templates to guide implementation of FAIR data principles will be launched in November. The CABI team will inform stakeholders as soon as the resources are available.*

3.6.2 Develop data plan for 'processes'

Workshop findings:

- **Data sharing challenges were a widely discussed topic through the two days of the workshop, and the following solutions were share:**
  - SRI will provide a template that follows the FAIR data principles for how the stakeholders can share their data.
  - The universities represented agreed that they would send every year new research generated by students to SRI, following the template SRI will provide.
  - Stakeholders agreed that the focus should be more on establishing better data sharing processes rather than developing data policies.

- **Data quality and standards were a concern across the stakeholders, and so needs and possible solutions were shared during the workshop's breakout sessions:**
  - A challenge is that there is use of different standards and protocols, and so there's a need for interoperability and harmonization.
  - There is a need for synthesis of existing information from existing projects.
- **To ensure the SIS is updated with new data, the following ideas were discussed**:
  - It was agreed that there should be new data collection every 5 years, specifically looking at soil fertility.

- It was suggested that research institutes and universities that receive grants for soil related projects that generate data could be drawn upon to update the SIS.

Recommended additional next steps:

- **Review the optional tool to assess the quality of data**: Data Quality & Plausibility Tool.
- **Review the Soil Assimilation guidance** on soil data standardisation and harmonisation.
- **For guidance on soil data collection/soil monitoring**, refer to Chapter 3 of Development options for a Soil Information Workflow and System
  - Review the example of Australia's national soil monitoring program
  - Review how EUSO conducts regular soil monitoring
- **Data sharing templates**: The technical committee who will develop the data sharing templates could also consider reviewing the data sharing agreement (DSA) template in Annex IV. *Please note, the template is just a guide, and you will need to seek your own legal advice before using this or any DSA.*
- **Benefits of data sharing policies**: Although there was discussion on the benefits of data policies, consider reviewing the impact of such data sharing policies in the Ethiopian context, as well as the template for developing a data sharing policy in Annex IV.
- **Develop a Data Management Access Plan (DMAP),** as this will create a clear plan for managing the lifecycle of your data, from collection to usage, ensuring that all stakeholders understand their roles and responsibilities. The DMAP should include:
  - a description of the data to be collected or used during a project, this might include reuse of existing data assets as well as collection of new data.
  - the data formats in which data will be stored, and why those formats and standards are appropriate.
  - notes on the sources, volume, storage, sharing and archiving of data.
  - the processes by which data will be collected and processed.
  - notes on data management, including naming conventions, version control, etc.
  - a description of how the quality of the data will be assessed, documented, and maintained.
  - a description of the metadata and documentation that will be produced.
  - notes on the standards used to create and format the metadata.
  - ethics and privacy implications of collecting, storing, and sharing data.
  - notes on any intellectual property rights or licensing issues that are relevant to the data.
- *More guidance can be found on the SIS framework platform here- please note, the "FAIR Process Framework" that contains all resources and templates to guide*

3.7 Component 9: Organisational and financial sustainability plan

Component nine of the SIS Framework seeks to build on the high-level plan brainstormed financial plans in the Initiation Phase, to develop a concrete financial sustainability plan and organisational plan that will guide the following phases. This is intended to be a living document to be iterated throughout the lifespan of the SIS.

Workshop findings:

- **Funding sources**: It was discussed what the role of Ghana Statistical Services might play in the funding of the SIS- can funds be drawn from this to collect new soil data to keep GhaSIS updated?
- **Income generation**:
  - There is a need to define who is to pay to access information from GhaSIS, e.g. private companies. Also, there is a need to define who does not need to pay, e.g. students and smallholder farmers.
  - There is a need to assess the different end users and determine which entity pays with price variations.
  - It was also discussed what the initial value for money of the system would be, and that it could start with no payment option, then introduce fees once GhaSIS is more established and high-quality data is delivered.
  - It was discussed that adverts could be used to generate income for the system.
- **Roles and responsibilities**: Finalising the financial sustainability plan is the responsibility of the steering committee, with a deadline to complete this within 6 months.
- **Capacity building needs and potential costs**:
  - There is limited capacity of labs.
  - It was discussed how there is a decrease in the number of students taking soil science at university.
  - Possibility of starting training programs within CSIR and universities to address the skills gap needed for GhaSIS.
  - Technical (IT) staff don't have soil science training.
  - There is a need to identify the costs of digitalization of data and technology.
- Initial funding needs were developed during the workshop:
  - **Short-term Funding Needs (1-2 years)**
    1. Personnel and operational costs: $200,000 - $500,000
    2. Soil data collection and analysis: $300,000 - $700,000

3. GIS software and hardware: $50,000 - $150,000

4. Training and capacity building: $20,000 - $50,000

5. Website development and maintenance: $10,000 - $30,000

- **Medium-term Funding Needs (2-5 years)**

1. Expansion of soil data collection: $500,000 - $1,500,000

2. Development of mobile apps: $50,000 - $150,000

3. Integration with other agricultural databases: $100,000 - $300,000

4. Research and development: $200,000 - $500,000

5. Stakeholder engagement and outreach: $50,000 - $150,000

- **Long-term Funding Needs (5+ years)**

1. Sustainability and maintenance: $500,000 - $1,000,000

2. Scaling up to national level: $1,000,000 - $3,000,000

3. Integration with regional and global soil information systems: $200,000 - $500,000

4. Development of decision-support tools: $300,000 - $700,000

5. Human resource development and capacity building: $200,000 - $500,000

Recommended additional next steps:

- **Capacity building plan**: The Universities and SRI could consider developing a strategy to gain interest of prospective students as part of the long-term capacity building plan for soil scientists in Ghana.
- Review the Guide to support SIS financial sustainability planning.
- The steering committee might consider **updating the financial sustainability plan** once there has been an agreement of initial target end users and an in-depth assessment of their needs, as well as their willingness to pay.
- Consider defining what information might be free to access and what information that can be more tailored, granular and actionable might need to be paid for.
- *More guidance can be found on the SIS framework platform here.*

Conclusion

The roadmap for implementing GhaSIS has been carefully crafted based on the insights gathered throughout the workshop and preceding stakeholder consultations, using the SIS framework to support the design and development plans for GhaSIS.

The suggested recommendations provided give advice for next steps in the development for a sustainable GhaSIS, with the note that responsibility to decide which recommendations to follow lies firmly with the GhaSIS project team. They will be best placed to understand which ones to prioritise to ensure that the SIS best matches stakeholders need to ensure GhaSIS can be sustained over the longer term. Identifying the relevant action points and suggestions in this roadmap and building this into a workplan with assigned roles and responsibilities will provide a clear, actionable pathway for the GhaSIS project team.

Below is a summary of **key considerations** based on the workshop, noting it is for SRI to determine which suggested next steps to take:

1. Draft a **comprehensive concept note for GhaSIS** development to present at the West Africa Hub meeting in November, following the outline provided by CABI and ISRIC (Annex VI).
2. Establish the **steering and technical committees** as part of the GhaSIS partnership, defining roles, responsibilities, membership terms, and activities.
3. Finalize the **financial sustainability plan** in agreement with all partners, ensuring that the SIS owner and operator take responsibility for its implementation.
4. Develop **data-sharing agreements** among committee members, using templates from Annex IV, and share these with identified data producers for GhaSIS.
5. Circulate the working document on the **mission, definition, and goals** of GhaSIS to the broader stakeholder group for feedback.
6. The technical committee to conduct a comprehensive **review of data and capacity gaps**, leveraging the supporting resources and solutions outlined in this roadmap report.
7. Identify initial **target users**, assess their **needs**, and create a **SIS design plan** (both front-end and back-end) that aligns with user requirements.
8. Organise a **validation workshop** with broader stakeholder participation once design and work plans are drafted and priority next steps have been consolidated by the GhaSIS project team.

Annexes

Annex I: The SIS framework

Annex II: Preparation materials

Annex III: Workshop materials

Annex IV: Data sharing templates

Annex V: FAIR aligning principles

Annex VI: Outline GhaSIS concept note

Annex VII: Draft ToR for KenSIS steering committee