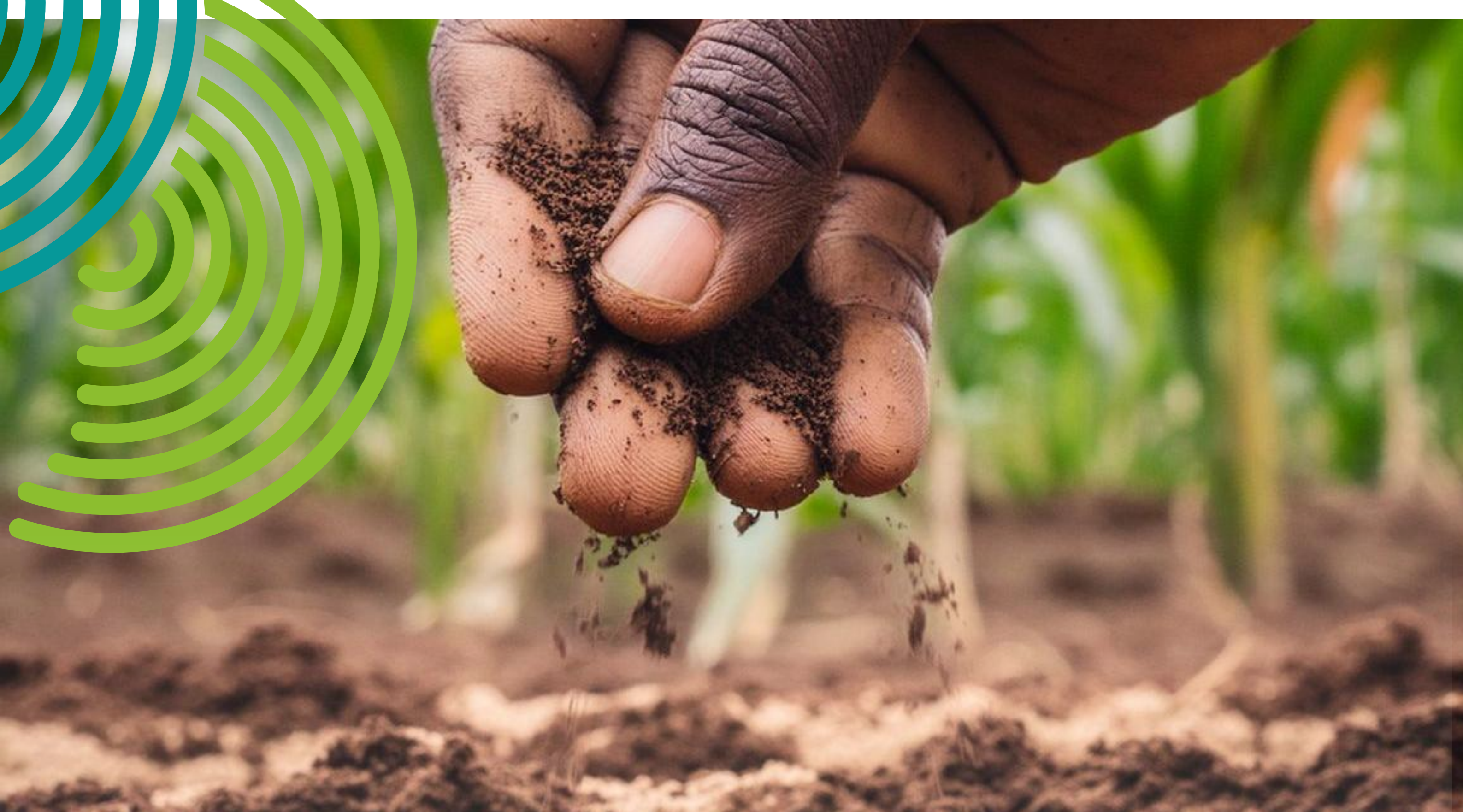

[PROGRESS WITH THE DELIVERY OF INTERMEDIARY PERFORMANCE INDICATOR IPI 1.3 OF AICCRA-AF: NEW SOIL MAPPING GENERATED BY THE REGIONAL HUB FOR FERTILIZER FOR WEST AFRICA AND THE SAHEL]

Report on IPI 1.3

CGIAR

AICCRA
Accelerating Impacts of CGIAR Climate Research for Africa

Kadja, Lionel Axel | Vanlauwe, Bernard | Sinha, Surajit |et al

[November] • [2025]

To cite this report

[Kadja, L; Vanlauwe, B; Sinha, S; Shehu, B; Dalaa, M; Ampadu-Boakye, T (2025), AICCRA Report Type: **Progress with the delivery of Intermediary Performance Indicator IPI 1.3 of AICCRA AF: New soil mapping generated by the Regional Hub for Fertilizer and Soil Health for West Africa and the Sahel** Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA)]

Acknowledgements

Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA) is a project that helps deliver a climate-smart African future driven by science and innovation in agriculture. It is led by the Alliance of Bioversity International and CIAT and supported by a grant from the International Development Association (IDA) of the World Bank.

The authors would like to thank…

About AICCRA Reports

Titles in this series aim to disseminate interim research on the scaling of climate services and climate-smart agriculture in Africa, in order to stimulate feedback from the scientific community.

Photos

© AICCRA / [Photographer]

Disclaimer

Partners

CONTENTS

Abbreviations

AICCRA	Accelerating Impacts of CGIAR Climate Research in Africa
AU	African Union
AUC	African Union Commission
AUDA	African Union Development Agency
BAU	business as usual
CA	conservation agriculture
CAADP	Comprehensive Africa Agriculture Development Programme
CBA	cost-benefit analysis
CCAFS	Climate Change Agriculture and Food Security
CGIAR	Consultative Group of International Agricultural Research Centres
CIS	climate information services
CSA	climate-smart agriculture
CSAIP	climate-smart agriculture investment plan
CSEP	Climate-Smart Agriculture Education and Policy Project
CSV	climate-smart village
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	Food and Agriculture Organization of the United Nations
FNS	food and nutrition security
GCCASP	Gender Climate Change and Agriculture Support Programme
ICT	information and communications technology
iNGO	international non-governmental organisation
IRR	internal rate of return
MoAMID	Ministries of Agriculture, Mechanisation and Irrigation Development
MSP	multi-stakeholder platform
NDE	National Designated Entity
NEPAD	New Partnership for Africa's Development
NGO	non-governmental organisation
NPV	net present value
PICZ	Professional Insurance Company of Zambia
REC	Regional Economic Community

SUMMARY

Between October and December 2024, the Regional Hub for Fertilizer and Soil Health conducted scoping missions in 11 West African and Sahelian countries to assess demand for technical assistance on fertilizer and soil health. Seven countries were selected—Nigeria, Ghana, Togo, Liberia, Sierra Leone, Mali, and Senegal—based on expressed demand, institutional readiness, and the presence of active scaling programs. The Intermediary Performance Indicator (IPI) 1.3 responds to governments and Soil Values programme requests for Digital Soil Mapping (DSM) in priority agricultural watersheds, with the aim of supporting the generation of locally relevant ISFM recommendations.

Target areas cover 2.9 million ha in Nigeria and 1.3 million ha in Mali. Progress to date includes the completion of V0 maps using ISRIC SoilGrids data sets and V1 maps integrating legacy datasets from IFDC, iSDA, OCP Africa, and Soils4Africa. V2 maps, based on new soil sampling, will be delivered by Mid November and during the first quarter of 2026.

Two complementary workstreams are underway: the development of national Soil Information Systems (SIS) to host and update soil and agronomic data, and the establishment of a regional hub-and-spoke model for analytical laboratories to improve soil and plant testing capacity. In partnership with ECOWAS, the Hub will also develop a dynamic soil health and fertilizer dashboard and expand its regional knowledge repository. Future work under AICCRA-III will shift from DSM generation toward fully operational SIS platforms, strengthened laboratory networks, and long-term decision-support services at national scal

1. CONTEXT

A digital soil map (DSM) is critical for nutrient and fertilizer recommendations because it provides spatially explicit, high-resolution information on soil heterogeneity, generated through the integration of geo-statistics, remote sensing, GIS techniques, and machine-learning algorithms. DSMs quantify the spatial distribution of key soil physicochemical properties—including texture, soil organic carbon, pH, cation exchange capacity, bulk density, moisture-retention parameters, and macro- and micronutrient availability—with significantly greater precision. These variables directly determine nutrient dynamics, fertilizer responsiveness, and nutrient-use efficiency, and their spatial prediction enables the development of site-specific nutrient management strategies. By capturing inter-field variability, DSMs facilitate the formulation of variable-rate fertilizer prescriptions, thereby optimizing nutrient inputs and reducing the risk of nutrient over- or under-application. This not only enhances crop productivity but also mitigates environmental externalities such as nitrate leaching, phosphorus runoff, and greenhouse gas emissions associated with excessive fertilization. Furthermore, DSMs serve as foundational inputs for crop growth models and decision-support systems, improving the accuracy of nutrient budgeting, yield simulation, and fertilizer recommendation algorithms at both field and regional scales. Consequently, digital soil maps play a fundamental role in advancing precision agriculture and promoting sustainable, evidence-based nutrient management practices.

The following section outlines progress on the delivery of Intermediary Performance Indicator (IPI) 1.3 during 2025.

2. COUNTRY ENGAGEMENT

The Hub operates as a demand-driven mechanism, responding to national and regional needs articulated through ministries, research institutes, and private sector actors. It functions as a technical assistance platform that supports the implementation of countries soil health and fertilizer action plans. In each country, the Hub operates through three coordination mechanisms. A National Focal Point, designated and empowered by the relevant Ministry, serves as the primary point of contact. A National Technical Team, composed of technical experts from relevant organizations and empowered by the Ministry, is responsible for the in-country implementation of the agreed workplans. Another important layer of coordination is the Hub Focal Point, whose role is to ensure continuous liaison between the Regional Hub and the National Technical Teams.

Though the Regional hub focuses on the entire West Africa and Sahel, the activities of this project commenced with the 5 Wave 1 countries: Nigeria, Ghana, Togo, Liberia, and Sierra Leone. These were the countries with the highest potential of success based on the data availability and country readiness. Within these countries regions were selected based on the presence of scaling programs and other existing CGIAR projects. This enabled achievement of impact relatively faster (Table 2).

Table 2*: Countries, priority regions, and scaling programs.*

Country	Target region	Crops	Previous or current scaling initiatives	Target area per crop (000 ha)
Togo	Central, Kara, Savane	Maize, Rice	Food system resilience program (FSRP)	891
Liberia	Margibi, Bong, Lofa	Rice	STAR-P, EU-Soils4Liberia project	19.6
Sierra Leone	Bo, Kenema, Moyamba	Maize, Rice	FSRP	28.5
Nigeria	Kaduna, Kano, Bauchi, Jigawa	Maize, Rice	Soil Values project; ACReSAL project	2,600
Ghana	Upper West, Upper East, North-East, Northern, Bono, Ashanti, and Bono East	Maize, Rice	FSRP	2,500
Mali	Moyen Banni, Niger Supérieur, and Haut Banni	Rice	Soil Values project	1,300
Senegal	Thies, Diourbel, Kaolack	Rice	FSRP	454

In Ghana, the project covered the key production regions for maize and rice in the Upper West, Upper East, Northeast, Northern, Bono, Ashanti, and Bono East Regions. The selected sites capture the region's biophysical diversity, ranging from humid lowlands to sub-humid and dry savannah environments, and were chosen to reflect dominant cropping systems, soil fertility gradients, and climate variability. The annual rainfall in these selected areas ranges from 900 to 1,400 mm in the north to over 1,600 mm in the humid south, with Ferric and Plinthic Acrisols, Lixisols, and Nitisols dominating the soil landscape.

In Nigeria, the analysis focused on major maize- and rice-producing states in the Sudan and Northern Guinea Savannas, specifically the two watersheds (covered by the Soil Values Programme) comprising the states of Jigawa, Bauchi, and Kano. These areas represent high-production zones characterized by mean annual rainfall ranging from 700 – 1,100 mm, sandy to loamy soils with inherently low organic carbon, and a distinct unimodal rainfall pattern supporting one main cropping season (May–October).

In Togo, the focus was on maize- and rice-based systems across the Savanes, Kara, and Centrale Regions, spanning the northern dry savannah to sub-humid transition zones. These areas experience an annual rainfall between 1,000 and 1,200 mm, with sandy-loam soils derived from granite and gneiss parent materials that are typically low in nitrogen and phosphorus.

In Liberia, maize and rice sites were in the Bong, Lofa, and Margibi Counties, representing humid tropical environments with rainfall exceeding 1,800 mm per year. Soils are highly weathered Ferralsols and Acrisols with low base saturation and moderate-to-severe nutrient leaching, necessitating balanced N–P–K management to sustain productivity.

In Sierra Leone, the project districts (Bo, Moyamba, and Kenema Districts) targeted maize and rice production areas, which also typify the country's humid forest and derived savannah agroecological zones. The annual rainfall ranges from 2,000 to 2,500 mm, with deep, weathered soils (mainly Acrisols and Ferralsols) characterized by low inherent fertility and high leaching potential.

In Senegal, activities focus on Thiès, Diourbel, and Kaolack, key agricultural regions in west-central Senegal. Thiès is a coastal peri-urban zone with mixed farming, horticulture, and rainfed cereals, receiving 400–600 mm of irregular rainfall and benefiting from its proximity to Dakar. Diourbel is important for groundnuts, millet, and livestock but faces hot conditions, low rainfall (350–500 mm), frequent dry spells, and declining soil fertility. Kaolack is a major commercial hub for rice, groundnuts, and cereals, with 500–800 mm of rain concentrated in a short season and often experiencing high temperatures and late rains. These regions contain key lowland and upland rice environments where yield gaps persist due to soil degradation, limited nutrient inputs, and climate variability.

In Mali, work builds on the Soil Values project across the Moyen Bani, Niger Supérieur, and Haut Bani watersheds in the Sudano–Sahelian zone. Moyen Bani features floodplains and lowland rice areas with 600–900 mm of seasonal rainfall and periodic flooding. Niger Supérieur experiences high temperatures (often >38°C) and 500–900 mm of rainfall, with irrigated systems buffered from climate shocks compared to vulnerable uplands. Haut Bani receives 600–800 mm of rain with erratic distribution, dry spells, and increasing land degradation. Across these watersheds, short rainy seasons, unpredictable onset of rains, and rising temperatures intensify moisture stress and soil fertility constraints, sustaining large yield gaps and highlighting the need for ISFM and climate-resilient practices.

For IPI 1.3, implementation is currently conducted in collaboration with the Institut d'Economie Rurale in Mali and the Center for Dryland Agriculture at Bayero University Kano (CDA-BUK) in Nigeria

3. PROGRESS REPORT IN RELATION TO IPI 1.3

Development of digital soil maps

The Implementation of IPI 1.3 is carried out in close collaboration with the International Soil Reference and Information Centre (ISRIC) and national research institutions. The generation of new digital soil maps follows a workflow that unfolds gradually in three phases described as follows.

Development of V0 maps: The V0 maps were generated using existing soil datasets available with the ISRIC database, which formed the basis for the development of the SoilGrids product (*https://soilgrids.org*). These maps provide a first approximation of currently available soil healthy conditions, however often based on incomplete and/or lacking recent information.

The V0 maps are available at *https://shiny.wur.nl/content/19155f6b-3103-4d1f-9df4-645cafeee26a*.

From V0 to V1 versions of the digital soil maps: To improve upon the version V0, the V1 maps are produced by integrating legacy data collected from multiple partners (IFDC, iSDA, OCP Africa, and the Soils4Africa project) that had not been used previously for digital soil mapping. Since the digital soil information is critical for the delivery of IPI 1.4. V1 version covers the target areas of IPI 1.4, with the following actual acreages obtained : (i) Ghana - 3.27 million ha, (ii) Nigeria - 2.94 million ha, (iii) Mali - 2.88 million ha, (iv) Senegal -2.53 million ha.

The V1 maps are available at *'https://shiny.wur.nl/content/b3c1f85e-a0b0-40a7-a068-bb3ed94bcc49/'*.

From V1 to V2 versions of the digital soil maps: While the V0 and V1 maps provided valuable foundations, information is insufficient to generate up-to-date crop- and soil-specific nutrient combinations for fertilizer, in support of the generation of locally relevant ISFM recommendations. Fresh soil sampling campaigns are being conducted in prioritized watersheds of Soil Values: (i) Nigeria: Yartiti, Komadougou (with an area of 2.88 million ha and (ii) Mali – Moyen Banni, Niger Supérieur, and Haut Banni (with an area of 1.3 million ha). The V2 map for Nigeria will be available by mid-November 2025 while the one for Mali will be delivered by mid-January 2026.

The V2 maps are available at *West-Africa-Soil-Health-Hub---Version-2-Maps.-World-Bank-report.pdf*

Complementary activities to IPI 1.3

Besides above digital soil mapping activities, two supporting activities are critical in support of IPI 1.3: (i) development of national soil information systems and (ii) improvement of national soil and plant analytical capacity.

National Soil Information Systems (SIS): While the digital soil mapping activity generates soil data, the SIS provides a platform for countries to organize, host, and update these data and other agronomic and climate datasets within the national systems, ensuring sustainability beyond project cycles. Four national SIS workshops were organized in 2025 in Togo (June 2025), Liberia (August 2025), Sierra Leone and Nigeria (both in October 2025) to assess capacities and define priorities. Two Workshops are in preparation for Mali and Senegal in the last quarter of 2025. The Hub is now working with these national systems to translate the resolutions of these workshops into investable Plans of Work and budgets.

The reports for the 2 workshops done in Togo and Liberia are available and are provided below for reference. The others that happened in October 2025 are being finalized.

The report of the SIS workshop in Togo is accessible here: *Regional Hub_Final TogoSIS Technical Workshop Report June 2025.pdf*

The report of the SIS workshop in Liberia is accessible here: ***Regional Hub_. Liberia_LiNSIS Technical Workshop Report August 2025.pdf***

Improvement of national soil and plant analytical capacity: Laboratory analyses form the backbone of the digital-soil-mapping workflow under IPI 1.3. The accuracy of V2 maps depends on the quality of laboratory data generated through high quality analytical laboratories. The Hub is conducting a comprehensive laboratory-capacity assessment across the region (Senegal, Mali, Ghana, Togo, Nigeria, Sierra Leone, Liberia) to evaluate the readiness of wet-chemistry and spectral labs, their associated infrastructure, their staff skills, their throughput and quality assurance, as well as their data management practices. Insights from this assessment will guide the creation of a tiered Hub-and-Spoke lab-coordination framework (projected by ECOWAS) linking national labs with regional reference centers for cross-validation and data sharing.

The terms of reference(ToRs) for the above work are accessible here: *Regional Hub_ Lab Analytics Expert Consultancy Agreement_ 2025.docx*

.

4. FUTURE PLANS

From digital soil maps to soil information systems

Under the potential AICCRA-III project, the Regional Hub for Fertilizer and Soil Health for West Africa and the Sahel will prioritize the development of Soil Information Systems, building on the digital soil mapping data generated under AICCRA-II Additional Funding (AF). These systems will support data-driven decision-making for crop production and soil nutrient management. As a next phase, Soil Information Systems (SIS) for countries will be made operational, meaning that a digital platform is operational that contains digital soil information and agronomic data and that provides a user-friendly interface for interested stakeholders to access and use this information. The Data Science team of the Hub will support countries to review their existing platforms capabilities, system accessibility, update frequency, and integration with other national or regional databases.

***Revised indicator description: IRI** 1.2: Area covered with updated/new soil information system and associated solutions generated (hectares).*

This indicator measures the total area (in hectares) for which improved digital soil maps are available that are integrated into digital soil information systems. This includes the generation and digital soil maps, based on the integration of secondary and newly generated data, as well as the development of nationally relevant soil information systems.

The project starts with a baseline of 3,000,000, increasing to 4,500,000 in Year 1, 6,000,000 in Year 2, 7,500,000 in Year 3, 9,000,000 in Year 4, and 10,000,000 in Year 5, reaching a final target of 10,000,000 by September 2030.

Implementation of a hub-and-spoke analytical system and dashboard

Also, the Hub will implement a master plan for a regional hub-and-spoke model for soil and plant analytics, developed under AICCRA-AF. This model enhances diagnostic and laboratory capacity across the region. In partnership with ECOWAS, the Regional Hub will spearhead the development of a dynamic soil health and fertility dashboard to monitor changes over time. It will also continue to enrich its knowledge repository to consolidate and share key insights and data on soil health and fertilizer use.

5. REFERENCES

IITA (2020). Balanced fertilizer recommendations for maize in Nigeria using QUEFTS model.

Janssen, B.H. et al. (1990). A system for quantitative evaluation of the fertility of tropical soils (QUEFTS). Geoderma 46: 299–318.

Kempen, B., Brus, D.J., De Soussa, L., Jones, A., Shephered, K., Leenaars, J., Micheli, E., Csorba, A., Huising, J., Patterson, G. (2021). Soils4Africa Sampling Design, EU Horizon 2020 Research and Innovation Programme.

K T Aliyu et al. (2022). Environmental Research Letters, 17, 064025.

Minarsch, E.M.L., Thoss, V.M., Beule, L. (2025). Guidance on spatial sampling designs and data reusability in agroforestry research. Agroforestry Systems, 99, 1–21. https://doi.org/10.1007/s10457-025-01225-5

Rodrigues, H.M., Vasques, G.M., Oliveira, R.P., Tavares, S.R.L., Ceddia, M.B., Hernani, L.C. (2020). Finding suitable transect spacing and sampling designs for accurate soil ECa mapping from EM38-MK2. Soil Systems 4: 1–19. https://doi.org/10.3390/soilsystems4030056

Samaké, O., Smaling, E.M.A., Kropff, M.J., Stomph, T.J., Kodio, A. (2005). Effects of cultivation practices on spatial variation of soil fertility and millet yields in the Sahel of Mali. Agriculture, Ecosystems & Environment 109: 335–345. https://doi.org/10.1016/j.agee.2005.02.024

Shehu, B.M. et al. (2019). Balanced nutrient requirements for maize in the Northern Nigerian Savanna: Parameterization and validation of QUEFTS. Field Crops Research.