Scaling Delivery Strategy for Harmonized Digital Fertilizer and Agronomic Solutions (HaFAS) for Transforming Crop Production in Ethiopia

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Innovation, Harmonized fertilizer solutions, scaling delivery, scaling pathways, responsible scaling, Ethiopia

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Abbreviations

ACC	Agriculture Commercialization Cluster
ACIAR	Australian Centre for International Agricultural Research
AfDB	Africa Development Bank
AGRA	Alliance for Green Revolution in Africa
AICCRA	Accelerating Impact of CGIAR Climate Research in Africa
API	Application Programming Interface
ATI	Ethiopian Agricultural Transformation Institute
AU	Africa Union
BCR	Benefit to Cost Ratio
BMZ	German Federal Ministry for Economic Cooperation and Development
CAADP	Comprehensive Africa Agriculture Program
CBO	Community-based Organizations
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
COW	Coalition of the Willing
CSA	Climate Smart Agriculture
DA	Development agents
DAEAS	Digital agriculture and extension advisory services
DAEAS	Digital Agriculture Extension and Advisory Services
DAR	Digital Agriculture Roadmap
DGF	Digital Green Foundation
DST	Decision Support Tool
EAA	Ethiopian Agricultural Authority
EABC	Ethiopia Agriculture Business Corporation
EABC	Ethiopian Agricultural Business Corporation
EFS	Ethiopian Food System
EIA	Excellence in Agronomy
EIAR	Ethiopian Institute of Agricultural Research
EthioSIS	Ethiopian Soil Information System
EU	European Union
FARA	Forum for Agricultural Research in Africa
FCA	Federal Cooperative Agency
FDRE	Federal Democratic Republic of Ethiopia
FGDs	Focus Group Discussions
FTC	Farmer Training Centers
GCF	Green Climate Fund
HaFAS	Harmonized Digital Fertilizer and Agronomy Solutions
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technology

IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center
IGAD	Intergovernmental Authority for Development
IK	Indigenous Knowledge
INSA	Information Network Security Agency
IRR	Internal Rate of Return
ISFM	Integrated Soil Fertility Management
IVR	Interactive Voice Response
KPI	Key Performance Indicator
LAFA	Localized Agronomy and Fertilizer Advisory
MEL	Monitoring, Evaluation, and Learning
MELIA	Monitoring, Evaluation, Learning, and Impact Assessment
MInT	Ministry of Innovation and Technology
MOA	Ministry of Agriculture
NARS	National Research System
NGOs	Non-Government Organizations
NPS	Nitrogen, Phosphorus and Sulphur
NSIS	National Soil Information System
OCP	Office Chérifien des Phosphates
OFRA	Optimizing Fertilizer Recommendation in Africa
OoA	Office of Agriculture
PES	Pluralistic Extension Service
PPP	Private Public Partnership
PVP	Partner Value Proposition
PxD	Precision Development
R&D	Research and Development
RARIs	Regional Agricultural research Institutes
RBOA	Regional Bureaus of Agriculture
RDP	Rural Development Policy
SAA	Sasakawa Africa Association
SACCOS	Saving and Credit Cooperative Society
SHA	Self Help Africa
SLM	Sustainable Land Management
SMS	Short Message Service
SWC	Soil and Water Conservation
SWRE	Stichting Wageningen Research Ethiopia
TAMAS	Taking Maize Agronomy to Scale
TOC	Theory of Change
USAID	United States Agency for International Development
WB	World bank

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Executive Summary

The Problem: Ethiopia's agriculture sector, which employs over 70% of the population, faces significant challenges in enhancing crop productivity and maintaining soil health. Over 70% of cultivated agricultural land is used to produce cereals, using 60% of the rural workforce. Moreover, over 50% of the daily caloric intake of an average household in Ethiopia is from wheat, sorghum, and maize. Yet, there are substantial yield gaps in maize, wheat, teff, and sorghum, with actual yields far below their potential. Inefficient fertilization practices, including incorrect application rates based on blanket recommendations that do not account for variations in soil type, topography, and crop type, limit the effectiveness of fertilizer use. Soil quality has been a concern of the Ethiopian government for some time, with soil fertility research starting in the 1950s. Affordability of fertilizer has become a major issue, even among commercial farmers, since the onset of the Russian Ukrainian war. The Ethiopian government is committed to improving crop productivity, as demonstrated by their expenditure of $1.1 billion on 1.35 million metric tons of fertilizer imports in 2023. Increasing fertilizer use efficiency is central to maximizing the benefit from its fertilizer investment and minimizing the potential negative impacts of its use on the environment. In addition, as fertilizer is mostly distributed through cooperatives, fertilizer is mostly accessed by market-oriented male farmers. The government recognizes that women's access to advisory services, in person or digital, is 41% lower than men's.

The Core Innovation: The core innovation is a digital localized agronomy and fertilizer advisory tool (LAFA) that combines and harmonizes earlier work on two separately developed digital tools, the NextGen Fertilizer Advisory System developed by the Alliance of CIAT and Bioversity, and the landscape-based Specific Fertilizer Recommendation (LANDWise) developed by ICRISAT. There are other agro-advisory services, such as climate information, lime application advice, and crop-specific soil and agronomic advice that can be potentially bundled into LAFA and/or broader Harmonized Digital Fertilizer and Agronomic Solutions (HaFAS). The HaFAS framework is modular, meaning innovations and improvements in one part of the HaFAS ecosystem do not affect other parts of the system.

Through a convening harmonization meeting in September 2023 and a subsequent launch meeting in November 2023, a harmonized digital decision-support tool (DST) framework led by the Ministry of Agriculture (MoA) and NARS (EIAR and RARIs) was adopted, which integrated multiple decision support tools (DSTs) into a comprehensive agro-advisory system, principally using digital delivery channels to service rural farmers directly or through extension personnel. The HaFAS will provide public access to data contributed by multiple organizations in a "Coalition of the Willing (CoW)," including a national soil database, remote sensing databases, and decades of findings from on-farm trials on fertilizer response for specific crops. A major component is harmonized site-specific fertilizer recommendations and bundled agro-advisories tailored to specific crop and geographic needs and adapted to variable climate scenarios, referred to as the Localized Agronomy and Fertilizer Advisory (LAFA).

Extensive field validations of the LAFA have been conducted in 2024 across 1,570 farmers' fields to ensure the recommendations are practical and context specific. Data are being analyzed during the first quarter of 2025. The LAFA integrates machine learning, the QUEFTS model, extensive agronomic data, and geospatial covariates to provide optimized fertilizer recommendations. Practitioners can integrate the LAFA into user-friendly interfaces, such as APIs, dashboards, chatbots, IVR, mobile apps, web apps, and SMS, to ensure accessibility and practicality. This initiative aligns with the government's focus on Digital Agriculture Roadmap 2032 and modernized agricultural strategies on digital agriculture and extension advisory services (DAEAS). It is of note that the core now harmonized innovation, LAFA, is still under wide-scale validation in 2025 under different paths and referred to as the pre-scaling period.

Current Demand and Market Context: There is a clear demand for innovative, site-specific nutrient management solutions in Ethiopia due to yield gaps, soil fertility issues, and the need for sustainable agricultural practices. The Ethiopian government imports approximately 1.6 million MT of fertilizer annually (from 2020 through 2023) and 2.4 million MT in 2024, with the Ethiopian Agricultural Business Corporation (EABC) importing 90% of the fertilizers used and distributing them through cooperatives. The agriculture market size in Ethiopia is estimated at USD 5.09 billion in 2024 and is expected to reach USD 6.65 billion by 2029. Despite the high use of fertilizer, farmers' yields reach only 20-40% of what is possible with best practices. The HaFAS aims to improve nutrient use efficiency by 20% and increase national cereal production from 31.6 million to at least 140 million metric tons by 2040.

Emerging interest from impact investors indicates a growing recognition of the potential for technology-driven agriculture in Ethiopia. The challenge for the government is to coordinate public and private efforts in the digital agriculture arena to avoid duplication and inefficiencies.

Enabling Environment: Ethiopia has made notable progress in digital agriculture roadmap development, bolstered by government policies that foster innovation and technological adoption and encourage private sector participation. Ethiopia's government has enacted several policy instruments and produced technical documents that support digital agriculture, including the Agricultural and Rural Development Policy (2024), the Digital Agriculture Extension and Advisory Services (DAEAS) Roadmap 2025, the Digital Agriculture Roadmap (DAR) 2032, and the Digital Ethiopia 2025 strategy. The vision of the DAR 2032 is to have "inclusive, affordable, sustainable, and interoperable digital solutions, supported by a coordinated and aligned ecosystem, which

transform the lives of farmers and pastoralists." Significant improvements in digital infrastructure, such as enhanced internet connectivity and mobile phone coverage, are critical for expanding digital solutions in agriculture. The DAR 2032 has clearly defined three main intervention areas: 1) Solution Areas and Use Cases, 2) Digital Stack (necessary digital elements to support the product development and the utilization of use cases), and 3) Enabling Environment. LAFA falls within the Solution Areas and Use Cases, under agricultural intelligence; whereas HaFAS falls under advisory and extension services.

There are also several agreements in place, such as the one between the Agricultural Transformation Institute (ATI) and Ethio Telecom, which is for digital extension and advisory service delivery and distribution of tablets to extension agents. The Ethiopian Food Systems Roadmap (EFSR) identifies 22 game-changing solutions, some aligned with the HaFAS initiative, such as improving the supply of inputs and technologies and creating digitalized input supply chains. Moreover, Ethiopia is in the final stages of approving a Pluralistic Agricultural Extension Strategy, in which advisory services are provided by different actors, mainly private service providers, and funded by diverse sources, in contrast to the state-led extension service, which has dominated to date.

Barriers to Scale: The key barriers to scaling are: 1) inadequate farmer profile and typology information for achieving a market-segmented delivery of the advisory; 2) digital illiteracy of innovation users and extension agents to utilize available digital delivery channels; 3) financial and logistic resource limitations to scale the advisories; 4) fragmented approach to deliver bundled solutions; 5) limited reach of digital infrastructures and ICT technologies to all farmer typologies; 6) inadequate and low efficient input supply system and not easy to change the status quo to a digitalized input and extension delivery; and 7) insufficient multi stakeholder collaborated actions and platforms for scaling digital innovations. These barriers are relevant for many digital solutions for agriculture. They have been recognized with plans to address them in the Digital Agriculture Roadmap 2025-2032 to a considerable extent.

Economic Benefits: In 2025, the economic benefit of the LAFA use will be determined, combining validated agronomic trial findings with actual costs of fertilizer and output prices. To date, tool use has been led by the public sector. The government's extension network and key demand partners have actively participated in piloting and promoting the earlier advisory tools, collectively reaching hundreds of stakeholders and benefiting more than ninety thousand farmers prior to harmonization. Currently, estimates of the benefits for the end user need to be drawn from the previously developed tools. Using the LANDWise tool, the results of the benefit-to-cost ratio (BCR) demonstrated that applying landscape-targeted fertilizer resulted in an optimum return on investment ($10.0, $12 and $30 net profits for teff, wheat and sorghum respectively, per $1.0 investment) while also enhancing optimized nutrient use efficiency across the three landscape positions. The hill slope generated the lowest net benefit for all crops because of its natural low yield potential compared to the foot-slope and mid-slope positions. Using the NextGen tool for wheat production resulted in additional net benefits of $475 to $665 per hectare per season compared to traditional practices or standard research-based recommendations.

From previous work on the separate fertilizer advisory tools on wheat, teff and sorghum, there were notable yield increases ranging from 16% to 53% over conventional practices, along with improvements in nutrient use efficiency between 32% and 45%. Average profit gains among smallholder farmers using the fertilizer advisory tools ranged from USD 183 to USD 665 per hectare per season. Findings concerning maize will be generated during the 2025 data analysis of the validation process.

Clearly, the total benefits to the economy depend on the number of cereal farmers who adopt the recommendations provided by the tool. Benefits generated vary by crop, soil type, climate, and other management practices. For example, with each 10% of wheat and teff producers in the country that adopt LAFA recommendations (with 0.25 ha allocated to wheat and 0.25 ha to teff), an additional $10 million per year from wheat production (assuming $90 profit per hectare* 450,000 * 0.25 ha) and $17.6 million per year from teff production (assuming $107 profit per hectare * 660,000 * 0.25 ha) are generated.

Scaling Ambition and Timeline: The agriculture sector plays a vital role in the life and livelihood of 130 million Ethiopians, where about 16 million smallholder farming households having on average less than one hectare of land account for an estimated 95 percent of agricultural production and 85 percent of all employment. 85% of current fertilizer use is on cereals. Improving fertilizer use efficiency with the deployment of site-specific agro advisories is potentially a game-changing strategy for smallholder farmers to boost their productivity and livelihoods.

> **Our scaling ambition by 2040 is to reach 6.85 million farmers (50% of fertilizer users for cereals), of which 2.05 million are women and 2.74 million are youth (<30 years of age) with digital fertilizer advisory services. Adoption of the advice will increase from 45% (Phase 1) to 75% by 2040. Use of the HaFAS framework and LAFA will generate a 30% increase of cereal productivity and 20% improved nutrient use efficiency, leading to an increase of national cereal production from 31.6 million to 140 million metric tons by 2040.**

Three scaling phases are envisioned:

Phase I: Consolidated innovation validation, piloting, and scaling operation phase across the geographies of validation zones of the core LAFA innovation (2025-2030). During this phase, maize, sorghum, teff, and wheat-growing farmers who are aware of the validated LAFA solutions in 129 districts of validation areas and those engaged in the piloting and pre-scaling stages for the preceding Nextgen and Landscape Fertilizer Advisory of CIAT and ICRISAT will be the primary target farmer segments. Two million farmers will be reached, with 45% using the recommendations.

Phase II: Scaling phase across major cereal growing areas (2031-2035). This phase aims to reach most of the maize, sorghum, teff, and wheat producer farmers at validation zones and similar agroecology settings in the country. This phase will cover all potential scaling pathways, including public sector-led, PPP, COOPs, and private business pathways. Cumulatively, 4.6 million farmers will have been reached, with 65% using the recommendations.

Phase III: Scaling phase with the realization of digitalized extension services across highland, midland and lowland mixed farming systems (2036-2040). Mature and multiple soil and agronomy advisory solutions that bundle soil, agronomy, climate, and pest management solutions and a complementary bundle of financial and insurance innovations will be ready for use. All means of scaling pathways and delivery strategies, including dissemination channels, with greater emphasis given to digital business models that have proven to be effective. This will be operationalized through private and cooperative entities and cost-sharing schemes through public sector-led pathways. By 2040, 6.85 million farmers will have been reached, of which 76% are market-oriented, and 24% have a low resource endowment. Three-quarters will be using the recommendations.

The number of households targeted through the public-led pathway will be 1.49 million, 2.28 million, and 2.74 million households in the first, second, and third phases. Apart from the public pathway, the scaling delivery strategy aims to reach about 0.36 million, 1.14 million, and 1.71 million households through the PPP pathway and 0.14 million, 0.68 million, and 1.37 million households through cooperative pathways. The private-led pathway will be expected to be realized during the second and third phases to reach 0.45 million and 1.03 million households, respectively.

The anticipated adoption rate for each segment of farmers will be 45%, 60%, and 75%, respectively. With a targeted 60% average adoption rate of LAFA by the end of 2040, an additional $20 to $35 million per year per crop (if each user applies fertilizer on 0.25 ha) can be earned from the scaling of the innovation.

Responsible Scaling: Market segmentation is a key strategy for disaggregating the HaFAS innovations based on different client segments. This includes identifying farmers' needs, their ability to invest, and the unique challenges they face. Detailed context analysis about farmer segmentation has identified that smallholder farmers can be grouped into different segments based on production orientation, membership to local associations, risk aversion, digital literacy, land use rights, age, and gender which are prioritized based on measurable data and their relevance. It also classifies each farmer segment based on his/her probability of adopting agro-advisory services. The more literate group and wealthier farmers are likely to have high readiness and access to technology and are thus more likely to use the agro-advisory through extension agent services and other alternative services. While non-literate farmer groups have less capacity or incentive to engage and use digital services and typically must access the information through trained extension personnel.

The strategy will address the specific needs of diverse farmer segments, including existing fertilizer utilizers (mostly commercially oriented farmers), subsistence farmers, women farmers, and youth– the future farmers of tomorrow. Women make up a large part of the agricultural labor force in Ethiopia but have less access to information and advice, thus requiring targeted services**.** Moreover, advisory services are more likely to reach women in female-headed households than married women. However, it is unclear whether female-headed households can afford inputs even when they can access them. The strategy has set specific targets by 2040 that 30% of those reached with LAFA are women and 40% are youth (<30 years of age) to tackle current inequities. There is a significant potential to reach young farmers for the scaling of the agro-advisories as they have a strong affinity for digital innovations and digital platforms as well as a preference for social networking. This will require negotiation with those currently in charge of fertilizer distribution policies, including cooperative leaders.

Since the innovation involves using site-specific nutrients to avoid blanket fertilizer recommendations, it enhances the efficient and optimum use of fertilizers based on crop nutrient requirements and minimizes fertilizer overuse, with obvious benefits to water quality and soil quality (less acidification). Some may argue that any use of fertilizer does harm, but the promotion of concurrent organic and inorganic fertilization will lower any negative effects of fertilizer use.

Responsible scaling also calls for co-design with major partners. While initiated by the CGIAR, the government is now in the lead in coordinating and implementing the HaFAS. The effort is in alignment with the government's digital agriculture policies as well.

Delivery Design, Governance, and Partner Roles: A broad network of national and international players is engaged in the HaFAS initiative, including the Ministry of Agriculture (MOA), Ethiopian Institute of Agricultural Research (EIAR), Regional Agricultural Research Institutes (RARIs), the Agricultural Transformation Institute (ATI), ICRISAT, CIAT, Digital Green, Farm Radio International, Precision Development (PXD), LERSHA, Stichting Wageningen University Research (SWR), Self Help Africa (SHA), and Sasakawa Africa Association (SAA). At least 40 partners have potential roles in HaFAS. Major potential investors for this initiative include the Gates Foundation (GF), the World Bank, BMZ, GIZ, IFAD, AGRA, and USAID. The strategy emphasizes collaboration among various actors, tools, and projects to support the same goal of improving soil management and advisory services and minimizing duplication. The Ethiopian government and PxD, with the financial support from the Gates Foundation (GF) will establish in 2025 the Project Management Unit for the Digital Agriculture Roadmap (DAR), and this will be one potential avenue to explore and finetune digital delivery strategies. A proposed governance structure is presented in the strategy, which aligns with the overarching coordination in the DAR 2032 under the Ministry of Agriculture.

This scaling strategy will envision four scaling pathways. By carefully monitoring the effectiveness of each pathway, lessons learned as to which is best in the Ethiopian context are expected to emerge. These pathways are:

- **Existing public extension delivery systems**. There is an enormous potential within the government extension service structure, which accommodates 72,000 extension workers with 14,065 farmer and agropastoral training centers. This can build on existing partnerships with NGOs like Digital Green and PXD. The program targets increasing agricultural productivity by delivering location- and time-specific advice to farmers across multiple channels, including video, SMS, chatbots, and IVR channels. To support this effort, extension workers and subject matter specialists at the district level were trained to develop localized extension videos using local languages. There is also the **direct call to farmers,** through ATI and LERSHA, allows farmers to call free of charge and receive information about major crop management practices, crop prices, and availability of agricultural inputs.

- **Public-private Partnership (PPP) Pathway.** This pathway will mirror the strategies employed in public-led pathways. However, the emphasis will be on resource pooling and using the complementary capacities of government, private entities, and NGOs to minimize risks and costs through shared investments.

- **Cooperative-led Pathway:** There are more than 92,755 cooperatives in Ethiopia with 21,043,370 members (6,743,429 female and 14,299,941 male). Cooperatives in Ethiopia are already playing an active role in the fields of finance, input and output marketing, consumer goods, agro processing, mechanization, and many other social and economic activities. The cooperatives have a strong institutional setup and can facilitate the bundling of the agro advisory services with their current roles in accessing fertilizer and improved seed services for their members. This pathway will focus on cooperative members and market-oriented farmers.

- **Private Business (Market-led) Pathway.** To date, market entry of private businesses into the extension service arena has been challenging due to regulatory barriers (which are being addressed). With a growing digital market, private businesses will have ample potential to disseminate digital solutions to willing farmers who invest or pay for the services individually or through their cooperatives in the future.

Various delivery channels and databases will be tested during phase 1, with more refined use in subsequent phases, including mobile applications, artificial intelligence tools, SMS phone messaging, interactive voice response systems (IVS), digital kiosks, web-based platforms, development agent (DA) networks, farmer training centers, development groups, video-based extension services, farmer and DA registries, and geolocation and land administration data.

The Cost Structure: A dynamic digital innovation generation and regular updating and refining process, especially when it requires dynamic data integration, like in the case of site-specific digitally enabled bundles of agro-advisory services, run through a series of costs. There are also costs associated with establishing, operating, and maintaining the distinct delivery channels. As LAFA is still in the process of being validated and is going to be integrated into multiple delivery channels, estimating the cost to achieve scale will need to be done once the best delivery mechanisms are established. These costs will include the institutional costs to deliver, the costs of trials for continued advisory development, the costs for validation of advisory tools (as novel approaches/technologies are likely to continue to emerge), the costs for capacity development for delivery, the costs for servers, managing data and analytical modeling works, and the environmental costs.

Annual field experiments by EIAR and regional agriculture research centers (RARIs) are requisite for the advisory system to continue to be upgraded and improved with additional field research data from new parts of the countries and additional crops. Based on the 2024 LAFA experience, a minimum of 1,500 trial sites will be needed, with an estimated $1200 per farmer site required to cover all costs of trial management, including soil and plant analysis. In addition, validation trials on farmers' fields will cost $125 per farmer site. Thus, the ongoing research effort would be around $2 million USD annually. At a country level, at least 22,000 farmers would need to be generating $90 additional profit each from using the fertilizer advisory to cover these two essential components for sustaining and expanding the quality of the advisory system.

Financial Sustainability: The strategy considers a phased, iterative scaling process for the site-specific, digitally enabled agro-advisory system. In phase one, public and development support will be critical drivers of the implementation and application of the innovation as extension personnel are trained on how to use the digital tools, and farmers are exposed to the economic benefits from using the site-specific recommendations. The registering of farmers and collection of their profile data will need to be supported. Robust and sustainable public-private partnerships (PPPs) shall be identified, developed, and nurtured through the first and the second phases. During the second half of the second phase and the third phase, market-based models will be piloted and capacitated to lead the delivery of the innovation. The most likely sustainable scenario is to bundle the costs of disseminating and updating advisory services into the purchase price of seeds and fertilizers. Given that fertilizers are delivered through cooperatives, a private sector enterprise delivering services to these cooperatives could charge a fee per cooperative or per member. Estimates of PPP or market-led scenarios to achieve partial or full financial sustainability are provided in the strategy. Clearly, monitoring the value of the sum of the benefit streams for the public and private for a given phase to see if it outweighs the costs of technology updating, coordination, and delivery will be essential.

Environmental Sustainability: Site-specific fertilizer recommendations provided through LAFA will tailor fertilizer application based on localized soil characteristics and climate data, optimizing nutrient use. This precision application reduces the excess application of nitrogen-based fertilizers, a major source of nitrous oxide (N_2O) emissions, which is approximately 298 times more potent as a greenhouse gas (GHG) than CO_2. One greenhouse gas (GHG) emission estimation in Ethiopian wheat production found that the use of specific fertilizer recommendations over blanket ones, led to an average increase of 24% in wheat production and resulted in a lower emission intensity per ton of wheat produced. Experts note that integrating fertilizer use with liming and organic inputs indirectly mitigates emissions by improving soil carbon sequestration potential, as healthy soils can retain organic carbon more effectively, and offsetting emissions using liming by improving nutrient availability to crops. Recommended practices for liming are being integrated into LAFA; and ideally some organic fertilization recommendations would be integrated into it.

Sustainable Scaling: Sustainable scaling demands a shift from isolated and sectoral innovation projects to systemic, inclusive, and adaptive strategies. Key enablers include participatory governance, cross-sector partnerships, iterative learning, and long-term investment. The financial viability and sustainability of digital agronomic advisory services in Ethiopia are underpinned by strategic partnerships, scalable technology frameworks, and targeted investments.

Communication and Advocacy: A robust communication and advocacy strategy must popularize the benefits of site-specific digitally enabled agro-advisories and shift from blanket recommendations for the public, policymakers, the extension ecosystem, development partners, and donors. Targeted efforts to raise awareness among extension personnel, cooperatives, and farmers are also needed. Partnerships must be built for effective dissemination of the tools and to attract resources for scaling the HaFAS. The strategy document lists for each target audience the key messages required, the preferred communication channels, and advocacy strategies to employ. During the first scaling phase, the effectiveness of different delivery channels in getting significant use of LAFA recommendations should be assessed, and the key messages, communication, and delivery channel recommendations subsequently refined.

Key Outcomes: The scaling of the LAFA, and broader HaFAS is a transformative step toward achieving Ethiopia's vision of agricultural self-sufficiency and economic resilience and is in full alignment with the government's Digital Agriculture Roadmap 2032. By providing farmers with tailored, data-driven agro-advisories, the initiative empowers them to boost productivity, increase profitability, and adopt more sustainable practices. The aim is to generate a 30% increase in cereal productivity and 20% improved nutrient use efficiency by 2040. It is estimated that with 10% of wheat and teff producers using the site-specific digitally enabled agro-advisory, the country can gain an additional $10 million per year from wheat production and $17.6 million per year from teff production. The goal by 2040 is to reach at least 50% of Ethiopia's major cereal producers, with 75% adopting recommended practices in HaFAS. This initiative also supports the green economic policy by prioritizing climate-smart agricultural production practices and reducing emissions.

A detailed monitoring, evaluation, learning, and impact evaluation (MELIA) plan is presented, with key performance indicators for monitoring progress defined. Key priority research areas for further development are listed, along with their justification.

Section 1. Problem Statement and Existing Demand

1.1 Background

Ethiopia, an industrializing yet still agrarian-dominated society, has over 70% of its population engaged in farming (Stellmacher and Kelboro, 2019; CSA, 2020; World Bank, 2022). The country faces considerable challenges in enhancing crop productivity and sustaining soil health (Zerssa et al., 2021). Significant yield gaps, particularly in cereals, indicate that actual yields are often less than a third of their potential (Tesfaye, 2016; Silva et al., 2021; Debebe et al., 2022). For instance, the national average yields for maize (4 t/ha) and wheat (3.1 t/ha) are 19.7% and 26.8% lower, respectively, than compared to on-station research findings (Belachew et al., 2022; CSA, 2023).

Key constraints to achieving potential yields include poor soil fertility, erratic and unpredictable rainfall patterns, reliance on traditional and outdated farming practices, and low adoption of modern agro-inputs such as improved crop varieties and fertilizers (Bekabil, 2014). In addition, generalized blanket fertilizer recommendations often fail to account for local soil and topographic variability and environmental conditions, leading to inefficient or excessive nutrient application that adversely affects crop performance and profitability (Getaneh et al., 2024). In addition to the environmental constraints, there are barriers related to equitable access to fertilizer in different locations away from the main transportation routes and warehouses and those affected by drought. Although the government subsidizes fertilizer, subsistence farmers, specifically drought-affected communities, women, and youth who rely on rented land have low purchasing capacity to access fertilizer in cash. Fertilizer use in Ethiopia has been a key strategy to enhance crop productivity, particularly for staple crops such as teff, wheat, and maize. From 2004/05 to 2020/21, there was a significant increase in the use of inorganic fertilizers such as urea and di-ammonium phosphate (DAP)/nitrogen-phosphorus-sulfur (NPS) by smallholder farmers (Abebe et al., 2022). Fertilizer is one of Ethiopia's most critical imported inputs, with the country purchasing 1.35 million metric tons in 2023 at a total cost of approximately 1.1 billion USD (IFDC, 2024; Trading Economics, 2025)[1]. The country purchased 1.99 million metric tons in 2024. The government approved 1.3 billion USD to purchase 2.5 million metric tons in 2025[2]. Recognizing the importance of fertilizer use efficiency, the use of efficient fertilizer application techniques and advanced advisory tools plays a crucial role in optimizing its effectiveness.

Fertilizer importation and distribution is a public-sector led intervention in Ethiopia, with distribution mainly occurring through cooperatives. With a focus on increasing total output of key cereals, fertilizer is mainly purchased by market-oriented farmers, unless included in a specific project. To date, the commercial sector has been dominated by mature men. The government recognizes that women have less access to agricultural services and inputs. For instance, women's access to advisories is 41% lower than men's (CSA 2023). Moreover, youth (15–29 years) face land tenure constraints, with 40% relying on rented land.

Clearly, beginning in 2020, global fertilizer markets experienced a significant price surge due to higher natural gas prices as well as supply chain and trade disruptions triggered by COVID-19 and the Russia–Ukraine war. Assefa et al. (2025) found that fertilizer adoption by wheat, teff and maize farmers and yields were increasing until this crisis period, but this trend has now ceased. Affordability of fertilizer is a major constraint, excluding in particular poorer farmers. Given the high cost of inorganic fertilizer, its effective use is paramount.

Several factors influence the limited effectiveness of fertilizer use in Ethiopia, particularly its inappropriate application rates, inefficient fertilization practices, and lack of site-specific recommendations. For example, farmers typically apply 37-40 kg/ha of inorganic fertilizers (Spielman et al., 2013), which is far below the recommended rates, limiting yield potential. Furthermore, the widespread use of "blanket" fertilizer recommendations that overlook variations in soil type, fertility, topography, and crop type in different agro-ecological zones often leads to nutrient imbalance or leaching and soil degradation without achieving anticipated yield improvements (Erkossa et al., 2022).

Ethiopian agricultural research has long recognized the potential of site-specific recommendations to address yield gaps. Initiatives such as the Ethiopian Soil Information System (EthioSIS), established in 2012 by the Ethiopian government's Agricultural Transformation Agency (ATA), have laid the groundwork for digital soil mapping of nutrient levels nationwide, facilitating targeted fertilizer use (EthioSIS, 2014). However, previous efforts to segment recommendations based on broad agroecological zones have fallen short of addressing micro-level variations in soil and landscape conditions, resulting in mismatches between crop nutrient needs and the actual fertilizer application (Abera et al., 2022). For site-specific recommendations to be effective, a data-driven approach must be integrated into usable tools for farmers and their advisors. Yet, in Ethiopia, data remains fragmented and often inaccessible, limiting the potential for data-driven decision-making (Abera et al., 2022). To address this, in 2018, a group of volunteer researchers formed the Coalition of the Willing (CoW), an informal collective aimed at consolidating decades of scattered agricultural data into a national soil and agronomy database. The comprehensive agronomic and environmental database is now accessible through the centralized Ag-Datahub (https://datahub.et), providing public access to valuable data. With advancements in data-mining techniques, the platform enables complex multivariate analysis and machine learning tools, offering significant

[1] Ethiopia Imports of Fertilizers - 2025 Data 2026 Forecast 1995-2023 Historical
[2] https://www.fanamc.com/english/govt-approves-us1-3-for-25m-quintals-of-soil-fertilizer-procurement/

potential for optimizing fertilizer use through tailored, site-specific fertilizer recommendations with integrated decision support tools (Tamene et al., 2021; Abera et al., 2022; Liben et al., 2024).

Since the launch of the One CGIAR Excellence in Agronomy (EiA) initiative in 2020, ICRISAT and the Alliance of Bioversity International & CIAT in collaboration with EIAR and other key partners, have developed and piloted their own advanced decision support tools (DSTs): the NextGen Fertilizer Advisory Tool of CIAT and the Landscape-Based Fertilizer Recommendation DST (LANDWise) of ICRISAT. The advisories have been developed and validated together with both national and international partners and have been tested extensively across diverse Ethiopian conditions. The NextGen DST provides season-specific recommendations tailored to soil and climate variations (Liben et al., 2022; Tamene et al., 2024b), while the Landscape-Based Fertilizer DST offers landscape-tailored fertilizer recommendations based on landscape segments—such as upslope, mid-slope, and foot-slope—addressing nutrient variability across different positions in the landscape (Abera et al., 2022; Ebrahim et al., 2023; Desta et al., 2023a). These innovative solutions represent major advancements in Ethiopia's agronomic advisory capabilities.

The demonstrated effectiveness of these robust recommendations based on those DSTs in enhancing crop yields, nutrient use efficiency, and economic returns for four cereal crops (wheat, teff, sorghum, and maize) has generated significant interest among Ethiopian farmers, agricultural stakeholders, and the government. Validation trials have shown a notable yield increase ranging from 16% to 53% over conventional practices, along with improvements in nutrient use efficiency between 32% and 45% (Desta et al., 2023; Liben et al., 2024). These gains not only offer an increase in yield and resource efficiency but also contribute to sustainability by reducing excessive nutrient application and minimizing environmental impact. The results highlight the potential of these DSTs to address the persistent yield gaps and boost the profitability of smallholder crop production, with average profit gains of USD 183 to 412 per hectare per season (Desta et al., 2023; Liben et al., 2024). The government's extension network and key demand partners have actively participated in piloting and promoting these DSTs, collectively reaching hundreds of stakeholders and benefiting more than twenty thousand farmers (Tamene et al., 2024b). This widespread, demand-driven adoption reflects the tools' value in enhancing productivity and aligns with Ethiopia's broader agricultural transformation goals (MoA, 2020).

To enhance integration, reduce duplication of efforts, and avoid confusion by engaging decision-makers with similar advisories, national partners asked for the harmonization of agro-advisory systems available in the country. The relatively advanced and well-validated tools were those mentioned above, and a concerted effort has been made to harmonize them, leading to an integrated site-specific and tailored DST. The harmonization efforts began with the development of a framework that integrates multiple DSTs into a cohesive system, which was adopted in September 2023. In this framework, the Ethiopian Ministry of Agriculture (MoA) and the National Agricultural Research System (NARS) play a central coordination role. This has led in 2024 to the development of a single harmonized site-specific (localized) agronomy and fertilizer advisory (LAFA) as part of a broader, more comprehensive, harmonized digital agro-advisory system (HaFAS) aimed at boosting agricultural productivity and profitability in Ethiopia (Tamene et al., 2024a).

The primary goal of the LAFA system is to bridge the productivity gaps for key cereal crops in Ethiopian agriculture by expanding the scope and use of a harmonized digital agro-advisory service (HaFAS) that provides site- and context-specific, user-driven, and climate-smart recommendations with bundled agro-advice. Given the significant yield gap, low nutrient use efficiency, and profitability in Ethiopia, where average yields of major staple crops such as maize, wheat, teff, and sorghum are far below their potential due to various factors, the HaFAS, represents a transformative approach for more effective, seasonally adapted, and tailored nutrient management and agronomic practices in the face of variable and changing climate scenarios. LAFA integrates different solutions to promote improved production and productivity of these four key cereal crops for Ethiopia: maize, teff, wheat, and sorghum. Currently, average wheat yields achieve only 20-30% of their potential, while maize and sorghum reach just 15-25% and 25-30%, respectively (Tesfaye 2016; Mann et al., 2017; Silva et al., 2021; Belachew et al., 2022). In addition to the contextualized advisory system, LAFA also embraces its use in multiple tailored dissemination channels to deliver agriculture extension services. To address diverse contexts in a country the size of Ethiopia, the government sees using digital delivery channels as essential for building a more agile, inclusive, pluralistic extension system (Tamene and Ali, 2022). In 2022, the Digital Agriculture Extension and Advisory Services Roadmap 2030 was launched, with the ultimate goal of providing high-quality, customized, and cost-efficient data and advisory information to Ethiopian farmers. After a successful first phase, on 4 February 2025, the Digital Agriculture Roadmap 2025-2032 was launched, which will make significant investments in both the infrastructure and the software to improve use of digital advisory and marketing systems. Its vision is to have "inclusive, affordable, sustainable, and interoperable digital solutions, supported by a coordinated and aligned ecosystem, which transform the lives of farmers and pastoralists." In both roadmaps, providing advice on fertilizer recommendations is a prioritized use case.

Clearly, LAFA can play a major role in the digital agriculture space. Scaling out LAFA advisory services should assist in narrowing the existing yield gaps, enhancing nutrient use efficiency, and improving soil fertility, which in turn optimizes resource allocation and broadly supports Ethiopia's agriculture production goals.

1.2 Relevance in the Country Context

Maize, teff, wheat, and sorghum are the dominant cereals produced by smallholders in the four major cereal-producing regions of Ethiopia (Amhara, Oromia, SNNPR, and Tigray), with maize showing the largest increase in production of 315% between 2003/2004 and 2020/2021 in the *meher* (main rainy) season (Ahmed and Mekuriaw, 2023) (Figure 1.2). Concurrently, the use of extension packages for cereals by smallholders has increased from 23.9% in 2004 to 62.7% in 2021, indicative of the increasing use of recommended agricultural practices (Ahmed and Mekuriaw, 2023).

Ethiopia is at a pivotal moment for paving a pathway for digital agriculture as part of its national strategy to enhance agricultural productivity and economic growth (MinT, 2020). Leveraging LAFA to bridge the yield gap through optimized fertilizer recommendations and soil health management supports the government's efforts to tackle challenges in cereal production, and stakeholder consultations note significant government demand for this tool.

As previously noted, the Ethiopian government has shown interest in supporting digital support services. First, the Digital Ethiopia 2025 is set to implement the **digitization strategy launched by Ethiopia in 2020**[3]. The strategy aims to bring technology to the people of Ethiopia and its industries, with a focus on e-commerce and the ability to digitize services in traditionally non-digital industries such as agriculture and manufacturing. The strategy includes five priorities: implementation of a digital ID, digital payments, e-governance, e-commerce, and cybersecurity. Under the DAEAS

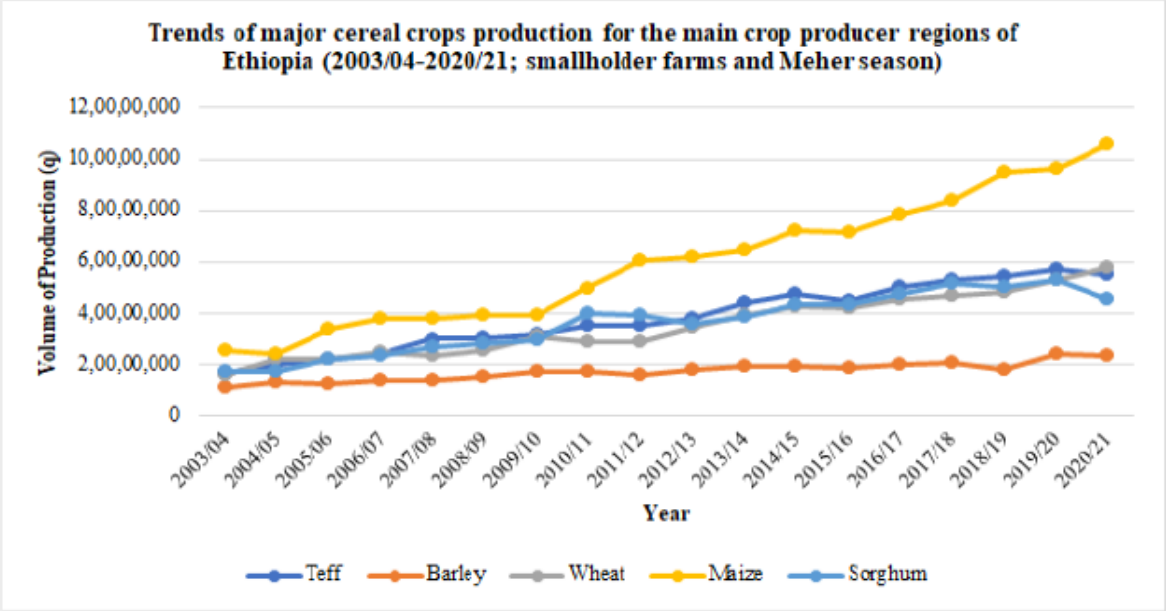

Figure 1.2. Trends in major cereal crop production on smallholder farms (meher season) from 2003/04-2020/21 (CSA data). Source: Ahmed and Mekuriaw (2023).

Roadmap, the HaFAS aligns with Pillar 1, the Solutions Pipeline, which champions the development of digital innovations for priority farmer use cases. The use of the HaFAS at scale will require the government to make significant advancements in digital infrastructure and an enabling environment, which is a major component of the Digital Agriculture Roadmap 2025-2032 recently launched in February 2025.

1.3 Current Demand in Broader Context and Relevant Competition

With Ethiopia's large population (134.5 million estimated for 2025)[4], its cereal sector has attracted substantial investments aimed at boosting productivity and sustainability. Key investors include international organizations, governmental bodies, and private sector entities. The World Bank, USAID, BMZ-GIZ, AGRA, and the Gates Foundation have funded projects focusing on agricultural technology and infrastructure. The Ethiopian government, through the Ministry of Agriculture (MoA), significantly invests in fertilizer subsidies, research, and extension services. Emerging interest from impact investors and venture capital firms indicates a growing recognition of the potential for technology-driven agriculture in Ethiopia. These investments collectively aim to enhance food security, improve farmer livelihoods, and drive economic growth.

[3] The World Bank has approved a 200 million USD concession loan agreement for its implementation.
[4] https://www.worldometers.info/world-population/ethiopia-population/

The government of Ethiopia is deeply committed to the use of inorganic fertilizer to increase cereal productivity, with average annual imports of around 1.6 million MT from 2020-2023 (Figure 1.3.1)

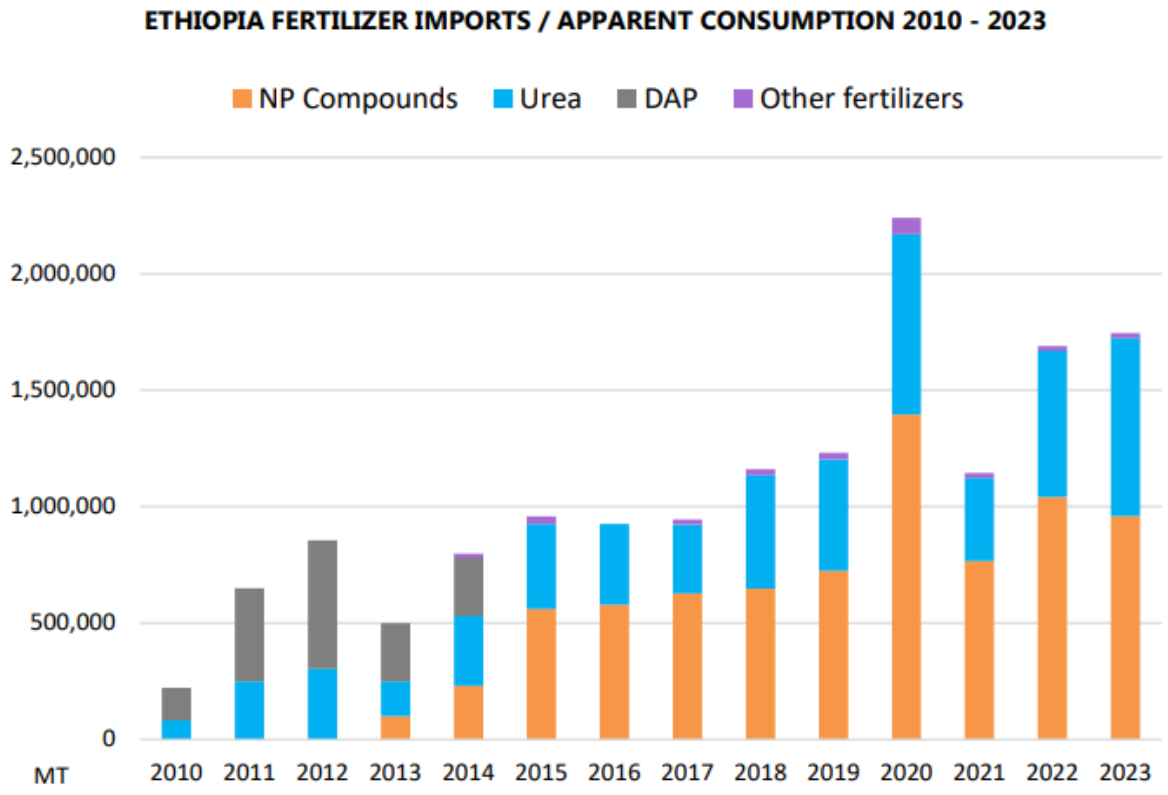

Figure 1.3.1. Africa Fertilizer: Fertilizer Statistics Overview Ethiopia: 2010-2023 (Source: IFDC (2024))

The Ethiopian Agricultural Transformation Institute (ATI) formerly Agricultural Transformation Agency (ATA) reports that the Ethiopian Agricultural Business Corporation (EABC) imports 90% of the fertilizers used, with distribution to farmers done through cooperatives (IFDC, 2024). The remaining fertilizers are imported by private companies engaged in horticulture production for export. The Nitrogen-Phosphorus (NP) compounds contain either Boron, Sulphur, or Zinc (IFDC, 2024). The private sector company OCP has been engaged to operationalize two of the five defunct fertilizer blending plants (MoA, 2023). Note that soil analysis from the EthioSIS initiative has led to a shift from DAP to NP compound fertilizers over the past two decades. However, the recent countrywide fertilizer source validation research reaffirmed using DAP and urea fertilizers. With recent recognition that soil acidity is seriously affecting 43% of the cultivated lands in the Northern highlands, calcium carbonate and calcium oxide use as soil amendments is expected to increase (IFDC, 2024).

Demand estimates for fertilizer are highly variable (IFDC, 2024). In the post-COVID period, soaring prices and limited availability led to decreasing demand by smallholders, either abandoning its use, applying below recommended rates, or shifting to crops requiring less fertilizer (World Bank, 2023). Moreover, inadequate demand assessment can lead to a mismatch between demand and supply at all levels, with some cooperatives reporting significant levels of unused fertilizer (Alemu and Koomen, 2023). Under such conditions, appropriate recommendations on inorganic fertilizer use should enhance, over time, better estimates of area-specific demand.

The strategic timing for scaling the HaFAS in Ethiopia is particularly advantageous due to several favorable conditions. Ethiopia has made notable progress in digital agriculture roadmap development, bolstered by government policies that foster innovation and technological adoption and encourage private sector participation. Significant improvements in digital infrastructure, such as enhanced internet connectivity and mobile phone coverage, are critical for expanding digital solutions in agriculture. The Digital Agriculture Roadmap has clearly defined three main intervention areas: 1) Solution Areas and Use Cases, 2) Digital Stack (necessary digital elements to support the product development and the utilization of use cases), and 3) Enabling Environment (Figure 1.3.2). LAFA falls within the Solution Areas and Use Cases, under agricultural intelligence; whereas HaFAS falls under advisory and extension services.

The HaFAS framework is essential to scan similar developments to continue harmonizing and bundling agro-advisory solutions and avoid duplication of efforts. These include digital agronomy tools being developed and implemented in Ethiopia and beyond. Within Ethiopia, there is: 1) the Optimizing Fertilizer Recommendations for Africa (OFRA) tool that offers agro-ecological zone-based recommendations, which is more targeted than blanket applications but still falls short of fully capturing micro-level soil and landscape variability (Kaizzi et al., 2017); and

2) the Ethiopian Soil Information System (EthioSIS), which has created maps of fertilizer types based on soil nutrient levels nationwide. Although EthioSIS has aimed to advance site-specific fertilizer recommendations, it does not provide site-specific fertilizer recommendations that fully integrate factors such as climate, topography, and nutrient interactions that affect crop responses (Abera et al., 2022).

Moving forward, the question will be how existing and new players in the Ethiopian Digital space are coordinated so that duplication of prior efforts is minimized, delivery channels continue to improve, and advisory reaches more farmers in new areas. The integrated harmonized digital platform, the HaFAS, provides the mechanism for doing so. For example, the government of Ethiopia recently signed an agreement with Cropin, an Indian company that runs a cloud-based AI platform for food and agriculture and will be seeking to profile 100,000 Ethiopian farmers over the next two years. The efforts on the HaFAS framework are to provide a collaborative and nationally coordinated digital platform for the ongoing agro advisory initiatives and upcoming ones to align and contribute to the Digital Agriculture Roadmap (DAR) 2032.

Collaborating with local stakeholders, including smallholder farmers, ensures that the recommendations are driven by local requirements and needs, practical, and signed with real-world needs. By successfully implementing the bundled agro-advisories through the multi-partnership of government, private, non-government, civil societies, and farmers, Ethiopia has the potential to serve as a model for building a big data ecosystem and scaling the agro-advisories, offering lessons applicable to other African countries facing similar agricultural challenges.

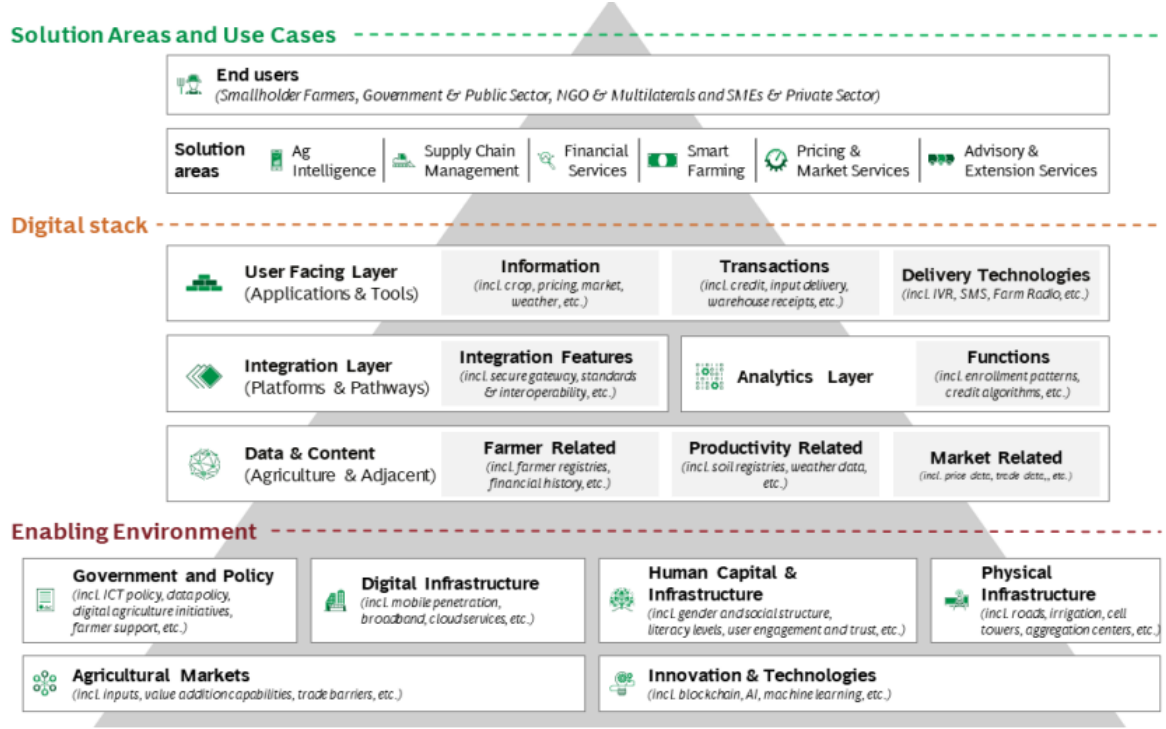

Figure 1.3.2. Digital Agriculture Roadmap (DAR) Digital Agriculture Ecosystem Assessment Framework

In a broader context, many countries are investing in digital agriculture tools. For example, in Rwanda, a digital fertilizer recommendation tool for six crops (cassava, potato, rice, wheat, maize, beans) was developed so that it could be successfully integrated into an existing platform – the country's Smart Nkunganire System (SNS), which provides Rwandan farmers access to critical subsidized farm inputs and currently has 1.5 million registered users. In 2025, the advisory component is expected to reach 300,000 of the registered users[5]. With the growing interest and sophistication of the digital agriculture environment, sharing information between as well as within countries will accelerate the learning process.

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[5] https://www.cgiar.org/news-events/news/a-smart-and-smartly-delivered-advisory-service-for-rwandas-small-scale-farmers/

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Section 2. The Core Innovation(s) and Solution Statement

2.1 History of Innovation Development

In Ethiopia, farming is marked by considerable spatial and temporal variations in key production factors, including climate, soil type, topography, and crop management. These variations create significant disparities in potential crop yield, fertilizer use efficiency, and economic returns on fertilizer investments. Yield gaps between actual and potential yields, both at farm and national levels, are among the highest in Sub-Saharan Africa due to factors such as land degradation, climate variability, and low or improper input application– highlighting a critical opportunity to increase crop productivity.

To tackle these yield gaps and transform agriculture to enhance food security, various efforts have been made over the past one and a half decades. These efforts include site-specific and context-based fertilizer recommendations, integrated soil fertility management (ISFM), soil and land management practices (SWC), and climate advisory services, all aimed at closing yield gaps and promoting sustainable agriculture (Tamene, et al, 2017).

Suboptimal fertilizer application is widely recognized as a key factor contributing to yields that remain low compared to yield potentials. Traditionally, blanket fertilizer recommendations, prescribing uniform fertilizer amounts regardless of crop type or environmental conditions, have been the standard practice. However, recent efforts (Kaizzi et al., 2017; Abera et al., 2022; Amede et al., 2022) aim to improve these recommendations. Since the launch of the Ethiopian Soil Information System (EthioSIS) initiative in 2012, NARS has conducted extensive on-farm trials to assess crop response to fertilizer and validate EthioSIS soil fertility maps. Later, national partners, in collaboration with CG centers, reviewed legacy crop response to fertilizer and identified research gaps, with a particular focus on location-specific nutrient management (Tamene, et al., 2017). In the quest to develop site- and context-specific fertilizer recommendations, collaborative efforts were undertaken to review and document existing information on crop responses to organic and inorganic fertilizer applications, facilitating the design of fertilizer recommendation tools. The review studies provided evidence on how soil fertility status varied across cropping systems, land uses, landscape positions, and rainfall gradients in response to different types and combinations of organic and inorganic fertilizers. These findings contributed to the development of guidelines for innovative and targeted fertilizer recommendations suited to rapidly transitioning landscapes (Tamene, et al 2017; Amede, et al, 2020; Desta et al, 2021). Erkossa et al. (2022) mapped the historical trajectory of soil fertility research in Ethiopia, charting its progression from the early efforts in the 1950's to contemporary advances in data-driven agronomic solutions (Figure 2.1).

The generation of EthioSIS soil information data spurred government agencies, research institutions, and donors to prioritize soil health and sustainable fertilizer management practices as a top agenda item. In response, the Ministry of Agriculture (MoA) and the Agricultural Transformation Agency (ATA) jointly developed the Soil Health and Fertility Strategy and Roadmap between 2011 and 2012. This framework aimed to address critical soil fertility challenges and transform the agriculture sector by integrating soil health into national policies and on-the-ground farming practices. The 2015 International Year of Soil campaign encouraged the launch of soil health and site-specific nutrient management research and development projects, supported by various donors, including Africa RISING, GIZ-ISFM, CGIAR (Consultative Group on International Agricultural Research) WLE (Water, Land, and Ecosystems), AICCRA (Accelerating Impact of CGIAR Climate Research in Africa), GeoNutrition, IFDC-Soil Consortium, CGIAR EiA (Excellence in Agronomy) initiative, and AGRA-Digitalization of fertilizer extension. These projects facilitated the generation of diverse datasets and technological advancements, contributing to optimal fertilizer recommendations across different biophysical and socioeconomic contexts.

Through the Africa RISING and GIZ-ISFM projects, demand grew for Site-Specific Nutrient Management decision guides that optimize fertilizer application based on landscape positions, advancing the approach into a structured decision-making framework. Since 2020, building on previous experiences, the Fertilizer Ethiopia and Digital Green Use Cases under the EIA initiative of One CGIAR have employed a co-design approach to develop agronomy turnkey digital solutions, specifically providing fertilizer rate recommendations based on legacy crop response data. The innovation's development followed a seven-step process ranging from demand analysis and co-design to data acquisition, analytics, prototype development, validation, piloting, and scaling readiness (EiA, 2021). Each use case advanced through EIA's seven stage gate system to ensure the technical validity of the prototypes.

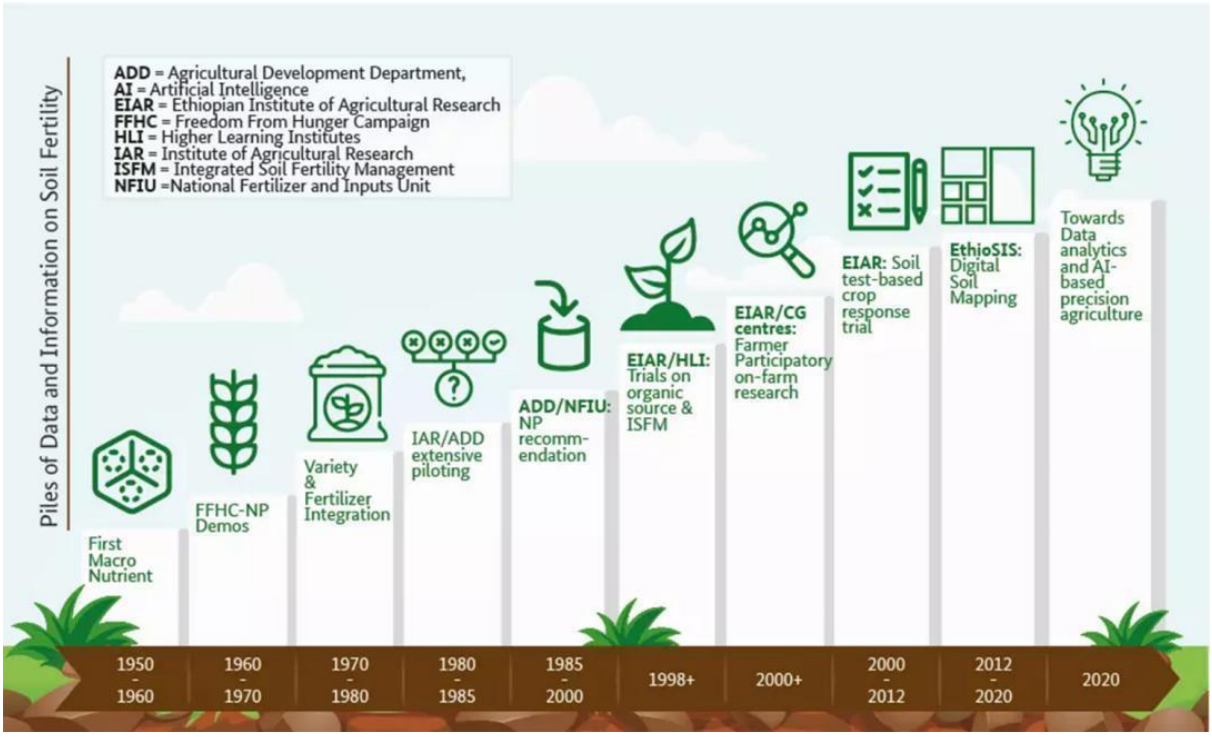

Figure 2.1. Key timeline and efforts in soil fertility research and development in Ethiopia (Erkossa et al., 2022)

2.2 Innovations: Core Innovation and Complementary Recommendations

The HaFAS framework accommodates a package of innovations, including advisory tools that provide site-specific fertilizer recommendations, soil and agronomy recommendations, and complementary soil, agronomy, land, and water management practices applied at context and technology-specific recommendation domains. These packages of innovations are bundled into an integrated digital and analog tool channeled to end users using different delivery mechanisms.

- *Core Innovation*

  Since late 2022, in response to national demands for a unified advisory tool and donor interest in coordinated, impactful digital agronomy and fertilizer advisories, discussions among key stakeholders led to an agreement to develop a harmonized digital advisory tool for site specific fertilizer and agronomy recommendations. Building on previous efforts, a collaborative modular harmonization framework was established by national and international actors, consolidating mature decision support tools, including the EiA NextGen agro-advisory tool of CIAT and the landscape-based fertilizer advisory system of ICRISAT (Liben et al., 2022; Desta &

Nagaraji, 2022). This harmonization initiative involves numerous partners, mainly the Ministry of Agriculture (MOA), Ethiopian Institute of Agricultural Research (EIAR), Regional Agricultural Research institutes (RARIs), and CGIAR centers, with MoA and EIAR chairing the coordination.

The national research system as a whole and EIAR now host the harmonized agro-advisory decision support tool (HaFAS) and play a central role in technical coordination and validation. Following the official launch of the HaFAS coordination platform in September 2023, attended by government officials, donors, national agricultural research systems (NARS), and CGIAR partners, CGIAR and NARS experts collaborated to develop a harmonized agro advisory system. Since its launch, the HaFAS has garnered interest from scaling partners, extension agents, farmers, and donors, all working toward improved soil health and fertilizer efficiency. Supported by major donors like BMGF, USAID, and GIZ, the tool facilitates streamlined data aggregation and curation, leverages advanced data analytics, and enables more efficient use of agronomic resources. This demand-driven HaFAS represents a significant advancement in Ethiopia's agricultural productivity efforts.

The two EiA use cases (Digital Green and Fertilizer Ethiopia) that have contributed to the harmonized agro-advisory components include: 1) the NextGen Fertilizer Advisory System is a system that integrates machine learning, the QUEFTS model, extensive agronomic legacy data, and geospatial covariates to provide optimized fertilizer recommendations for wheat. The advisory adapts to either agronomic or economic objectives based on the farmer's preferences and available price data (Abera et al., 2021; Liben et al., 2022; Liben et al., 2024; Mesfin et al., 2023); 2) The landscape-based Specific Fertilizer Recommendation (LANDWise) is a data-driven machine-learning approach for tailored fertilizer recommendations. It also considers landscape position as a critical factor in farmers' agronomic and fertilizer management decisions for sorghum, teff, and wheat. The method utilizes long-term crop response to fertilizer data, considering soil fertility and moisture gradients along landscape positions. Data are collected along landscape positions, soil, and climate data to develop landscape-targeted fertilizer advisories for optimized improved nutrient use efficiency and economic efficiency. Its use should result in the reduction of costs and enhanced productivity for smallholder farmers. Applied to crops like teff, wheat, and sorghum, this advisory uses an app-based digital decision support tool that guides extension agents and farmers with crop and landscape-specific fertilizer applications (Amede et al., 2022; Desta et al., 2023; Desta & Nagaraji, 2022).

The experiences from the two site-specific agro advisory systems highlight key learnings in terms of data sources and quality, data analytics for model development like optimization approach, and scales like farm or landscape level. These experiences result in a harmonized agro advisory benefiting from the experience of the two use cases. The core technical components of the national agro-advisory HaFAS are organized in both bundled and modular formats, enhancing accessibility and providing tailored solutions for diverse farming needs. The core agro-advisory constitutes a bundle of site- and crop-specific innovations for fertilizer, lime, climate, and complementary agronomic applications. The core innovation will continue to bundle more site- and crop-specific soil and agronomic advice to respond to tailored demands for enhancing cereal productivity.

- *Complementary Innovations*

  i. Agronomic practices

     Recommendations for good agronomic practices such as tillage, seeding rate, weeding, pest management, crop rotations, and post-harvest techniques are integrated into the site-specific core innovation using national agronomy package guidelines. These agronomic advisories are complementary to site-specific advisories.

  ii. Climate-smart practices

     Climate advisory services, including planting dates, Climate Information Services (CIS), and seasonal forecasts, are integrated into the LAFA, making it a climate-smart tool that enhances decision-making in an evolving climate landscape. These advisories help users anticipate climate impacts on crops and adjust their practices proactively, promoting resilience and adaptability in agricultural planning.

  iii. SLM/SWC recommendations

     Ethiopia has documented experiences related to the restoration and implementation of the best soil and water conservation practices since the mid-1970s. Later, beginning in the early 1990s, the SLM concept and practices (including natural resources management, production, and livelihoods) in a watershed approach were widely scaled in the highlands of Ethiopia. The scaling process evolved different strategies and approaches over the last five decades. The scaling is guided by a comprehensive community-driven participatory guideline at a watershed scale that reflects step-by-step procedures for planning, implementation, monitoring, and post-evaluation. The guideline has incorporated individual technology infotechs describing the environmental, socioeconomic adaptation conditions, and design specifications. Given the decades of experiences and skilled expertise in the field as well as well-documented evidence on the impacts of the SWC practices (Adimassu et al, 2018; Wolka et al, 2018; Abera et al, 2020; Desta et al, 2021) there is ample opportunity to translate the existing SLM/SWC

technology guidelines into site-specific technology recommendation tools that could be used as a complementary, integral advisory with the core innovation. The available evidence on SWC and other CSA practices in complementing soil fertility and supporting productivity, adaptation, and mitigation objectives has been synthesized and is being targeted to complement the LAFA.

2.3 Scaling Readiness of Core Innovation(s)

The HaFAS is built upon the experiences of the innovations from the two EiA initiative cases and serves as an integrative approach that brings together the wealth of experiences and expertise from national and international experts to create a state-of-the-art HaFAS that addresses the needs, challenges, and problems of Ethiopia's highland and midland mixed farming system. The core innovation primarily covers the soil and agronomic advisories for the major cereals (i.e. wheat, teff, maize, and sorghum) that integrate existing advisory experiences to support decision-making by policymakers, extension workers, and smallholder farmers for site and context advisory services. The HaFAS framework is modular (Figure 2.2), meaning innovations and improvements in one part of the HaFAS ecosystem do not affect other parts of the system. Integrated output (or bundled output) from one component serves as input for another, such as transferring data from the data module to the analytics module, requiring integration and innovation to harmonize within each modular. Apart from the modular HaFAS framework, the readiness of the core innovation is influenced by the level of readiness of other innovation packages. It is anticipated that once the LAFA validation is completed (by April 2025), that it will be a core innovation ready to begin scaling while awaiting for other components of HaFAS to be developed and/or integrated into the HaFAS.

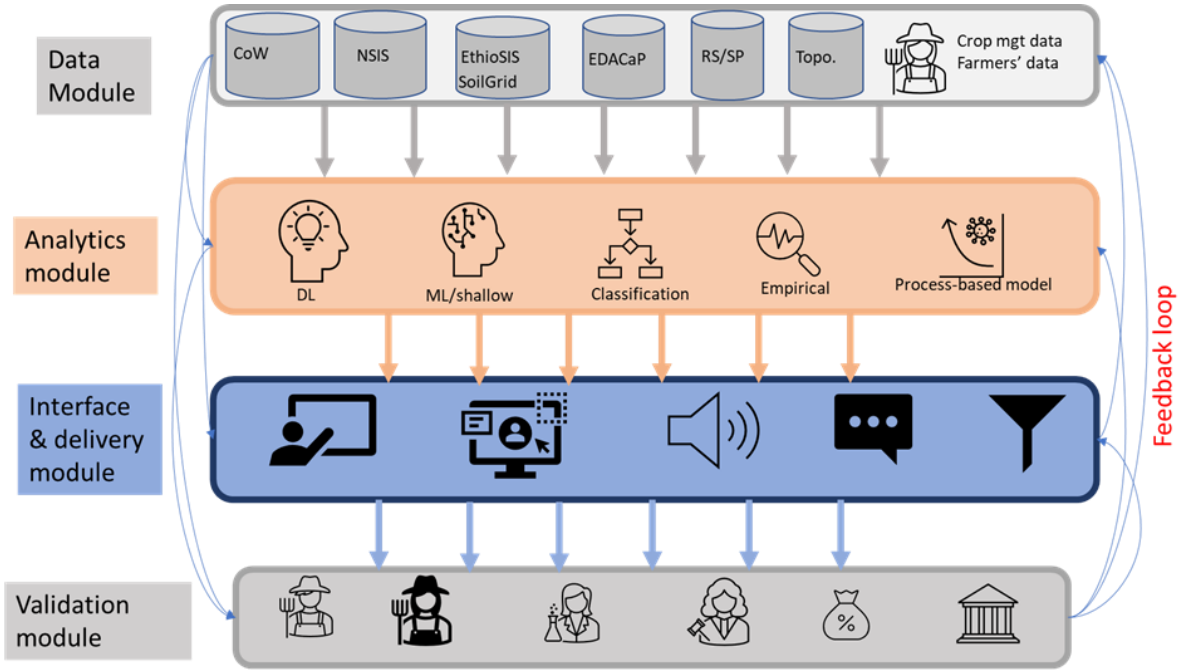

Figure 2.2. The framework of the technical solutions of the national harmonized HaFAS workflow

Data Modules: CoW (Coalition of the Willing, their pooled data); NSIS (National Soil Information System); EthioSIS (Ethiopia soil information grids); SoilGrid (Soil information grid of International Soil Reference and Information Center (ISRIC)); EDACaP (Climate advisory); RS/SP (Remote sensing); Topo (Topographic raster variables); Crop management data (On-farm fertilizer response data)

The Data Module addresses all challenges related to input datasets required for building and deploying the HaFAS framework (including calculating fertilizer use, data training, and validation) across different target geographic areas. Core components of the Data Module include collating and integrating relevant legacy agronomic and spatial data, filling data gaps with hyper-localized farmer field-level variables, and producing model-ready datasets. Data from governmental institutes are centralized in a data hub at EIAR for efficient use.

The Analytical/Modeling Module utilizes various machine learning techniques, mechanistic models, and empirical models to capitalize on the strengths of each and enhance the predictive capacity of the HaFAS system. The HaFAS analytics module generates site-specific, season-smart, and context-specific recommendations for fertilizer, climate resilience, and soil health (including lime and organic options) with required levels of accuracy and user acceptance. The HaFAS generates advisories at various levels of granularity, depending on farmer segmentation (e.g., commercial vs. smallholder farmers) and delivery formats (e.g., apps, chatbots, phone, SMS, dashboard, extension agents). The modeling components are dynamic, drawing on the available data from the

national research system to update the accuracy of and fine-tune different typologies of targets such as resource-endowed farmers, subsistence farmers, and market-oriented farmers.

The Delivery Module focuses on packaging and presenting advisories from the analytics for different end-users (e.g., smallholder or large-scale farms, digital vs. analog platforms, public vs. private extension systems, and individual farms vs. cooperative organizations). The user interfaces are designed to prioritize performance accuracy, ease of use, transparency, and accessibility across various digital communication technologies.

The Validation Module checks the technical validity and performance of the specific content of advice on field conditions against current practices and works with key stakeholders. More specifically, the bundled localized agro advisory tools have multiple components, each of which plays a critical role in building data partnerships, innovative algorithms, and user-friendly dissemination interfaces.

The Feedback loop provides an iterative process of collecting feedback from end users and national experts to refine the agro advisory.

For simplicity, the following describes the specific **core innovation component profile** that forms the national, integrated, and harmonized advisory system:

- **Data and Knowledge Partnership**: Serving as the foundation of the HaFAS, this component leverages data and knowledge co-designed with key institutions. (e.g., CoW, the Harmonized DST Coordination Platform). This partnership enables the pooling of high-quality, validated data inputs from multiple expert sources, setting the stage for informed decision-making. Collaboration across institutions ensures that the HaFAS draws from a consensus-driven data pool, establishing trust and reliability. Although the current focus is on optimizing limited inputs based on legacy data, this partnership—or the national research system—should establish spatially representative, long-term data observation collection sites. These sites would not only provide new evidence for system updates but also support model adjustments based on crop type and management history.

- **Data Pooling and Sourcing Workflow/Algorithms**: To harmonize data, this workflow involves algorithms that pool and process data from diverse sources, establishing a streamlined and standardized format for input across the HaFAS framework. This tool combines the agronomic and soil data from a database and other covariates from a server and helps to create a huge database that will be used for the modeling. This ensures uniformity in data quality, enabling consistent analysis and interpretation within the HaFAS framework.

- **Data, Databases, and National Data Hubs:** A core innovation of the HaFAS is its integration with datasets from major hubs like EIAR (https://datalabs.eiar.gov.et/user/h.desalegn@cgiar.org/lab/tree/shared-data) and CoW (Website) which serve as the foundation of the tool. By leveraging these established databases, the HaFAS is structured to enable a seamless flow from data collection to analytics. Additionally, the availability of such centralized data warehouses is paramount for automating the entire data-to-advisory pipeline, creating an efficient system for delivering timely, data-driven recommendations.

- **Data Standardization and Access Protocols**: The data collection, standardization, and access protocols, along with specialized tools and workflows, address the need for consistent and standardized data formatting to generate new datasets (Abera et al., 2020; Wogi *et al*., 2021; Mnalku et al., 2020). Data standardization tools, such as Carob (GitHub - reagro/carob: Aggregating agronomic data), harmonize legacy data for integration, while data-sharing guidelines (CoW, 2020) among key knowledge partners enable collaborative, secure data exchange.

- **Fertilizer and Agronomy Optimization Advisory**: The HaFAS leverages advanced machine learning, process-based, and statistical algorithms specifically designed to optimize recommendations in terms of nutrient and agronomic use efficiency and economic efficiency for diverse crop conditions. The fertilizer advice provides site-specific recommendations of N (Urea) and P (DAP or NPS) fertilizer rates considering landscape segments with appropriate split application time of urea for wheat, sorghum, teff, and maize crops (Liben et al., 2020). These algorithms are hyper-localized to provide tailored recommendations, considering factors like farmers' resource endowments, specific climate scenarios, and landscape conditions (Pawar et al., 2023). Recommendations are generated at multiple scales, such as farm level, recommendation domains, and agricultural commercialization clusters (ACC) to suit varying needs. The format and resolution of advisories are also customized based on the dissemination channels preferred by stakeholders. For example, where digital access is limited, recommendations can be provided in printed maps available at kebele-level or Farmer Training Centers (FTCs) for use by extension agents and farmers. For stakeholders using videos or needing broader spatial advisories, Agriculture Commercialization Clusters (ACC) and recommendation-domain level outputs can be provided, facilitating convenient video dissemination. Where farm-specific, landscape position-specific, highly localized advisories are required, the algorithm generates content at the necessary spatial scale, available in formats like maps or APIs, ensuring accessibility across diverse media and user needs.

- **Validation Protocols**: The validation protocols ensure the HaFAS outputs, specifically LAFA and complementary innovations, remain reliable and accurate, confirming that recommendations are tailored to actual conditions on the ground. The LAFA is usually validated before it takes to wider piloting and goes to the new farming environment. These validations support credibility and trust in the LAFA's recommendations.

- **Dissemination Interfaces**: User-friendly interfaces (APIs, dashboards, chatbots, SMS, etc.) make the LAFA accessible and practical. These interfaces deliver timely, actionable information to end-users in accessible formats, empowering farmers, policymakers, and advisors to make informed, real-time decisions.

2.3.1 Barriers to Scale and Ideas for Overcoming or Mitigating These Barriers

As we plan to achieve an ambitious 15-year scaling strategy, it is important to identify and address the barriers that may hold back the scaling of the agro advisories. An innovation is said to be ready to scale not only if it is technically feasible but also if it has also been adaptable and can potentially be sustainably scaled up. For an innovation ready to scale, there needs to be an enabling condition of the sociotechnical aspects of the core innovation. For scaling a digital innovation like LAFA, there are scaling barriers to be overcome for a sustained scaling up of the innovation.

Among the key barriers to scaling include: 1) inadequate farmer profile and typology information for achieving a market-segmented delivery of the advisory; 2) digital illiteracy of innovation users and extension agents to utilize available digital delivery channels; 3) financial and logistic resource limitations to scale the advisories; 4) fragmented approach to deliver bundled solutions; 5) limited reach of digital infrastructures and ICT technologies to all farmer typologies; 6) inadequate and low efficient input supply system and not easy to change the status quo to a digitalized input and extension delivery; and 7) insufficient multi stakeholder collaborated actions and platforms for scaling digital innovations. To overcome these barriers, it is essential to align resources and engage stakeholders effectively. Table 2.1 presents key challenges and barriers we may encounter on the scaling journey and presents actionable strategies to overcome them. Fortunately, these barriers are relevant for many digital solutions for agriculture. They have been recognized with plans to address them in the Digital Agriculture Roadmap 2025-2032 to a large extent.

Table 2.1. Identified barriers to scale, their relevance to different market segments, and proposed mitigation strategies

Barrier	Description	Market Segment Differences	Mitigation Strategy	Stage of Innovation
Unavailability of farmer profile data	Insufficient data on • Farmer endowment profile • Farmers' land holding • Complete value chain-related information • Farmer's geo-location, without which innovation targeting and effective service delivery is limited.	Smallholder farmers, especially those who are illiterate, have lower adoption rates due to limited awareness on the other hand, commercial farmers need tailored data for large-scale operations.	Using the existing farmer profile data from responsible partners • Develop a farmer profile data collection strategy including surveys • Plan for farmer profile creation	Early stage
Limited Digital Infrastructure and Delivery Systems	Limited digital infrastructure prevents scaling and restricts service accessibility, • Limited avenues or hubs for advisory dissemination especially in rural areas, as some places are inaccessible.	Smallholder farmers often lack basic digital access such as mobile phones. This can also be a case for those farmers who are not members of cooperatives. On the other hand, commercial farmers may face challenges integrating new technology into their existing systems.	• Assess the status of existing infrastructure and update this frequently. • This also includes prioritization based on accessibility for all stakeholders • Utilize existing technology hubs. • Data sharing: improve data use and exchange mechanisms	Scaling

Barrier	Description	Market Segment Differences	Mitigation Strategy	Stage of Innovation
Capacity Gaps	Skills and knowledge limitations among extension agents and farmers prevent effective innovation utilization and adoption.	Illiterate smallholder farmers struggle to adopt new technologies. Cooperative members often receive more training than non-members do.	• Launch targeted training programs for digital literacy and technical skills • Incentives for motivation; acknowledgment and reward for better adopting and promoting farmer and DAs • Awareness creation activities • A digital community of practice using appropriate social media (Telegram, WhatsApp) • Review change and adjust	Implementation
Insufficient Multi-Stakeholder Partnerships	Limited collaboration among public, private, research and development partners restrict resource sharing and innovation scaling support.	Smallholder farmers outside cooperatives miss collective support benefits. On the other hand, cooperative members get more resource-sharing opportunities.	• Stakeholder Mapping • Establish collaborative platforms • Create shared initiatives • Develop MOUs between platform members and outline clear roles and responsibilities for each stakeholder • Organize Learning Events	Early Stage
Ineffective Monitoring and Evaluation (MEL)	The absence of inclusive MEL frameworks reduces ongoing improvement, feedback, and innovation adaptability.	Cooperative members and commercial farmers have more structured feedback channels, while those who are not members have limited access to feedback channels and evaluation.	Develop MEL frameworks and collect relevant data (gender, age) using the framework. Use the knowledge to improve the scaling effort.	Implementation and Scaling
Innovation not yet Bundled	Failure to bundle complementary technologies and services decreases user adoption potential and options for tailored solutions.	Literate farmers benefit from customized solutions. Illiterate farmers more from accessible, comprehensive packages. Cooperative members benefit from bundled resources more than others.	Conduct assessment on matching bundles with clients' needs, design bundled packages, and initiate pilot launches to provide comprehensive offerings and increase adoption.	Scaling

Barrier	Description	Market Segment Differences	Mitigation Strategy	Stage of Innovation
Technology package issues (Fertilizer, lime, ISFM, Biofertilizer, SLM	Inadequate comprehensive and complimentary agronomy technology packages • Involves fertilizer amount, rate, time of application, lime • High demand for location-specific packages of agronomic technologies	Deference in package use between women men, youth, rich, and poor exist. The issue also differs between groups and innovation	• Carry out an innovation neutrality assessment to understand how each group will be affected by the different innovations. • Integrate gender and socially inclusive technologies in the bundle	Implementation
Input Supply: Access to seed, fertilizer, lime, and credit	As these ag advisories scale, issues such as lack of access to effective input and output value chains could be a problem Farmers can also be restricted from accessing the recommended amount because of a finance limitation. The magnitude of the problem could vary from segment to segment.	Members of farmer cooperative unions may be less affected by these barriers but still could be an issue in delivering the right number of recommended inputs according to the Advisories. On the other hand, farmers who are outside of the cooperative system could be affected.	• Need Assessment • Institutional reform along the value chain of supply actors! • Creating room for digitalized input supply and engaging the private sector could help • Introducing credit and crop insurance access • Explore the possibility of an input voucher system to benefit poor farmers	Implementation

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Section 3. The Context-Specific Innovation Bundle and Package

3.1 Complementary Solutions for Effective, Efficient, and Inclusive Scaling

To design the innovation package, a combination of suggestions from the literature and consultation with partner experts was used to generate innovation components driven by scaling issues and drivers. The components are either a practice, tool, knowledge, procedure, or enabler. Initially, during the start of innovation piloting in 2021, the innovation readiness process of the Fertilizer Ethiopia Use Case (Table 3.1.1) and Digital Green Use Case (Table 3.1.2) (Sartas, et al. 2021) through literature review assessed and identified 10 innovation components, with stakeholders agreeing upon the level of readiness (maximum 9).

Table 3.1.1. Innovation package components for Fertilizer Ethiopia Use Case (Sartas, et al., 2021)

Component Name	Type	Level	Evidence Sources
reciprocal multi-stakeholder information exchange	practice	6	Gardeazabal-46,Govaerts-47,Amerasinghe-48,Sartas-49, Varghese-26
Using experiments as entry point for collaboration	principle	4	Abraham-67
Standardized data governance and access protocols	procedure	9	Whittard-33,Tamane-39
Site-specific recommendations	knowledge	8	Udias-5,Ngome-6,Ngome-7,CIP-8,IITA-9,Guardian-10,Tolani-11,Zossou-12,Ngome-13,Bonilla Cedrez-14,Coombs-15,Pypers-16,Wolf-40,Bunn-41,Kpienbaareh-42, Delerce-43,Andrea-44,Hashim-54,Abdelhaleem-60,Mann-68
National innovation platform	organisational arrangement	9	Rollings-36,Myeni-65,Sell-66,Wordofa-71
Multi-domain data integration	practice	8	Petsakos-1,CIP-2,Timler-3,IFPRI-4,CIP-17,Scheerer-18,Pemsl-19,Pemsl-20,Arega-21,Hareau-22,Hareau-23,Abdoulaye-24, CIP-25,IRRI-27,Alcober-28,Tamane-39,Ran-29,Sánchez-Cuervo-32,Palomino-35,Urfels-45,Omran-50,Blasco- 51, Abdelnabby-52,Ahmed-53,Hashim-54,Khadr-55,Munir-56, Kassem-58,Zakarya-59,Mann-68
Fertilizer use optimization algorithms	tool	9	Udias-5,Ngome-6,Ngome-7,CIP-8,IITA-9,Guardian-10, Tolani-11,Zossou-12,Ngome-13,Bonilla Cedrez-14, Coombs-15,Pypers-16,Mugabo-37,Falconnier-69,Liben-70
Data pooling from multiple interventions	practice	8	Petsakos-1,CIP-17,Scheerer-18,Pemsl-19,Pemsl-20,Arega-21,Hareau-22,Hareau-23,Abdoulaye-24,CIP-25,IRRI-27, Alcober-28,Whittard-38,Mudege-31,Beer-34,Baker-30, Blasco-51,Almas-57,Zakarya-59,Mann-68
Collaboration with land and cadastre organization	organisational arrangement	6	Rubinov-63,Ozcelik-64
Agricultural production forecasting models	tool	6	Petsakos-1,Tesfahunegn-61,Lala-62

Table 3.1.2. Innovation package components for Digital Green Use Case (Sartas, et al, 2021)

Component Name	Type	Level	Evidence Sources
Wheat Rust surveillance, early warning and management	Technology	6	Allen-Sader-11
Standardized data governance and access protocols	Procedure	9	Whittard-19,Tamane-27
Local-led agricultural extension, farmer engagement and capacity building	Service	6	Gebrehiwot-22, Hailemichael- 23, Krishnan-20,ILRI- 28
Integrations of climate interactions and implications into agricultural decision making	Practice	6	Verdin-14,Freduah-33
Gender-sensitive testing and validation	Service	6	Tsige-29,Tsige-30, Grabowski-34, Nyantakyi-Frimpong- 24
Detailed terms of reference for multi-stakeholder collaboration	Plan	6	Nigussie-32
Data sharing benefits for farmers	Service	3	Whittard-25 ,Beer-21
Data pooling from multiple interventions	Practice	6	Petsakos-1,CIP-2 Scheerer-3,Pemsl-4, Pemsl-5,Arega-6 Hareau-7,Hareau- 8, Abdoulaye-9,CIP- 10,IRRI-12,Alcober-13,Whittard-26, Mudege-18,Beer-21,Baker-17
Coalition of the willing	Organizational Arrangement	9	Whittard-19,Tamene-16, Tamane-27,Coalition of the Willing (CoW)-15
Application programming interfaces (APIs)	Tool	6	Correndo-31

We assessed the scaling readiness of core innovation components using the Scaling Readiness scale (Sartas et al., 2021). Table 3.1.3 presents the scaling readiness level assessment for the components of the current HaFAS as of November 2024. To generate updated scaling readiness scores, we reviewed the literature and consulted key stakeholders and experts. The core innovations, which may include technologies, practices, tools, knowledge products, procedures, or enabling factors, are primarily focused here on technologies and tools. A participatory process with scaling partners identified innovation components based on critical scaling issues and drivers. Through consultative workshops, key scaling partners with diverse and essential roles in innovation scaling collaborated to explore the relevant scaling challenges, drivers, and enablers.

Table 3.1.3. The innovation readiness levels for each component of the LAFA agro-advisory tools

Component	Description of readiness	Current/ potential readiness scale
Data and Knowledge Partnership	More than 150 experts from the country and 10 institutions are joining the partnership to tap into the opportunities in the partnership (e.g. CoW, national DST coordination platform, scaling partners network at operation level).	*9*
Data Pooling and Sourcing Workflow	The workflow is being used by multiple actors	*9*
Data, Databases, and National Data Hubs	Being accessed and requested by the key national players as go to place for agronomic and soil data	*9*
Data Standardization and Access Protocols	EIAR, NARS, universities are using for their project and research data collection protocol	*9*
Fertilizer Optimization advisory	MoA district office, Digital Green, Lersha, ICRISAT, and others are already testing and piloting the previous version with more than 100K farmers. The updated, harmonized advisory is now being validated at 1570 farmer fields.	*7*

Due to the ever-evolving policies and conditions affecting agriculture, the HaFAS system will need regular updating to stay relevant. The LAFA will be the focus in Phase 1; in Phase 2, it is envisioned that insurance and credit access will be linked in; in Phase 3, the challenge areas of soil and land management (SLM) and mechanization will be included.

Figure 3.1.4. Stepwise scaling implementation of core advisories and complementary innovations during the three scaling phases. Data, validation, and interface-related innovations will be continuously deployed to generate bundled core advisories

3.1.1 Going Beyond Single Advisory Tool for Multiple Crops

The development of the HaFAS framework, hosted by the Ethiopian Institute of Agricultural Research (EIAR), was officially launched in September 2023 during a high-profile event attended by government officials, donors, and representatives from national agricultural research systems (NARS) and CGIAR partners. Following the launch, technical experts from CGIAR and NARS finalized the harmonized advisory framework to develop a comprehensive Harmonized Digital Agro-Advisory System (HaFAS). Since its introduction, the HaFAS has gained significant momentum, driven by the CGIAR's Excellence in Agronomy Initiative (EiA), ICRISAT, the Alliance of Bioversity International & CIAT, and strong collaboration with key partners. This collaboration integrates extensive datasets and machine learning tools to deliver multiple tailored agro-advisory services. The LAFA component optimizes nitrogen and phosphorus use, maximizes yield potential and profitability, and centralizes data from field trials, geospatial sources, and climate models, creating a robust data ecosystem. Partners have played a vital role in conducting analytics, generating advisory content, and validating the tool under real-world conditions.

Starting in 2024, EIAR and RARIs have been leading extensive field validations of the harmonized LAFA, covering 1570 farmers' fields in major cereal-growing areas across seven regional states in 49 zone administrations and 129 districts (Figure 3.2)[6]. These validations are aimed at ensuring that the recommendations are practical, context-specific, and aligned with farmers' needs and practices (Tamene et al., 2024b).

[6] With the exception of the Tigray region, due to insecurity.

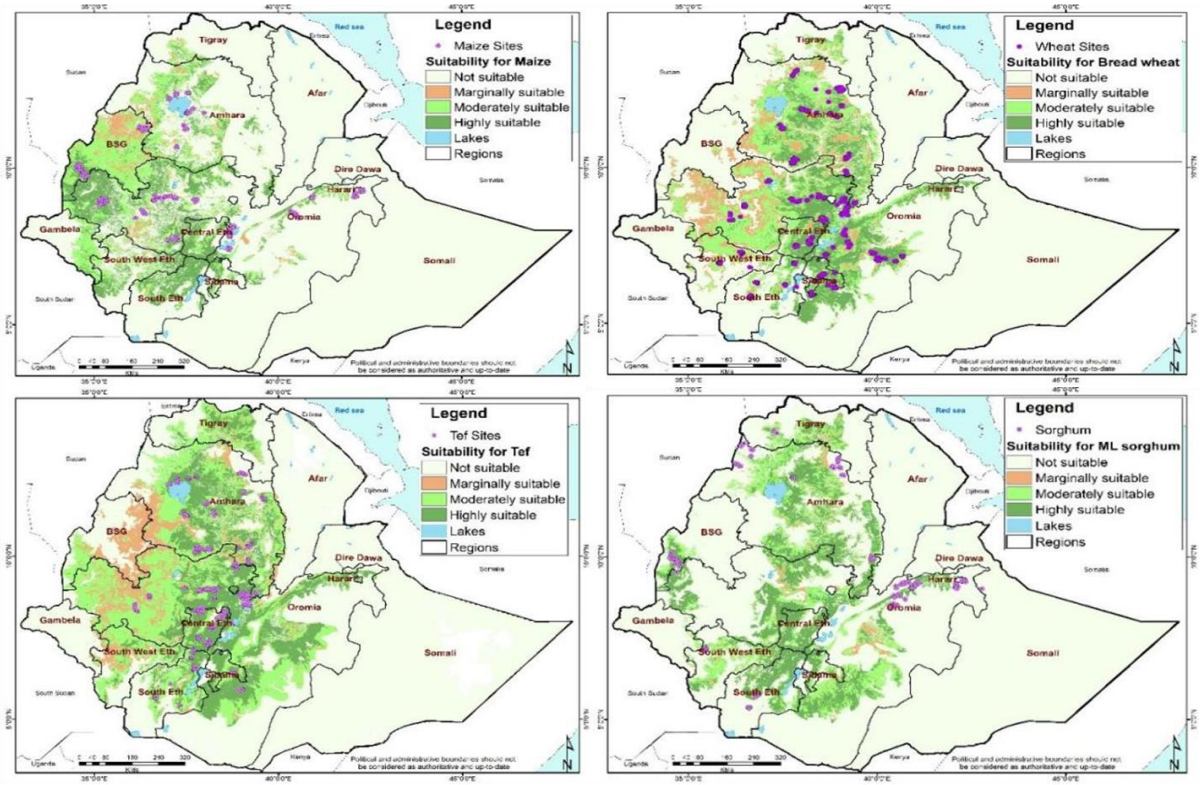

Figure 3.2. Validation sites across the major cereal growing areas in forty-nine zones across seven regional states

The LAFA offers a coordinated response to the needs of Ethiopian farmers by providing precise, data-driven advisory services that enhance fertilizer application efficiency and support sustainable soil management and productivity gain for multiple crops, initially wheat, teff, sorghum, and maize. The strong collaboration among key stakeholders marks a shift from traditional blanket recommendations towards tailored, digitally enabled fertilizer recommendations and agronomic advice. These recommendations will be delivered effectively through agile channels to local extension agents and farmers, improving agro-advisory services in major cereal-growing areas of Ethiopia. This approach aligns with the government's priorities for the digital delivery of customized extension services nationwide. Scaling the LAFA as a core innovation as part of a comprehensive HaFAS represents a transformation in the cereal sector and a significant step toward achieving Ethiopia's goals of agricultural self-sufficiency and economic resilience.

This proposed strategy for scaling up HaFAS delivery addresses Ethiopia's pressing need to close yield gaps, improve soil health, increase access to complementary services (for example, crop insurance, credit, and input services), and advance sustainable agriculture. With strong national demand, proven effectiveness, and alignment with agriculture and digital innovation policy priorities, the HaFAS offers a transformative solution for the future of Ethiopian agriculture.

Initially, scaling the LAFA as a core innovation while other components continue to develop is a transformative step toward achieving Ethiopia's agricultural and food system transformation and economic resilience vision. Providing farmers with tailored, data-driven agro-advisories, empowers them to boost productivity, increase profitability, and adopt sustainable practices. This initiative positions Ethiopia to make substantial progress toward its agricultural goals, strengthen food security, and build a resilient, more inclusive agricultural sector capable of adapting to climate change and mitigating environmental challenges.

3.2 Reflection on Responsible Scaling Principles

Though innovations are meant to benefit society, there could be instances where they bring unintended and unwanted changes or impacts. These could be related to social, environmental, and economic aspects. Therefore, when designing and implementing scaling, we should deliberately plan and manage to minimize or avoid unintended and unwanted changes.

Cognizant of this fact, this scaling strategy has purposively planned actions that ensure

a. **Equity and Inclusion**

To ensure equity and inclusion, the strategy has segmented clients based on their specific needs and capacity. This was made to adapt the innovation to suit the different groups as well as design appropriate delivery strategies. In line with this, the scaling strategy has identified segments of clients based on objective/orientation towards market, membership in local associations, risk aversion, digital literacy, and land use rights. These are prioritized based on easily measured data and their relevance. It has also sub-segmented each farmer based on his/her probability of adopting agro-advisory services, gender, and age. This is intended to enable targeted service provision, matching smallholder farmers to the services they most need and can use. Some digital agro-advisory services and digital segments are of interest to just one segment, while others are of importance to most segments.

The gender dimension is of particular importance in the Ethiopian context, where women make up 50% of the agricultural workforce but contribute much less than 30% to agricultural productivity (Abdisa *et al.,* 2024). Analyzing national panel data, Abdisa *et al.* (2024) found a gender productivity difference between female-headed and male-headed households, with productivity among female-headed households being 11.2% lower when measured on a value basis. While fertilizer use (not distinguished between organic and inorganic) was almost equal between female-headed (67%) and male-headed (68%) households, the differences in extension service contact were large—24% for female-headed versus 65% for male-headed farmers. Although female-headed households may have equal access to fertilizer, they have limited capacity to afford the required inputs. Extension contact, soil fertility, use of inorganic fertilizer, credit use, machinery use, and plantation methods are among the key determinants of the gender gap in agricultural productivity. If not specifically addressed, there is a potential danger that the LAFA and complementary innovations will further contribute to the structural barriers that inhibit women from productivity-enhancing training and input access (Abdiisa *et al*., 2024).

b. **Contextual Relevance and Adaptation**

The harmonized LAFA underwent data collection for validation in different regions and woredas of the country in 2024. Then analysis was carried out in early 2025. The finding confirmed that the innovation was better than the blanket use of fertilizer. Therefore, it was found to be relevant to what farmers need. Many farmers were finding fertilizers unavailable when needed, and others found them too costly when available. Therefore, with the LAFA being efficient in fertilizer use, it helped farmers participating in the validation exercise to reduce the total cost of fertilizer used and fulfill their fertilizer needs with what they were able to access. The benefit was observed by individual farmers as well as farmers exposed to the cluster-based production.

In addition, as the LAFA will be updated annually responding to client needs and technology development, additional package components will be added (Figure 3.1.4). For example, in the first phase, liming, organic inputs, and crop rotations will be incorporated as part of the LAFA package. In the subsequent phases, other components of Integrated Soil Fertility Management (ISFM), crop insurance, and good agronomic practices will be added. The adaptation will be based on information that will be collected through the gender-sensitive and farmer-segmented monitoring, evaluation, and learning (MEL) system and scanning the technological innovation in other sectors as well as by other competitors.

c. **Environmental Sustainability and "Do No Harm"**

The innovation involves using site-specific nutrients to avoid blanket fertilizer recommendations. Therefore, it enhances the efficient and optimum use of fertilizers based on crop nutrient requirements and minimizes fertilizer overuse, with obvious benefits to water quality, soil quality (less acidification), etc.

This makes the innovation environmentally friendly. In addition, as mentioned in the section that describes the packaging of the innovation, in the first phase, the package will include liming as one component. In subsequent phases, other Integrated Soil Fertilizer Management innovations such as crop rotation, farmyard manure, compost, mulching, vermicomposting, and double cropping will be added as complements. Therefore, this will further make the innovation environmentally sound.

d. **Monitoring, Evaluation, and Learning (MEL)**

The MEL system of the strategy is organized to respond to the two main pillars of MEL—proving and improving. The proving part is organized to collect data and communicate to appropriate stakeholders so that they keep informed on the progress, achievements, challenges, and suggested actions. This will capture the accountability purpose of the MEL system. The other part that is emphasized in this strategy is the improving pillar. To be useful over time, any digital advisory system needs regular updating, including plot-level validation. This is especially true regarding inorganic fertilizer recommendations, as soil needs change, and the cost vs benefit of different fertilizer blends are assessed. Feedback from end users must be gathered and used to inform the design of the system. Hence, the MEL system must include a mechanism for Reflection and Refinement (R&R) through feedback assessment, ensuring that all relevant sub-groups (men, female

heads of household, married women, and youth) are represented. As the scaling strategy is a multi-stakeholder initiative, the R&R will involve all stakeholders, including the different client groups.

As detailed in the MEL section, the MEL structure will have a focal person in each participating organization and one central unit coordinating the efforts of the different MEL carried out by each organization. Therefore, the structure will allow both centralized and decentralized data collection and repository. The centralized approach will ensure that data are collected on jointly agreed indicators and data collection methods. In addition, it also facilitates a centralized database which allows access to all stakeholders. On the other hand, the decentralized system will encourage the use of MEL for organizational learning.

e. **Collaboration and Local Ownership.**

Initially, the HaFAS framework began as a collaborative output of a joint work by ICRISAT and Alliance Bioversity-CIAT. However, when it was out for validation, different stakeholders became involved, including federal and regional public research institutes, federal and regional extension organizations, NGOs, and civil society organizations. The government is now in the lead in coordinating and implementing the HaFAS. This public sector ownership of the process will ensure partners' cooperation and sustainability.

The current scaling delivery strategy will expand the tool interest group beyond the technical experts to include policymakers and decision-makers, digital service providers, and farmer representatives.

3.3 Scaling Ambition, Key Desired Outcomes and Target Client Groups

3.3.1 Scaling Ambition

The agriculture sector plays a central role in the life and livelihood of 130 million Ethiopians, where about 16 million smallholder farming households having on average less than one hectare of land account for an estimated 95 percent of agricultural production and 85 percent of all employment (Okoth ***et al.***, 2023). Given the agriculture sector is the backbone of the economy, the Ethiopian Government has formulated a series of policies, strategies and programs to promote agricultural development to achieve food and nutrition security and build resilience. The plan under this sector focused on improving agricultural production and productivity and commercialization; reducing degradation of natural resources and improving productivity; reducing vulnerability to disaster and building disaster mitigation capacity by ensuring food security.

Production of food crops such as cereals accounts for one of Ethiopia's significant shares of the economy from the agricultural sector. Over 70% of cultivated agricultural land (10 million ha) is used to produce cereals, using 60% of the rural workforce (CSA, 2022). The five main cereal crops, teff (24% of area), wheat (13%), maize (17%), sorghum (9%), and barley (5.5%) are the staple foods for people and the foundation of Ethiopia's food economy and agriculture. As per the International Trade Administration report, over 50% of the daily caloric intake of an average household in Ethiopia is from wheat, sorghum, and maize[7]. Teff provides two-thirds of the daily protein intake and 11% of the per capita caloric intake. Concerning input use, of the total 16 million farming households, 15.3 million households have access to fertilizers. About 13.65 million households use 1.63 million tons of fertilizer for cereals (CSA, 2022) which accounts for 85% of the annual fertilizer supply. Farmers' yields only reach about 20-40% of what is possible with agronomic best practices (Assefa et al. 2020; Silva et al., 2021). Such low productivity levels cannot satisfy cereal demand in the country, resulting in high dependence on imported cereal grains. Current yield constraints are related to poor agronomy, including suboptimal crop management and low input levels (Assefa et al. 2020; Silva et al., 2021), and low adoption of soil fertility management practices and improved varieties.

Thus, given cereals account for three-fourths of the crop production areas and take a large share of fertilizer use, improving fertilizer use efficiency with the deployment of site-specific agro advisories is an ambitious and game-changing strategy to reach a large size of farming households who rely on blanket and inefficient fertilizer use in the country and ultimately lead to an outcome of maximizing economic benefit and boosting crop productivity. The existing fertilizer supply and potential for digital agriculture tool use to improve efficiency of fertilizer use for cereals are the foundation of the scaling ambition for this delivery strategy.

Our scaling ambition by 2040 is to reach 6.85 million farmers (50% of fertilizer users for cereals), of which 2.05 million are women and 2.74 million are youth (<30 years of age) with digital fertilizer advisory services. Adoption of the advice will increase from 45% (Phase 1) to 75% by 2040. Use of the HaFAS framework and LAFA will generate a 30% increase of cereal productivity and 20% improved nutrient use efficiency, leading to an increase of national cereal production from 31.6 million to 140 million metric tons by 2040.

[7] Source: https://www.mordorintelligence.com/industry-reports/agriculture-in-ethiopia

3.3.2 Market Size of Digital Advisory Tools

Market segmentation is a good strategy for disaggregating HaFAS innovation based on different client segments. The agriculture market size in Ethiopia is estimated at USD 5.09 billion in 2024 and is expected to reach USD 6.65 billion by 2029[2]. This agriculture market size has the potential to grow by leveraging the expansion of digital agriculture technologies to embrace recommendations at the individual farm level and the promotion of precision agriculture practices. Digital technology in agriculture can help by providing access to site-specific good agriculture practices, information, and training; helping farmers determine the best seasonal climate for crop growth; improving communication between input suppliers, insurance services, and farmers; and tracking performances and outcomes.

The need for all types of digital media and specifically for the digitalization of extension services is driven by the expansion of mobile internet access and the increasing number of mobile and streaming devices. The Ethiopian telecom company has 40.4 million mobile broadband and 75.6 million mobile voice users during the 2023/24 fiscal year[8]. Ethiopia has an estimated demand for 9000 mobile towers, and as of November 2022, there were 7000 mobile towers in Ethiopia, and an additional 213 new mobile towers are in various stages of construction[9]. Safaricom Ethiopia recently purchased 68 telecom towers, and 2G and 3G network expansion has been implemented in the different rural districts. The expansion of digital infrastructures opened opportunities for digitalized agriculture extension services. Given the enabling environment of the digital infrastructure, Ethiopia is experiencing rapid growth in digital media with an increasing number of online platforms. The digital media market in Ethiopia is projected to grow by 11.19% (2024-2027) resulting in a market volume of US$512.50 million in 2027[10]. In 2024, the projected revenue in the digital media market is estimated to reach $372.8 million. The launch of solar mini-grids through the Distributed Renewable Energy-Agriculture Modalities (DREAM) project provides additional capability to use digital technologies for agriculture in rural areas.

Provided with these communication potentials, Ethiopia developed the Digital Agriculture Roadmap (DAR) 2032 to guide the use of digital solutions to transform the country's agricultural sector. The roadmap aims to align efforts across stakeholders to benefit farmers. It envisions a productive, inclusive, and sustainable agri-food system. The roadmap encompasses six pillars: digital innovations, hardware and connectivity, data and analytics, governance and policy, human capital, and business environment. The road map recognizes the opportunity for collaboration of the government, NGOs, and private sector to deliver extension services and have multifront digital initiatives to reach farmers through different market segments. Along with this, the government is creating a favorable environment for the private sector engagement in innovation and technology as exemplified in the ratification of the pluralistic extension policy and agricultural data-sharing directive. In addition, the recent National Digital Payment Strategy (2021) includes a targeted action to digitize payments in agriculture. These changes in communication infrastructures and digital policy environment would bring considerable benefits to diversify digital market segments (videos, SMS, social media, web apps, hotlines, IVR, chatbots).

3.3.3 Farmer Segmentation

A wide range of agriculture services are available to help farmers, often using new technologies and services, but most service delivery models struggle to reach scale or to make a significant impact. This is usually because the “one size fits all” approach leads to many smallholder farmers being offered services that they do not consider relevant or are poorly matched to the individual farmer’s specific needs and capacities. As a result, these services have little impact on farmers’ livelihoods, and they are unlikely to recommend them to others. This implies that successful digital agro-advisory services must identify and recognize the potential for different client segments to access and use the HaFAS tools.

Farmer segmentation is placing farmers into distinct groups to better understand their challenges and needs and their ability to invest to develop more targeted, effective solutions. Knowing the farmers' needs and capabilities means a greater likelihood of the agro-advisory of various digital segments and other agriculture services being adopted to provide sustained, long-term business. Governments and non-government organizations can also benefit from segmenting farmers to effectively target and fine-tune their investments in scaling the agro advisory.

Detailed context analysis about farmer segmentation has identified that smallholder farmers can be grouped into different segments based on production objective/orientation, membership to local association, risk aversion, digital literacy, land use rights, age, and gender which are prioritized based on measurable data and their relevance. It also classifies each farmer segment based on his/her probability of adopting agro-advisory services. This enables targeted service provision, matching smallholder farmers to the services they most need and can use. Some digital agro-advisory services and digital segments are of interest to just one segment, while others attract many segments. For example, subsistence farmers have little access to cash, so their highest priority tends to be various types of credit or subsidies from a variety of sources. Their hand-to-mouth existence requires them to focus on solving immediate problems like buying inputs. Market-oriented farmers tend to be better off financially and farm as a business, so whilst access to loans is important to them, their highest priorities are around expanding markets for their produce. Farmers who can pay for services tend to have more resources and

[8] Source: https://www.ethiotelecom.et/
[9] Source: https://www.trade.gov/market-intelligence/ethiopia-telecom-and-internet-services
[10] Source: https://www.statista.com/outlook/dmo/digital-media/ethiopia

are more likely to make use of tailored training and information services. Farmers can be categorized by digital literacy as digitally literate and non-literate for specific digital formats, based on their readiness to take up digital agro-advisory services. The more literate group and wealthier farmers are likely to have high readiness and access to technology and are thus more likely to use the agro-advisory through extension agent services and other alternative services. -While non-literate farmer groups have less capacity or incentive to engage and use digital services and typically must access the information through trained extension personnel.

Women are a major part of Ethiopia's agricultural sector, heading more than 25% of farming households and 40 to 50% of the agricultural labor force (Yalemzewud, et al, 2022). Women represent fewer than 20% of cooperative membership, and there are even fewer women in leadership positions. Women farmers often had less access to information and advice (Abdisa *et al.,* 2024). Considerable effort on segmented services must be made to provide women farmers and women on the farm with efficient, effective, and appropriate technology, training, and information on digital innovations and solutions.

The scaling of agro-advisory needs to specifically target the working-age adult rural population. Most of this population is young, with 40% under the age of 15 and 32% between the ages of 15 to 29. These farmer segments are often targeted by development and business entities and technology delivery agents due to their unique needs, interests, and technology use behavior. There is a significant potential to reach young farmers for the scaling of the agro-advisories as they have a strong affinity for digital innovations and digital platforms as well as a preference for social networking. The youth segment is important for businesses because they represent future consumers. To effectively reach the youth segment, specific delivery strategies and digital markets can be designed, and social media platforms can be exploited to engage with them and expand their access to important digital knowledge and information[11].

Many of the smallholder farmers are registered members of cooperative institutions. They often have better access to input and bundled services than non-cooperative members. According to the Federal Cooperative Agency (FCA) official report (2021), there are more than 92,755 cooperatives in Ethiopia with 21,043,370 members (6,743,429 female and 14,299,941 male). In addition, there are 21,328 primary savings and credit cooperatives (SACCOS), with 5,384,559 members (3,122,454 female and 2,262,105 male). Overall, the opportunities created through the existence of enormous government and non-government partners actively engaged in agricultural extension services and the presence of diverse farmer-facing institutions and platforms assist in the identification and development of diverse pathways to reach alternative market segments with digital agro-advisory solutions.

The needs of each segment can then be prioritized based on the appropriateness of setting user targets and delivery services. Table 3.3.3 shows the priority segments identified and their relative needs for each segment.

Table 3.3.3. Diverse farmer segments in Ethiopia and their key characteristics

Segmentation criteria	Segments	Characteristics
Production orientation	Subsistence	• Low purchasing capacity • Low technology use • Prioritize fertilizer application to food crops mainly for teff, wheat • Demand less fertilizer input rates • The main source of income is from agriculture • Supplemented by income from casual labor • Consume their crops and sell any surplus • The lowest income segment
	Farmers able to pay for services	• Have mobile phones, some with smartphones • High purchasing capacity • High input and fertilizer use rates • Mainly produce for market • High proportion of crop sold in markets • A high proportion of land rented in • Farming is the main source of income • More likely to invest in the farm • The highest income segment

[11] https://www.uncdf.org/article/8366/how-are-digital-tools-empowering-youth-led-businesses-in-ethiopia-to-adapt-to-a-changing-world

Segmentation criteria	Segments	Characteristics
Resource endowment	Farm size (< 0.5 ha)	• Low capacity to diversify farming for small holdings • Demand small-size fertilizer packages • Need support in the form of subsidy or credit services • Rely on off-farm income to compensate for small size • Crop sharing to diversity income
	(> 0.5 ha)	• High purchasing capacity • Demand more input use for diversifying commodities • Require large-size fertilizer packages • More bundled technologies for intensification
	Livestock number (<5 TLU HH)	• Mixed income sources • High-risk aversion capacity of households with large livestock numbers • Source of organic fertilizers to optimize fertilizer demand and better contribution to soil health management
	> 5 TLU per HH	• Relatively higher amounts of organic fertilizer to optimize fertilizer demand and better contribution to soil health management • Better income from livestock to increase input purchase capacity
Gender	Women	• Women are disadvantaged in their access to schooling • Less access to extension services • Lower financial capacity to pay for inputs then men • High workloads for women • Low financial decision-making
	Men	• Main contributor to farm work and the main decision maker on the main plot • Make decisions on input use
Age	15-29	• Youth receive more formal schooling than older farmers • Low access to finance • Access land through rental, crop sharing, and inherited
	>29	• Make decisions on fertilizer use
Cooperative (COOP) member	Member	• Better access to inputs, including inorganic fertilizers • Access finance or credit through the COOPs • Benefit from market linkage through COOPsa • Access mechanization and storage services • Benefit from the financial management system of COOPs

References

Yalemzewud Simachew Tiruneh, Nigel Ross Hughes, Kalyani Kandula (2022). Supporting Ethiopian women farmers in adapting to a changing climate. World Bank.

3.4 Theory of Change to Reach Desired Outcomes

The theory of change (ToC) provides a conceptual roadmap that offers guidance on how HaFAS core and complementary innovation development and outputs are expected to lead to specified outcomes and impacts. The premise is that the use of harmonized digital solutions that provide site-specific recommendations with bundled agro-advisories and collaborative digital platforms can help improve the adoption of agricultural inputs and advisories that will ultimately increase resource use efficiency and reduce costs, productivity, and profitability of targeted crops and increased fertilizer investments. The key activities include designing site-specific and tailored digital advisories, establishing partnerships, and developing delivery strategies. These activities will explicitly account for cross-cutting development of gender and youth for equity and inclusion, the enabling environment, and strengthening the capacity of national partners and local institutions as well as the capacity of the end-users

of the digital solutions and agro-advisory services. The activities will be supported by a functional MELIA system that will actively collect and analyze data to monitor progress and ensure learning to get more insights into existing knowledge, communication, and learning systems. This will facilitate the continued identification of entry and leverage points for improving delivery through feedback and learning.

Outcomes and impacts on development goals will be achieved through two impact pathways. The first and primary pathway is to improve development outcomes. The Theory of Change (ToC) presents this impact pathway (see Figure 3.4). The LAFA and complementary advisory tools are expected to increase the efficiency of fertilizer use, reduce costs to end-users, and improve the efficiency of fertilizer investment, ultimately improving income and food security, nutrition and health, livelihoods, climate resilience, and environmental health. These impacts will be achieved through improving several intermediate and cross-cutting development outcomes (Figure 3.4). The second impact pathway for contributing to development outcomes is policy processes. National and regional governments and other local and regional stakeholders can influence policy and regulatory options for digital innovations to promote the adoption of agricultural technologies. To inform these policy discussions and regulations, relevant evidence and lessons will be synthesized and provided to support informed decisions on digital innovations and pluralistic digital extension systems. Key policymakers and other policy stakeholders (i.e., from the private sector and other organizations) are identified and will be engaged in the scaling up of the innovation. This participation will also help in building institutional capacity to harness digital agriculture and the capacity of local actors and stakeholders to implement integrated solutions and market-led interventions. Furthermore, understanding key factors and local institutional configurations that increase (or constrain) the success of digital innovations and adoption of digital agro-advisories at scale can help policymakers and other stakeholders to design appropriate mechanisms of promoting such solutions and technologies. To ensure the adoption levels, such as behavioral change and usability of the innovation by different segments of users, behavioral change science frameworks and randomized control trials on accountability and learning of the solutions for different paths to scale could be integrated at different phases of the scaling if resources permit.

The ToC relies on the assumption that digital solutions enhance the flow of information and increase awareness about the importance and benefits of site-specific recommendations and are supported with regular updates and improvements. To achieve this, the provided digital solutions need to be effective and sustained. This will be achieved by strengthening public and private sector partnerships and collaboration to ensure that the right information and evidence reaches the right decision-makers and key stakeholders. It also assumes that farmers and value chain actors have the resources, skills, and knowledge to adopt site-specific recommendations. Given that site-specific recommendations improve fertilizer use efficiency and reduce the costs of inputs, farmers are expected to be increasingly willing to take the risk embedded in the adoption of digital solutions and applying site-specific recommendations. In parallel, business development services will be used to help the private sector, cooperatives, and other actors learn about digital innovations and embed them as business opportunities. Finally, national partners and beneficiaries will be enabled to support scaling up through targeted capacity building, knowledge dissemination, and policy engagement.

<table>
<tr><td>IMPACTS</td><td>Food security</td><td>Nutrition & health</td><td>Resilience and environmental health</td></tr>
<tr><td>OUTCOMES</td><td>Increased total production & profitability</td><td>Reduced costs of inputs</td><td>Increased efficient and diversified fertilizer investment</td></tr>
<tr><td>INTERMEDIATE OUTCOMES</td><td>Women and men farmers use localized fertilizer and agronomy advisory solutions</td><td colspan="2">Harmonized digital agriculture solutions and platforms institutionalized through diversified pathways (Public, Private, PPP and Coops)</td></tr>
<tr><td>OUTPUTS</td><td>Scaling partners and farmers digital capacity built</td><td>Digital delivery strategies and capabilities strengthened and established</td><td>Harmonized platforms for digital advisory services and scaling operations strengthened and institutionalized</td></tr>
<tr><td rowspan="3">ACTIVITIES</td><td>Delivery strategies</td><td>Digital advisory tools</td><td>Partnership</td></tr>
<tr><td>FTC
Coops
PPP
Inclusive approaches</td><td>Generate data for updating & bundling advices
Data management
Develop bundled applications</td><td>Governance of digital platforms
Operation of scaling
Resource mobilization</td></tr>
<tr><td colspan="3">MELIA (evaluation, learning, reflection)</td></tr>
</table>

Figure 3.4. Theory of Change for the Use of the Harmonized Digital Fertilizer and Agronomy Solutions (HaFAS)

3.5 Context of the Existing Enabling Environment in Ethiopia

3.5.1 Overview of the Enabling Environment in Ethiopia

Designing adaptive and context-specific scaling delivery strategies requires an understanding of the enabling environment in which the scaling processes will be introduced. In the case of the scaling strategy of bundled innovations and enabling frameworks regarding the harmonized digital fertilizer and agronomy solutions (HaFAS), it is about identifying enablers that have the potential to influence the success and sustainability for scaling agro

advisory solutions in this case LAFA and complementary tools. The formal elements of the enabling environment include public policies, governance structures, strategies, frameworks, investment programs, and other formal aspects. On the other hand, the informal elements include social, cultural, and economic norms, rules and practices.

Public policy is a purposive course of action taken to deal with a problem or concern. Besides public and government communities, the private sector entities are equally important in placing and disseminating relevant policy environments, including strategic delivery of HaFAS innovations. The private sector and formal and informal community organizations (including the farming community) can influence public policy using four main capacity-strengthening approaches (Strickland, 2018): (i) training provisions and policy awareness to the private sector; (ii) knowledge and experience sharing and exchange between the private sector and public officials/policymakers; (iii) campaign contributions; and (iv) lobbying efforts.

Ethiopia has enacted many policy and technical documents that support digital agriculture regardless of limited inclusivity and poor evidence-based policymaking processes. The following list provides major national policy instruments in pertinent to HaFAS:

1. Ethiopian Constitution (FDRE, 1995),
2. New Agriculture and Rural Development Policy (FDRE, 2024)
3. Recent Seed Proclamation No. 1288/2023 (FDRE, 2023)
4. Agricultural Production Contract Proclamation No No.1289/2023 (FDRE, 2023)
5. Fertilizer Manufacturing and Trade Proclamation No. 137/1998 (FDRE, 1998)

Program and policy documents include the

1. Research Advisory on Fertilizer Nutrient Type and Rates in Ethiopia (EIAR, 2024)
2. Draft proclamation on Ethiopian Pluralistic Agricultural Extension Service (PES) (MoA, 2023 unpublished),
3. Digital Agriculture Extension and Advisory Services (DAEAS) Roadmap 2030 for Ethiopia (MoA and ATI, 2022)
4. Digital Agriculture Roadmap 2025-2032 (ATI and MOA)
5. Ethiopian Food System Pathway Commitment Draft Statement (FDRE, 2021, unpublished)
6. Digital Ethiopia 2025 - Building Competitiveness through Innovation: Strategy for Inclusive Prosperity, National Science, Technology and Innovation Policy (FDRE, 2010)

The country also ratified several agricultural policy instruments, including the

1. AU's Comprehensive Africa Agriculture Program (CAADP) Compact in September 2009, and in agreement with the updated Strategy and Action Plan 2026-2035 (CAADP, 2024) in which promoting digitization and Agri-Tech is a key intervention.
2. International Treaty of Plant Genetic Resources for Food and Agriculture (IT-PGRFA) in June 2003

3.5.2 Descriptions on the Existing Policy Instruments

Agricultural and Rural Development (ARD) Policy: The Federal Democratic Republic of Ethiopia (FDRE) has replaced the former Rural Development Policy (RDP) with a comprehensive Agricultural and Rural Development in 2024. This policy outlines detailed strategies and implementation guidelines. Key strategies include agricultural technology generation and utilization, a pluralistic extension approach, effective natural resource management, the development and utilization of agricultural inputs, agricultural production contract proclamation, digital agricultural extension advisory services, etc. In addition, the Indigenous knowledge (IK) of Ethiopian farmers and their inherent social and cultural norms and values would create a conducive environment for scaling agricultural technologies in general and HaFAS scaling initiative in particular. Strong and visible policies and strategy on the one hand and socio-cultural capital on the other hand are crucial opportunities for scaling agro-advisory solutions.

This ARD policy acknowledges the need to strengthen agricultural research institutes and embraces the involvement of private institutions and individual researchers in agricultural research, along with the establishment of guidelines and regulations to facilitate their participation (FDRE, 2024). This will open a good opportunity to disseminate and scale digital agro-advisory to the smallholder farmers at large. In terms of natural resources utilization and management, the new ARD policy places special emphasis on the utilization and management of natural resources. It prioritizes the improvement of soil fertility and health through targeted technology generation and dissemination. The policy advocates for the development of site- and context-specific technologies, presenting a significant opportunity to scale the dissemination of agricultural innovations effectively. Regarding

agricultural input development and utilization, the new ARD policy ensures the role of the private sector in input development and supply chains. This collaboration will create a shared responsibility between public extension services and private providers, improving efficiency and expanding access for smallholder farmers. Ultimately, this will enable large-scale dissemination of agricultural technology and practices through HaFAS.

Agricultural Product Contract Proclamation: While this proclamation legally guarantees intensive technology transfer through ensuring strong and legal producer-contractor relationships, it also smooths the pathways for digital transfer of agricultural technologies. The proclamation recognizes that Ethiopian smallholder farmers are the major producers of agricultural produce in Ethiopia. Therefore, the pertinence of the proclamation for facilitating the scaling of the HaFAS system approach is obvious. Singh (2002) stresses that legal placement of such contractual legislation enforces the commitment of key stakeholders to deliver a specific type of agricultural commodity at a predetermined time, price, and quantity from known producers to known buyers. Therefore, this contract proclamation presents a significant opportunity for the widespread dissemination and scaling of HaFAS in Ethiopia with private sector engagement.

Draft Pluralistic Extension Service (PES): Under the previous ARD policy, agricultural extension services in Ethiopia were exclusively public-led. However, the current policy promotes a pluralistic extension approach, aiming to unify diverse efforts toward common objectives. Public-Private Partnerships (PPPs) are increasingly emphasized in agricultural research and innovation, enabling the leveraging of public funding, enhancing efficiency, and aligning innovations more closely with market demand for quicker and broader dissemination. This policy shift positions PPPs as an alternative pathway for agricultural technology generation, involving key players such as private institutions and non-governmental organizations (NGOs) engaged in agricultural research and innovation. The number of national and local NGOs in Ethiopia is on the rise, and their capacity to address the country's complex development challenges is significantly growing (Clark, 2000). Recognizing this, the policy envisions NGOs and private institutions taking on critical roles in technology generation and dissemination. Such shared involvement will be a good asset for the agro-advisory scaling for Ethiopian smallholder farmers. Additionally, private institutions are encouraged to play a vital role in the input supply sector. Their involvement in research and input supply activities is expected to enhance the scaling of agricultural innovations, especially digital tools. In all instances, the official endorsement and enforcement of the awaiting PES policy document provide the legal backing for embracing pluralism in the extension services in general and this scaling delivery strategy in particular.

Digital Agriculture Extension and Advisory Services (DAEES) Roadmap: The placement of this roadmap document is an opportunity for scaling the Decision Support Tool (HaFAS). Pertinent to the implementation of the provisions in this roadmap, the Ethiopian government has undertaken significant steps such as signing an agreement between the Agricultural Transformation Institute (ATI) and Ethio Telecom for digital extension and advisory service delivery, distribution of digital tablets to extension agents (2 tablets per one rural kebele), etc. Moreover, the ATI has rich experience in dissemination agriculture technologies (push) through farmers' hotline services.

Digital Agriculture Roadmap (DAR) 2032: Ethiopia has launched the Digital Agriculture Roadmap (DAR) 2025-2032 on 4 February 2025. The vision of DAR is to create a digitally advanced agricultural sector where farmers and pastoralists have access to real-time data, modern tools, improved market linkages, as well as drive productivity, sustainability, and food security. DAR is instrumental in modernizing agricultural data, providing market information and financial accessibility for farmers and pastoralists. The roadmap is also developed to serve as a holistic framework to advance Ethiopia's agricultural transformation by empowering farmers and pastoralists. The roadmap builds on the achievement of Digital Agricultural Extension and Advisory Services (DAEAS) Roadmap 2030 and aims to create an inclusive, sustainable, and prosperous ecosystem for farmers and pastoralists. The roadmap is structured into two phases. Phase one runs from 2025-2029, focusing on building foundational digital infrastructure and addressing key challenges in agriculture. Phase two runs from 2030-2032, which aims to diversify and scale the digital ecosystem across the sector.

National Science, Technology, and Innovation Policy (2010): This policy can serve as a springboard to build competitiveness through the conscious application of innovative technologies. The policy is a key instrument to support the adaptation and use of the HaFAS to disseminate improved fertilizer use and other agricultural innovations.

Socio-economic and Cultural Norms: Respecting local-specific social, cultural, and economic norms/rules/practices would matter to sustainable design and ensure an effective utilization of decision support tools in Ethiopia. Among many others, certain prioritized advisories of norms and practices are described as follows:

- Webs of strong interactions with farming communities could bring effective scaling and adoption.
- Ignoring the socio-political context may result in perpetuating the status quo.
- Tackling social exclusion requires addressing the constrained agencies of the poor.

- Mechanisms that are designed to provide complete access and transfer of technologies would determine the success or failure of the scaling strategy in question.

3.5.3 The Regulatory Environment

Establishing laws and regulatory frameworks could enable the effective utilization of the HaFAS approach for agricultural technology dissemination and scaling. The regulatory framework should address the production, packaging, labeling, marketing, distribution, extension, and advisory services through appropriate legal grounds. Weak regulatory environment and standards undermine effective coordination in fertilizer, marketing, extension, and advisory service deliveries.

Although Ethiopia enacted a Fertilizer Manufacturing and Trade Proclamation No. 137/1998 (FDRE, 1998), it has several drawbacks and gaps in the design of legal mechanisms to support fertilizer research and innovation and to properly engage the private sector. The existing fertilizer regulation should either provide appropriate articles or enact proper oversight schemes to enable the controlling of adulteration, fake labeling, misbranded fertilizers, improper packaging, and conflicting advisory services, as well as underweight bags (Shikur, 2023). The nomenclature and authorized body designed in the existing proclamation also need revision. Recognizing such major policy provision gaps, the country is in the process of amending this proclamation and preparing a draft ready for endorsement. The new draft fertilizer proclamation is designed to promote private sector participation in the fertilizer industry by creating a more favorable regulatory environment and encouraging private companies to enter the market and participate in the fertilizer supply chain. This is seen as a key element to improve the overall fertilizer market in the country. The new draft stipulates essential provisions to encourage private sector engagement and improve fertilizer quality standards. It also outlines the extension and delivery, coordination, and collaboration of actors and builds competitiveness, thereby ensuring proper function of the fertilizer sector. The country should also either establish an appropriate regulatory institution or delegate (fully or partially) an existing institution such as the Ministry of Agriculture (MoA) or Ethiopian Agricultural Authority (EAA) or others for all regulatory and quarantine measures and functions. Such regulatory measures would enable effective utilization of the agricultural technology advisory services.

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3.5.4 How Innovation Package Fits within Food System or Ecosystem Framework

The Government of Ethiopia launched the Ethiopian Food Systems (EFR) roadmap with the objective of defining Ethiopia's vision and pathway for national food systems transformation. The EFS roadmap pathway follows in the footsteps of Ethiopia's Homegrown Economic Reform Agenda, which aims to transform Ethiopia from a largely agrarian low-income country to an industrialized lower-middle-income country by 2025. The EFSR identified 22 game-changing solutions that are designed to act on systemic bottlenecks across Ethiopia's food systems.

Among the listed 22 game-changers, the following five game-changers do have significant alignment with the contribution of the HaFAS advisory solutions:

EFS GC 2: Support diversified nutrient-dense foods production by promoting smallholder, greenhouse and garden-level production

The fertilizer application advisory service will have a direct contribution and alignment with the EFS roadmap in the identified game changers to promote and enhance the production and consumption of diversified nutrient-dense staple foods (i.e. biofortified staples) to increase accessibility and expand market access to smallholder farmers at large. The innovation plays a critical role in strengthening supply and value chains, with special attention to linking production to markets across all primary agricultural products having a competitive market opportunity to generate considerable income through increased productivity per unit area.

EFS – GC: Enhanced Digital Technology and Innovation throughout the Food System

The h-DST will have an overall sounding contribution in the EFSR to boost production and productivity using fertilizer application advisory service, and there is an integrated and coherent policymaking infrastructure development initiated by EFS to facilitate rapid food systems transformation for the purpose of increasing production and income from the selected commodities (Wheat, Teff, Sorghum and Maize).

EFS GC 15: Selection and timely supply of inputs and technologies to boost production and productivity

Although Ethiopia does have untapped potential to produce varieties of commodity crops, timely supply of input and technologies has been a challenge. This focus on improving timeliness of supply will engage multiple partners under the entire value chain, including research and development practitioners, to achieve this. The digital fertilizer application advisory service will play a significant role in the demand-driven supply of inputs to increase production and income within the entire farming system.

EFS GC 16: Advanced forecasting system for variables affecting agriculture-based activities on fine spatiotemporal weather models in Ethiopia

Weather changes have a great impact on agriculture production and productivity, and accurately learning about the future state of the weather is significant, especially in countries like Ethiopia where farming practices are dependent on nature, advancement of innovative technology, spatiotemporal weather models in Ethiopia get proportionate consideration for technology dissemination under EFSR strategic document; this implies there are fertile opportunities for h-DST to expand its scope and support the upcoming innovation technology advisory service to support EFS.

Section 4. Scaling Pathways

4.1 Pathways to Scale LAFA and HaFAS Innovation Components

The Agriculture Extension Service Program of Ethiopia is a century-old program and played a vital role in promoting the adoption of modern agricultural inputs, farm technologies, and effective farm management skills. Since the inception of a facilitated extension service system, extension workers (also known as development agents (DAs)) have grown to 72,000, and thus, Ethiopia hosts the largest number of extension service workers in Africa, with an agent-to-farmer ratio of 1 to 230 (Brehane et al., 2018). In 2010, the extension worker-to-farmer ratio stood at 476. The extension workers provide advisory services using door-to-door visits, development group meetings, community meetings and training, and field demonstrations. Services are also delivered to farmers in

the form of development groups consisting of one to five groups of farmers., However, over time, more and more tasks are assigned to extension workers, which limit their capacities to effectively reach all farmers in every village. Moreover, only around 22% of rural Ethiopian households are within 2 kms of a road, making access to extension and also marketing opportunities more challenging (MoA and ATI, 2025). Continuous deterioration in providing quality extension services is observed, and the delivery approach has become resource-intensive and time-consuming. Therefore, despite the large number of extension workers, reaching all segments of farmers at scale with inclusive agronomic advisories remains a bottleneck and has resulted in low adoption of agricultural technologies.

In response, Ethiopia has seen a growing demand for digital innovations for most of its agriculture advisory services, including soil health and agronomy advice. This calls for resource-efficient agro-advisory services that can reach more farmers at a time but still cater to their specific individual needs. Cognizant of this fact, ICRISAT and CIAT-Bioversity, in collaboration with the national agricultural research systems were engaged in the development and validation of a harmonized Decision Support Tool for site-specific fertilizer and agronomy advisory (LAFA). Developing this scaling delivery strategy for LAFA builds on the experiences of developing and testing previous iterations of digital fertilizer advisory tools and aligns to the broader HaFAS framework. We envisage different scaling potential pathways to reach different types of farmers and digital market segments depending on their needs, attitudes, capacities, social networks, and demographic characteristics. Using the alternative pathways, the harmonized soil health and agronomy advisory could enhance the efficiency of the agriculture extension system, attain scale, and facilitate the adoption of new agronomic practices resulting in yield improvements and higher income for farming households throughout the mixed farming system of Ethiopia. By carefully monitoring the effectiveness of each pathway, lessons learned as to which is best in the Ethiopian context are expected to emerge.

This scaling strategy will envision four scaling pathways (Figure 4.1), which are described below.

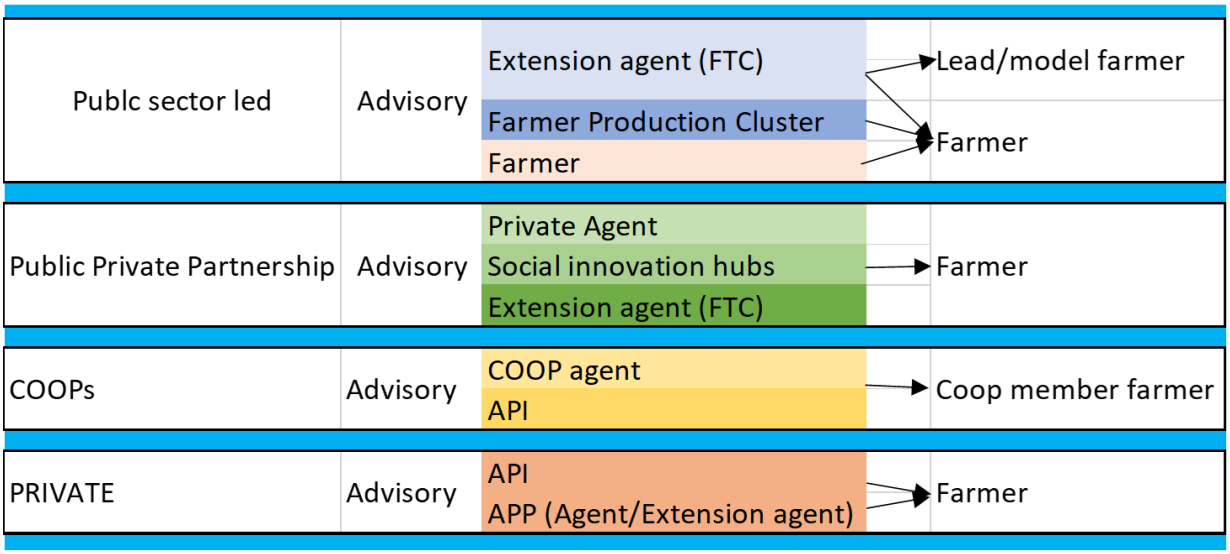

Figure 4.1. A pictorial illustration of the scaling pathways and potential delivery channels to reach different segments of farmers

4.1.1 Public Sector-led Pathway

In this public-led pathway, two options are proposed.

a. ***The existing public extension delivery systems.*** There is a huge potential within the government extension service structure, which accommodates 72,000 extension workers with 14,065 farmer and agropastoral training centers (AFAAS, 2024) at the kebele level, and a significant number of subject matter specialists are assigned at the district level. In terms of the delivery of digital agriculture advisories, the public-led pathway is the priority scaling pathway to reach farmers at scale due to the strong government commitment to the use of digital agro-advisory tools.

   This scaling pathway at scale will build on existing partnerships. In 2019, with support from the Bill & Melinda Gates Foundation (BMFG), Digital Green Foundation (DGF), Precision Development (PxD) and the government launched a five-year "Digital Agricultural Advisory Services" program. The program targets increasing agricultural productivity by delivering location- and time-specific advice to farmers across multiple channels, including video, SMS, chatbots, and IVR channels. To support this effort, extension workers and subject matter specialists at the district level were trained to develop localized extension videos using local languages. Development agents were also equipped with small projectors to disseminate the extension videos to farmers. Using the videos, extension workers deliver agronomic advice and knowledge to farmers

simply and attractively. Based on the extension module developed by the government, digital contents were developed through a human-centered design approach and tailored to farmers' needs and capacities. In addition, using PADDY - a phone-based service that can make 200 simultaneous calls at a time—PxD delivers timely and customized agro-advisory solutions for farmers. In this project, DG and PxD were able to reach more than 2 million farmers and helped them to improve the adoption of practices and increase farm productivity. The available digital tools have the potential to integrate other services such as finance, insurance, and market tools into a digital hub of solutions. Given these piloting experiences on ICT-based extension services, it is possible to reach many farmers using this pathway with an increased focus on semi-subsistence farming households, women-headed households, and cooperative member farmers.

b. ***Direct call to farmers.*** The Ethiopian government, through ATI and LERSHA, has also introduced hotline services, interactive voice response, and short message systems. The initiative allows farmers to call free of charge and receive information about major crop management practices, crop prices, and availability of agricultural inputs. The "8028" farmers' hotline began delivering information and advisory services on 21 crops. The hotline service offered features such as a call-in option, an alert system, a survey tool, and a help desk. The service hosted over six million callers and can accommodate 330 calls simultaneously. The platform can also help to conduct surveys on crop diseases and pests with the participation of frontline extension workers[12]. A platform on a market information system for five crops (teff, wheat, maize, sesame, and haricot bean) is also deployed to collect price information offered by producers, wholesalers, and retailers. Using the 6077 hotline, farmers call to listen to market information of their choice. This rich experience on the hotline or direct call to farmers can be taken as an alternative pathway to be considered within the public sector-led pathway to expand the hotline services and reach farmers at scale.

4.1.2 Public-private Partnership (PPP) Pathway

Recently within Ethiopia, a pluralistic extension approach has been promoted and supported by policy makers to unify efforts made by different organizations towards an efficient and effective extension delivery. In line with this, Public-Private Partnerships (PPPs) are increasingly being utilized in agricultural innovation dissemination to leverage public funding, enhance efficiency, and better align innovations with market demand, facilitating broader and faster diffusion. This scaling pathway positions PPPs as an alternative route for implementing the HaFAS. Key players in this pathway include private institutions and non-governmental organizations (NGOs) operating in scaling agricultural innovations. This pathway will mirror the strategies employed in public-led pathways. However, the emphasis will be on resource pooling and using the complementary capacities of government, private entities, and NGOs to minimize risks and costs through shared investments. PPPs aim to foster ongoing development and support integrated solutions. This pathway will reach all segments of farmers as indicated in the farmer segmentation section.

4.1.3 Cooperative-led Pathway

In this pathway, the scaling strategy will focus on the rural farmer cooperative institutions. In Ethiopia, there are numerous unions and primary cooperatives that can be utilized for digital agro advisory dissemination. Cooperatives in Ethiopia are playing an active role in the fields of finance, input and output marketing, consumer goods, agro processing, mechanization, and many other social and economic activities. Despite the challenges they are facing, the cooperative movement in Ethiopia has registered numerical growth over the past decades both in terms of membership and capital. Ethiopia has approximately 391 unions and 92,755 primary cooperatives, among which 62,145 are focusing on agriculture. Those unions employing agronomists and maintaining their facilities are particularly important for this pathway. The cooperative-led pathway can be considered a semi-private or PPP approach as the public sector strongly engages with cooperatives. The cooperatives have a strong institutional setup and can facilitate the bundling of the agro advisory services with their current roles in accessing fertilizer and improved seed services for their members. This pathway will focus on cooperative members and market-oriented farmers. The existence of organized cooperatives and unions distributed across the different parts of the country can be opportunities for scaling LAFA and other HaFAS components bundled with other services at a wider scale. This pathway can also be linked with public-private partnerships across various agroecological areas and crop commodities. The pathway aims for a phased-scale impact, potentially benefiting farmers while demonstrating substantial financial returns and environmental advantages.

4.1.4 Private Business (Market-led) Pathway

With favorable digital policy environments and because of the growing digital market, private businesses will have ample potential to disseminate digital solutions to willing farmers who invest or pay for the services individually or through their cooperatives in the future. To date, market entry of private businesses into the extension service arena has been challenging due to regulatory barriers which are being addressed. These business models have the potential to introduce agricultural innovations to market-oriented smallholder and commercial farmers. The

[12] A data driven, evidence-based and user-centered approach - Precision Development

private businesses employ their agents to disseminate these innovations and packages of services, such as the provision of fertilizers, seeds, mechanization, and inputs.

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4.2 Timeline and Pathways to Scale

At a workshop in September 2024, the multi-organizational Coalition of the Willing developed a vision for scaling the HaFAS broken down into three scaling phases for the next 15 years: Phase 1: 2026 to 2030; Phase 2: 2031-2035; and Phase 3: 2036-2040. For each phase, target numbers for access to the LAFA for fertilizer use for the four cereal crops (teff, wheat, sorghum, and maize) and complementary advisory services were set, and the pathways and delivery strategies were discussed. With an adaptive monitoring approach to be used, the pathways will be no doubt altered in their significance depending on their performance and the realization and institutionalization of decentralized digital extension delivery mechanisms, delivery of contextualized and tailored advisory tools, collaborative partnership efforts, and effective governance of the coalition. The scaling phases will be dynamic and evolving in terms of bundled innovations and corresponding applications or interfaces and reach different segments of farmers.

Phase I: Consolidated innovation validation, piloting, and scaling operation phase across the geographies of validation zones

This scaling phase spans over the first five years, between 2026 and 2030. It is designed to implement 1) the pre-scaling stage, where a consolidated technical validation of the LAFA for maize, sorghum, teff, and wheat crops that were implemented in 2024 across the potential growing areas together with expert and stakeholder feedback will inform updated LAFA. In 2024, harmonized LAFA validation has been implemented in 1,570 validation field sites in 129 districts across 49 administrative zones in seven regional states. In 2025, there will be implementation of broader piloting or pre-scaling of the validated LAFA to ensure agronomic feasibility and economic viability of LAFA and testing and adapting the functionality of delivery strategies in different pathways. Throughout the first phase, the implementation of the agreed-upon delivery strategies will be supported by establishing institutional frameworks and partnership platforms and operationalizing the feasible scaling strategies to achieve the innovation use targets set for 2030. If sufficient funding exists to conduct validation trials in the first phase using existing legacy fertilizer and lime response database, barley fertilizer application and lime advisories could be integrated into the LAFA advisory solutions. In this phase, the public-led scaling pathway will take the largest share of the innovation scaling pathway using the well-established existing government extension workers and FTC structures, building on the DAEES advisory tool piloting experiences and farmer production clusters created under the Agriculture Commercialization Cluster (ACC) initiative of ATI, leveraging on the 8028 hotline pilot experiences in the country. This could be complemented by the work being carried out through PPP pathways by PxD's phone-based delivery model (PADDY) and the Digital Green video-based dissemination, ICRISAT's mobile app and chatbot applications, and similar other ongoing digital agro-advisory initiatives. During this phase, maize, sorghum, teff, and wheat-growing farmers who are aware of the validated LAFA solutions in 129 districts of validation areas and those engaged in the piloting and pre-scaling stages for the preceding Nextgen and Landscape fertilizer advisory of CIAT and ICRISAT will be the primary target farmer segments.

Phase II: Scaling phase across major cereal growing areas

This phase will be implemented between 2031 and 2035 and aims to reach most of the maize, sorghum, teff, and wheat producer farmers at validation zones and similar agroecology settings in the country. This phase will represent all potential scaling pathways, including public sector-led, PPP, COOPs, and private business pathways. This phase will represent an ambition to institutionalize decentralized digital dissemination hubs, kiosks, and digital extension service agents with several alternative dissemination applications such as mobile apps, SMS, chatbots, videos, web apps and API. During this phase, the pluralistic extension and digital agriculture roadmap strategies are expected to realize and enable and regulate the extension service delivery with strong infrastructure for digital access having been developed concurrently under the DAR 2032 framework. With these expectations, this phase will target a significant number of different types of farmers, especially subsistence farmers, female-head households, and youth and it will realize LAFA delivery combined with other advisory tools in HaFAS. This

second phase of scaling will mark a gradual transition from the public sector towards more diversified PPPs cooperative-led as well as private business scaling pathways on priority marketable commodities.

Phase III: Scaling phase with the realization of digitalized extension services across highland, midland and lowland mixed farming systems

At this stage of the scaling, which laps between 2036 and 2040, it is expected that matured and multiple soil and agronomy advisory solutions that bundle soil, agronomy, climate, and pest management solutions and a complementary bundle of financial and insurance innovations will be ready for use. In terms of delivery strategies and partnership, collaborative governance of the scaling and joint mitigation strategies will be in place for most of the scaling barriers along the value chain. Accordingly, this final phase of the strategy will represent all means of scaling pathways and delivery strategies, including dissemination channels, with greater emphasis given to digital business models that have proven to be effective. This will be operationalized through private and cooperative entities and cost-sharing schemes through public sector-led pathways. A certain number of farmer segments will remain targeted with credit and subsidy support services.

The details of the timelines corresponding to scaling pathways for several target farmers for various segments are presented in Table 5.4 (see the Scaling Use and Adoption Target in section 4.11).

4.3 Prospects for Financial Sustainability

The development, refinement, and scaling of the fertilizer decision support tool (LAFA) is an integrated co-evolutionary process with a broad digital agriculture ecosystem described in DAR 2032. Therefore, monitoring and learning from its concept, design, and deployment will require numerous feedback processes, reactions, and adaptations. Consequently, multiple actors with various but complementary roles and responsibilities need resources to perform their tasks effectively. Researchers and digital technicians must respond to data collected from plot, farm, and woreda levels to adjust models, outputs, and interfaces for end users. End users can include government and non-government extension agents, cooperatives, lead farmers, and the farmers themselves. Institutionalization demands deep knowledge and buy-in from high-level decision-makers within government, NGOs, and large development partners to scale up. Given the diversity of actions that require funding, different funding mechanisms may be necessary for the sustainability of the advisory use, development, updating, and scaling. Over time, once the economic benefits of the system are clear to end users, their willingness to at least partially cover the cost of access to services offered is likely to increase, particularly if advisory services are bundled to priority extension and input services and combined with input or output market access.

The costs for the routine information transactions with key partner institutions and the large number of development agents, extension service providers, and the ultimate beneficiary require a budget. Therefore, inclusion of diverse kinds of stakeholders will be necessary for the sustained development and dissemination of the innovation and cooperation to diversify funding for the innovation development process and innovation scaling. In addition, the database system and developed scripts now hosted under the MoA server and the technical requirements in administering the data in the web system require the attention of the Ethiopian government to provide policy support for handling it in the appropriate digital infrastructures, provision of technical capacities, and a dedicated budget to run the system. The scaling of the LAFA and the subsequent progress to be made for bundling the advisories with new complementary innovations is possible with the continuous buildup and management of the database system kept in the web system. A multistakeholder undertaking, such as the HaFAS framework, requires a well-thought-out coordination mechanism and financial investment. Fortunately, the government has established a Digital Agro-Advisory Platform to coordinate this diverse set of partners under the leadership of the MoA, chaired by the state minister for Agriculture and Horticultural Development and co-chaired by the Ethiopian Institute of Agricultural Research (EIAR).

To ensure the long-term financial sustainability of the HaFAS strategy, in addition to the public government finance resources, the following will be prioritized:

- Market-Based Models: Exploring the feasibility of market-led approaches where private sector actors play a major role in dissemination.
- Public-Private Partnerships: Nurturing PPPs through the first and second phases so that they can operate successfully in the long term.
- Willingness to Pay: Periodically assessing farmers' willingness to pay for DST services and developing tailored payment models as confidence in digital advisories grows.
- Cost-Sharing Schemes: Implementing cost-sharing schemes between the public and private sectors, as well as the end users of the services.

1. *Refinement and further development of bundle of advisory services*

   With the deployment of the LAFA, feedback for correction, refinement, and further development based on a well-defined monitoring, evaluation, learning, and impact plan will be needed (see Section 7.3 for details). This will be the technical team's responsibility for conceptual design, data, data analysis, and modeling, as well as prototype development and refinement. Typically, this is a research and development activity conducted by relevant scientists, IT professionals, and communication experts (EIAR, RARIs and CGIAR scientists and technicians). The government funds staff time with its research bodies, but levels of operational funds often are inadequate for the scope of work required. Traditional science funders can provide financial support for this specialized science-based work. A variety of funders back traditional "upstream" agricultural research and development. Here are some notable examples:

   - Gates Foundation,
   - United States Agency for International Development (USAID)
   - German Federal Ministry for Economic Cooperation and Development (BMZ)
   - International Fund for Agricultural Development (IFAD)
   - Australian Centre for International Agricultural Research (ACIAR)
   - Alliance for Green Revolution in Africa (AGRA)

2. *Roll out to end-users*

   In close collaboration with the R&D team, government extension and support services should undertake the primary scaling, with local and international NGOs playing a complementary and cooperative role. These entities will partner with farmers through community-based organizations (CBOs) such as cooperatives and other farmer-based groups. Ideally, this effort should be funded through government resources and mainstreamed innovations scaling portfolios of non-government organizations (both human and financial), as it needs to be integrated into the routine operations of government-funded extension services. Other funders, such as the World Bank, Gates Foundation, IFAD, GIZ, and FAO, may back the Ministry of Agriculture, but funding for the scaling program at the end-user level should be embedded within regular extension services during the early stages of scaling and service fee-driven investments at later stages of the scaling phases.

3. *Institutionalization*

   The scaling up of the HaFAS and its institutionalization will be crucial for the broad adoption and implementation of the LAFA and complementary advisory services and tools and will necessitate the government creating and sustaining an enabling environment for scaling operations and financing. Achieving this will depend on gaining the support of high-level government decision-makers to institutionalize the use of the HaFAS scaling framework to contribute to the DAR 2032 outcomes. This, in turn, will require evidence of its value through impact analysis based principally on increased agricultural output, poverty reduction, more efficient use of imported and/or state-purchased inputs, and contributions to more sustainable production practices. Therefore, it will rely on the outcomes of the MELIA plan to provide the necessary evidence and to establish an effective communication strategy that informs relevant and effective policy. The same set of donors applies from the above refinement and further development, especially those backing the operation of DAR 2032 expected to play key role in the institutionalization.

4. *The farmers and the private sector support*

   The overall goal of the scaling strategy should be to generate demand for the LAFA through evidence-based increases in returns on investments, an enabling environment supported by policies and structures, and infrastructure that incentivizes investments in the fertilizer value chain, of which farmers and the private sector are integral. In developed countries and some developing nations, the private sector is primarily responsible for manufacturing, importing, and selling fertilizer. This condition is only viable if farmers are willing and able to buy fertilizer in an open market with market-determined prices. Within the broader context of this scaling program, it is suggested that more efficient fertilizer use and better returns on investment will encourage the adoption of the LAFA, trigger increased commercialization of the fertilizer industry involving the private sector, and reduce expensive government investment. If this holds, the private sector could provide part of the funding needed for the ongoing use and expansion of the LAFA and other components of the HaFAS.

   Sustainable scaling depends on financial models that balance short-term costs with long-term benefits. This includes blended financing (public-private partnerships) and subscription-based services. If farmers themselves see the value of an integrated HaFAS in general and LAFA specifically, with access to input and output markets combined with a bundle of agro-advisory modules, their own willingness to pay is likely to increase over time, either individually or through the extensive cooperative system throughout Ethiopia. The challenge will be for a percentage of those funds to be systematically allocated to support HaFAS maintenance and improvement. This service fee investment opportunity needs to be regulated by the

provisions set in the pluralistic extension strategy and proclamation. In the case of fertilizer, there are mechanisms to imbed a service fee for LAFA support in the cost of the fertilizer itself. Another mechanism to raise revenue can be through specific taxation of cellphone services linked to the provision of HaFAS as a whole or LAFA services. Given the size of Ethiopia's population, even a low tax rate could potentially generate significant resources for HaFAS system support. Nevertheless, additional research and development to enhance and strengthen the HaFAS's value proposition may require ongoing donor funding.

5. *Broad scaling, Ethiopia and beyond.*

   Scaling at the landscape level and beyond Ethiopia will involve the support of regional bodies, such as FARA, AGRA, AfDB, and IGAD, with the support of large funders and banks. The same evidence can be used for the institutionalization above.

   The above suggests that donors with varying but complementary objectives and areas of interest can or should support different actors and stakeholders. A larger constellation of donors working with diverse stakeholders may facilitate greater agility in the development process, as a single donor might prioritize their objectives and downplay the need for funding other components. A single donor might also restrict a scaling strategy to a singular path, limiting the exploration of alternative scaling strategies. However, this does not exclude the value of a single large donor as a scaling partner. Ideally, such a single donor would ensure that funding is available for the most critical moving parts of the scaling strategy and synchronize work plans, outcomes, and impact.

   Clearly the Ethiopia example highlights the critical importance of government coordination of the multi-donor, multi-partner digital agriculture system. It is a space where continual innovation is to be encouraged, but clear prioritization of what is most cost-effective to scale for the benefit of the most rural farmers is essential. Governments need to sustain evidence-backed refinement and development of DSTs, efficient digital governance and management platforms, and strong technical teams to correctly advise on the best way forward aligned with their priorities.

Section 5. Critical Design Elements, Costs and Benefits

5.1 Value Proposition for Each Partner in the Scaling Strategy

The partner value proposition (PVP) process started with the identification of partners who will have direct or indirect functions in the process of scaling the HaFAS and LAFA component with the fertilizer advisory and bundled agronomic technologies. Partner institutions include government, non-government, and international research institutions along with cooperatives and private sector companies. Along with the listing (Table 5.1), a detailed characterization of partners' capabilities and values that provide the partner's assessment of what they can do, how they can do it, their skills, and resources were collected and are available upon request. Particularly, the PVP endeavor highlights the partner's unique and distinctive capabilities and value and how they align with the HaFAS framework and LAFA scaling delivery journey. An examination of the PVPs permits overlapping or competing functions and strategies between partner institutions to be identified and eventually mapped. However, the collaborative advantage is the extra power, alchemy, or 'magic'—that' – that allows a group of actors to collectively deliver more than the sum of their input parts (Figure 5.1). The collaborative advantage is that the partnership facilitates the combining or aligning of multiple different resources from different sectors, and the partnership delta that emanates from the synergies are key levers that together have the power to transform a system (info@tpiglobal.org).

Figure 5.1. Collaborative Advantage of a group of actors to collectively deliver more than the sum of their input parts (info@tpiglobal.org[13]).

[13] info@tpiglobal.org. How do partnerships create value? The Partnering Initiative (TPI) 21B Park End Street, Oxford, OX1 1HU, United Kingdom.

The focus of the PVP will be limited to the following four points:

- Description of individual partner institutions against their contributions and roles in the scaling of the HaFAS framework and LAFA and bundles of other innovations.
- Identification of key functions, areas of responsibility, and roles of the components of the HaFAS scaling phase.
- Identification of gaps and show how the gaps could be filled.
- Clustering the institutions in their roles/functions and mapping where synergies could be created.

Table 5.1 describes the relationship of partner institutions against the value propositions in the scaling of the HaFAS. In this PVP mapping practice, we identified five categories of partners. The first category, the MoA, ATI, and the regional BoA are at the forefront in the provision of extension services using over 70 thousand government extension agents deployed at the kebele level that are trained at least to communicate reports using digital tools (tablets with appropriate software, which at times are connected with the internet). Although still at an early stage, private sector companies, as well as NGOs (Digital Green, Farm Radio International, Precision Development (PxD), Self Help Africa (SHA), GIZ, Stitching Wageningen Research Ethiopia (SWRE), IFDC, Sasakawa Africa Association (SAA)), are currently working towards providing farmers with digital advisories.

The second tier of partners are those that are engaged in research (EIAR, RARIs, universities, and CGIAR centers) and are focused on developing the technical components of the innovation package so it is ready for scaling. They will also contribute toward the continuous refinement of the fertilizer advisories with bundles of complementary innovations being added as they become available. There are over 10 national agricultural research institutions and over 40 agricultural research centers working throughout the country. The research institutions will also be important in the scaling strategy by providing technical backstopping and training of the extension agents on the use and management of the digital advisories. The third category of the partners is input and service providers, including for the digital infrastructure. This group includes INSA, Ethio-telecom, Safaricom, input delivery by OCP (a private sector fertilizer company), and the Ethiopian Agricultural Business Corporation (EABC). The fourth category of partners is composed of the federal as well as the regional Cooperative Promotion Agencies (CPAs) that will be playing critical roles in input delivery and provision of extension services through one-stop shops, DAs, cooperatives, unions, and FTCs. The fifth category of partner institutions could include the Ministry of Agriculture (MoA) and the Ministry of Innovation and Technology (MInT) by facilitating the HaFAS scaling delivery strategy with affordable web services for data storage and analytics, deploying digital advisories in the MoA, Ethio-telecom, and INSA digital infrastructures.

There are also relevant external stakeholders or partners, including the Gates Foundation, BMZ, AGRA, IFAD, and until recently USAID etc. that have immense interest in the development of the LAFA and the digitalization of the fertilizer extension services. These donor organizations played important roles during the development of the LAFA with the vision of making the management of fertilizer use, distribution, and management in Ethiopia a model to be adapted and scaled in other African countries. Therefore, the inclusion of such diverse kinds of stakeholders will be necessary for the sustained development and dissemination of the innovation and cooperation to diversify funding for the innovation development process and innovation scaling.

Table 5.1. Summary of Partners' Key Functions (Existing and Potential) for the HaFAS Scaling Delivery Strategy

No.	Partner Institution	Key Functions and Focus Areas	Roles regarding the Scaling Delivery strategy	Level of partnership
1	MoA and Regional BoAs	Promoting agricultural development, policy, extension, demonstrations and training	Lead the scaling delivery strategy coordination and support policy and enabling environment, DAR roadmap 2032	Key stakeholder
2	ATI	Accelerate growth and transformation of the agriculture sector. Working on improving the livelihoods of smallholder farmers.	System designing, Agricultural Commercial Clusters, digital extension and youth engagement in dignified occupations (ADEY) (2023-2028)	
3	NARS: EIAR and RARIs	Provide validated market-competitive agricultural technologies and innovations for sustainable food security and economic provision	Sources of technology & innovations, including technical updating of advisory applications	
4	Universities	Universities including Haramaya, Jimma, Hawassa, Arba Minch,	Sources of technology & innovations, advisory applications	

No.	Partner Institution	Key Functions and Focus Areas	Roles regarding the Scaling Delivery strategy	Level of partnership
		Bahir Dar, Gonder, Jimma, Wolaita Sodo, Wachamo and Mekele are involving in the market competitive agricultural technologies and innovations		
5	ICRISAT/CIAT-ABC/CIMMYT/ IITA	Support the innovation and technological development process, fine-tuning quality of the LAFA, bundling of complementary innovations and capacity sharing	Supporting the LAFA development, advisory applications and training, impact assessments	
6	Federal Cooperative Promotion Agencies (CPA)/ Regional CPAs	Facilitate policies and strategies for improved promotion of fertilizer technologies through cooperative structures in regions and unions	Policy support for the Cooperative-based extension, input supply	Supporting organizations
7	Private & NGOs institutions (SHA, DG, PxD, Lersha and FRI)	Works through agri-enterprise development, supporting scaling of evidence-based innovations to commercial and smallholder farmers (SHFs), provide digital advisories, and advocacy	Delivery of digital extension services and advocating, using distinct delivery channels	
	NGOs (IFDC, GIZ, SAA, SWRE, SHA, etc.)	Supports the Soils Consortium, Integrated Soil Fertility Management (ISFM) and Soil Health program, Enhance extension systems and agricultural value chains and Regenerative and inclusive food system as well as seed systems	Technical and financial support services and scaling implementation of the digital scaling strategy	
8	Policy Link USAID (C4FS)	An enabler for innovation and scaling-up of agricultural technologies and pluralistic agricultural extension service (PES)	Policy enabling that complements policies required for HaFAS scaling	
9	MinT/ INSA	The Ministry of Innovation and Technology (MInT) is responsible for overseeing the development of science, technology, and innovation in Ethiopia. The Information Network Security Administration (INSA) is responsible for protecting national interests in terms of information and information infrastructure.	Safe server service in a web for the big data storage and policy support	Broader collaboration
10	Telecom/ Safaricom	Provide extensive web-based data storages mobile and internet services	Enable connectivity and data storage services	
11	OCP	Supplying right fertilizers with affordable prices, training and finance supports to research and extension of fertilizers	Delivering the required fertilizer sources, financial and training	
12	Ethiopia Agriculture Business Corporation (EABC)	The state-owned EABC imports and supplies agricultural imports and machinery to supply to farmers and agricultural enterprises	Deliver the required fertilizers in time at favorable prices	

No.	Partner Institution	Key Functions and Focus Areas	Roles regarding the Scaling Delivery strategy	Level of partnership
13	BMGF, USAID, BMZ, AGRA, IFAD, AfDB, GCF, WB, EU	Financial support and guidance for developing, improving and scaling the HaFAS innovations and technologies	Financial support to implement the use of HaFAS at scale, to enable more inclusive access	External stakeholders

Identification of gaps and mitigation options: The HaFAS in Ethiopia brought multiple institutions together, partnering and working for the same goal. These include core LAFA implementing institutions such as research, extension, and NGOs. However, bringing the public extension systems in digital literacy to the level of the NGOs (e.g., Digital Green, Precision for Development or PxD) and private companies (LERSHA) would ease the scaling operations. Sometimes, a platform is a voluntary gathering among institutions that have common interests but do not have common resources to have an equal pace in the implementation process. Scaling HaFAS solutions involves a multi-faceted strategy that addresses key gaps and leverages the strengths of various stakeholders. Details of possible gaps identified and counterpart solutions are given in Table 5.2.

Table 5.2. Possible gaps and proposed solutions while working in partnerships among multiple actors

Gaps	Solutions
Barriers at the grassroots levels- low digital literacy, infrastructure, language barriers and low trust or farmers may remain skeptical	Enhance digital literacy through trainings, establishing digital infrastructures, and language barriers, and improve trust for users at the grassroots levels
Misalignment with Stakeholder Needs - The value proposition may not fully address the specific needs, preferences, and priorities of all stakeholder groups	Conduct regular needs assessments and engage stakeholders in co-creating the value proposition. Gather feedback from farmers, policymakers, private sector partners, and NGOs to ensure the service aligns with their specific needs and preferences
Lack of Differentiation: If the value proposition is similar among competitors, it may not stand out and attract stakeholder partnership effectively	Highlight unique features and benefits of digital agro-advisory service, such as personalized advice, real-time updates, and data-driven insights. Develop a strong brand identity and emphasize the impact and success stories of the service
Poor Communication - The value proposition of each actor may not be communicated clearly or compellingly, leading to misunderstandings or lack of awareness among stakeholders	Develop clear, compelling communication strategies to articulate the value proposition. Use various channels, such as social media, community radio, local events, and printed materials, to reach different stakeholder groups effectively
Insufficient Value Delivery - Promised value may not be delivered consistently or to the expected standard, causing dissatisfaction	Ensure consistent quality and reliability of the services provided. Monitor and evaluate the performance of digital advisory services regularly, and make improvements based on feedback and performance data
Neglect of Emerging Trends - Failing to address current market trends, technological advancements, AI developments, or changing regulatory environments can make the value proposition less relevant	Stay informed about market trends, technological advancements, and regulatory changes. Adapt the value proposition to incorporate new developments, such as climate-smart agriculture, precision farming, and AI supported data analytics
Ignoring Feedback - not listening to or acting on feedback from stakeholders and benefits can result in a disconnect between what is offered and what is expected or needed	Establish feedback mechanisms, such as surveys, focus groups, and suggestion boxes, to gather input from stakeholders. Act on the feedback received and communicate the changes made based on stakeholders' suggestions
Overlooking Emotional Connection - focusing only on functional benefits and ignoring emotional or experiential aspects can weaken the overall appeal of the value proposition	Emphasize the emotional and experiential benefits of the digital agro-advisory service. Share success stories, testimonials, and case studies that highlight the positive impact on farmers' livelihoods, and environments
Resource Constraints - limited resources (financial, human, and technological) may hinder the ability to deliver on the value proposition.	Seek funding and support from donors, development partners, and private sector investors. Leverage partnerships to share resources, expertise, and infrastructure, and explore cost-effective solutions for delivering digital services

Gaps	Solutions
Ethical and Sustainability Concerns - stakeholders are increasingly valuing ethical practices and sustainability; however, ignoring these aspects can create gaps in perceived value	Commit to ethical practices and sustainability in all aspects of the service. Address equity and environmental, social, and economic sustainability in the value proposition, and communicate these commitments to stakeholders
Short-Term Focus - prioritizing short-term gains over long-term relationships and value creation can erode trust and commitment from stakeholders.	Prioritize long-term value creation and relationship-building with stakeholders. Develop sustainable business models, invest in capacity building, and focus on creating lasting positive impacts for farmers and communities
Poor Advocacy - low attention given to the role of advocacy and lack of a consolidated plan to properly advocate the scaling delivery and societal impacts of the digital solutions such as HaFAS framework under consideration	Develop comprehensive advocacy strategies that focus on policy support, resource mobilization, capacity building, and awareness campaigns. Other important solution may include ensuring that digital advisories are accessible, inclusive, and continuously improved based on the feedback loops between research and users, and among the actors in the value chain

5.2 Designing a Practical Delivery System for a Digitally Enabled Agro-advisory System, LAFA

The practical delivery design for HaFAS scaling is crafted based on scaling ambitions for the envisaged three-phased scaling effort. In the first phase, which lasts between 2026 and 2030, the scaling ambition will be to have LAFA reach at least 2 million cereal farmers (wheat, maize, Teff, and sorghum producing farmers), expecting at least 45% to use the recommendations. During the second phase of scaling, planned to be implemented between 2031 and 2035, the scaling ambition is to reach at least 4.5 million cereal farmers with LAFA, with a high likelihood that additional advisory and other services will be bundled together by that time (Figure 3.4.1). The uptake of the recommendations will increase to 65% as the farmers increasingly recognize the benefits of the LAFA. The ultimate scaling ambition, designed to be realized by 2040 after completion of the third phase of scaling, was envisaged to be a situation where around half of all wheat, teff, maize, and sorghum-producing farmers in the mixed farming systems use site-specific, digitally enabled agro-advisory system, with at least a 75% uptake.

Based on these ambitions, an analysis of the scaling readiness and the scaling use level for the existing core innovation was done. This analysis involved a thorough discussion among scientists involved in designing the LAFA and early users of the system who were not directly involved in the design of the system. The result of this discussion revealed that, at present, the scaling readiness of the LAFA was assessed to be at the level of “Proven application” as there were thousands of farmers using the preceding distinct versions of the site-specific fertilizer DSTs. About the innovation use level, the core innovation was assessed to be at a state of “commonly used at the innovation network level”; i.e., the innovation is commonly used by organizations such as MoA and its subsidiaries as well as NGOs that are not formally involved in the design of the tool but are connected to the designing partners. This two-dimensional analysis implied that the overall innovation readiness level for the core innovation can be assessed to be at the level of a high impact potential at scale, but clearly more strengthening is needed.

Following this, an assessment of complementary innovations and bottlenecks for scaling and enabling environments was done by the groups of scientists and other partners. Accordingly, the following key bottlenecks and enabling environments were identified. The solutions to the bottlenecks and the tasks that need to be done to capitalize on the existing enabling environments or the tasks that need to be done to realize an essential missing element of the enabling environment were important complementary innovations that fulfill the sufficiency condition for the essential core innovation.

The use of core and complementary innovations was taken to be practical delivery activities to be undertaken in a phased manner based on feasibility and the gradually expanding nature of the scaling ambition. Many of these practical delivery activities are planned to be undertaken during the first phase of the scaling process. Based on the scaling readiness step-wise approach, scaling is taken as an iterative and cyclical process that passes through the **characterization** of innovations, **diagnosis** of bottlenecks, designing **strategies**, **agreeing,** and **implementation** in partnership with key stakeholders as well as **navigation** through reflection and learning, which will again lead to another iterative cycle of innovation characterization and so on (Figure 5.2). Table 5.3 shows the scaling ambition by phases and associated practical delivery activities to be undertaken to scale up and out LAFA and subsequent advisory tools in cereal-dominated farming systems of Ethiopia.

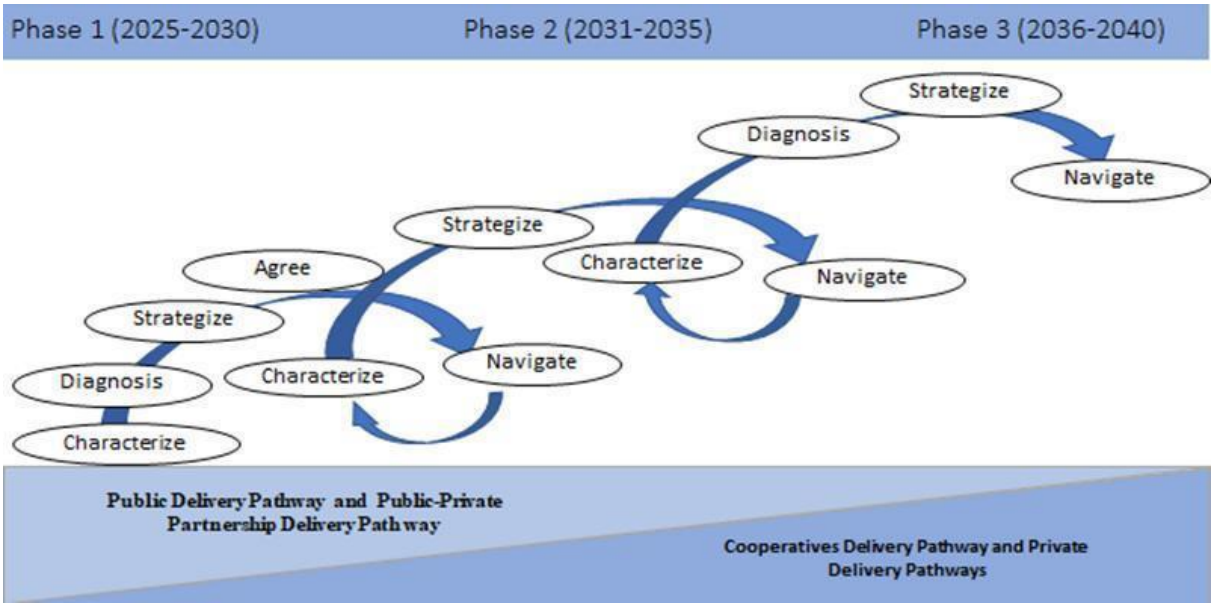

Figure 5.2. A graphical representation of a phased iterative scaling process for a site-specific, digitally enabled fertilizer and agronomy advisory solutions

The delivery pathways for the LAFA and complementary advisory tools developed within the HaFAS framework can be conceived to take four forms: namely, the public, cooperative, private and public-private partnership (PPP) pathways. During the first phase of the scaling process, it is envisaged that the public sector along with development partners, will play a dominant role in the delivery of the LAFA and complementary innovations. However, when the pluralistic extension system policy framework takes shape and when sufficient demand for the LAFA and associated digital services surges because of the public sector effort during the first phase, the amenability of the digital services as business opportunities for cooperatives and private sector extension service providers could grow. Such a situation would lead to the emergence and thriving of private and cooperative-led digital extension services alongside more traditional in-person services. The gradually declining role of the public delivery pathway and its transition to private and cooperative-based delivery services may require the metamorphic stage of public-private partnership. Therefore, the practical delivery design is detailed as follows:

1. Delivery Channels for Scaling LAFA and complementary advisory services

Ethiopia's Digital Agriculture Roadmap (DAR) 2032, National Agricultural Extension Strategy, and the Digital Transformation Strategy 2025 provide a solid foundation for developing and delivering tailored digital agro-advisories and enabling environments such as those embedded in HaFAS harmonized framework. The Ethiopian government and PxD, with the financial support from the Gates Foundation (GF) are about to establish the Project Management Unit for the Digital Agriculture Roadmap (DAR), and this will be one potential avenue to explore and finetune digital delivery strategies. These strategies support a pluralistic, digital-first extension approach that involves government, NGOs,

Table 5.3. Phased Scaling Ambitions and Practical Delivery Design for site-specific, digitally enabled fertilizer and agronomy advisory solutions

Delivery strategy	Phase 1	Phase 2	Phase 3
Scaling Ambition	At least 2 million farmers cultivating wheat, teff, maize, and sorghum benefit from site-specific, digitally enabled agro-advisory services.	At least 4.5 million farmers growing wheat, teff, maize, and sorghum benefit from site-specific, digitally enabled agro-advisory services.	At least 6.8 million farmers cultivating wheat, teff, maize, and sorghum benefit from site-specific, digitally enabled agro-advisory services.
Practical Delivery Activities	• Deliver LAFA service through extension agents at FTC level • Deliver LAFA service by digital channels: apps, chatbots, IVR, phone-based and web apps prioritized by connectivity	• Deliver soil test-based e-delivery kiosks for LAFA with a bundle of services • Deliver digitally capable Coop Extension service for LAFA and bundled services	• Enable institutionalization of scaling delivery strategy aligned with the DAR 2032. • Strengthen digital infrastructure capability of public, PPP, and private delivery pathways

Delivery strategy	Phase 1	Phase 2	Phase 3
	and literacy level of users; also maps when digital services do not exist. • Link LAFA to existing digital initiatives using API • Advocate site-specific nutrient management for broader impact • Promote and validate use of small fertilizer packages • Build farmer profile and typology information for ease of tailored delivery channels • Timely supply and distribution of fertilizer, lime and organic inputs • Promote access to finance (CSC) • E-marketing/market linkage • Link LAFA to crop insurance • Capacitate SMS/DAs for digital delivery services • Negotiate with telecom services for better access to digital services • Strengthen partnership platforms at all levels for governance and operation of LAFA scaling • Inception and first movers for ultimate institutionalization. • Exploit potential synergies in developing a unified and collaborative digital platform for effective governance and management system of HaFAS and LAFA	• Create linkage of digital advisory tools to cadastral parcel maps • Pilot E-agri-kiosks • Strengthen private extension for LAFA services • Strengthen digital governance and scaling operation platforms at all levels • Critical mass creation for institutionalization of HaFAS and LAFA tools	• Institutionalize and enable market-based digital delivery services

Cooperatives, private sector actors, and research institutions, with a focus on inclusivity and sustainability. Below are the key delivery channels and methods for delivering site-specific advisories and particularly LAFA, enhanced by robust data frameworks such as farmer and DA registries and geolocation data for precision agriculture.

a. Mobile Applications

Mobile applications are cornerstones in Ethiopia's vision for digital extension, providing on-demand information that considers specific variables like crop type, topography, and socioeconomic context. According to the DAR 2032, mobile apps can reduce barriers to advisory access, especially for those who are literate, who may not otherwise interact directly with advisory services (*National Agricultural Extension Strategy*, 2017). Apps like ICRISAT mobile app and chatbot, Digital Green's chatbot and LERSHA app exemplify how interactive platforms can deliver LAFA directly to farmers through SMS messages or via development agents during in-person visits. The Digital Transformation Strategy 2025 emphasizes the importance of inclusive technology, ensuring that even non-smartphone users benefit indirectly through DAs, who can access apps and share the advisory content during regular annual package trainings with farmer

development groups, at digital kiosks in accessible locations, farmer producer clusters, village savings and loan associations (VSLAs), women development groups, and other community groups.

b. Artificial Intelligence (AI) Tools

AI tools, as emphasized in Ethiopia's Digital Transformation Strategy 2025, enable real-time, data-driven advisories that enhance the responsiveness and precision of LAFA and complementary advice (*Ethiopia's Digital Transformation Strategy, 2021*). These platforms can analyze extensive datasets such as packages of practices, fertilizer response trials, climate data, remote sensing information, and other approved research outputs to generate tailored advisories based on specific climatic and seasonal conditions. For example, Digital Green's Farmer Chat uses AI-powered diagnostics to allow farmers to submit crop images for analysis and generates recommendations on fertilizer application, planting schedules, and pest management. This enables highly specific advice that can improve productivity and resource use efficiency in diverse farming contexts. Such technologies can be enhanced and leveraged to provide site-specific agro-advisories for farmers at a wider scale.

Development Agents (DAs) can leverage AI tools in Farmer Training Centers (FTCs) and through community structures like development groups, improving accessibility to high-quality, targeted advisory services. According to the National Agricultural Extension Strategy, such AI-driven tools are key to modernizing Ethiopia's extension services by adapting them to specific farmer needs and local conditions (Digital farmer registry process evaluation, IFPRI, 2023). AI-driven tools can be accessed via mobile applications or installed in digital kiosks, making them versatile and accessible across various advisory channels. Farmers with smartphones, such as lead farmers, can directly access AI-powered advisories, allowing them to share insights within their communities, while those without digital access benefit through guidance from DAs during field visits or group training sessions.

c. SMS and Interactive Voice Response (IVR) Systems

Currently, there is low mobile internet penetration in rural areas and with farmers and pastoralists due to low digital and financial literacy, unaffordable data plans and smart phone devices, and poor 4G connectivity. Device and data costs are high: "data costs 5% of the GNI per capita in Ethiopia vs 3% for LMICs53 and a smartphone costs 96% GNI per capita vs 34% in Kenya" (MoA and ATI, 2025). Given the limitations in smartphone access and levels of literacy of farmers in rural Ethiopia, SMS and IVR systems play a critical role in extending advisory services to the broader farmer base. The National Agricultural Extension Strategy recognizes these channels as essential for reaching farmers in remote areas, ensuring that advisory dissemination is accessible across literacy levels and technological access (National Agricultural Extension Strategy, 2017). SMS-based advisories are effective for literate farmers, delivering concise, text-based recommendations on topics such as fertilizer application, pest management, and planting schedules. IVR systems, meanwhile, cater farmers with lower literacy by offering spoken advisories that can be accessed via any type of mobile phone.

Leveraging the existing direct-to-farmer phone-based delivery tools, like ATI's 8028 farmers' hotline and PxD's PADDY platform, would be crucial to help this program to timely reach millions of smallholder farmers. ATI and PXD provide advisory services for farmers using IVR and SMS. The ATI's 8028 hotline exemplifies this model by providing inbound and outbound advisory services and so far has reached over 6 million farmers. In addition to 8028, EIAR has 7604 a text messaging platform to push[14] various extension and advisory services about newly released technologies and management practices besides agrometeorology information. The PADDY system run by PxD employs push call, SMS, and chatbot functions that complement each other to provide customized advisory for farmers and DAs. Integrating the contents of LAFA and complementary advisory tools with these hotlines would enable reaching a wider number of farmers and providing more customized complementary recommendations on crop cycles, soil preparation, and pest control, delivering tailored, site-specific advice across Ethiopia's varied agricultural landscape. This multi-tiered approach ensures that all farmers, regardless of literacy level or device type, can access actionable, timely advice to support informed farming practices.

d. Digital Kiosks

Digital kiosks are central hubs for farmers to access agro advisory services such as LAFA, enhancing the inclusivity and reach of Ethiopia's agricultural extension services. The DAR Roadmap 2032 recommends placing these kiosks at Farmer Training Centers (FTCs) and cooperative centers or other strategic locations within kebeles managed by digitally capable service provider agents (e.g., development agents, cooperative managers, entrepreneurs) where they can serve as accessible, AI-driven interfaces for real-time advisory.

This model provides user-friendly, practical support in local languages and incorporates visual aids to bridge literacy gaps, making LAFA advisories accessible even to underserved or digitally limited communities. By creating a centralized, interactive access point, digital kiosks reinforce Ethiopia's efforts to extend agricultural

[14] A push call is a message sent from an application to the phone or other instrument used by an end user that is initiated by the managers of the application, not the end user.

advisory services inclusively, aligning with the country's goals to modernize and expand extension access through responsive, locally relevant solutions.

e. Web-Based Platforms

Web-based platforms are an essential complement to mobile applications, offering LAFA and complementary advisories that can be accessed from any internet-enabled device. Aligned with Ethiopia's Digital Transformation Strategy 2025, these platforms provide both farmers and Development Agents (DAs) with a range of resources. By linking these platforms with LAFA data, advisory content remains accurate and responsive to changing conditions, enabling farmers to make informed decisions. Additionally, DAs can download materials from web-based platforms for offline sharing during field visits, ensuring that even farmers in low-connectivity areas receive timely, data-driven insights. This adaptability makes web platforms a powerful tool for disseminating site-specific recommendations, especially in regions where connectivity may be intermittent. The Alliance of Biodiversity and CIAT's Nextgen based app (a LAFA precursor) and ICRISAT's lime rate app are examples of such web platforms that can be made more accessible for DAs and experts who might want to use the platforms.

f. DA Networks, FTCs, and Development Groups

Ethiopia's National Agricultural Extension Strategy emphasizes the country's extensive network of Development Agents (DAs) at the MOA as a vital mechanism for delivering T-agro advisories across diverse farming communities (National Agricultural Extension Strategy, 2017). With approximately 43 DAs per 10,000 farmers and more than 15,000 Farmer Training Centers (FTCs) nationwide, DAs are well-positioned to provide direct, site-specific guidance to farmers on topics such as fertilizer applications and soil health if they receive adequate training. Development groups within each kebele serve as structured platforms where DAs can deliver insights obtained from the LAFA, facilitate training, and promote peer learning among farmers. The DAR Roadmap 2032 emphasizes the importance of digital training for DAs, equipping them to effectively access and share LAFA recommendations during group sessions, community meetings, and local gatherings (Ethiopia DAR Roadmap). This model fosters a scalable, community-based approach to agricultural extension, leveraging both digital tools and trusted DA networks to maximize the reach and impact of LAFA and complementary advisories.

g. Video-Based Extension Services

LERSHA's agro-advisory integrated with CIAT's NextGen is an example of how private sectors can cater to providing advisories to farmers. Digital Green has also experienced providing video-based extension services to enhance broader awareness of improved agricultural practices. Video-based services often are powerful in providing information, increasing knowledge of new technologies and practices, and helping to influence change in behavior[15]. It is also relevant to reach many farmers (Abate et al., 2023).

h. Farmer and DA Registries

The Digital Farmer Registry, piloted by Digital Green in collaboration with the Ministry of Agriculture and ATI, is designed to create detailed profiles for farmers, capturing critical information such as demographics, crop types, and land characteristics. These profiles support the delivery of tailored advisories by aligning recommendations with each farmer's unique conditions and needs (Digital farmer registry process evaluation, IFPRI, 2017). Accessible via a mobile application and web portal, the registry allows Development Agents (DAs) to maintain up-to-date records on farmers, improving the quality, relevance, and precision of advisory services. For DAs, the registry streamlines data entry, program reporting, and the transition from generic to site-specific advisory use, fostering a data-driven extension service model.

Expanding the Digital Farmer Registry system nationwide would significantly enhance Ethiopia's extension capabilities by aligning advisory services closely with LAFA recommendations, ensuring accuracy and efficiency. Additionally, leveraging the national ID system and integrating it with other digital extension tools can enhance the platform, enabling the aggregation of data across similar farmer profiles. This integration would facilitate plot-level recommendations, allowing extension services to be hyper-localized based on a wide range of data sources, such as soil type, historical yield, climate resilience metrics, and household economic capacity, thus offering highly customized support to each farmer. Extensive farmer profiling is a prioritized activity in the first phase of DAR 2032.

i. Geolocation and Land Administration Data

Integrating geolocation data and land administration information with the LAFA platform would further refine the precision of agricultural advisories. The DAR Roadmap 2032 emphasizes the importance of geolocation for supporting site-specific recommendations that consider factors such as soil type, altitude, and climate, which can all be mapped to individual farm plots using digital land records (Ethiopia DAEAS Roadmap). By

[15] https://digitalgreen.org/tag/video-based-extensioncommunity-videoethiopia/#:~:text=Improved%20agricultural%20practices%20that%20yield%20happiness%20and%20resilient%20livelihoods&text=In%20Ethiopia%2C%20Digital%20Green%20has,sense%20of%20satisfaction%20to%20farmers.

leveraging Ethiopia's existing land cadaster data, LAFA can deliver tailored recommendations for crop management, land conservation, financial loans, insurance, and pest control, adapting advisories to each farm's unique environmental conditions. As of 2024, the National Rural Land Administration Information System (NRLAIS) has digitalized 60% of land registries and the Central Statistics Agency's production data, but according to the DAR 2032 ecosystem assessment, these need to be rapidly scaled or improved to support use-case-specific insights (MoA and ATI, 2025). This combination of geolocation and land data fosters a highly precise, resilient agricultural advisory system that supports Ethiopia's broader goals of sustainable, climate-smart agriculture and environmental protection.

2. Partnering with Telecom service providers

Telecom infrastructure is fundamental to the successful scaling of digital services, as it enables seamless connectivity across digital platforms essential for delivering real-time, site-specific recommendations to farmers. Robust telecom networks ensure that mobile applications, AI tools, SMS, and IVR systems can operate reliably, providing accessible advisories even in remote areas. Reliable connectivity allows Development Agents (DAs) and farmers to access and utilize these platforms continuously, enhancing the effectiveness and reach of LAFA by delivering timely, site-specific advisories. Given this reliance on connectivity, establishing collaborative agreements with telecom providers like Ethio Telecom and Safaricom becomes crucial. By negotiating affordable data packages or zero-rated access for farmers and DAs financial barriers can be reduced, making digital advisory tools more accessible. Additionally, telecom partnerships can support infrastructure expansion in underserved areas, closing connectivity gaps and ensuring that all farmers, regardless of location, benefit from digital advisory services. Such collaboration will be pivotal in scaling LAFA, as it leverages telecom resources to enhance the accessibility and sustainability of digital agriculture solutions.

3. Promote access to finance (Digital Credit Scoring Card)

Lack of access to finance and problems of financial inclusion are pervasive hindrances for at impact scaling of agricultural innovations in Ethiopia, including fertilizer purchase. Tackling this bottleneck can facilitate scaling innovations. In this regard, availability of new digital options could be exploited for better financial products and services. Digital agriculture tools such as smart farming advisory service, digital weather and climate services, as well as market information and e-commerce services can be linked to digital ids and geographical locations of farmers to establish other services such as crop insurance and digital financial services. With such tools, it is possible for financial institutions to assess the credit risk levels of individual farmers and design financial products customized to individual farmers' financial needs and capacity to repay loans. Such tools could increase the reach of lending services than present methods and reduce transaction costs and risks for lenders. Therefore, it is essential to adapt and adopt existing digital financial products and conduct pilot validation activities as well as integration of such systems with the LAFA during phase one of the scaling plan. Assuring digital access to financial services in a prioritized use case in Phase 1 of DAR 2032 (MoA and ATI, 2025).

4. E-marketing/market linkage

In addition to digital products for financial services, market linkages can be facilitated through digital means. Digital marketing services encompass market information, e-marketing platforms, and real-time traceability monitoring. Improving market information services using digital platforms provides farmers with real-time prices, demand and supply estimates and potentially improved quality standards. E-marketing platforms create a virtual marketplace where farmers can interact directly with retailers and consumers in the absence of middlemen which will reduce transaction costs, improve farmers' reach to better paying markets and improve their profit margins. Digital platforms designed for real-time monitoring and data collection in the production and distribution continuum facilitate transactions through supply chain transparency, improving safety standards and building trust between farmers and consumers. At present, the application of such innovations is inadequate in Ethiopia and is mostly limited to market information provision. There is a need to exploit the enormous opportunities these innovations create in the transformation of smallholder agriculture in Ethiopia. In this regard, it is crucial to adapt and adopt digital marketing tools. This calls for pilot testing of these innovations and integrating them with the LAFA to capture synergetic benefits.

5. Link Crop Insurance into LAFA

Cropping in many parts of the mixed farming system of Ethiopia is a venture with a lot of risks. These farming systems are characterized by complexity, diversity, and risks associated with weather, pest and price fluctuations. Many of these risks are increasing given climate change. The use of fertilizer decision support system tools is also not devoid of risks. One way of dealing with these risks is spreading them over time and actors through the use of crop insurance schemes. Crop insurance involves compensation for crop losses due to crop damage caused by uncontrollable natural disasters based on an insurance policy purchased by farmers. There are different types of crop insurance products in different parts of the world. In developing economies, the emergence of index-based insurances, which make use of predetermined indexes for payments, has made these products feasible for many insurers, especially with some financial support or guarantees from governments. Some of these crop insurance products use digital technologies that enable

insurers to collect better data on weather and rainfall as well as reach previously unreachable rural clients due to remoteness and high transaction costs. Digital crop insurance can go hand in hand with other related digitally enabled agro advisory services such as LAFA. Therefore, as a complementary innovation, digital insurance services need to be promoted in collaboration with key insurers and local, regional, and national-level government entities to amplify the use and impact of site-specific fertilizer use recommendations.

6. **Capacitate SMS/DAs to effectively deliver LAFA and complementary innovations**

   The level of digital literacy is low in rural areas among farmers in Ethiopia. This calls for support for farmers by Subject Matter Specialists (SMS) and Development Agents (DAs). However, the capacity of these support giving professionals in terms of general digital literacy and the use of digitally enabled site-specific agro-advisory tools is low. Improving the capacity of subject matter specialists and development agents at local levels is an essential component for promoting digitally based extension services and the use of digitally enabled decision support tools in agriculture. Therefore, one of the crucial practical delivery activities in the first phase of the scaling effort involves developing the digital capacity of these actors through intensive training aimed at creating a critical mass of experts to serve farmers directly as well as train others.

7. **Promote soil test-based e-delivery kiosks for LAFA with a bundle of services**

   These delivery agro kiosks or simply Agri kiosks, are local-level hubs for a bundle of digital agro advisory services, including quick soil sample tests for enhanced site-specific fertilizer and soil amendment recommendations such as lime and organic fertilizer use. They are designed to provide all-round interactive agro-advisory including agronomic advisory, market information, and e-marketing. The establishment of such hubs could be at Farmers' Training Centers and Woreda Offices of Agriculture, where trained experts could assist farmers in getting the services. These hubs could be designed to integrate all agriculture related digital aids as well as associated services such as bill payments, etc. Piloting a few hubs that integrate LAFA with other digital advisory tools in few places in the country needs to be done to generate data on their feasibility and farmers' demand for such services.

8. **Strengthen platforms at all levels**

   Scaling, by its nature, is an effort that needs partnership among various actors. In the absence of strong partnership among the relevant stakeholders, it is not possible to scale an innovation for impact. Hence, it is important that all relevant stakeholders at local and higher levels are brought together in innovation platforms to discuss and solve important operational, policy and institutional problems towards the scaling of site specific, digitally enabled agro advisory systems such as LAFA. At present, there exists a DST Harmonization Platform for data sharing, harmonization of the various fertilizer uses decision support tools as well as validation of the product by all relevant stakeholders. This partnership platform for enabling HaFAS framework needs to be re-oriented to be involved in bundling of relevant innovations, solving structural and operational problems for scaling, as well as institutionalization of site-specific, digitally enabled agro-advisory innovations intending to reach the multitude of farmers including the disadvantaged ones. The institutional and governance section in the subsequent chapter below provides an elaborated framework of the HaFAS platform to manage the innovation development process (data generation, data management/repository, modeling, validation, and piloting), scaling operation, and monitoring and learning.

5.3 Customizing Delivery of LAFA Services using Potential Interfaces

Despite the potential delivery strategies and digital dissemination channels discussed in the preceding sections, there remain barriers to effectively disseminating and delivering site-specific advice such as LAFA through all the available delivery channels. The major barriers include inadequate availability of farmer profile data for tailoring services, absence of high resolution and localized geolocation information layers, digital illiteracy of end users, absence of smart and digital technologies owned by end users, and increasing cost of collecting parcel-level geolocation data. To overcome these barriers and enhance a customized use of site-specific agro advisory solutions like LAFA, priority and adaptable delivery channels integrated with context-specific and site-specific input data access strategies are identified and recommended. These barriers will be addressed in the subsequent phases of the scaling strategy. These integrated strategies vary by the delivery channels, as the nature of delivery channels/interfaces requires different user or local information. For example, LAFA can be used through mobile apps and chatbots if geolocation information of parcels is available and integrated into the advisory tool. But hotlines, phone-based calls, videos, and radios can disseminate advisories to all end-user audiences, and the geolocation information is not necessarily integrated into the advisory; rather, broader recommendation spatial domains are sufficient.

Accordingly, customized delivery channels are suggested to effectively deliver LAFA services. The customization strategies need to enable advice from end users to use site specific recommendations.

1. *Chatbot delivery channel*: LAFA can be disseminated using chatbots by using either geolocation information of a parcel, or high resolution and homogenous recommendation domain maps, or cadastral land map as input to the advisory tool.

2. *Mobile app delivery channel*: LAFA can be disseminated using mobile apps by using either geolocation information of a parcel, or high resolution and homogenous recommendation domain maps, or cadastral land map as input to the advisory tool.

3. *Phone system-based delivery channel*: LAFA can be disseminated through phone-based calls (outgoing calls) when it is integrated with village and cluster level information. It provides recommendation for a group of users at appropriate aggregation level relevant for the specific target group.

4. *Hotline delivery channel*: For example, ATI 8028 hotline is an out and in bound calls to deliver advice and receive request from end users. This mechanism does not give site specific advice and need to assess integration mechanisms at appropriate aggregation levels.

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5.4 Expected Benefits for End Users

Tailoring fertilizer and agronomic innovations to specific farm and farmer conditions can enhance profitability and reduce investment risks. Economic analysis is crucial for optimizing agricultural practices and making informed investment decisions for farmers and extension service providers. For example, it helps in understanding how site changes specific innovations impact both costs and returns and plays a vital role in evaluating the cost-effectiveness and potential benefits of agricultural investment. It highlights the advantages of new technologies adoption over current practices.

Benefit to Cost ratio, Internal Rate of Return (IRR), and period of cost recovery time analyses are standard ways that are used to measure the economic feasibility of site-specific innovations to end users that provide potential benefits and the time required to recover the investment. The cost-benefit method can show an actual impact of the investment on outputs and outcomes (Stansfield and Giles 1980) and highlight the financial and economic feasibility of the innovation. This analysis plays a vital role in evaluating the cost-effectiveness and potential benefits of the innovation. In addition, this is vital to compare the net benefits of innovation over alternative and conventional practices. Achieving this goal requires identifying and measuring streams of benefits, costs and potential spillovers of the wider implementation and application of the innovation.

The economic analysis of a site-specific fertilizer advisory is explained through efficient nutrient application, meet crop requirements and landscape segmentation and its impacts on production, productivity, and profitability of crop production. This highlights the necessity of cost benefit analysis for farmers to adopt a comprehensive approach to fertilizer management that considers both agronomic and economic factors. Studies indicated that nutrient application rates can lead to a wide range of breakeven prices, depending on local soil conditions (Aberle et al., 2016; Obour et al., 2017).

The benefit from the use of LAFA for the different target groups (end users) would potentially vary across their risk perception, resource endowments, and adoption pathways. Such groups are broadly divided according to their focus and targets to get maximum yield and/or maximum net benefits. Benefits are likely to be heterogeneous, depending, for instance, on a user's gender, social class, or wealth status. It is important to quantify benefits for different groups of farmers, such as market-oriented male farmers (currently the dominant users of inorganic fertilizers), women, youths and subsistence farmers. This helps to identify target groups where the greatest potential welfare gains can be achieved, as well as adjust the program to be more inclusive, creating greater benefits for the various client categories considering their specific conditions and constraints.

Empirical evaluation using a precision agriculture approach, as opposed to the traditional economic evaluations, is an optimal decision-making method involving conducting farm-level experiments to evaluate the economic efficiency of site-specific input and agronomic management. By estimating yield response functions and conducting economic analyses, this approach helps determine the optimality of implementing site-specific fertilizer and agronomic recommendations (Gardner et al., 2021).

From a micro perspective, tailoring fertilizer and agronomic application to specific farm conditions could substantially increase farm efficiency (nutrient use efficiency or factor productivity), productivity (measured with both grain and biomass yield), profit (dependent on input and output prices) and enhance sustainability while minimizing production risks. Reducing any overuse of fertilizer, leading to reduced water pollution, is expected to be a significant environmental benefit.

Since the LAFA is still under validation, we can draw on cost-benefit information obtained by its predecessors, LANDWise and NEXTGen Fertilizer Advisory

5.4.1 Benefits of Landscape-based Fertilizer Advisory Tool (LANDWise), a Preceding Tool to LAFA

Landscape segmented fertilizer advisory (LSFA), called LANDWise is a decision support tool that provides landscape-segmented fertilizer application for wheat, teff, and sorghum crops which was codeveloped, validated, and piloted from 2020 to 2024 in 120 districts across seven zones of four regional states. Based on a landscape-specific fertilizer advisory tool that took landscape into account, ICRISAT evaluated the economic outcomes of landscape-segmented fertilizer recommendations across different landscape strata. The tool helps farmers to apply fertilizers according to the marginal return, which should help to reduce the overall cost of fertilizer per kilogram of grain. The net benefit analysis during the validation and piloting stages indicated variations by crop and landscape strata. The agronomic and economic analysis found that landscape-specific fertilizer application resulted in much higher yield improvements, 23% and 56% at foot slopes and 21% and 6.5% at mid slopes for wheat and teff, respectively, than using the blanket recommendations (Desta et al., 2023). The optimized net benefit per hectare increase over the current extension recommendation was $176 and $333 at foot slopes and $159 and $64 at mid slopes for wheat and teff respectively. For the case of sorghum, the optimum net benefit was $526 for the foot slope and mid slopes and $438 for the hill slope landscape strata. The hill slope generated the lowest net benefit for all crops because of its natural low yield potential. The results of the benefit-to-cost ratio (BCR) demonstrated that applying landscape-targeted fertilizer resulted in an optimum return on investment ($10.0, $12 and $30 net profits for teff, wheat and sorghum respectively, per $1.0 investment) while also enhancing optimized nutrient use efficiency across the three landscape positions (Desta et al., 2023). The Benefit Cost Ratio (BCR) analysis indicated that the BCR value of the tested crops across the landscapes reduced the gaps and approached optimum across the landscape strata. The direct benefits need to consider changes in crop yield and prices, output prices, and the amount and value of fertilizer “saved” by using the site-specific recommendations.

5.4.2 NextGen Fertilizer Advisory Tool, a Preceding Tool to LAFA

The NextGen DST-based advisory is transforming precision agriculture by delivering site-specific fertilizer recommendations that significantly boost wheat yields and maximize economic gains for smallholder farmers. Independent on-farm validation trials conducted in 2023/24 by the Ethiopian Institute of Agricultural Research confirms that these recommendations can boost yields by up to 25% while improving water productivity and nutrient utilization. For farmers, this translates to higher grain and biomass yields, improved input efficiency, and reduced production risks—key factors in strengthening net returns. Results from trials across 25 major wheat-growing sites indicate that adopting NextGen DST can generate additional net benefits of $475 to $665 per hectare per season compared to traditional practices or standard research-based recommendations (Tamene et al., 2024). These substantial gains make mineral fertilizer investments through NextGen DST far more attractive to smallholder farmers, as improved marginal returns help offset input costs. At a national level, extrapolated estimates suggest that applying these site-specific recommendations across Ethiopia’s 1.7 million hectares of rain-fed wheat production could increase national seasonal earnings by $1.38 to $1.95 billion (Tamene et al., 2024). Given this immense potential, NextGen DST has been integrated into HaFAS as a core component of Ethiopia’s digital agro advisory system. It is now set for scaling and deployment of LAFA within the national extension framework, paving the way for greater productivity, profitability, and sustainability in the country’s wheat sector and other key cropping systems.

5.4.3 Environmental Benefits

Targeted site-specific advisory services guide farmers to align fertilizer usage to the recommended levels and it will reduce overuse of fertilizer. The LAFA tailors' fertilizer application based on localized soil characteristics and climate data and optimize nutrient use. This precision application reduces the excess application of nitrogen-based fertilizers, a major source of nitrous oxide (N_2O) emissions, which is approximately 298 times more potent as a greenhouse gas (GHG) than CO_2.

An unpublished report that estimated this contribution by using the FAO’s EX-ACT (Ex-Ante Carbon-Balance Tool) method for GHG emission estimation in Ethiopian wheat production found that site-specific fertilizer applications (example, LANDWise and NextGen tools) practices increased wheat yields by 24% compared to blanket recommendations. Despite an increase in absolute emissions per hectare with site specific fertilizer applications (4.1 t CO_2 eq/ha) compared to the blanket recommendation (3.9 t CO_2 eq/ha), the site-specific fertilizer advisory tools approach resulted in a lower emission intensity per ton of wheat produced (Digital Green and CIAT, 2023).

Furthermore, site specific fertilizer applications contribute to better soil health by preventing over and under-fertilization, which can degrade soil structure and nutrient balance over time. The recent data-driven model by You et al. (2023) showed that the N recovery efficiency can increase by 30%, from the current average of 48% to 78%, using optimal combinations of nutrient (27%), crop (6.6%) and soil (0.6%) management. This sustainable nutrient management approach, including integrated use of fertilizer with liming and organic inputs, indirectly mitigates

emissions by improving soil carbon sequestration potential, as healthy soils can retain organic carbon more effectively, and offsetting emissions using liming by improving nutrient availability to crops. In addition, less reliance on blanket nitrogen applications reduces risks of nitrogen leaching and runoff into water bodies. which can contribute to aquatic eutrophication and indirect emissions of nitrous oxide from water systems.

At the same time, proper use of fertilizers will improve biomass production, which will translate into soil organic matter improvement. Furthermore, through time not only fertilizer but also lime and organic fertilizers such as compost, vermicompost, and farmyard manure (FYM) will be bundled into the LAFA. This will again improve the extent of soil acidity, reduce aluminum toxicity, and enhance nutrient use efficiency, which will in turn improve soil microbial diversity, function, and organic matter accumulation in the soil. Thus, the indirect benefits include the cost savings for the country from reduced excessive fertilizer use and over time, the environmental benefits from emission reduction and improved soil health.

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5.5 The Cost Structure

A dynamic digital innovation generation and regular updating and refining process, especially when it requires dynamic data integration, like in the case of site-specific digitally enabled bundle of agro-advisory services, runs through a series of costs. There are also costs associated with establishing, operating, and maintaining the distinct delivery channels. Effective and efficient extension delivery requires developing appropriate content, and the performance of an extension delivery services depends, in large part, on the appropriateness of its content and messages for farmers. The more customized and appropriate the message is, the more relevant the extension services would be for the farmers, which in turn leads to a better extension agent-farmer relationship. But continuously customizing messages to suit all heterogeneous farmers is not possible for economic reasons. From a cost perspective, site-specific and farmer tailored messaging remains optimal for production resources. The generation, diffusion, and application of impactful innovations entail various costs for systemic integration and dissemination that promote communication, interaction, and cooperation between partners, like agricultural

research, education, extension, farmers, the private sector and policy regulatory systems (Yeboah, 2023). This section illustrates the various costs associated with the HaFAS management and governance and LAFA services.

The costs of scaling LAFA and bundles of complementary innovations and the HaFAS system are associated with data generation for continued development of bundles of advisory services, digital platform system management and governance, LAFA and complementary innovation delivery services, and evidence collection for feedback and learning. These costs can be classified into three categories: institutional/organizational, end-user, and environmental cost elements.

1. **Costs of end users:** The first cost category is related to the end users' costs that are primarily the cost of farmers for accessing and using LAFA and a complementary bundle of advice. These costs include input costs incurred to produce crops (i.e. fertilizer, lime, seed, etc.); and the indirect costs include storage cost, opportunity costs (e.g. interest rate), loans, and management costs. An estimate of end user costs is undertaken based on 2024 advisory pilot dissemination. During the 2024 production season, farmers purchased 50 kg of Urea and 50 Kg NPSB with average prices of $32.75 and $30.17, respectively. The costs of 100 kg lime are about $9.0. The improved seeds of wheat, teff and sorghum costs $130 to $160, $150 to $200, and $100 to $130 per 100 kg seeds. Concerning the labor cost and machinery costs for land preparation and harvesting, a combine harvester for wheat costs an estimated $4.14 per 100 kg of wheat grain, and for teff and sorghum crops harvesting was done by manual labor with a cost of $5 to $5.7 per person per day that varied from location to location. Other activities done by family labor include weeding, ploughing, planting, threshing, and chemical spray. The seed price varied from crop to crop.

2. **Institutional costs:** The second category of cost is related to institutional cost. Institutes incur costs related to innovation generation, data management, and carrying out promotion and dissemination of LAFA services. Public and private sectors play a key role in supporting the provision of extension service. This requires incurring costs in communication and coordination. Organizational and facilitation costs include the costs associated with technology generation and maintenance, farmer-friendly content preparation (personalization) and delivery cost, partnership management, innovation niche assessment, knowledge transfer, capacity building, and monitoring and follow-up costs. Institutions must assess operational expenses and potential returns to justify investments in scaling strategies. Key institutional costs are estimated.

    a. **Costs of trials for continued advisory development:** This cost category is needed, noting that the advisory system will continue to be upgraded and improved with additional field research data from new parts of the countries and additional crops. To generate the on-farm experimental data, there will be a need for field experiments. To conduct field experiments, a minimum budget must be allocated to improve the model efficiency. For generating on-farm experimental data, an estimate of $1200 per farmer site with an appropriate size of replications will be required to cover all costs of trial management, including soil and plant analysis. Such experimental data generation activities could include designed experiments that evaluate a range of treatments in a replicated manner. The EIAR and RARIs have experience conducting a maximum of 1500 to 2000 experimental trials in a multi-location for the development of two to three agronomic or fertilizer technologies. As a result, the digital fertilizer and agronomic advisories could address crops that were not in the list including barley, potato, and other pulse and oilseed crops.

    b. **Costs for validation of advisory tools:** Costs will be expected to incur for validating new digital prototype advisories every year. For the LAFA validation trials on farmers' fields in 2024, EIAR spends on average $125 per farmer site to establish validation prototypes against farmer practices, manage trials, data collection, monitoring and follow-up, and feedback collection from farmers and extension agents. About 1,500 validation trials will be expected every year in verification of new technologies or practices that will be bundled with LAFA including liming for acid soil management, composts, ISFM and crop rotations as well as fertilizer applications for new crops.

    c. **Costs for capacity development for delivery**: The other institutional cost components include workshops for awareness, planning, training, and field day events. The workshop costs per person per day varied based on the number of sites and the number of participants. The average workshop costs, including accommodation, transportation, daily subsistence, and related costs. The estimated cost will be $120 per person per day. In addition to technical capacity, digital delivery services incur airtime and internet costs that can be charged as subscription costs. For unlimited calls, SMS and data, about $8 will be subscribed on a monthly basis.

    d. **Costs for servers, managing data and analytical modeling works**: The EIAR has incurred costs of $60,000 per year associated with data management and ICT personnel, including hiring of AWS server during the validation year in 2024. During the scaling period, the data management and analytical works will be hosted in the MoA server and the only costs associated with data management, maintenance, and ICT personnel which will be estimated $25,000 to 30,000 per year to cover the salaries of two ICT personnel and operation costs. The refinement and updating of the prototype model and algorithms for model applications will be done by modeling staff team in EIAR and intermittently supported by CGIAR modelers. Their time will be covered by their annual salary covered by the public sector.

3. **Environmental costs**: The third cost category is environmental costs. The environment is associated with the implementation of innovation by end users and the consequences on the environment and the community. Nitrogen is the main limiting nutrient for photosynthetic processes, growth, and development of crops. In contrast, excessive use of N fertilizer leads to low N recovery efficiency. Increasing the nitrogen recovery efficiency of crops is critical to settling crop production and environmental quality. Management of nitrogen, crops, and soil affects nitrogen recovery efficiency, which justifies its dependency on site conditions, including mean annual temperature and precipitation, soil organic carbon, clay, and soil ph. The current global average N recovery efficiency is 48% (Quan et al., 2021). This increase will help reconcile crop production with acceptable N losses. This indicated that depending on the management practices, 22-52% N will be emitted to the environment and cause GHG emissions. The environmental cost of N loss is estimated to be about 10.12 kg per 100 kg of Urea, equivalent to 10 USD.

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5.6 Understanding the Competition

Since September 2024, broad network of national and international players, including the EIAR, RARIs, ICRISAT, CIAT, Agricultural Transformation Institute (ATI), Digital Green, PxD, and Lersha are engaged in the HaFAS initiative. The key players across the 'data value chain' are analyzed, consulted, and integrated, and some of them, like the LAFA are already harmonized. The HaFAS platform and the National DST Coordination platform can be used to harmonize efforts, promote collaboration, and **reduce competition while enhancing bundled innovations at a national level**. Globally, partners such as GIZ, USAID, GF, IFDC, and CGIAR (CIAT, ICRISAT, CIMMYT, IITA) contribute to the HaFAS harmonization and validation through financial and technical support to the Ethiopian government, CG centers, and NGO delivery partners. In Ethiopia, key service providers include public/private extension services, input suppliers, microfinance institutions, and digital platforms such as the ATA 8028 Farmer Hotline, Lersha, and Farm Radio International.

The LAFA has brought about two very successful fertilizer advisories that are contextualized to the country's farming systems and are tailored to households. They have used recent developments in data science and together have reached close to 100,000 farmers, showing the agronomic and economic gains discussed in section 5.3. The HaFAS approach and LAFA tools are thus best placed to scale not only within Ethiopia but also across Africa. The HaFAS leverages recent advancements in machine learning, data science, and mobile technologies to provide precise, data-driven recommendations. This trend is pivotal in improving efficiency, reducing fertilizer wastage, and boosting agricultural productivity.

The success of the Harmonized HaFAS depends on strong collaboration with national research systems, extension services, NGOs, and international donors. The integration of local and global expertise enhances the effectiveness and reach of advisory services. With proven success in Ethiopia, the HaFAS approach is poised for wider adoption across Africa. The tool's scalability is facilitated by partnerships, data-sharing platforms, and its integration into existing extension systems and farmer-facing platforms.

The strategy emphasizes the importance of integrating various data sources, such as soil mapping, crop modeling, and climate forecasts, into the HaFAS to tailor agronomic advisories (Figure 5.3). The strategy also emphasizes complementarity rather than competition. Various actors, tools, and projects are aligned to support the same goal: improving soil management and advisory services, minimizing duplication, and fostering innovation in agricultural advisory. Projects such as the Optimizing Fertilizer Recommendation in Africa (OFRA) and Taking Maize Agronomy to Scale (TAMASA) contribute through digital tools for fertilizer optimization and promoting agronomy best practices. The data used for the HaFAS were generated with the contributions of various partners such as the Ethiopian Institute of Agricultural Research (EIAR), Regional Agricultural Research Institutes (RARIs), Higher Learning Institutions, Optimizing Fertilizer Recommendation in Africa (OFRA) through AGRA, Taking Maize Agronomy to Scale in Africa (TAMASA), Ethiopian Soil Information System (EthioSIS) and SG2000.

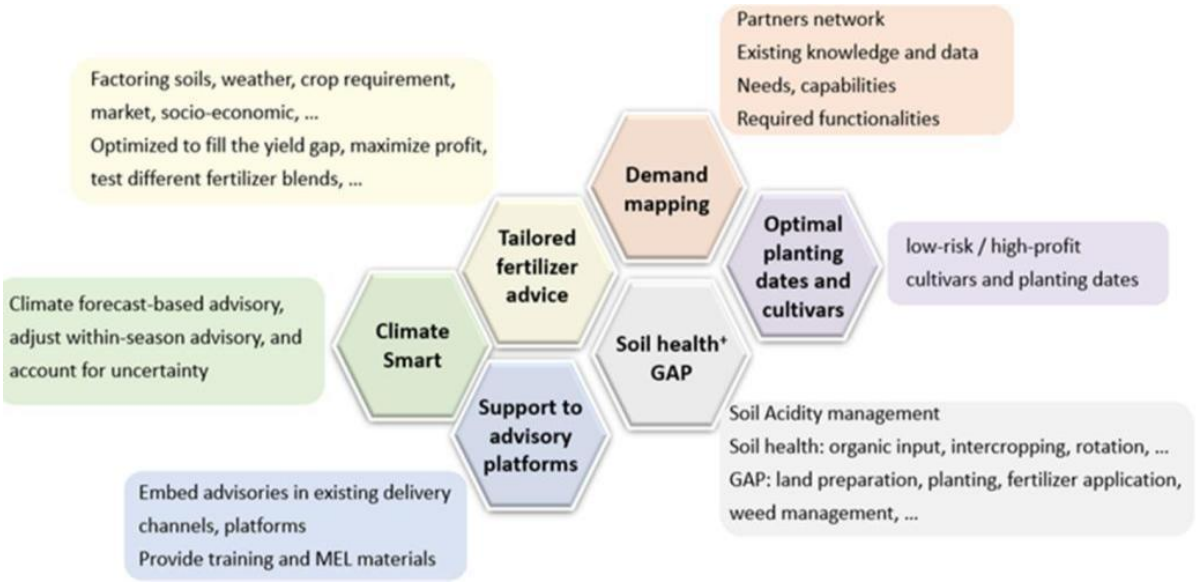

Figure 5.3. Complementarity Components of the Harmonized Advisory System

Long-term sustainability requires continued support and commitment by the Ethiopian government to the creation of resilient agrifood systems and inclusive extension systems. The document offers a comprehensive roadmap to improve agricultural productivity through digital tools, partnerships, and harmonized advisory systems, which can be scaled across Africa to benefit smallholder farmers. Thus, the current competitive tools available in the country are harmonized and no competition is expected. Given the dynamic nature of the digital space, as new actors like CropIn arrive with potentially competing tools, it is critical that they are brought into the HaFAS framework as partners and contribute their databases and expertise as well to building a better LAFA under the coordination of the Ethiopian government.

5.7 Business Case for Market-led Packages and Selected Components of PPPs

The public and PPP pathways are the preferred models for the first and second phases of scaling. The market-based model is the preferred delivery model for agro-advisory innovation when the delivery design strategies, digital infrastructures, and institutional setups mature towards the third phase of the scaling.

- **Public model:** Phase one public and development support will be critical drivers of the implementation and application of the innovation in the first phase.
- **PPP model:** Robust and sustainable PPPs shall be identified, developed, and nurtured through the first and the second phases.
- **Market-based model:** The second half of the second phase and the third phase market-based models will be piloted and capacitated to lead the delivery of the innovation.

5.7.1 Market-based Model

The private sector is expected to play a major role in the dissemination of LAFA. It is envisaged that private extension service providers will fill the gap of customized advisory services to increase the efficiency of extension delivery. The private sector includes seed and input companies, distributors and agro-dealers, service providers of various kinds, food processors, and retailers. The private sector extension providers are considered the future pathway to complement public sector services and deliver more inclusive, effective extension provision in the country. Therefore, the private sector service providers will be encouraged to enter the business of HaFAS delivery. This will include presenting different business scenarios including developing models of how certain categories of farmers will pay for services. Such models will be piloted and later upscaled within the respective categories. One such example could be utilizing the cooperative sector as they play a vital role in promoting site-specific fertilizer recommendations and other HaFAS components. Cooperatives currently consist of 391 unions and 92,755 primary cooperatives and could play a role in operationalizing the business model. Cooperatives can bundle the costs of dissemination of the advisory services into the purchase price of seeds and fertilizers for their cooperative members and potentially non-cooperative members. Therefore, this could be taken as one form of business model.

Sample business model:

The benefit estimation for the private sector:

a. ***A private sector delivering the LAFA product/service through cooperatives***: A market-based model is one of the key delivery mechanisms that this localized digital fertilizer advisory could reach farmers. Ethiopia has recently opened various sectors to private investment and has a growing private sector. Agriculture is not an exception to this, and the country has just developed a pluralistic extension strategy that provides space for private investment. This localized digital fertilizer advisory could be one additional service that the private sector could add to their bundle of products. In that sense, the advisory could help the private sector to create and increase demand for its products including agro-chemicals, fertilizers, improved seeds, and mechanization. Given this and based on the qualitative discussions that have happened so far, there is an adequate incentive for the private sector to engage in this scaling journey. The public good nature of this intervention would help to enhance their food and nutrition security through increased productivity of farmers and its contribution to reducing environmental costs would remain an additional benefit even when disseminated through the private sector. Even when the private sector decides to develop this tool as a separate business portfolio, this model can be financially sustainable by charging $0.5 per farmer from cooperatives for the service. The following cost-benefit analysis of a private sector model that charges $150 per cooperative for a pilot of 100 cooperatives with an average of 300 members will substantiate this claim. The benefit estimation for the private sector shows that one firm could get about 15,000 USD from this portfolio with transaction cost for demand aggregation of $15 per cooperative and content preparation and delivery cost of $3 per cooperative. Based on the assumption provided in the above section, the gross profit from this portfolio would be 13,200 USD per year. This gross profit figure would be even larger when we consider the health, food security, social, and environmental benefits of the 30,000 direct beneficiary households and their families that would benefit from the intervention and the system update and maintenance costs. However, it is important to note that technology generation and coordination function are not covered in this calculation and are assumed to come through government funding or donor funding.

b. ***A private sector delivering the product/service directly to farmers*****:** As indicated in the previous section, there is a strong interest from the private sector to include this localized digital fertilizer advisory into their portfolio of products and services. Like the cooperative pathway, there are at least two options for the private sector. The first one is to provide the advisory as part of the bundle of products where they can charge for this service indirectly as part of the other products (fertilizer, seeds, or agro-chemicals). Alternatively, the private sector could deliver the advisory as one service portfolio and charge a small amount of money for farmers. The following cost-benefit analysis of a private sector model that charges $1 per farmer for a pilot serving 30000 farmers shows that a private firm in this business would get about $3000 gross profit. Through this approach, the firm would collect $30000 with $0.6 transaction cost for demand creation per farmer and a $0.3 cost of delivery and content creation in providing this service. It is vital to note that this gross profit figure is underestimated as we did not consider the health, food security, social, and environmental benefits of direct beneficiary households and their families that would benefit from the intervention and the system update and maintenance costs. Again, it is assumed that technology generation and coordination remain the responsibility of the public sector.

5.7.2 A Public Private Partnership model

Agri-PPPs are broadly promoted as having the potential to help modernize the agriculture sector and deliver multiple benefits that can contribute towards the pursuit of sustainable agricultural development that is inclusive of smallholder farmers. This scaling strategy document promotes the use of the Public-Private-Partnership (PPP) model – through a collaboration of the government, development actors, and the private sector—to disseminate innovations. This recognizes the comparative advantage different actors have for different functions. In this case, focus shall be given to building the capacity of these actors for delivery.

The partnership should be designed in a way that:

- Allocates tasks, obligations, and risks among public- and private-sector partners optimally.
- Recognizes that the public and private sectors each have comparative advantages relative to each other in performing specific tasks.
- Aims to minimize costs while improving performance in terms of relevance, efficiency, effectiveness, impact, and sustainability. This implies that by working together, the public and private partners generate more value for money than the government could by single-handedly delivering the public good/service

The financial sustainability of the public-private partnership model is determined by the long-term benefit potential and cost streams of this pathway for both the public and private sector actors.

- For private sector actors, the farmers' willingness to pay for the service translated into the provision of services and products around this innovation (that includes bundled services) vis-a-vis the cost of delivery determines

the financial sustainability of the model. The benefit stream for the private sector encompasses the revenue that the private sector achieved through the provision of advisory services.

- If the value of the sum of the benefit streams for the private sector for the given period (e.g. phase 3 for five years) outweighs the costs of advisory development, coordination, and delivery, we would say the channel can be financially sustainable and a major approach to scaling HaFAS services, we would consider this channel for scaling.

In the PPP model, the public sector would play the technology generation, coordination, and regulatory functions while the private sector would lead the farmer-facing and dissemination part. In the PPP model, the private sector may introduce a smart subsidy scheme where farmers would only cover a portion of the cost in the initial period and would gradually move into a fully market-based model in the subsequent years. The public sector would seek grants from donors and governments to cover its costs for technology generation, maintenance, coordination, and regulatory functions. In the early stages of this scaling journey, some of the costs of the private sector should also be covered through grants. This model is unique in the sense that it would take into consideration most smallholder farmers who are unable to pay for the service in the short run given their high-risk aversion characteristics and the effort that is required to popularize and market the service and will aim to sort this out by combining the public and private sector in the arrangement. The financial sustainability of the public-private partnership model is determined by the long-term benefit potential and cost streams of this pathway for both the public and private sector actors.

- For the public, the cost recovery potential of the pathway through economic and social benefits for farmers, value-chain actors, and the public and overall national benefits is key for financial sustainability. The benefit stream encompasses the yield and income contribution of the innovation for farmers, the impact on poverty reduction and food security, its contribution to reducing environmental pollution, and the opportunity created due to efficient fertilizer use and input supplier and dealer benefits because of increased fertilizer use, etc.

- For private sector actors, the farmers' willingness to pay for the service translated into the provision of services and products around this innovation (that includes bundled services) vis-a-vis the cost of delivery, it determines the financial sustainability of the model. The benefit stream for the private sector encompasses the revenue that the private sector achieves through the provision of advisory services.

- If the value of the sum of the benefit streams for the public and private for the given business implementation period (e.g. phase 1 for five years) outweighs the costs of technology updating, coordination, and delivery, we would say the channel is financially sustainable and we would consider this channel for scaling.

The following cost-benefit analysis of this model shows that a PPP model can be financially sustainable in the long run that charges $0.25 per farmer for the first season, $ 0.5 for the second season, and later $1 per farmer for the rest of the project period for a pilot of serving 30000 farmers shows that it is economically sound in the long run to go for this arrangement. With the transaction cost of $0.6 and $0.3 cost of delivery and content creation, the cost of the private firm should be covered through grants to offset the losses of (-$19,500) for the first season and (-$12,000) for the second season. However, the private firm would get about $3,000 from the start of the third production season. In the same way, this model requires looking for grant money from donors and governments to cover the costs of the public sector. In the same way with the private sector led pathway, the benefit is even larger when we consider the health, food security, social and environmental benefits of direct beneficiary households and their families that would benefit from the intervention and the system update and maintenance costs.

5.8 Capacity and Investment Needs to Implement the Scaling Strategy

Strong and capacitated institutions as well as development partners are crucial for the appropriate implementation and scaling of the HaFAS framework and LAFA advisory and sustaining its existence for 15 years and beyond. However, for effective implementation of the HaFAS scaling strategy, the capacity of partner institutions in terms of human and infrastructure capacity needs to be strengthened, specifically to fill gaps identified in the value proposition analysis of partners (section 5.1, Table 5.2) and build new capabilities on digital literacy and digital infrastructure.

The core capacity development and investment areas are structured around the key components required to implement the HaFAS framework and scale LAFA and complementary innovations effectively. These are:

1. Technology and Infrastructure

    - Data and Analytics Platforms: Capacity and investments are needed to enhance data collection, storage, and analysis capabilities, including the establishment of continuous data generation and updating across representative geographies and cropping systems, and the integration of various data sources like soil mapping, remote sensing, crop modeling, and climate forecasts.

    - Digital Infrastructure: Capability and funding are required for developing and maintaining digital platforms, including mobile apps, web apps, dashboards, SMS, IVR, video, and chatbots, as well as digital kiosks in

rural areas. This also includes addressing the challenge of limited digital infrastructure by creating local hubs for advisory dissemination.

- Hardware and Connectivity: Investments are necessary for hardware such as digital tablets for extension agents, mobile soil testing vans, and drones for data collection, as well as ensuring reliable internet connectivity, especially in rural areas.

2. Capacity Building and Training

   - Training Programs: Developing and implementing training programs for extension workers, farmers, and other stakeholders on the effective use of the advisory tools is crucial. This includes training in data collection, analysis, and digital literacy.

   - Technical Assistance: Providing technical assistance to government staff, research institutions, and private sector partners to build their capacity in data management and digital tools, partnership and scaling for impact.

3. Extension and Dissemination

   - Development Agent (DA) Networks: Strengthening the existing network of DAs by providing them with the tools and training to deliver DST-based advisories.

   - Farmer Training Centers (FTCs): Utilizing FTCs as centers for promoting the DST service and delivering training to farmers.

   - Digital Delivery Channels: Investing in various channels (mobile apps, SMS, IVR, videos) to ensure that advisories reach all segments of farmers.

   - Demonstration Plots: Setting up demonstration plots to showcase the benefits of site-specific fertilizer recommendations.

   - Cooperatives: Investing to strengthen and utilize the huge setup and capacity of farmers' primary cooperatives as advisory dissemination hubs.

4. Research and Development (R&D)

   - Model Development and Validation: Continuous improvement of the DST models using new data, legacy crop response data, and user feedback, while establishing long-term trial sites for comprehensive datasets.

   - Innovation and Adaptation: Investing in R&D to develop and adapt the DSTs for diverse contexts, including different crops, soil types, and farming systems. This also includes integrating complementary technologies and innovations into the agro-advisory bundles, including fertilizer, lime, climate, and good agronomic practices. Continuous testing and validation of scaling pathways, business models, and delivery channels under different contexts and market segments to adapt HaFAS and LAFA under different contexts and geographies.

5. Monitoring, Evaluation, Learning, and Impact Assessment (MELIA)

   - Data Collection and Analysis: Establishing a robust MELIA system to track progress, assess impact, and ensure continuous improvement by collecting and analyzing data on key indicators, such as changes in income, yields, and adoption rates.

   - Feedback Mechanisms: Implementing feedback mechanisms to capture user experience and adjust, as well as researching the inclusiveness and effectiveness of the DST.

6. Partnership Management and Coordination

   - Stakeholder Engagement: Establishing and maintaining multi-stakeholder platforms to facilitate communication, knowledge sharing, and joint problem-solving.

   - Governance Structures: Defining clear governance structures and operational units to ensure effective collaboration, accountability, and flexibility within partnerships.

   - Coordination Mechanisms: Ensuring effective coordination between partner institutions to minimize duplication and maximize impact.

5.9 Setting Scaling Use and Adoption Targets

The scaling strategy of the LAFA and complementary innovation tools, as the initial component of the HaFAS to go to scale, aims to address the low agronomic efficiency of major cereal crops (maize, sorghum, teff, wheat) and low productivity through precision nutrient management and agronomic practices and input economic optimization and thereby improve adoption rates. The four major cereal crops (wheat, teff, sorghum, maize) cover nearly 70% of all crop areas of the country. Therefore, improvement in the productivity of these crops and increased fertilizer and agronomic input efficiency will significantly improve the food security and income of smallholder farmers and enhance the agriculture's economic contribution to the national growth.

The scaling strategy will be a guiding document and is crucial to implementing the digital extension delivery operation of LAFA and complementary innovations and reaching wider segments of farmers across major cereal-growing geographies. The scaling strategy will span 15 years in three implementation phases from 2026 to 2040. The chronological distribution of each phase will illustrate the dynamics and evolution of the scaling pathways and the reach and adoption targets for the different user farmer groups.

Scaling use and adoption targets will be set based on current fertilizer use as a baseline, fertilizer supply and distribution trends, the potential and impact of fertilizer use by cereal grower farmers as well as the realization of the digital infrastructures for delivery of the LAFA and complementary advisories. This will be used to set scaling use and adoption targets. The scaling targets are set for the cereal grower farmers in the highland, midland, and lowland mixed farming system, specifically for cereal-dominated production both for smallholder and commercial farmers (Table 5.4). Scaling targets will start at the LAFA validation zones (49) and districts (129) used in 2024 and gradually expand to cover potential cereal-growing areas of the country provided that enabling environment conditions are met. Moreover, over time as resources become available, other crops will be added, like barley, millet, and non-cereal crops like potato.

The following criteria were considered in setting the targets:

- **Current fertilizer use**: According to the 2021/22 Agricultural Survey Report of CSA, more than 13.65 million cereal growers used 1.63 million tons of inorganic fertilizers at average rate of application of 228 kg/ha (average rate of 188 kg/ha for teff and sorghum each, 226 kg/ha for wheat, and 315 kg/ha for maize) and 120 kg per household (85-95 kg for teff, wheat and maize each and 40 kg for sorghum). Cereals share 80% to 85% of the national fertilizer use. The current fertilizer use will be set as a baseline for the scaling delivery targets. By the end of the 15-year scaling, we target to reach at least 50% of the current fertilizer user households who grow cereals in the highland, midland, and lowland mixed farming systems. More specifically, in the first phase of scaling, we aim to target 2 million households that grow four crops within the 2024 validation target zones (129 districts in 49 zones across the different regional states) where 5.7 million households currently use fertilizer for maize, sorghum, teff and wheat. In the second and third phases, we aim to increase to 4.56 and 6.85 million households, respectively.

- **National fertilizer supply**: According to the data from the Agricultural Input Supply Department of the Ministry of Agriculture, the national fertilizer supply trend from 2015 to 2023 shows an average increase in supply over the years by 8% with some irregularities in some years. The minimum supply was 1.17 million metric tons in 2016/17, and the maximum was 1.94 million metric tons in 2023, which is less by 4.5 million than the total anticipated demand. The expected supply in 2025 will be 2.4 million metric tons. We assumed the supply will continue with the same trend as in the last five years and with the efficient and more targeted use of fertilizer with the digital advisories and increasing access to credit services, more beneficiaries will have access to fertilizer.

- **Economic return of fertilizer use**: The economics of fertilizer use among the four target crops is used to guide the proportion of user targets of the four crops. The profitability for fertilizer investment and then the overall national production impact will dictate the proportion of targets for each crop. In terms of the economic return that is proportional to the large share of fertilizer use and area coverage, wheat and teff take the largest share followed by maize and sorghum.

- **Realization of digital infrastructures and services**: It is well recognized that the enabling environment for the delivery of digital advisories will influence the scale of use of the fertilizer recommendations. From the second phase onwards, digital hubs in the rural kebeles across the different scaling pathways will have been enabled to ensure a pluralistic well-functioning extension system.

Scaling use targets are set to help guide the operation plan of scaling delivery. Given the mentioned criteria above, the full potential of reaching all current fertilizer user farmers through LAFA and complementary innovations is not realistic mainly because of insufficient digital infrastructure and digitally enabled dissemination services. Accordingly, scaling use targets are defined for each of the four scaling pathways (public, PPP, cooperative, and private) and different market segments of farmers (Table 5.7). The number of households targeted through the public-led pathway will be 1.49 million, 2.28 million, and 2.74 million households in the first, second, and third phases. Apart from the public pathway, the scaling delivery strategy aims to reach about 0.36 million, 1.14 million, and 1.71 million households through the PPP pathway and 0.14 million, 0.68 million, and 1.37

million households through cooperative pathways. The private-led pathway will be expected to be realized during the second and third phases to reach 0.45 million and 1.03 million households, respectively.

Three segments of farmers based on their economic capacity, gender, and age will be targeted differently over the scaling phases. We assumed that of all the total target households, on average 20% of wheat farmers, 30% of teff farmers, 24% of maize farmers, and 50% of sorghum farmers are subsistence as they often experience rainfall variability or need to access fertilizer either using subsidy schemes or access credit for long-term repayment. About 0.82 million, 1.1 million, and 1.64 million subsistence households will be targeted, while 1.18 million, 3.47 million, and 5.21 million households are categorized as wealthier farmers who can pay themselves to access fertilizer. About 20% (0.4 million), 30% (1.36 million), and 30% (2.05 million) of total target farmer households in the first, second, and third phases will be women farmers. Similarly, 30% (0.6 million), 40% (1.82 million), and 40% (2.74 million) of total target households in the first, second, and third phases will be youth (15-29 years of age). The anticipated adoption rate for each segment of farmers will be 45%, 60%, and 75%, respectively. With a targeted 60% average adoption rate of LAFA by end of 2040, an additional $20 to $35 million per year per crop (if each user applies fertilizer on 0.25 ha) can be earned from the scaling of the innovation.

Table 5.4. Scaling use and adoption targets by three scaling phases (2026 to 2040)

	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
	INNOVATION VALIDATION	SCALING PHASE I					SCALING PHASE II					SCALING PHASE III				
INNOVATION DEV PHASES																
BASELINE (for cereals)	**13.65 million**															
VALIDATION ZONES by CROPS																
Baseline fertilizer user HHs (Total)	**5,706,185**															
Wheat	1,816,768															
Teff	1,434,374															
Maize	1,238,352															
Sorghum	1,216,691															
SCALING PHASES			ALL VALIDATION ZONES				MAJOR CEREAL GROWING AREAS					MAJOR MIXED FARMING SYSTEM (ADDITIONAL CROPS, REALIZATION OF POTENTIAL DIGITAL HUBS)				
						0.15					0.33					0.50
SCALING PATHWAY EVOLUTION		Wheat-30%	Teff-40%	Sorghum-70%	Maize 30%	**1,997,165**	Wheat-15%	Teff-25%	Sorghum-40%	Maize 20%	**4,564,948**	Wheat-15%	Teff-25%	Sorghum-40%	Maize 20%	**6,847,422**
PUBLIC LED		476,902	376,523	319,381	325,067	**1,497,873**	726,707	573,749	486,676	495,341	2,282,474	872,049	688,499	584,012	594,409	2,738,969
PPP Led		114,456	90,366	76,652	78,016	**359,490**	363,354	286,875	243,338	247,670	1,141,237	545,031	430,312	365,007	371,505	1,711,855
COOPs LED		44,511	35,142	29,809	30,340	**139,802**	218,012	172,125	146,003	148,602	684,742	436,024	344,250	292,006	297,204	1,369,484
PRIVATE BUSINESS LED							145,341	114,750	97,335	99,068	456,495	327,018	258,187	219,004	222,903	1,027,113
						29.17					66.67					
SCALING REACH/USE	Subsistence ra	Wheat-30%	Teff-40%	Sorghum-70%	Maize 30%	**1,997,165**	Wheat-15%	Teff-25%	Sorghum-40%	Maize 20%	**4,564,948**	Wheat-15%	Teff-25%	Sorghum-40%	Maize 20%	**6,847,422**
PRODUCTION ORIENTATION SEGMENT						**1,997,165**					**4,564,948**					**6,847,422**
Subsistence/low resource endowment		190,761	200,812	298,089	130,027	819,689	218,012	286,875	389,341	198,136	1,092,364	327,018	430,312	584,012	297,204	1,638,546
Market oriented/high resource endowment		445,108	301,218	127,753	303,396	1,177,475	1,235,403	860,624	584,012	792,545	3,472,583	1,853,104	1,290,936	876,017	1,188,818	5,208,875
GENDER SEGMENT						**1,997,165**					**4,564,948**					**6,847,422**
Women		127,174	100,406	85,168	86,685	399,433	436,024	344,250	292,006	297,204	1,369,484	654,037	516,375	438,009	445,807	2,054,226
Men		508,695	401,625	340,673	346,738	1,597,732	1,017,390	803,249	681,347	693,477	3,195,463	1,526,085	1,204,874	1,022,020	1,040,215	4,793,195
AGE SEGMENT						**1,997,165**					**4,564,948**					**6,847,422**
15-29		190,761	150,609	127,753	130,027	599,149	581,366	459,000	389,341	396,273	1,825,979	872,049	688,499	584,012	594,409	2,738,969
>29		445,108	351,422	298,089	303,396	1,398,015	872,049	688,499	584,012	594,409	2,738,969	1,308,073	1,032,749	876,017	891,613	4,108,453
ADOPTION						45%					60%					75%
PRODUCTION ORIENTATION SEGMENT						**898,724**					**2,738,969**					**5,135,566**
Subsistence/low resource endowment		85,842	90,366	134,140	58,512	368,860	130,807	172,125	233,605	118,882	655,419	245,264	322,734	438,009	222,903	1,228,910
Market oriented/high resource endowment		200,299	135,548	57,489	136,528	529,864	741,242	516,375	350,407	475,527	2,083,550	1,389,828	968,202	657,013	891,613	3,906,656
GENDER SEGMENT						**898,724**					**2,738,969**					**5,135,566**
Women		57,228	45,183	38,326	39,008	179,745	261,615	206,550	175,203	178,323	821,691	490,527	387,281	328,507	334,355	1,540,670
Men		228,913	180,731	153,303	156,032	718,979	610,434	481,950	408,808	416,086	1,917,278	1,144,564	903,655	766,515	780,162	3,594,896
AGE SEGMENT						**898,724**					**2,738,969**					**5,135,566**
15-29		85,842	67,774	57,489	58,512	269,617	348,820	275,400	233,605	237,764	1,095,587	654,037	516,375	438,009	445,807	**2,054,226**
>29		200,299	158,140	134,140	136,528	629,107	523,229	413,100	350,407	356,645	1,643,381	981,055	774,562	657,013	668,710	**3,081,340**

Section 6. Financial and Strategic Support for the Next Six Years

6.1 Identification of Best Options for Financial Support

The identification of top investors and funding scenarios provides a strategic roadmap for mobilizing financial resources to scale up LAFA and HaFAS components (Table 6.1). Ethiopia cascaded CAADP commitments in 2003 into their national agricultural development plans. The CAADP agreement urged all African member states to commit, at least, 10% of their investments to agriculture so the sector would grow 6% per year. This insight that the government of Ethiopia is a major donor for scaling agriculture innovations throughout all phases, especially in terms of dedicated staff time, but constrained in the scaling effort by limited operational funds and digital infrastructure capability. By aligning with donors whose objectives complement innovation scaling, it is possible to secure the necessary funding at different stages of innovation development and scaling, ultimately driving a greater impact on agricultural productivity and sustainability.

The implementation of the innovation dissemination activities for the LAFA is tailored according to the target groups' needs to be identified in each phase with various pathways. The agriculture advisory has three phases of implementation. During Phase I, the strategic scaling delivery plan will play a critical role in raising awareness, popularization, documentation, partnership management, and adoption of the LAFA. Therefore, a major focus during phase I is to seek financial support to support both adaptive research to refine and validate new advisories, scaling the LAFA and improving all components of the HaFAS.

Given the scope of this initiative, a diversified funding approach is essential. Potential funding sources include:

- International Donors:
    - USAID: Focuses on improving agricultural productivity, food security, and sustainable practices, aligning well with the HaFAS's objectives. Recent political developments indicate that this critical donor may not be able to support this effort at least in the short term.
    - The Gates Foundation (GF): Invests in agricultural development to improve food security and reduce poverty, with a strong interest in supporting sustainable agriculture innovations.
    - Alliance for a Green Revolution in Africa (AGRA): Aims to increase smallholder productivity and strengthen agricultural institutions in Africa.
    - World Bank: Focuses on private sector development in emerging markets and emphasizes impact-driven investments in agriculture.
    - Other donors: BMZ, AfDB, Master Card, EU, IFAD, and GCF have also been mentioned as potential partners.
- Government of Ethiopia:
    - Direct Funding: The Ethiopian government is deeply committed to the use of inorganic fertilizer and ISFM and digital agriculture innovations and increasing cereal production and has already committed resources to digital agriculture.
    - Policy Support: The government's Digital Agriculture Strategy (2025), Digital Agriculture Roadmap 2032 and other related policies provide a supportive framework for scaling the HaFAS.
- Private Sector:
    - Impact Investments: Attracting impact investments from private companies interested in social and environmental impact alongside financial returns.
    - Public-Private Partnerships (PPPs): Developing PPPs to leverage the resources and expertise of both the public and private sectors.
    - Corporate Social Responsibility (CSR): Engaging companies interested in supporting sustainable agricultural development in Ethiopia, especially those engaged in fertilizer and seed sales.
- Farmer Contributions:
    - Willingness to Pay: Developing business models to explore farmers' willingness to pay for the LAFA service, particularly when bundled with other inputs or services.

Among the international donors, ranking each donor into High, Medium, and Low probability of likely support provides an operational framework for identifying the best financial support options throughout the different stages of scaling the LAFA and HaFAS components (Table 6.1). By aligning funding sources with the specific needs and maturity of the scaling process, stakeholders and scaling partners can maximize their chances of success and impact.

Table 6.1. Donor support mapping over the scaling phases

Donor Type	Phase I	Phase II	Phase III
A grant from bilateral and multilateral donor organizations E.g., **USAID, BMGF, AGRA**	Highest	Medium	Low
Development Finance Institutions E.g., **BMZ**	Medium	High	High
Banks and Traditional Financial Institutions E.g., **Commercial and Private Banks offering Agricultural Loans**	Low to Medium	High	High
Corporate Investors E.g., **Large Agribusiness companies, fertilizer manufacturers**	Low	Medium	High
International Finance Institution E.g., **Africa Development Bank, World Bank, IFAD**	Low to Medium	Medium	High

6.2 Investor Assessment

Based on stakeholder consultation at workshops, the top five potential donor investors are described below: However, this may need to be revised from time to time and depending on the shift in donor priority strategy.

1. **USAID (United States Agency for International Development)**

   Prior to the dismantling of USAID in January 2025, the goal for USAID/Ethiopia's 2019-2024 Country Development Cooperation Strategy (CDCS) is to support Ethiopia's transition to a more democratic, prosperous, and resilient society, with accountable institutions and private-sector-led growth. To achieve this goal, USAID/Ethiopia will partner with the Government of Ethiopia (GOE), other donors, the private sector, and civil society across sectors to address challenges in the areas of democracy, demographics, and disasters that threaten the country's Journey to Self-Reliance (JTSR).

   With a greater focus on private sector investment, a diversified economy, and increased employment opportunities, the Mission will support Ethiopia to withstand the pressures of its rapidly growing, urbanizing, and youthful population. USAID will support reforms that will unleash the power of the private sector to meet these increasing demographic pressures, as well as the expectations of a government that has announced its intent to move away from a state-led economy. Ethiopia will be a reliable partner for U.S. trade and investment and continue to serve as a force for stability in the Horn of Africa.

   - Current Strategies
     - Focuses on improving agricultural productivity, food security, and sustainable practices globally
     - Support innovations in AgTech and Climate Smart Agriculture (CSA) through grants and technical assistance.
   - Potential Alignment
     - Strong alignment with objectives to scale fertilizer application tools that enhance productivity and sustainability.
     - Potential funding in the early stages and partnerships in the pilot projects.

   Clearly, events since the inauguration of the Trump Administration will require a re-evaluation of USAID's priority ranking in support for digital agriculture.

2. Gates Foundation (GF)

In the agricultural sector, the Gates Foundation supports Ethiopia's Agricultural Transformation Institute (ATI), which works to help smallholder farmers by scaling up agricultural extension services, fighting crop and livestock diseases, improving crop and poultry breeding, spurring growth in markets for agricultural products, and supporting women in agriculture. In this endeavor, the donor strategy focuses on policy and advocacy to address systemic challenges and capture emerging opportunities. The Gates Foundation was a principal supporter of the development of the Digital Agriculture Roadmap 2032. The Ethiopian government and PxD with financial support from the Gates Foundation, will establish the Project Management Unit for the Digital Agriculture Roadmap (DAR) 2032, and this will be one potential avenue to explore and finetune digital delivery strategies. These strategies support a pluralistic, digital-first extension approach that involves government, NGOs, cooperatives, private sector actors, and research institutions, with a focus on inclusivity and sustainability. BMGF has also backed the development of fertilizer digital advisories through the Excellence in Agronomy (EIA) initiative of One CGIAR, including a grant to develop this scaling delivery strategy.

- Current Strategies
    - Invest in agricultural development to improve food security and reduce poverty, particularly in developing countries.
    - Supports research and innovations that promote sustainable agriculture and farming practices, including digital tools.
- Potential Alignment
    - High alignment with objectives focused on sustainability and enhancing agricultural yields.
    - Interest in funding initiatives that can demonstrate measurable impacts on food security that are inclusive in nature.

3. Alliance for a Green Revolution in Africa (AGRA)

AGRA is an African-led, African-based organization that seeks to catalyze agriculture transformation in Africa. In Ethiopia, AGRA aims to increase the productivity and resilience of smallholder farmers by reversing recurrent climate shocks, focusing on key strategic crops and government flagship priority commodities. Hence, the AGRA country strategy goals focus on transforming Ethiopia's food system to enhance food security and the resilience of smallholder farmers under changing climate and other extreme events. To reach this goal, AGRA aims to achieve three strategic objectives: 1) increasing the productivity of smallholders, 2) strengthening the resilience of smallholders, and 3) enhancing the capacity of agriculture sector institutions at the national and sub-national level. The focus of AGRA's new investment in Ethiopia will tilt towards providing catalytic funding of solutions to address the challenges in areas such as poor productivity of major crops because of recurrent drought, soil fertility declines, and limited access to critical inputs and technologies. This focus aligns well with the objectives of the HaFAS.

- Current Strategies
    - The strategy focuses on improving agricultural productivity and food security in Africa.
    - Invest in research and development in crop varieties and farming techniques that are resilient to climate change.
- Potential Alignment
    - Strong alignment with objectives to scale fertilizer application tools to enhance productivity in the selected commodity value chains prioritized by the government.

4. World Bank

The World Bank is supporting Ethiopia to address fragility and enhance resilience by emphasizing social inclusion, institutional development, economic opportunities, job creation, and service delivery. The World Bank policy operation supports home-grown reforms that will ultimately help the country transition to a more inclusive economy that allows the private sector to contribute more strongly to growth. While strengthening the financial sector, expanding trade options, and improving fiscal transparency, this engagement will also boost protections for poor and vulnerable households during periods of economic change. Current support consists of a $1 billion grant and $500 million concessional credit from the International Development Association (IDA).

- Current Strategies
  - Focuses on private sector development in emerging markets, providing investment and advisory services.
  - It emphasizes financial sustainability and impact-driven investment in agriculture.
- Potential Alignment
  - Well aligned with the homegrown reform agenda of the Ministry of Agriculture and digital technology priority, it can provide financing, making it suitable for growth and scaling.
  - Alignment with objectives that demonstrate the financial viability alongside the social and environmental impact of climate change.

5. **International Fund for Agricultural Development (IFAD)**

   IFAD is an international financial institution and a United Nations-specialized agency that focuses on empowering rural people to reduce poverty, increase food security, improve nutrition and strengthen resilience. Since 1980, IFAD has invested US$ 829.83 million in 21 rural development programs and projects in Ethiopia worth a total of US$ 2.3 billion. In 2023, it launched the 7-year Participatory Agriculture and Climate Transformation Programme (PACT) grant agreement for US$ 106.54 million with the Government of Ethiopia, citing the strong impact of climate change on Ethiopia's rainfed-dependent smallholder farmers. The grant aims to benefit 750,000 rural people in 6 regional states—Amhara, Oromia; Southern Nations, Nationalities and Peoples' Region; Sidama, Somali, and Southwestern Ethiopia – with a focus on women (50 percent of project participants), youth (40 percent) and people with disabilities (5 percent). IFAD is supporting the Indian company, CropIn to enter the digital tool support arena in collaboration with the MoA with a two-year project (2025-2026) to profile and reach 100,000 farmers.

6.3 Funding Scenarios

In today's rapidly evolving economic landscape, organizations across various sectors are increasingly seeking funding to support their initiatives. Understanding the implications and requirements of the different funding levels-low, medium, and high can help to strategize effectively and align resource mobilization with organizational goals. The following outlines three distinct funding scenarios, each characterized by its specific level of investment and the impact of projects and overall organizational strategic growth to meet its intended goals.

1. **Low Funding Scenario**

   In this case scenario, it is vital to continue to implement the LAFA with partners by leveraging ongoing secured funding to scale digital innovations, such as those of ATI and Digital Green and other partners' ongoing initiatives, in addition to using available research funds to continue small-scale trials of inorganic and organic fertilizer and lime applications in new areas in selected regions to expand and validate the effectiveness of the advisory tool. Investors who are potentially flexible to fund the initial research and development include the Ethiopian government and grants in partnership with research institutions from CGIAR. Furthermore, it is essential to identify partners with present and future projects that can coordinate and integrate the scale-up initiatives in their respective regions of operation.

2. **Medium Funding Scenario**

   Expanding the pilot project to multiple regions developing advisory tools and platforms and developing training programs for extension workers and farmers on the effective use of technology. Interested donors and financial institutions such as IFAD and the World Bank envisage aligning their investment during the scaling and initial market penetration stage.

3. **High Funding Scenario**

   In this scenario, it is envisaged that donors and investors will be interested in high growth potential projects, willing to provide significant equity investment. The rapid scaling and market linkages will mature during this time, launching a comprehensive national campaign to roll out and scale beyond Ethiopia, the LAFA across multiple regions, supported by robust marketing and training initiatives and linked to private sector and other service providers supplying inputs. Donors under this scenario will be interested in high-growth potential projects and may be willing to provide significant equity investment.

6.4 Development of the Convincing Pitch

At the two-day stakeholder workshop in October 2024, the need for resource mobilization to support the scaling delivery of the LAFA and the overall HaFAS was discussed. Teams prepared 90-second elevator pitches that were to include: 1) a **Hook** to interest the listener; 2) the **value proposition** for the innovation; 3) **Evidence** of the

potential for success; 4) how it is **different** compared to what exists; and 5) the **call to action** or specific support needed from the listener. Table 6.2 captures the key attributes of the LAFA that can potentially be highlighted in any pitch. An example of a pitch is provided in the accompanying box.

Table 6.2. Values of the LAFA and complementary innovation for pitching

Supported by strong & rigorous evidence	Improving farmers' lives	Resource use efficiency & environment	Economic development	Aligned with government policies and strategies
Evidence-based and site-specific digital advisory - 10+ years of research	25%-30% yield benefits for farmers	Efficient nutrient use, reducing nitrogen run-off into the environment	Contribution to yield increase thereby food security and food self-sufficiency, contribute to climate resilience.	35,000 tablets, 40.4 million broadband, 71 million mobile users, 9000 mobile towers
Harmonized various efforts of HaFAS in the country (EIAR, RARIs, ICRISAT, CIAT, CIMMYT, etc.)	A $1 investment yields a return of $6 to $30.	Climate-smart management of nutrient use; diverse landscape and cropping system oriented; data sharing—collaboration, not competition	Inclusive (women, youth)	Fits with the ongoing national digital agriculture roadmap 2025-2032; and continental agenda (e.g. African Fertilizer and Soil Health Action Plan, Africa Soil Initiative)
Fast track extension delivery	Reduced fertilizer application on unproductive fields; more farmers accessed	Environmentally friendly	Cost-effectiveness of extension and delivery; increased profits for farmers by lowering costs	72,000 DAs, 92,000 cooperatives, 14,000 FTCs; growing commitment to pluralistic extension services
Evidence for higher levels of staple crop production	The intervention addresses major cereal crops that cover 80% of the production area and contributes to food security	Bundling with lime application reduces 80% of exchangeable soil acidity	Higher profits with efficient fertilizer use, Efficiency gain – more farmers reached with correct level of fertilizer use	Alignment with food systems of the country-grown economic policy

One pager pitch

Transforming Ethiopia's Agriculture Through Digitally Enabled Site-Specific Agro-Advisory

Agriculture is the major livelihood of farmers in Ethiopia, contributing 80% of export earnings, offering employment for 75% of the economically active population, and constituting around 39% of the GDP (Neglo et al., 2021; USAID, 2020). Despite its significance, Ethiopian agriculture faces substantial challenges, including a significant yield gap in cereal production and low efficient nutrient use.

Low productivity levels and large yield gaps in Ethiopia highlight a critical opportunity to increase crop productivity. To tackle these yield gaps, transform agriculture, and enhance food security, various efforts have been made. These efforts include site-specific and context-based fertilizer recommendations, integrated soil fertility management (ISFM), soil and land management practices (SWC), and climate advisory services, all aimed at closing yield gaps and promoting sustainable agricultural growth. In 2023, diverse partners joined together to have one centralized source of data to draw on to create a harmonized advisory system or HaFAS. The localized agronomy and fertilizer advisory or LAFA is a validated site-specific digitally enabled agro-advisory that provides recommendations derived from various databases to develop tailored advisories that aim to significantly improve yields on specific cereal plots on individual farms.

This initiative aligns closely with the Ethiopian food systems strategy and the homegrown economic reform agenda through improving the supply of nutrient-dense diet, reducing poverty and contributing to economic transformation.

*Most Ethiopian smallholder farmers apply blanket fertilizer recommendations which are not adequate to exploit the genetic potential of crop varieties. Making a sub-optimal decision leads to lower productivity levels and profitability. The digitally-enabled Localized agronomic and fertilizer advisory, known as LAFA, helps farmers to improve productivity, reduce food insecurity, and boost their incomes. This fits into the national agenda for the Ethiopian government to boost economic development and reduce the poverty of cereal producers in the country. Imagine if just 10% of wheat and teff producers in the country adopt the site-specific digitally enabled agro-advisory (with 0.25 ha allocated to wheat and 0.25 ha for teff), the country can get an additional $10 million per year from wheat production ($90 profit per hectare*450,000 *0.25ha) and $17.6 million per year from teff production ($107 profit per hectare*660,000*0.25ha).*

*In developing countries including Ethiopia, agriculture is the major contributor to greenhouse gas emissions. With the green economic policy implemented in the country, it is a high priority to invest in climate-smart agricultural production practices and reduce emissions. The LAFA ensures that the right amount of fertilizer is applied for a given level of output and hence reduces emissions. This aligns with the green economic policy of the government of Ethiopia (GoE). The use of this innovation could reduce emissions measured as tons of CO2 equivalents per ton of wheat yield per ha from 1.3 using available blanket fertilizer recommendations to 1.1 with the application of LAFA. For example, if 10% of wheat-growing farmers apply the recommendation in a 0.25 ha parcel, the country could reduce emissions by 416 tons of CO2 equivalent per ton of wheat yield per ha (3.7 ton yield per hectare*450,000*0.25ha).*

The scaling pathway for the LAFA and other HaFAS components as they are bundled together would employ three potential pathways:

***Public Extension and Advisory services**: The government extension system will disseminate the agro-advisory through its existing structures and channels, reaching smallholder farmers across the country.*

***Private - Public Partnerships:** Leveraging partnerships in agriculture and food systems will allow for broader dissemination and impact.*

***Market-Based Delivery Channels:** The private sector will imbed market-driven agricultural extension and advisory services schemes into paid input or market output opportunities, playing a critical role in Ethiopia's pluralistic extension system.*

Given the economic, environmental, and social benefits of the innovation and alignment with the various economic and food systems strategies of the country, the government should prioritize this investment. By adopting the LAFA system, Ethiopia has the potential to transform its agricultural sector, improve livelihoods, and contribute to sustainable growth. Your support will be crucial in amplifying the reach and impact of this solution, ultimately transforming agriculture for millions of smallholder farmers. We call on you to further provide detail accounts of the innovations.

Extended pitch

Background

Ethiopia is an agriculture-dominated society, with the sector serving as the backbone of the economy. Agriculture accounts for approximately 80% of export earnings and employs nearly 75% of the economically active population (Neglo et al., 2021; USAID, 2020). It also contributes 39.5% of the GDP. Despite its significance, Ethiopian agriculture faces substantial challenges, including a significant yield gap in cereal production. Average yields for major crops such as maize, wheat, teff, and sorghum remain well below their potential, with national averages of 3.4 t/ha for maize, 2.5 t/ha for wheat, 1.3/ha for teff and 2.3 t/ha for sorghum (Debebe et al., 2022; Ethiopia - Global Yield Gap Atlas). Wheat, for example, produces only 26.8% of its water-limited potential, while maize and sorghum reach just 19.7% and 29.3%, respectively.

In Ethiopia, farming is marked by considerable spatial and temporal variability in production factors, including climate, soil type, topography, and crop management. This variability directly impacts potential crop yield, fertilizer use efficiency, and the return on fertilizer investment. Yield gaps, both at farm and national levels, are among the highest in Sub-Saharan Africa due to factors like land degradation, climate variability, and low or improper input application, highlighting a critical opportunity to increase crop productivity and farmer's profits.

Traditional soil fertility management has relied heavily on organic sources, particularly animal manure, for maintaining soil health in crop and grazing lands. However, after agricultural reforms in the 1990s that promoted market liberalization, the focus shifted back to integrating organic sources with inorganic fertilizers to mitigate high costs and improve sustainability. This shift led to several initiatives in the late 1990s to research the benefits of combining organic and inorganic fertilizers, resulting in increased crop yields, improved soil quality, and the engagement of private companies in producing organic fertilizers.

The innovation

There have been various efforts in the past decade to address soil health challenges, and these include site-specific and context-based fertilizer recommendations, Integrated soil fertility management (ISFM), soil and land management practices (SWC), and climate advisory services, all aimed at closing yield gaps and promoting sustainable agricultural growth.

This innovation, the landscape-specific, site-specific digitally enabled agro-advisory, combines various databases to develop tailored advisories that aim to significantly improve farm productivity. Using long-term crop response data to fertilizer along landscape gradients, the Localized Agronomy and Fertilizer Advisory or LAFA will help teff, wheat, maize, and sorghum farmers improve nutrient use efficiency, reduce costs, and enhance productivity, impacting soil health and farming systems. The agronomic solution is an app-based digital decision support tool that fetches crop-specific decision tree models to guide extension agents and farmers in applying landscape-specific fertilizer recommendations for wheat, teff, maize, and sorghum. The integration of crop management practices and the ambitions of farmers and key stakeholders into the advisory, through learning and experience derived from field observation data and other user-defined, real-time inputs, further localizes the advisory system. The LAFA recommendations were developed by integrating machine learning, the QUEFTS model, extensive agronomic legacy data, and geospatial covariates. The fertilizer advisory is optimized for either agronomic yield or economic returns, depending on the farmer's interests and the availability of price information. The approach considers farmers' agronomic and fertilizer management decisions, guided by landscape positions as a determining factor for the amount and type of fertilizer to apply.

The alignment with policies and strategies of the government of Ethiopia

The Government of Ethiopia launched the Ethiopian Food Systems (EFS) Program to define Ethiopia's vision and pathway for national food systems transformation. The EFS pathway follows in the footsteps of Ethiopia's Homegrown Economic Reform Agenda, which aims to transform Ethiopia from largely agrarian low-income country to an industrialized, lower-middle-income country by 2025. The EFS identified 22 game-changing solutions designed to act on systemic bottlenecks across Ethiopia's food systems. The landscape-specific, digitally enabled agro-advisory service is well-aligned with the proposed EFS solutions. For instance, innovation plays a critical role in strengthening the food supply and value chains, with special attention to linking production to input and output markets across the focus commodities of the intervention. Cereals constitute about 80% of the cultivation area and comprise a substantial proportion of the Ethiopian diet. This intervention makes a direct contribution to food security through surplus production and increased marketable output, while reducing carbon emissions through more efficient nutrient utilization. Furthermore, this intervention goes in-line with the country's strategies to leverage digital interventions in the economic transformation process.

Overall, this initiative is well-aligned with the Ethiopian food systems strategy and the homegrown economic reform agenda by improving the supply of critical staples, reducing poverty, and contributing to economic transformation.

Scaling pathway

The LAFA and potentially other HaFAS components would employ three potential scaling pathways. The first one is the public extension and advisory services pathway where the government extension system would disseminate the LAFA access to smallholder farmers through the existing structures and channels. The second one leverages existing and new Private-Public partnerships in agriculture and food systems to scale the LAFA which NGO and other partners bundle into a package of digital services. The third one will employ a market-based delivery channel where the private sector implements a market-driven agricultural extension and advisory services scheme and plays its critical role within the pluralistic extension strategy of the country. In this model, there is a fee associated with LAFA use. Given the economic and environmental benefits of the innovation and alignment with the various economic and food systems strategies of the country, the government will likely prioritize this investment.

The potential economic and environmental impact

Most Ethiopian smallholder farmers using fertilizer apply blanket fertilizer recommendations that are not adequate to exploit the genetic potential of genetic resources and the actual conditions of their soil and climate. Such sub-optimal decisions lead to lower profitability of their cropping operations and often lower output levels of the crop compared to potential output levels. The LAFA helps farmers to improve the efficiency of their input use, reducing food insecurity and boosting farm income. This aligns with the national agenda for the Ethiopian government to boost economic development and reduce poverty. With each 10% of wheat and teff producers in the country that adopt LAFA recommendations (with 0.25 ha allocated to wheat and 0.25 ha to teff), an additional $10 million per year from wheat production ($90 profit per hectare 450,000 * 0.25 ha) and $17.6 million per year from teff production ($107 profit per hectare * 660,000 * 0.25 ha) are generated.*

*In developing countries including Ethiopia, agriculture is the major contributor to greenhouse gas emissions. With the green economic policy implemented in the country, it is a high priority to invest in climate-smart agricultural production practices and reduce emissions. The LAFA ensures that the correct amount of fertilizer is applied for a given level of output and hence reduces harmful emissions. This goes in line with the green economic policy of the GoE. The uptake of LAFA recommendations could reduce emission measured with tons CO2 equivalents/tons of wheat yield per ha) from 1.3 when blanket recommendations are used to 1.1 with LAFA recommendations. If 10% of wheat-growing farmers apply the recommendation in 0.25 hectare land, the country could reduce emissions by 416 tons CO_2 equivalents per ton of wheat yield per ha (3.7 tons of yield per hectare*450,000*0.25 ha).*

6.5 Advocacy and Communication Plan for the Scaling Narrative

Scaling this project requires a robust communication and advocacy strategy that ensures stakeholder engagement, raises awareness, and encourages the adoption of these technologies.

The objectives of this communication strategy are:

- **Popularize the benefits** of site-specific digitally enabled agro-advisories and move away from blanket ғ recommendations for the public, policymakers, extension ecosystem, development partners, and donors.
- **Foster Partnerships**: Engage government bodies, NGOs, the private sector, and local communities to build strong partnerships that support the scaling of LAFA and other HaFAS components.
- **Raise awareness** and promote the benefits and potential impact of site-specific fertilizer recommendations among key stakeholders, including farmers, agricultural extension officers, policymakers, and agribusinesses.
- **Attract resources for scaling the HaFAS**: A clear and compelling value proposition is crucial to attracting investors and funding. Investors would like to know what makes this innovation unique from all the other innovations in the ecosystem and how that matches with their strategic objectives.
- **Encourage Adoption**: Advocate for the adoption of digital tools in fertilizer management by demonstrating their value in improving yields cost-effectively and reducing costs and evaluating different delivery channels to assess their effectiveness in reaching different client segments.
- **Capacity Building**: Ensure that farmers and agricultural officers have the necessary skills and knowledge to use digital advisory platforms effectively by designing effective training programs and job tools.

Table 6.3 highlights some of the key messages and most appropriate communication channels and advocacy approaches to use for reaching and affecting the behavior of distinct client segments.

How to communicate?

In developing materials for accessing or influencing different rural client groups, prioritize the development of communication and training tools that are easily translated into multiple languages or use understandable graphic-based formats. Due to the decentralized nature of governance, advocacy activities will need to be conducted at the national, regional, and at times even woreda level.

Field days, fair attendance, and workshops should be captured on social media and/or television to expand the reach and potential impact of the event. Seek to work with MoA and regional authorities to maximize opportunities to get media coverage on television and radio at a lower cost than private media.

Any written briefs and other advocacy materials should ensure partner consultation in their preparation and be available for all to use as a common resource. Likewise, key advocacy documents should be available in Amharic, English, and any other regional languages relevant to the use of the LAFA and/or HaFAS. During the first scaling phase, the effectiveness of different delivery channels in getting significant use of LAFA recommendations should be assessed and the communication and delivery channel mechanisms subsequently improved.

Table 6.3. Summary of communication channels and advocacy strategy by audience segment

Audience	Key messages	Communication channels	Advocacy strategy
Farmers	• Improve productivity and profitability with customized fertilizer recommendations	• Digital Platforms: Digital advisory services- mobile apps, video, SMS. • Local Media: Radio and television campaigns	• Utilize the Cooperatives and Associations • Utilize DAs and extension personnel; promote couples training

Audience	Key messages	Communication channels	Advocacy strategy
	• Lower costs by using the right amounts of the right kinds of fertilizer for the farm • Protect the environment by avoiding overuse of fertilizers and minimizing runoff pollution.	• Call in hotlines for low literacy clients • Social media: Facebook, WhatsApp, and Telegram • Trainings	and use of model farmers • Develop training modules for farmers and DAs. • Demonstration Plots • Promote exchange visits • Emphasize high-quality content to build trust
Rural Youth	• Increase skill level of and job opportunities for youth in the digital realm as service providers • Prioritize engagement with rural farming youth as client segment most likely to use digital advisories	• Digital Platforms: Digital advisory services- mobile apps, video, SMS. • Local Media: Radio and television campaigns • Social media: Facebook, WhatsApp, and Telegram • Trainings, including within advanced primary and secondary school curricula	• Heavy use of influencers on social media and television • On-line training programs • Strategies for farmers noted above
Policy makers and development partners	• Supporting this innovation contributes to national goals for agricultural productivity and environmental conservation. • Site-specific fertilizer recommendations are crucial for sustainable agricultural growth, food security, and optimal foreign reserves management	• Workshops, research papers, policy briefs, strategic documents, field visits, videos, social media (YouTube; face book), television campaigns	• Advocate for the inclusion of HaFAS in all the national agricultural policies and regional and woreda level policies and implementation plans.
Funders/ Donors	• Join hands with the project to scale an innovative solution that contributes to food security and the reduces negative impact on the environment • Invest in digital advisory platforms for agriculture to unlock new market opportunities, promote pluralistic extension services, and support small-holder farmers.	• Workshops, research papers, policy briefs, strategic documents, field visits, videos; social media: LinkedIn • Elevator Pitch • One-on-one meetings	• Government buy-in and explicit support are critical prior to approaching donors • Public-Private Partnerships: Build alliances with the private sector (e.g. fertilizer companies, and agri-tech startups). • Rationale for technical assistance and ongoing research to build more precise LAFA and other HaFAS tools and improve their ease of use.

Section 7. System Strengthening

7.1 Governance and Partnership Management

Along with the partners' value proposition (PVP) and mapping of stakeholders' engagement, there are over 40 partner institutions categorized into key institutions, supporting institutions, broader collaboration, and external stakeholders (Table 5.1) who will have roles in the functions of HaFAS. A well-defined governance structure for the key partners is essential to support effective collaboration, maintain engagement, ensure accountability, and enable innovation and flexibility within the partnership (Evans et al., 2004). Based on the key functionalities and key partnerships involved, a governance structure for the implementation of the scaling delivery strategy is

proposed (Figure 7.1). This governance structure considers the existing partnership platforms such as the DST Coordination Platform, Digital Extension Management Committee practiced by the DAEAS project by MOA extension department and Digital Green, and several operational partnership platforms available at the different levels of the MOA (national, regional, and zonal levels) and align with them to leverage the experiences and coordination capacities. The governance structure also envisions the governance and management units of the Digital Agriculture Roadmap 2032.

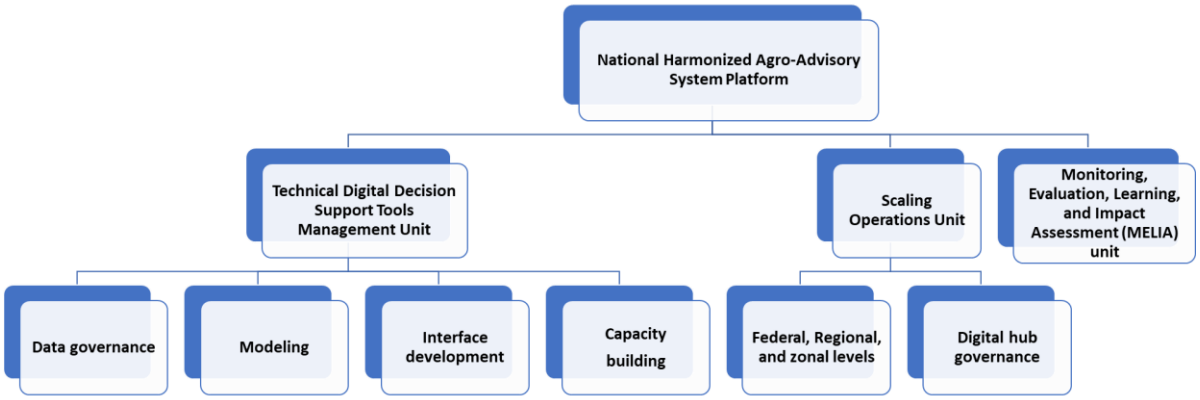

Figure 7.1. The structural arrangement of the governance of partnerships in the scaling of the HaFAS

The National HaFAS Platform operations will be embedded into the Digital Agriculture Delivery Unit of DAR 2032 (Figure 11 of DAR 2032 on page 99) and it will deliver data and decision tool governance and scaling operation functional units to be aligned with the Technical Committee of the DAR 2032. The HaFAS platform is an umbrella decision-making body composed of representatives of key stakeholders from governmental, non-governmental, private, and international research and development institutions that have critical roles in the successful implementation of the scaling. It is accountable directly to the DAR Steering Committee or represented through the Delivery Unit. The national scaling platform has three key components, each with its own units: the Technical Digital Decision Support Tools Management unit, the Scaling Operation unit, and the Monitoring, Evaluation, Learning, and Impact Assessment (MELIA) unit. As an ultimate body, the National HaFAS Platform will have the following responsibilities and functions:

- Steer the multi-partner national HaFAS platform.-The potential members of the scaling strategy platform will be BoAs, ATI, MInT, teleservice providers, banks and microfinance, EIAR, CG representatives, cooperative representatives, private sector input dealers and agri-tech providers. The chair of the national platform for the HaFAS is the state minister of the MoA for Agricultural Development and Horticulture.
- Establish operational units for facilitating scaling delivery including the technical unit, the scaling delivery unit, and the MELIA.
- Mobilize and allocate resources
- Through the chair of the platform, the HaFAS initiative will get the attention of the top management body of the “Digital Agriculture Roadmap 2032”, “Digital Ethiopia 2025” and “Rural Economic Development and Food Security (RED&FS)” platform.
- Create an enabling environment by supporting digital infrastructure development initiatives and appropriate government policies
- Make strategic and policy decisions
- Coordinate and streamline existing and emerging agro-advisory initiatives to maximize data use and avoid duplication of research efforts
- Oversee scaling delivery progress and commission evaluations at appropriate intervals

1. **Technical Decision Support Tools Management Unit**

The Technical Management Unit will oversee all core and complementary innovations and has functionality to ensure HaFAS sustainability, including data governance, dynamic modeling, interface development, and capacity building. Each of these areas will have dedicated subunits, focusing on specific components of the HaFAS system, such as the LAFA. The unit will integrate new information emerging from research and new data sources into the appropriate databases annually.

Data Governance

Led by EIAR, the data governance component coordinates essential data and knowledge-generating entities such as RARIs, universities, ATI, DG, PxD, CG centers, and private organizations like LERSA. Building on existing initiatives (e.g., the CoW and ATI's data partnerships), this component supports EIAR and MoA's FAIRfication strategies as per the data sharing directives. Key responsibilities include:

- Identifying data gaps for modeling and conducting data generation for model inputs
- Facilitating data partnerships, sharing, and access
- Assuring the collection and management of standardized farmer profiling data
- Establishing data quality protocols
- Validating data and collecting validation datasets for model improvement
- Establishing long-term, spatially representative trial sites for comprehensive datasets (e.g., crop patterns, crop history, temporal dynamics)

Dynamic Modeling

Dynamic modeling will be led by EIAR, CGIAR, and RARIs, focusing on:

- Model building, validation, and deployment
- Model versioning and updating
- Adapting models based on new data and users' needs

Interface Development

This sub-unit will involve key digital partners and farmer-facing organizations, such as ATI, Digital Green, PxD, Lersha and CG centers. The MoA extension system, alongside these partners, will help leverage existing interfaces or support the development of new infrastructure based on scaling needs. Key activities include:

- Leveraging existing interfaces from farmer-facing organizations.
- Integrating model outputs with various dissemination channels.
- Supporting dissemination channels aligns with a pluralistic extension strategy.
- Conducting human-centered design to develop interfaces addressing diverse needs (e.g., gender, resource availability, production goals)
- Streamline dissemination channels and interfaces according to farmer typologies

Capacity Building

Capacity building is essential for ensuring long-term engagement and effective HaFAS utilization. Initial efforts will focus on EIAR, RARIs, and MoA, followed by key private sector stakeholders. Training will cover data collection, standardization, analysis, and modeling, empowering participants to build, operationalize, and validate HaFAS components and safeguard data systems from outside hacking.

2. **The Scaling Operations Unit**

The scaling operations unit will consist of key partner institutions delivering extension and advisory services, including the MoA, ATI, NGOs (Digital Green, PXD, Farm Radio International, Self Help Africa, Sasakawa Africa Association, etc.), and private sector operators (Lersha) that are expected to increase over time. Following the strategic and policy decisions made by the national HaFAS strategy platform led by the top management of the Ministry of Agriculture (MoA), the scaling operational unit will materialize the scaling delivery operation through the existing regional, zonal, and district government agriculture structures. The

same unit could leverage technical support from other partner institutions (research, NGOs, etc.) towards the development of scaling implementation guidelines, capacity-sharing activities, and the expansion of digital infrastructures. The scaling operations unit will function at the national level, but tasks and responsibilities can be cascaded to equivalent units at the regional and zonal levels. Specific to the management of the LAFA, we envision the following roles for the Scaling Operations Units at different levels:

1. **At the federal level**

- The operational scaling unit plans to scale activities and resources with a detailed annual action plan and cascades this to the regions
- Works on bundling of complementary innovations and technologies
- Develop guidelines and training materials
- Identifies target regions for the scaling of LAFA use, considering the four major crops (Maize Wheat, Teff, and Sorghum) as priority and follows up with new crops and cascades LAFA into the regions
- Revisits and refreshes periodically the stakeholder analysis involved in the scaling process, adjusting roles and responsibilities as needed
- Collects and collates reports from across implementing regions and reports to the national platform
- Mobilizes and allocates resources, in coordination with the National Platform leadership

2. **At the regional level**

- Identifies target zones and districts, updating annually for each crop
- Adapts and cascades the scaling guidelines to the zonal level
- Participates in the national platform
- Organizes TOT training for the agricultural experts and extension agents
- Heads of the extension department of BoA in regions coordinate regional activities with relevant partners (Research, university, R-CPA, zonal department of agriculture, private sector, NGOs, etc.)
- Facilitates the expansion and management of the digital hubs/ kiosks in their respective regions
- Collects and collates reports from cross-implementing zones in the region and reports to the Extension Directorate of the MoA
- Mobilizes and allocates resources

3. **At a zonal level**

- Identifies the potential districts (woredas) for scaling LAFA use for the four crops and later for additional crops
- Establishes stakeholder mapping through identifying stakeholders and establishing the core alliance group with relevant partners (Research centers, universities, private sector, NGOs, unions, woreda office of agriculture representatives)
- Adapts and cascades the scaling guidelines to woredas and kebeles
- Participates in the regional platform
- Organizes trainings for the agricultural experts and extension agents
- Plan and allocate resources in consultation with woredas responsible for the scaling
- Develops operational and MEL plans and conducts learning events
- Collects and collates reports from cross-implementing woredas in the zone and report to the region's BoA

Governance of Digital hubs

The final and most important part in the governance of partnerships in the HaFAS scaling process is the management of digital hubs where the delivery of advisories to farmers materializes. These may include the use and management of a national digital hub platform, electronic Kiosks (e-Kiosks), one-stop shops, farmer training centers (FTCs), and cooperatives.

Capacity building

Similar to the capacity building planned for the Technical DST Management Unit, the scaling operational unit will also require a strong capacity enhancement in the area of digital literacy at the different levels (federal to regions and down to kebele level), particularly to the centers where digital advisories provided at the grass root level (e-kiosks, FTCs, DAs) and to the ultimate users (male and female farmers). The whole transaction of information from top down and bottom up, management of the HaFAS system and the digital hubs are the responsibilities of this Technical HaFAS Management Unit that shall be strengthened with the necessary knowledge and skills.

3. Governance of Monitoring, Evaluation, Learning and Impact Assessment Operational Unit

The MELIA (Monitoring, Evaluation, Learning, Impact, and Adaptation) Governance Unit will spearhead and oversee a range of initiatives, ensuring that activities are effectively implemented across all operational levels. This governance structure will be responsible for evaluating the performance, impact, and learning outcomes of scaling activities against established benchmarks. To achieve this, the MELIA unit will actively engage with and coordinate among key stakeholders involved in developing and scaling advisory services. These stakeholders will play vital roles in refining the scaling process and contributing to impactful outcomes.

Within the HaFAS Scaling Initiative, MELIA Governance will include the following interconnected components throughout the structure.

- Regular and continuous monitoring
- Performance Evaluation and Impact Assessment
- Learning, Reflecting, and Knowledge Sharing
- Benchmarking and Continuous Improvement of Stakeholder Engagement and Coordination
- Transparency and Accountability

Without appropriate information the partners involved in the HaFAS scaling cannot make appropriate, informed decisions about whether and how to adjust the scaling design or implementation arrangements to better achieve the intended objectives. The NARS, in collaboration with universities, will conduct the MELIA at each stage of the project phases. The roles and functions of different partners in the MELIA unit are outlined in Table 7.1.

Table 7.1. MELIA structure for governance of the partnership platform

Level of MELIA operation	Responsible body	Roles and functions
National Level	MELIA Team	Identify M&E topics during platform meetings, identify strategic research issues, present results on HaFAS implementation and progress
	MELIA lead	The HaFAS MELIA function coordinates M and E activities, standardizes indicators, and data collection efforts, leads research activities
Mid-level	Scaling partners	Implement the HaFAS, conduct routine monitoring activities, collect usage and adoption data, gather feedback from users
	Research partner	Update the HaFAS based on the new data addition and feedback, identify new research topics, conduct backup research, analyze, and present for decision-makers.
Grass-root level	Grass-root level (DAs, cooperatives, lead farmers, local administrations)	Carry out routine monitoring, gather feedback from users, reporting

7.2 Capacity Strengthening

To achieve the scaling objective, strengthening the human and infrastructure capability must be considered. For example, it will be necessary to equip the soil testing laboratories, including national and regional soil testing laboratories, which will have a direct link with scaling of the advisory, with key instruments and accessories. It will also be important to introduce and popularize mobile soil testing labs and soil testing kits for farmers to conduct soil analysis under field conditions. Mobile soil testing is particularly important for undertaking quick and efficient soil analysis and giving farmers more precise site-specific fertilizer recommendations. This will help to create awareness among farmers about the use of mobile soil testing and expand it in the country.

Capacity limitation in terms of human and infrastructure is a gap to effectively and efficiently demonstrate and scale LAFA use. Emphasis should be given to enhancing skills related to gender and climate resilience, digital tool use, providing technical assistance, and promoting climate information dissemination. The project will require focusing on empowering the capacity of women farmers to access inputs, access and be facilitated to use agro-advisory information and promote gender equity in agriculture. The other gap in delivering effective soil and agronomy services in the country is weak soil laboratory infrastructure, including equipment and facilities. There will be the need to strengthen agricultural input systems, technology development, and supply chain; digital tools; rural finance or credit system to get access to finance for rural people to purchase inputs, farm implements, and market their farm produce. Furthermore, the capacity of the pluralistic extension system needs to be enhanced through training and equipping staff with the necessary materials such as tablets and smartphones. The capacity gaps that should be considered during the implementation and scaling of the HaFAS advisory framework are summarized in Table 7.2. Annex 1 presents the outline of action plans that provide a framework for the phased implementation of the scaling strategy over 15 years.

Table 7.2. Summary of capacity strengthening priorities in different scaling phases

No	Activity	Phase 1 (2025-2030)	Phase 2 (2031-35)	Phase 3 (2036-40)	Pathway actors
1	Strengthen input supply system/chain and technology development	• Improve the supply and distribution of fertilizers in adequate quantity and quality, and at affordable prices • Introduce tailor-made fertilizer packaging in different pack sizes to satisfy the needs of farmers with small farms/plots. • Strengthen the bundling of other complementary inputs and agronomic practices with the LAFA for its effective implementation and adoption by users.	• Strengthen the bundling of other complementary inputs and agronomic practices with the LAFA for its effective implementation and adoption by users.	• Strengthen the bundling of other complementary inputs and agronomic practices with the LAFA for its effective implementation and adoption by users.	Input supply enterprises, agro-dealers, Unions, Cooperatives, farmers
2	Introduce and strengthen digital tools	• Introduce and strengthen digital tools to collect, store, analyze, and share data or information with users (e.g., LERSHA's data collection app aids in farmer registration, credit assessment, and agronomy follow-up, helping farmers to access financial services like loans). • Create links and strengthen the telecom system with the HaFAS innovations and improve the internet networks with digital tools/sensors for efficient and wider dissemination of the LAFA to users.	• Strengthen digital tools to collect, store, analyze, and share data or information with users. • Strengthen the link with the telecom system and improve the internet networks with digital tools/sensors for efficient and wider dissemination of the LAFA advisory to users. • Training researchers and		Extension personnel, public and private institutions

No	Activity	Phase 1 (2025-2030)	Phase 2 (2031-35)	Phase 3 (2036-40)	Pathway actors
		• Training researchers and agricultural experts on data analytics and digital advisory tools. • Enhance skills and knowledge in using machine learning to optimize fertilizer recommendations for various crop types and niches. • Strengthen collaborations among NARS and CGIAR.	extension agents in data analytics and digital advisory tools. • Enhance skills and knowledge in applying machine learning to optimize fertilizer recommendations for various crops.		
3	Strengthen the rural finance/credit system	• Strengthen access to finance to purchase inputs and farm implements and distribute and market farm produce.	• Expanding access to finance to purchase inputs and farm implements and distribute and market farm produce.	• Expanding access to finance to purchase inputs and farm implements and distribute and market farm produce.	Financial institutions, Unions, Cooperatives, farmers, agro-dealers
4	Extension system	• Strengthen and make more efficient and the existing Pluralistic Extension System (PES) • Create strong links with NGOs and other civil society organizations. • Diversify and provide extension services to various stakeholders, including the government, private organizations, NGOs, and cooperatives. • Establish farmers' field schools (FFS) and strengthen farmers' training centers (FTC) for effective implementation and scaling of the HaFAS • Train extension personnel at different levels • Equip extension agents with digital tools, such as tablets and smartphones. • Organize regular training programs for farmers by extension agents about the LAFA advisory and other complementary practices.	• Strengthen and make more efficient and the existing Pluralistic Extension System (PES) • Diversify and provide extension services to various stakeholders, including the government, private organizations, NGOs, and cooperatives. • Establish farmers' field schools (FFS) and strengthen farmers' training centers (FTC) for effective implementation and scaling of the LAFA • Train extension personnel at different levels • Equip extension agents with digital tools, such as tablets and smartphones.	• Strengthen farmers' field schools (FFS) farmers' training centers (FTC) for effective implementation and scaling of the LAFA	Extension personnel, farmers,

No	Activity	Phase 1 (2025-2030)	Phase 2 (2031-35)	Phase 3 (2036-40)	Pathway actors

5	Soil Lab and Soil Testing Services	• Strengthen national and regional soil labs with the necessary instruments, chemicals, and supplies, including mobile soil testing equipment
		  • Equipment installation and familiarization of technical staff with lab facilities at various laboratories.
		  • Establish centrally placed instrument maintenance and assembly coordinating units.
		  • Establish a high-capacity national soil database system to help update the advisory.
		• Introduce and promote mobile soil testing vans for quick and efficient soil analysis services to support site-specific fertilizer recommendations.
		• Conduct in-service training for lab assistants and technicians on soil sampling, analysis, and instrumentation.
		• Prepare training materials and technical guidelines.
		• Strengthen network and quick information exchange among soil testing laboratories.
			• Strengthen national and regional soil labs with the necessary instruments, chemicals, and supplies, including mobile soil testing equipment
			  • Equipment installation and familiarization of technical staff with lab facilities at various laboratories.
			  • Establish centrally placed instrument maintenance and assembly coordinating units.
			  • Establish a high-capacity national soil database system to help update the fertilizer advisory.
			• Promote mobile soil testing vans for quick and efficient soil analysis services to support site-specific fertilizer recommendations.
				• Strengthen national and regional soil labs with the necessary instruments, chemicals, and supplies, including mobile soil testing equipment
				• Promote mobile soil testing vans for quick and efficient soil analysis services to support site-specific fertilizer recommenda-tions.
					EIAR, RARIs

6	Communica-tion materials	• Extension materials, manuals • Brochures and leaflets • Videos (short training)	• Extension materials, manuals • Brochures and leaflets • Videos • Social media messaging		NGOs Communica-tion firms
7	Empower rural youth and women	• Empower rural youths and women and create job opportunities for input marketing and distribution.	• Empower rural youths and women and create job opportunities for input marketing and distribution.	• Empower rural youths and women and create job opportunities for input marketing and distribution.	Development partners, including MoA, NGOs, rural youths, women

7.3 Monitoring, Evaluation, Learning and Impact Assessment (MELIA) Plan

The MELIA framework for the HaFAS scaling delivery strategy is designed to systematically track progress, assess effectiveness, and provide insights for adaptive management and continuous improvement. The important components of this framework are a set of key performance indicators (KPIs) as part of the resulting framework; protocols for reporting and feedback mechanisms; a digital platform for data collection, integration, and visualization; and research and evaluation activities for refining the technologies based on the feedback.

7.3.1 Key Performance Indicators

Key Performance Indicators (KPIs) are designed to measure the success of the HaFAS in achieving its core objectives (Table 7.3). These KPIs provide measurable benchmarks that enable stakeholders to gauge progress and make data-driven decisions to optimize the HaFAS system performance and LAFA's reach and impact. When the term farmer is used, data collection should be disaggregated by target group, at a minimum by gender, household head status (i.e. male-head; female-headed) and broad age group (youth (<30 years versus 30 years and above). Outcome indicators for use of the HaFAS over time are provided in Annex 3.

Table 7.3. Key Performance Indicators

SN	Indicator	Level of Indicator	Definition	Data Source	Baseline	Target	Frequency
1	Percentage change in revenue gained from use of LAFA	Impact	Percentage increase in household revenue due to LAFA or other HaFAS component adoption	Impact assessment surveys	To be established at baseline	25% increase	Baseline, Midline, Endline
2	Percentage change in average yield or total output per area (by crop type)	Impact	Percentage increase in yield for specific crops because of adopting LAFA-recommended practices	Impact assessment surveys, Crop cut experiments	Wheat: To be established Maize: To be established Teff: To be established Sorghum: To be established	Wheat: 25% Maize: 20% Teff: 20% Sorghum: 30%	Baseline, Midline, Endline, Annual
3	Percentage of change in emission rate per unit of production output	Impact	Percent reduction in emission per unit of yield of crops	Model application	To be established	15 to 20% reduction	
4	Percentage of farmers adopting/practicing LAFA agro-advisories	Outcome	Percentage of farmers adopting improved practices disseminated through the LAFA or other HaFAS components	DA reports, Adoption surveys, Impact assessment	To be established at baseline	40% of targeted farmers disaggregated by gender and age	Quarterly (DA reports), Annual (surveys), Baseline, Midline, Endline
5	Percentage of farmers who have known practices promoted through LAFA or other HaFAS components	Outcome	Percentage of farmers aware of and able to recall at least one practice promoted through LAFA or other HaFAS components	Knowledge surveys, DA reports	To be established at baseline	70%	Baseline, Midline, Endline

SN	Indicator	Level of Indicator	Definition	Data Source	Baseline	Target	Frequency
6	Availability of suitable and multi-channel dissemination for end-users	Output (Qualitative Indicator)	Availability and accessibility of multiple channels (e.g., mobile apps, SMS, IVR, kiosks) for LAFA advisories across user segments	Program reports, DA surveys	To be established	100% of planned channels operational	Annual
7	Number of farmers directly accessing advisories through HaFAS advisory channels	Output	Total number of farmers (disaggregated by gender and major age groups) accessing advisory directly through direct to farmers dissemination channels	In-app data collections, Dashboards	To be established	20% of farmers	Quarterly
8	Number of farmers reached through LAFA advisories	Output	Total number of farmers (disaggregated by gender and major age groups) who have accessed LAFA advisories through any delivery channel	DA reports, Platform usage logs	To be established	12 million farmers	Quarterly
9	Number of DAs/SMS/experts trained in LAFA advisories	Output	Total number of DAs, Subject Matter Specialists (SMS), and experts (disaggregated by gender and major age groups) trained and proficient in LAFA and other HaFAS component content and tools	Training attendance records, Program reports	To be established	20,000 DAs/SMS	Quarterly
10	Number of community-based institutions and private sector entities with capacity for LAFA and other HaFAS components	Output	Total number of local institutions (e.g., cooperatives, private partners) equipped to support and deliver HaFAS framework and LAFA - advisories	Capacity assessment reports, Partner records	To be established	500 institutions	Annual
11	Number of partners actively involved in HaFAS system dissemination	Output	Number of partners (NGOs, government, research organizations, private sector) actively collaborating in HaFAS advisory outreach	Partnership reports, MOUs	To be established	50 active partners	Annual

SN	Indicator	Level of Indicator	Definition	Data Source	Baseline	Target	Frequency
12	Percentage of women and youth with access to LAFA advisories	Output	Percentage of women and youth farmers accessing advisories through LAFA channels	Gender-disaggregated access logs, DA reports	To be established at baseline	40% of all LAFA users	Baseline, Midline, Endline
13	Farmer satisfaction with LAFA advisory services	Output	Percentage of farmers (disaggregated by gender and major age groups) who report satisfaction with the quality, relevance, and accessibility of LAFA based advisories	Farmer satisfaction surveys, focus groups	To be established at baseline	85% of surveyed farmers satisfied	Annual

7.3.2 Monitoring, Reporting, and Feedback Protocols

Robust reporting and feedback mechanisms are critical to effectively monitor the scaling strategy for HaFAS-based advisory services, supporting adaptive management and promoting strong stakeholder engagement. These mechanisms ensure that data gathered through monitoring activities is systematically analyzed, reported, and leveraged for ongoing improvements in HaFAS implementation. Structured reporting protocols should be in place to monitor the KPIs at the designed monitoring frequency. The desired monitoring and reporting frequency shall be real-time, quarterly, and annual, which may depend on the KPI type. For example, the number of farmers accessing advisory needs to be captured in near-real time, whereas KPIs related to yield, and income may be captured semi-annually/annually. Establishing a regular reporting schedule is essential to ensure timely updates. Ideally, quarterly progress reports should be submitted to the regional and national HaFAS platforms, with quarterly meetings held to discuss updates, share feedback, and exchange insights between implementing partners.

Apart from formal monitoring schedules, a continuous process of collecting feedback is essential to complement regular reporting, providing ongoing, real-time insights from the field. In-app feedback systems allow immediate input from users, while quarterly or semi-annual feedback sessions with farmers enable discussions on field-level implementation, adoption challenges, and additional support needs. Regular farmer surveys and focus group discussions offer further insights into the HaFAS's relevance, accessibility, and effectiveness, capturing the user experience directly. Additionally, studies on the user experience of farmers and Development Agents (DAs) provide insights into the effectiveness and accessibility of digital advisory tools, while impact evaluations, process evaluations, and focused research support further HaFAS refinement. Digital feedback channels, such as in-app forms, SMS, or IVR-based options, enable farmers to provide feedback on HaFAS advisories in real-time. This dynamic feedback helps identify issues early and supports timely service adjustments.

7.3.3 Digital Data Collection, Analytics, and Visualization

Digital data collection is a foundational component of the Monitoring, Evaluation, Learning, and Impact Assessment (MELIA) framework, enabling efficient, real-time, and accurate data gathering essential to scaling the HaFAS strategy. By leveraging tools such as mobile applications, in-app surveys, GPS tracking, and online forms, the MELIA team captures critical information such as farmer adoption rates, feedback on advisory services, routine monitoring data, survey responses, and research insights—with minimal delay and high accuracy. These data support adaptive management and informed decision-making, allowing the HaFAS to dynamically adjust to meet emerging needs. Integrated data visualization tools and interactive dashboards further enhance this process, providing stakeholders with real-time insights into key performance indicators and scaling progress. These dashboards present adoption rates, regional reach, and impact metrics in an accessible format, facilitating data-driven decisions and transparent reporting.

To accommodate diverse data requirements, the MELIA team will adopt various data collection tools and workflows tailored to specific project or process needs. The data collection will include routine monitoring, periodic surveys, and feedback, as well as research data. Multiple methods, such as in-app data collection, field supervision, evaluations, and surveys, will be employed to gather comprehensive insights. The data collection will be implemented through approaches like face-to-face interviews, focus group discussions (FGDs), telephone surveys, and other relevant channels, depending on the advisory delivery format. A few of the data collection tools and monitoring workflows are provided in Table 7.4.

Table 7.4. Type of data collection tools and workflow to be adopted in MELIA

No	Data collection tools and workflows	Type of data	Description
1	In-app, chatbots	Monitoring data, Feedback	A short survey with objective-type questions to get feedback on the quality and usefulness of advisories. In-app: after every advisory, a popup may appear to rate the content of the advisory on a defined rating scale. A short survey may also push through the app two to three times in a season to get feedback from the users.
2	ODK or similar platforms	Feedback surveys, Baseline, mid-line, impact assessment.	This platform may be used for less frequent but detailed surveys such as baseline and impact assessment surveys. These tools will be used by trained enumerators to collect the information. The information collected by enumerators will be available on the platform for validation.
3	Customized web/mobile application with a dashboard	Monitor KPIs throughout the project period	The defined KPIs in the result framework required frequent monitoring and validation checks. A customized web and mobile application to collect the data for these KPIs will ensure consistency in data quality throughout the project period. This platform will also have customized data analytical processes that leverage the data collected from other tools to provide comprehensive visualization of project progress on a dashboard.
4	Algorithms for remote sensing-based indices	Monitoring large-scale areas for changes in vegetation indices	Use of remote sensing indices will be more useful to monitor and assess the impact of advisories on large areas and assess. Different vegetation indices may be used to differentiate the croplands where improved agronomic practices are promoted
5	IVR and SMS	Short surveys using IVR and SMS channels	There will be a significant user group with limited access to smartphones that may not be covered during the face-to-face feedback survey. The IVR or telephone-based surveys will be able to cover these farmers.

7.3.4 Data and Information Sharing

A centralized secured data platform or repository will be established to host data collected through various tools. Based on defined user roles, access to the data platform will be provided through secured applications. For example, enumerators will only have access to enter the data, and users with the role of a project administrator will have permission to use the application for validating the collected data, the project donors will have access to the platform's dashboards or reports sections, etc.

7.4 Research and Evaluation

The innovation is dynamic and evolving through changes at various stages and phases throughout the scaling phases. The strategy requires ongoing research and evaluation practices to improve the delivery quality and the target achievements (Table 7.5). The research component is integral to enhancing the HaFAS through expanding the number of crops covered and advancing sustainable agricultural practices that address yield and profitability improvement for the improvement of food security and resilience in diverse farming contexts. Below are identified research areas where further research is essential to improve and sustain the relevance of the HaFAS.

Table 7.5. Research needs and priority research areas

Research needs	Prioritized research areas	Justification
Refining HaFAS	• Retraining the data-driven models using the validation/feedback data. • Validate the HaFAS irrigation area.	• For improving model reliability • To improve water productivity
Soil health monitoring and management	• Soil acidity management • Reuse of organic waste as fertilizer. • Carbon sequestration and GHG emission • Rapid soil assessment methods using proximal sensing.	• Soil health and fertility issues • Low nutrient use efficiency • Low crop productivity • High cost of soil analysis
Small-scale farm implements /mechanized systems	• Planters • Harvesting and threshing • Lime spreader • Sprayers (fungicides and herbicides)	• Inefficient farming system • High manual drudgery • Need for farm productivity
Socio-economic feasibility studies	• Identifying the farm typologies and target research based on different social structures, such as farmer groups, cooperatives (ACCs), and the Farmers Field School approach. • Assessing the inclusiveness and effectiveness of key actors to advance research outputs for scaling with clearly defined roles when deploying the HaFAS • Evaluate the best extension approaches, whether through face-to-face conventional methods, community-based research, or a pluralistic extension system. • Evaluate farmers' willingness to pay for new technologies and innovations • Research how financial, market, and infrastructure services can be bundled with the HaFAS for better access and adoption.	• Scalability of the technology • Feasibility and efficiency of the technology • Social inclusiveness

The evaluation component encompasses both process evaluations and impact assessments, each serving a distinct purpose in understanding and optimizing the HaFAS scaling strategy. Process evaluations focus on assessing the implementation quality, efficiency, and reach of the HaFAS. These evaluations identify operational strengths and bottlenecks, offering insights into how delivery methods and training activities can be refined for better performance. Impact assessments, on the other hand, measure the direct outcomes of HaFAS recommendations on farming practices, yields, and income levels, providing a clear picture of the strategy's effectiveness in achieving its core goals. By comparing baseline and end-line data, impact assessments reveal the HaFAS's contribution to agricultural productivity, environmental sustainability, and rural livelihoods. A baseline must be established at the start of the first phase of the HaFAS and measure impacts at the end of each phase.

7.5 Adaptive Management and Stakeholder Engagement

Adaptive management and stakeholder engagement, when combined, these concepts create a robust framework for managing complex projects or systems in a way that is both flexible and inclusive. It is about being ready to change courses when necessary and ensuring everyone's voice is heard. Following these principles, the MELIA operation provides continuous insights to improve the HaFAS. The data on adoption rates, yield improvements, and income changes provide essential insights that allow the HaFAS platform to respond swiftly to observed trends. For instance, if data indicate low adoption rates in specific regions, adaptive management processes may lead to targeted training interventions, increased DA support, or enhanced awareness efforts to address barriers to adoption. Feedback might reveal that farmers in a particular area struggle with accessing the platform due to connectivity challenges or specific knowledge gaps or reveal a need to improve the recommendations. In response, adaptive management might prioritize infrastructure improvements in that region or develop additional resources to support farmer understanding. Regular analysis of KPIs enables stakeholders to assess the performance of various advisory channels, such as apps, SMS, IVR, and digital kiosks, and make necessary adjustments to strengthen outreach and accessibility.

Adaptive management within the MELIA framework also emphasizes flexibility in HaFAS implementation. For example, if data or user feedback indicates that a specific advisory approach is more effective, resources can be reallocated to prioritize that method. Similarly, if external factors such as changes in market prices, climate conditions, or pest outbreaks, the HaFAS platform can respond quickly by updating recommendations and advising partners to adjust their activities. By continuously applying adaptive management, the HaFAS scaling strategy is positioned to respond proactively to data-driven insights, optimize service delivery, and achieve sustainable improvements in Ethiopia's agricultural advisory services. This approach enables the HaFAS platform to remain responsive to farmers' needs, support better agricultural practices, and foster long-term resilience in Ethiopia's agricultural sector.

Roles and responsibility of MELIA are to:

- Design reachable and high-level contributions brought by research/ program/ project as part of impact, intermediate outputs/outcomes under HaFAS throughout the process of implementing innovative technology advisory services
- Design list of indicators specific to impact, intermediate outputs/outcomes how possible the result can be measured
- Generate learning around the interventions and disseminate the experience using all possible channels among reach, targets and partner institutions for further scaling
- Provide all necessary data for decision making partners to review, update and to share learnings across all participants who are using HaFAS in implementing an innovative digital technology advisory service
- Regularly collect data on the indicators to conduct evaluation, identify, verify, and understand the extent to which HaFAS influences on the implementation processes of scaling innovation digital technology advisory service
- Pinpoint, based on feedback from end users, where additional system improvement is needed and priority areas for further research and improvement of the HaFAS

References

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Section 8. Implementation Plan for 2025

The Ethiopian Institute of Agricultural Research (EIAR) and its partners have developed a harmonized fertilizer decision support tool (LAFA) for wheat, maize, teff, and sorghum. Currently, the tools are under validation to ensure that they are ready for dissemination, including popularization, pre-scaling demonstrations, advocacy, and scaling. However, due to limited resources, activities in 2025 will focus on pre-scaling demonstrations, strengthening platforms and operation units, and advocacy, while still aiming to support the 15-year strategic delivery scaling plan. By 2026, prerequisites for phase 1 of the scaling strategy, such as standardizing advisory tools, bundling contents, creating institutional and governance systems, and securing resources, will be achieved.

8.1 Projected Reach and Target Locations for Pre-scaling in 2025

In 2025, a pre-scaling of LAFA will provide a foundation for the scaling framework by piloting scaling operations of different delivery mechanisms and partnership pathways. The six key activities to operationalize the pre-scaling are: 1) consolidating findings from 2024 validation data and refining LAFA, refining N and P recommendations based on nutrient use efficiency and profitability; 2) developing advisory content for different delivery channels; 3) conducting capacity building on LAFA services; 4) coordination and monitoring; 5) advocacy and communication; and 6) integration of feedback from pre-scaling and upgrading LAFA (Tables 8.1 and 8.2). To achieve these action areas, discussions have been undertaken and will continue to engage key scaling partners to take a role in the pre-scaling implementation by embedding the action plan in their ongoing initiatives and accessing additional financing to support testing with as many delivery channels as possible and detailed planning of the first phase of scaling. The pre-scaling implementation will be guided by standardized protocols across the implementing partners and facilitated by a multi-partner team. The pre-scaling of LAFA for wheat, teff, sorghum, and maize crops will focus on districts where the validation sites were based (129 districts in 49 zones across seven regional states, Figure 1.1) and where ongoing investment options exist. Accordingly, the target validation locations will be identified and shared among partners. About eight to ten partners will take part in the pre-scaling operations, aligned within the existing partnership platforms in the MoA and DST Coordination Platform and the recently announced Digital Agriculture Roadmap 2032. The projected target for all partners will reach between 100,000

and 150,000 farmers during the pre-scaling phase. For example, at the time of this writing, Digital Green, ICRISAT, and Self Help Africa have confirmed they will be targeting 60,000, 20,000, and 10,000 farmers in their digital advisory program and will integrate the LAFA.

8.2 Outputs and Activities Matrix in 2025

Table 8.1. Output and activity matrix and approximate implementation by year (2025)

Outputs	Activities	2025	2026
Validation study findings integrated into LAFA tools.	• Data collection and validation • Collect geolocation data from the Land Administration • Finalize validation data compilation and cleaning • Validation data analyzed with economic component included • Finalize Delivery Strategy (requires validation findings) • Standardization of farmer profiling data collection and registration, with gender, age, and geolocation of all plots and other characteristics & standardization and naming of applications and products using the same channels • Domain-based recommendation advisory (Web app), including mapping • Stakeholder review and confirmation of findings from validation of 2024 data	✓	
Digital advisory tools developed	***Develop*** • Chatbot (priority) • Production of video • Mobile App + SMS messaging: For the extension farmers (Challenge of literacy) • Phone system based on kebele level recommendations (focus on outgoing calls) • ATI Hotline: Calls come in (incoming) and go out (Outgoing) • Conduct Quality Assurance of Knowledge in all Delivery Channels	✓	
Farmers and extension personnel trained.	***Conduct training sessions*** • Prepare Training Materials and Program & development selection criteria for field agents to be trained • Principal training on the use of digital tools in different delivery channels for subject matter specialists (Training of Trainers) in government and partner organizations and development agents (DAs) for maize, sorghum, teff, wheat • Selection of farmers to be reached for maize and sorghum, including farmer registration • Training for Farmers of maize and sorghum • Selection of farmers to be reached for 2nd Training, including farmer registration • Training for Farmers on DST advisory tool for maize, wheat, teff, and sorghum	✓	
Monitoring and evaluation framework established.	***Set up M&E committees, meetings*** • Meet with ATI ACC& digital team or management to explore synergies & integration • Set up regional level M&E committees focused more on learning to improve systems • Set up and train Zonal committees for monitoring & receiving feedback on digital advisory services: multi-partner • Conduct 1st round of Zonal committee meetings: Planning and M&E indicator agreement	✓	

Outputs	Activities	2025	2026
	• Conduct 2nd round of Zonal committee meetings: Supervision • Conduct 3rd round of Zonal Committee meetings: End of season evaluation & feedback from far • Agree upon standardized questions for collecting feedback from farmers • Standardize Digital/phone or field collection of data from Farmers (ODK or Chatbot with DAs) • Wrap-up Workshop for sharing lessons learned		
Awareness and advocacy campaigns organized	• Select Site for field days and exchange visits • Exchange Visits among farmers • Broadcast Radio programs, panel discussions with users • Broadcast TV programs, including panel discussions • Conduct Field days including regional & zonal extension leadership • Conduct Field Day, with MoA & its key staff (Directors), key donors, EIAR director general, Regional BoA heads, ATI Director • Conduct High-level Media event • Conduct a National Level meeting to Review Progress aligned with the DST Coordination Platform • Prepare a proposal for Scaling Phase 1 • Prepare a 4-page brief for Scaling Phase 1 • Open and manage Telegram, WhatsApp, and LinkedIn group	✓	
Incorporation of New Information into the System	• Preparation of Policy Brief • Preparation of Holding of Wrap-Up Workshop with session on Policy Forum • Upgrading of the Fertilizer Advisory for 2026		✓

Table 8.2. Implementation plan with major activities aligned with scaling the harmonized Fertilizer Digital Advisory (LAFA) in 2025

Activities	Period	Deadline	Who will deliver	Comments
I. Preparation of Findings from the 2024 Validation Study				
Collect geolocation data from the Land Administration	27 January-31 March	5-Feb	MoA, ICRISAT, CIAT, EIAR	Dr. Birru should lead this task. Information is built into deliver channel.
Strong request letter for validation data submission from field	Immediate	23-Jan	Dr. Birru (EIAR)	As indicated
Finalize validation data compilation and cleaning	25 Jan-10 Feb	10-Feb	EIAR (Dejene will be responsible), supported by CIAT, ICRISAT	An entire team of 8 staff (EIAR) will be involved with support from ICRISAT & CIAT
Validation data analyzed with economic components included	1 January-20 February	20-Feb	(EIAR/RARIs (8 staff), ATI, ICRISAT (Mekund, Henok), CIAT (Wuletaw)	A short meeting will be held among key experts from research and development to validate & endorse the final performance of the DST for scaling
Finalized Delivery Strategy (requires validation findings)	1 January-24 February	24-Feb	Core Delivery Team	Majority of document ready by 5th February
Standardization of farmer profiling data collection and registration, with gender, age, and geolocation of all plots and other characteristics & standardization and naming of applications and products using same channels	2-3 February	14 Feb	Dr. Birru/ Gizaw to coordinate for standardization of data Digital Green (DG), CropIn, ATI, LERSHA, who engage in collecting farmer profile data	One day meeting, suggesting key criteria to ensure best use of site-specific fertilization; Digital Farmer Registry Platform by DG and MoA can be used as a tool to build on/expand
Domain-based recommendation advisory (Webapp), including mapping	20-24 February	24-Feb	CIAT (Wuletaw) & ICRISAT (Gizachew) +EIAR (Demeke)	Spatial aggregated level of operation will be decided during the analysis of the validation data
Stakeholder review and confirmation of findings from validation of 2024 data	25-28 Feb	28-Feb	Dr. Birru	Senior agronomists, soil scientists
II. Integration (developing content) of Validation Findings for Different Delivery Channels				
Key partners meeting to discuss contents and priority delivery channels and digital hub/platform services	10-25 Feb	25 Feb	Dr. Birru to coordinate	
a. Chatbot** (priority)	21 Feb-5 March	5-Mar	Digital Green & ICRISAT, ICT-MoA, EIAR	Need GPS, size of farm (estimated); tools to measure area can be included Quality assurance issue

Activities	Period	Deadline	Who will deliver	Comments
b. Production of video	21 Feb-15 March	15-Mar	Digital Green, ICT-MoA, ATI, EIAR	Core language translation: at least 4 (Amharic; Sidama; Oromia, Tigrigna)
c. Mobile App + SMS messaging: For the extension farmers (Challenge of literacy)	21 Feb-15 March	15-Mar	LERSHA, ICRISAT, & Digital Green, ICT-MoA, EIAR	1-2 Apps
d. Phone system based on kebele level recommendations (focus on outgoing calls)	21 Feb-31 March	31-Mar	PXD, ICT-MoA, EIAR, LERSHA	Assuming recommendation zones ready by 30 Feb
e. ATI Hotline: Calls come in (incoming) and go out (outgoing)	21 Feb-31 March	31-Mar	LERSHA, MoA and ATI, EIAR	ATI hotline does not give site-specific site recommendation. Potential for integration needs to be discussed.
Conduct Quality Assurance of Knowledge in all Delivery Channels	15 Feb-31 March	31 March	ICT-MoA plus tool developers	
III. Training of Extension Personnel and Farmers on the Use of LAFA				
Additional resource mobilization for 2025	February	3 March	EIAR (lead) with partner input	
Preparation of Training Materials and Program & development selection criteria for field agents to be trained	5 Mar-10 March	15 March	EIAR (co-lead), MoA (co-lead) with inputs from ICRISAT, CIAT, ATI, NGO partners	Training materials will need to be adapted for different delivery pathways in coordination with implementing partners
Principal training on the use of digital tools in different delivery channels for subject matter specialists (Training of Trainers) in government and partner organizations and development agents (DAs) for maize, sorghum, teff, wheat	15 March-10 May	10-May	EIAR, ICRISAT, Digital Green, PXD, ATI, LERSHA, MoA	Training of 3 days
Selection of farmers to be reached for maize and sorghum, including farmer registration	1 Mar-15 Mar	15-Mar	Kebele extension agents (public) through Yenenesh Egu	Combination of existing farmers (Digital Green group (maize only) plus new farmers
Training for Farmers for maize and sorghum	20 March-15 April	15-Apr	District level extension personnel (MoA & LERSHA)	As it is
Selection of farmers to be reached for 2nd Training, including farmer registration	1 May-15 May	15-May	Kebele extension agents (public)	Combination of existing farmers plus new farmers
Training for Farmers on DST advisory tool for maize, wheat, teff, and sorghum	15 May-15 June	15-Jun	District level extension personnel of MoA and LERSHA agents	As it is
IV. Coordination and Monitoring				
Meeting with ATI ACC & digital team or management to explore synergies & integration	25-30 January	30-Jan	EIAR (Dr. Birru/Dr. Temesgen), MoA	

Activities	Period	Deadline	Who will deliver	Comments
Set up regional level M&E committees focused more on learning to improve systems	15-20 Feb	20 Feb	NGO partners, RARIs	Lead for each region to be determined by committee members
Set up and train Zonal committees for monitoring & receiving feedback on digital advisory services: multi-partners	1 Feb-31 March	31-Mar	MoA/EIAR and NGO partners will inform federal/ regional bodies of the plans	Zonal committee has a role to network with woreda and regions
1st round of Zonal committee meetings: Planning and M&E indicator agreement	Mid-Feb-31 March	31-Mar	Zonal Bureau of Agriculture; supported by Zonal research centers (secretariat)	Woredas will attend zonal meetings, plus 1 representative from region; minutes submitted to regional bureau
2nd round of Zonal committee meetings: Supervision	July-August	31 August	Zonal Bureau of Agriculture; supported by Zonal research centers (secretariat)	
3rd round of Zonal Committee meetings: End of season evaluation & feedback from farmers	15 October-30 November	30-Nov	Zonal Bureau of Agriculture; supported by Zonal research centers (secretariat)	
Agree upon standardized questions for collecting feedback from farmers	July	31-Jul	EIAR (Dr. Birru), MoA, ATI, ICRISAT, CIAT, Digital Green, PXD	
Standardized Digital/phone or field collection of data from Farmers (ODK or Chatbot with DAs)	1-15 October	15-Oct	EIAR (Dr. Birru), ATI, ICRISAT, CIAT	
Wrap-up Workshop for sharing lessons learned	November	30 Nov	MoA leads: all partners present	2-day workshop
V. Advocacy/ communication activities to create awareness and strengthen demand				
Site Selection for field days and exchange visits	August	31 Aug	Development partners, Zonal Department of Ag, Woredas, Kebeles	
Exchange Visits among farmers	Sept-Nov	30 Nov	Zonal Department of Agriculture	
Radio programs, panel discussions with users	May-August	31 Aug	EIAR, MoA and ATI	
TV programs, including panel discussions	May-August	31 Aug	EIAR, MoA and ATI	Frequency depends on resources
Fields days include regional & zonal extension leadership	October-November	28-Nov	Woreda Office of Agriculture	
Field day, with MoA & its key staff (Directors), key donors, EIAR director general, Regional BoA heads, ATI Director	November	28-Nov	Ministry of Agriculture	

Activities	Period	Deadline	Who will deliver	Comments
High-level Media event	November	30-Nov	Office of the Minister of Agriculture	
National Level meeting to Review Progress aligned with DST Coordination Platform	March & December 2025	31-Dec	Meets twice a year; State Ministers are co-chair; Dr. Birru is secretary;	Last meeting 27 December 2024
Proposal preparation for Scaling Phase 1	April-June	30 June	CIAT, ICRISAT with partners	
Preparation of a 4-page brief for Scaling Phase 1	December	10-Dec	EIAR, ICRISAT and CIAT with partners	
Telegram & What's App Group. Linked In	Every two weeks		Joint Knowledge Management Committee	Under the direction of a Digital Platform managed by MoA
VI. Incorporation of New Information into System: December-February 2026				
Preparation of Policy Brief	Dec 2025-Jan 2026	20-Jan	PXD & Policy Link, EIAR, MoA ICRISAT and CIAT with NGO partners	
Preparation of Holding of Wrap-Up Workshop with session on Policy Forum	26-30 Jan 2026	31 Jan 2026	MoA and EIAR	
Upgrading of the Fertilizer Advisory for 2026	Jan-Feb 2026	10 Feb 2026	EIAR, CIAT, ICRISAT	

8.3 Logic Model for Phase I

The logical framework narrates the results at different levels of impact and outcome levels and anticipates major risks likely to occur and measures taken to mitigate the risks. The results framework of phase I is formulated based on the Theory of Change discussed in Section 3.4. The action plan (Annex 1) and investment approach (Annex 2) provide a framework for implementing the three phases of the 15-year scaling strategy.

Table 8.3. Logical framework (with outcomes and outputs specified) and risks that may hinder the achieving of the desired results for phase I (2026 to 2030).

Results Statement in Phase I		Risks
Impact	The LAFA and complementary advisory tools and the HaFAS framework are expected to increase the efficiency of fertilizer use, reduce costs to end-users, and improve the efficiency of fertilizer investment; ultimately, with 45% adoption of the advisory, the country can benefit from $25 to $35 million in profit per year per crop with 0.25 ha allocation per crop per farmer and reduce emissions by 465 to 1210 tons CO_2 equivalents per year per crop, thereby ***improving income and food security***, ***enhancing climate resilience, and improving environmental health.***	**Risk:** Global dynamics in funding scenarios may affect investments for the supply of fertilizer inputs and indirectly influence the price of inputs as well as funding scenarios for scaling agriculture and digital innovations through delivery organizations. **Steps to mitigate the risk:** Develop adaptation plans to design solutions with government resources and investment models
Outcome	**Increased total production & profitability:** The scaling and use of LAFA and complementary innovations by 2 million households lead to a 30% yield gain and a 20% improvement in nutrient use efficiency and at least $10 profit per unit investment, eventually impacting yield production and annual profit for farmers. By applying more fertilizer at a lower cost, farmers can also achieve greater crop yields per unit of land, leading to increased food production.	**Risk:** Adopted innovation may yield less than the previous and slower operation to reach cereal growing areas **Steps to mitigate the risk:** Work only in areas where the technology is validated
	Reduced costs of inputs: Farmers benefit from optimized use of fertilizer and targeted use of inputs to most responsive cropping systems and increased use of localized advisories supported with institutionalized and enhanced capacity and delivery services. The efficient use reduces the costs of inputs to end users, and the facilitated services reduce transaction costs allowing them to potentially increase their crop yields and overall production due to the ability to apply more fertilizer to their fields, ultimately leading to higher profits and improved food security.	**Risk:** Costs could be volatile and may increase. **Steps to mitigate the risk:** Conduct proper sensitivity analysis before releasing the cost-benefit ratio result.
	Increased diversified fertilizer investment: Digitalized extension services and multi-partnership scaling operations allow efficiency in the input supply chain, enhance support on enabling environment supported by policies and structures, and infrastructure that incentivizes investments in the fertilizer value chain, of which farmers and the private sector gain diversified investment for manufacturing, importing, and selling fertilizer.	**Risk:** Global funding scenarios influence private sector fertilizer investment and foreign direct investment to manufacture inputs and import fertilizer **Steps to mitigate the risk:** Diversify domestic fertilizer investment for manufacturing locally
Intermediate outcome	**Women and Men farmers use the digital solutions: 635,869**, 502,030, 425,842, and 433,423 wheat, teff, sorghum, and maize farmers adopt LAFA advisory solutions by 2030.	**Risk:** Inadequate input supply and increase in prices limit the delivery of digital solutions to reach all interested farmers and result in low adoption **Steps to mitigate the risk**: Organize Innovation Package workshops to assess readiness to scale and evaluate readiness of innovation package components.

Results Statement in Phase I		Risks
	Digital solutions Institutionalized through diversified pathways (Public, Private, PPP, and co-ops): National digital platform hub and localized dissemination platforms/formats are tailored to local context and user profiles.	**Risk:** Some stakeholders may not find it profitable for their business model **Steps to mitigate the risk:** Pilot-test the business model before full scaling.
Outputs	**1. Scaling partners and farmers capacity built:** Advisory user households and extension agents, cooperative service providers acquired digital advisory use skills and facilitation of scaling operation	**Risk:** Enough budget may not be allotted for capacity building **Steps to mitigate the risk:** Make all necessary preparations and efforts for resource mobilization such as advocacy, pitching, and looking for funding sources
	2. Digital delivering hubs/kiosks established: Advisory dissemination hubs/kiosks and service provider agents aligned and suit to the scaling pathways institutionalized for effective delivery of advisory contents to end users	**Risk:** Enough budget may not be available and allotted for delivery hubs **Steps to mitigate the risk:** Make all necessary preparations and efforts for resource mobilization such as advocacy, pitching, and looking for funding sources
	3. Scaling and implementation partnership platform established: Multi partnership and governance of HaFAS convening platform established, operational and MELIA units become functional.	**Risk:** Some partners may lack interest in joining the platform **Steps to mitigate the risk:** Conduct repeated awareness-raising sessions to convince all stakeholders and
	4. Big database system, analytical capacity, and high-performance DST in place: A harmonized workflow and framework developed with a data management module, analytics and modeling module, prototype development module, validation module, and refining protocol standardized among the partners.	**Risk:** Data sharing and intellectual property rights are still not resolved. Insufficient research funding for refining advisory **Steps to mitigate the risk:** Categorizing data that are public and that require some sort of security and developing business models and investment opportunities

Section 9. Annexes

Annex 1. Action Plan

The scaling framework implementation action plan provides a framework for implementing the strategy, and it will need to be continuously adapted based on the results of ongoing MELIA activities. By phasing the activities, focusing on key priorities, and fostering strong partnerships, this action plan can contribute to achieving the goals of improved agricultural practices in Ethiopia.

Phase 1: Foundation (2025-2030)

- Establish Governance and Structure
    - Form the National HaFAS Platform: Convene representatives from key stakeholder groups (governmental, non-governmental, private, and international research and development institutions) to form the governing body. A state minister of the MoA for Crop Development and Horticulture should chair this platform.
    - Set up Operational Units: Create the Digital System Management unit, Scaling Operation unit, and MELIA unit within the National HaFAS Platform.
    - Develop Initial Action Plans: Create detailed annual action plans with specific activities, resource allocation, and timelines, and cascade these to regional levels.

- Strengthening HaFAS Digital System Development and Data Management
    - Data Needs Assessment: Identify specific data gaps for modeling and plan for experimental data generation.
    - Data Partnerships: Strengthen and expand partners' agreements and protocols for data sharing and access.
    - Data Quality Control: Implement procedures to ensure data quality.
    - Data Validation: Collect and validate data sets to improve models.
    - Develop Initial Models: Build, validate, and deploy initial models, with plans for versioning and updating.
    - Interface Development: Leverage existing interfaces from farmer-facing organizations where possible and integrate initial model outputs with key dissemination channels. Prioritize user-centered design, addressing diverse user needs such as gender, resource availability, and production goals.
    - Capacity Building: Start training on data collection, standardization, analysis, and modeling.
    - Integrate Climate and ISFM Data: Integrate climate advisories into the DST to enhance climate-smart decision-making.
- Scaling Operations - Phase 1 Focus
    - Initial Target Regions: Select target regions for scaling based on the four major crops (maize, wheat, teff, sorghum).
    - Regional Coordination: Adapt and cascade scaling guidelines to the regional level, organizing training for experts and extension agents.
    - Zonal Coordination: Identify potential districts for scaling, establish core groups with partners, and plan resource allocation at the zonal level.
    - Bundling of Innovations: Begin combining complementary innovations and technologies with the core innovation, LAFA.
    - Promote LAFA Service: Begin promoting LAFA services at Farmer Training Centers (FTCs) and through existing digital channels.
    - Pilot E-agri-kiosks: Test and implement digital kiosks for service delivery.
    - Link to Existing Initiatives: Connect the HaFAS with relevant digital and agricultural initiatives.
    - Advocate National Policy: Advocate for inclusion of the HaFAS scaling strategy in national policy.
    - Promote Small Fertilizer Packs: Encourage the use of smaller, more affordable fertilizer packages.
    - Ensure Timely Fertilizer Supply and Distribution: Prioritize effective and timely supply chains.
    - Promote Access to Finance: Implement mechanisms to facilitate access to finance for farmers.
- MELIA Implementation
    - Establish Monitoring Systems: Implement regular and continuous monitoring of the scaling process.
    - Define and Contextualize Key Performance Indicators: Establish measurable benchmarks to track progress.
    - Initial Data Collection: Start collecting data for the KPIs, using a customized web/mobile application to ensure data quality.
    - Process Evaluations: Conduct evaluations to identify operational strengths and bottlenecks.
    - Baseline Data: Establish a baseline at the start of the phase to measure progress against.
    - Data Analysis and Reporting: Collect and collate reports from implementing regions and report to the national platform
    - Implement a digital platform: Implement a platform for data collection, integration, and visualization.
    - Adaptive Management: Make initial adjustments based on user feedback.

Phase 2: Expansion and Integration (2031-2035)

- HaFAS Digital System Enhancement
    - Refine Models and Interfaces: Update and improve models based on new data and user feedback. Improve interfaces for user needs and accessibility.
    - Integrate SLM Data: Integrate and bundle SLM and more agronomic innovations.
- Scaling Operations - Phase 2 Focus
    - Link LAFA to Crop Insurance: Connect the DST to crop insurance programs to reduce risks for farmers.
    - Capacitate SMS/DAs for LAFA Service: Train SMS/DAs for effective LAFA service delivery.
    - Negotiate with Telecom Services: Work to improve access to digital services, especially in rural areas.
    - Promote Soil Test-based E-delivery Kiosks: Expand the use of soil test-based e-delivery kiosks for comprehensive service delivery.
    - Promote Coop Extension for LAFA Services: Engage with cooperative extension services to promote the LAFA.
    - Enhance Business Model Pathways: Enhance PPP business model pathways through cooperative services
    - Private Extension for LAFA Service: Integrate private extension services into the LAFA delivery system.
    - Expand Target Regions: Expand scaling operations to new regions based on the four major crops.
- MELIA Enhancement
    - Impact Assessments: Start conducting impact assessments to measure outcomes on farming practices, yields and income levels.
    - Refine Indicators: Review and refine key performance indicators as needed.
    - Knowledge Sharing: Enhance learning and knowledge-sharing systems.
    - Stakeholder Engagement: Engage with stakeholders to refine the scaling process.

Phase 3: Institutionalization and Sustainability (2036-2040)

- HaFAS Digital Platform System Optimization
    - Continuous Improvement: Focus on continuous improvement of the HaFAS system based on ongoing data and user feedback.
    - Integration of New Technologies: Explore and integrate new technologies to improve functionality.
- Scaling Operations - Phase 3 Focus
    - Strengthen Platforms: Strengthen platforms at all levels (local, regional, national) to ensure robust service delivery.
    - Institutionalize the HaFAS: Fully institutionalize the HaFAS into existing agricultural systems and practices.
    - Expand market linkages: Enhance access to markets for farmers.
    - Strengthen Business Model Pathways: Enhance business models for Cooperative and Private pathways
- MELIA and Sustainability
    - Long-Term Impact Evaluation: Conduct long-term impact assessments to evaluate sustainability of changes
    - Data-driven Adjustments: Make continuous data-driven adjustments to ensure the HaFAS remains responsive.
    - Ensure Transparency and Accountability: Ensure transparency and accountability in all MELIA activities.

Ongoing Activities (All Phases)

- Capacity Building and Support
  - Strengthen Input Supply: Continuously work to improve the supply and distribution of fertilizers, tailored packaging, and complementary inputs.
  - Strengthen Extension Systems: Train extension personnel in data analytics, digital tools, and machine learning.
  - Strengthen Rural Finance: Improve access to finance for farmers.
  - Soil Testing Services: Provide well-organized soil testing services with skilled technicians.
- Partnerships and Stakeholder Engagement
  - Engage all Relevant Stakeholders: Government, non-government, research, and private sector partners.
  - Coordination Platform: Maintain a coordination mechanism among partners.
  - Multi-Stakeholder Platforms: Solve operational, policy, and institutional problems through platforms.
  - Define Roles: Clarify the roles, responsibilities, and functions of each partner.
  - Address Gaps: Identify and address gaps in partner institutions' capabilities.
- Financial Sustainability and Resource Mobilization
  - Secure Financial Support: Align with donors such as USAID, BMGF, AGRA, and the World Bank, with a long-term perspective
  - Develop Funding Scenarios: Implement low, medium, and high funding scenarios to implement different phases of the project.
  - Assess Willingness to Pay: Assess different market segments' willingness to pay for the core and complementary innovations.
  - Develop Business Models: Develop business models for market-led dissemination channels.
- Communication and Advocacy
  - Promote Benefits: Highlight the benefits of site-specific digital agro-advisory tools.
  - Engage Stakeholders: Engage government, NGOs, private sector, and local communities.
  - Raise Awareness: Promote the impact of site-specific fertilizer recommendations.
  - Attract Resources: Communicate a clear value proposition to attract investors.
  - Encourage Adoption: Advocate for digital tools in fertilizer management.
  - Build Capacity: Ensure farmers and officers have skills to use digital platforms effectively.

Annex 2. Phased Investment Approach

The investment strategy will be implemented in three phases, aligning with the overall scaling timeline:

1. **Phase I (2025-2030): Foundation**
   - Focus: Establishing the core infrastructure, validating the bundle of innovations and LAFA delivery channels, and building capacity.
   - Activities:
     - Implement small-scale trials of fertilizer application tools in selected regions to validate their effectiveness.
     - Establish institutional frameworks and partnership platforms.
     - Operationalize the scaling strategies to achieve the innovation use target.

- Promote the LAFA service at the Farmer Training Centers (FTC) level and through digital channels, and pilot e-agri-kiosks.
- Link the DST to existing digital initiatives and promote small fertilizer packs.
- Strengthen the capacity of SMS/DAs for the LAFA service.
- Initiate a public-led scaling pathway using the well-established existing government extension structures.

- Investment Priorities: Technology development and data platform establishment, initial capacity building for extension staff, development of basic delivery systems, and securing funding for early adoption.

2. **Phase II (2031-2035): Scaling and Diversification**

- Focus: Expanding the reach of the LAFA to multiple regions and diversifying delivery channels.
- Activities:
  - Expand the pilot project to multiple regions, developing advisory tools and platforms and training programs for extension workers and farmers.
  - Institutionalize decentralized digital dissemination hubs, kiosks, and digital extension service agents.
  - Promote soil test-based e-delivery kiosks for the DST with a bundle of services.
  - Strengthen platforms at all levels, promote Coop Extension, and private extension for the DST.
  - Implement all potential scaling pathways, including public, PPP, COOPs, and private business pathways.
  - Integrate climate advisories and good agronomic practices into the DST.
- Investment Priorities: Scaling up digital infrastructure, developing diverse interfaces, strengthening partnerships, and investing in R&D to adapt the LAFA for different contexts.

3. **Phase 3 (2036-2040): Institutionalization and Sustainability**

- Focus: Achieving broad adoption of the LAFA and ensuring the financial sustainability of the program.
- Activities:
  - Institutionalize the DST through decentralized digital dissemination hubs, kiosks, and digital extension service agents.
  - Strengthen platforms at all levels to achieve institutionalization.
  - Focus on effective business models operationalized through private and cooperative entities.
  - Target specific farmer segments with credit and subsidy support services.
- Establish private and cooperative entities that can implement and sustain market-driven agricultural extension and advisory services.
- Launch a comprehensive national campaign to roll out and scale beyond Ethiopia.
- Investment Priorities: Developing market-based business models, strengthening local ownership, integrating the LAFA into routine agricultural practices, and ensuring long-term financial viability.

Annex 3. Key indicators and targets for the first five-year period

Key indicators and targets for a five-year period of the strategy and means of measurements and verification.

Results	Key performance indicators	Baseline	Target or milestones *for a five or six-year period*	Means OF verification *how will you measure* your results	Who will measure the results? periodicity
Impact	• Percentage of households experiencing food insecurity (reduced). • Average Dietary Diversity Score (increased). • Prevalence of stunting in children under 5 years (reduced). • Average household income (increased). • Average emission per unit of yield reduced	• 15–20% of rural households face moderate to severe food insecurity. • Dietary Diversity: average scores around 3.5 on a 7-point scale, • Stunting prevalence in the range of 35–40% among children under five. • Rural incomes are between US$500 and US$700 annually. • Job creation linked to agricultural innovations remains largely at a pilot or ad hoc stage.	After the right use of fertilizer, the households affected by food shortage will be reduced to 8%. Income increased by 15 to 20% varying by crops grown. Emission measured by ton CO2 equivalent per unit of yield is reduced by 15%	• Household surveys (e.g., Food Insecurity Experience Scale - FIES), food consumption surveys, and analysis of dietary diversity. • Surveys (e.g., Women's Dietary Diversity Score - WDDS, Household Dietary Diversity Score - HDDS). • Anthropometric measurements (height-for-age), Demographic and Health Surveys (DHS), and Multiple Indicator Cluster Surveys (MICS). • Income and expenditure surveys, financial records, and reports, and market price monitoring. • Emission monitoring	MoA, EIAR – Annually
Outcome 1	• Total agricultural production (volume or weight) of key crops/products (increased). • Average crop yields (increased). • Gross margin or profit per hectare/unit of production (increased).	• The average productivity of food crops is about 2.7 tons per hectare • Profit margins are low (often under $10 per unit investment)	The average productivity growth after the DST-based fertilizer advisories will increase by 30% Profit margin increased from $15 to $30	• Production data from the Ministry of Agriculture or related agencies, market survey data. • Yield assessments, farmer surveys, field measurements, and data from the Ministry of Agriculture. • Cost-benefit analysis, and enterprise budgets.	MoA, EIAR – Annually

Results	Key performance indicators	Baseline	Target or milestones *for a five or six-year period*	Means OF verification *how will you measure* your results	Who will measure the results? periodicity
Outcome 2	• Average cost of key inputs (fertilizer) per unit of production (reduced).	NA	NA	• Market price surveys on input cost analysis. • Reports on input use, and observation.	MoA, ATI – Annually
Outcome 3	• Value of imported agricultural inputs per unit of production (reduced).	NA	NA	• Trade data from customs or import records and import cost analysis. • Procurement records, farmer surveys, and supply chain analysis. • Financial records, and surveys of farmers and input suppliers.	MoA, Finance Ministry – Annually
Int Outcome 1	• Number of active men and women users of digital advisory platforms	None or 0.5% of the target farming population currently use digital advisory services, except innovation piloting	1 million farming households adopt LAFA by the end of 5th year	• System analytics, farmer registration • Farmer surveys, usage statistics from digital platforms, and mobile network operator data. • Usage data from digital platforms, and farmer surveys. • Farmer surveys, usage statistics from digital platforms, and gender-disaggregated data. • Farmer surveys, and feedback mechanisms.	EIAR, Digital Green, ICT-MoA – annually
Int. Outcome 2	• Number of coops, PPPs, and regions adopting digital solutions • Number of digital platforms/solutions implemented and sustained.	• Digital solutions are still mostly limited to a few pilot projects. • Only 1–2 main digital advisory platforms are	• 50% of extension agents and FTCs, and 30% of Coops adopt digital solutions • Digital platform hub	• Stakeholder feedback • Records of digital initiatives, platform usage data, and project reports. • Partnership agreements,	MoA, EIAR, Private Partners – Annually

Results	Key performance indicators	Baseline	Target or milestones *for a five or six-year period*	Means OF verification *how will you measure* your results	Who will measure the results? periodicity
	• Number of partnerships between public and private sectors (or other actors) for digital solutions (increased • Regulations supporting the use of digital solutions in agriculture (increased).	currently operational at a pilot scale. • Few partnerships among government, research institutions, and private actors. • Most initiatives are heavily reliant on donor support, with few cost-recovery models in place. • The regulatory framework for digital agriculture is in its early stages	established within MOA • A national convening platform of partners for facilitating scaling operation • Business model investments	memorandum of understanding, and collaboration reports. • Review of operational and maintenance plans, budget allocations, and stakeholder feedback. • Review of government documents, policy papers, and regulatory frameworks.	
Outputs	• Number of contents provided by the digital advisory services	There is digital advisory in piloting in the areas of fertilizer and ISFM such as IVR, videos, Chatbots	After the 5th year of the LAFA, about 5 distinct advisories/ contents developed (e.g., fertilizers, organics, lime, climate, crop rotation)	• Review of annual reports, policy briefs	National platform MELIA, MoA, EIAR
	• On-farm performance of digital fertilizer/ agronomic advisories	Preliminary results show that the DST on-farm performance is about 70 to 75%	At the end of the 5th year, and with the inclusion of more datasets, the performance will grow to over 90%	• Review of annual reports, policy briefs	National platform MELIA, MoA, EIAR
	• Number of crops addressed with digital fertilizer/ agronomic advisory services	Currently, the DST has been developed for 4 crops (tef, maize, wheat, and sorghum)	At the end of the 5th year of the project (2031), about 6 crops will be addressed.	• Review of annual reports, policy briefs	National platform MELIA, MoA, EIAR

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

About

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a pioneering International Organization committed to developing and improving dryland farming and agri-food systems to address the challenges of hunger, malnutrition, poverty, and environmental degradation affecting the 2.1 billion people residing in the drylands of Asia, Sub-Saharan Africa, and beyond.

ICRISAT was established under a Memorandum of Agreement between the Government of India and the CGIAR on the 28 March 1972. In accordance with the Headquarters Agreement, the Government of India has extended the status of a specified "International Organisation" to ICRISAT under section 3 of the United Nations (Privileges and Immunities) Act, 1947 of the Republic of India through Extraordinary Gazette Notification No. UI/222(66)/71, dated 28 October 1972, issued by the Ministry of External Affairs, Government of India.

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