TRANSFORM
TRANSFORMING SOILS, EMPOWERING FARMERS

Transform Soil Fertility Management in Ethiopia (TRANSFORM)

Inception Phase Report



October 2025

Consortium Partners

IFDC
WAGENINGEN UNIVERSITY & RESEARCH
ISRIC World Soil Information
ECFF Ethiopian Coffee Forest Forum
SOS SAHEL ETHIOPIA

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MINISTRY OF AGRICULTURE
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Acronyms

ACC	Agricultural Commercialization Cluster
ADPLAC	Agricultural Development Partners Linkage Advisory Council
AKIS	Agricultural Knowledge and Innovation System
AOSS	Agricultural One-Stop Shop
ATI	Ethiopian Agricultural Transformation Institute
ATVET	Agriculture Technical and Vocational Education and Training
B	Boron
CALM	Climate-Action through Landscape Management
CDD	Consecutive Dry Days
CERS	Central Ethiopia Regional State
DA	Development Agent
DAP	Diammonium Phosphate
ECFF	Environment and Coffee Forest Forum
EIAR	Ethiopian Institute of Agricultural Research
ETB	Ethiopian Birr
EthioSIS	Ethiopian Soil Information System
EU	European Union
FCS	Food Consumption Score
FSRP	Food Systems Resilience Program
FGD	Focus Group Discussion
FTC	Farmer Training Center
GIS	Geographic Information Systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GPS	Global Positioning System
HDDS	Household Dietary Diversity Score
ICT	Information and Communication Technology
HFIAS	Household Food Insecurity Access Scale
IFDC	International Fertilizer Development Center
IPP	Integrated Plot Plan
ISFM	Integrated Soil Fertility Management
ISRIC	ISRIC – World Soil Information
MELS	Monitoring, Evaluation, Learning, and Sharing
MFA	Ministry of Foreign Affairs
MFI	Microfinance Institution
MoA	Ministry of Agriculture
MoU	Memorandum of Understanding
MSME	Micro, Small, and Medium Enterprise
N	Nitrogen
NGO	Non-Governmental Organization
NSIS	National Soil Information System
P	Phosphorus
PI	PIP Innovator
PIP	Participatory Integrated Planning
PSNP	Productive Safety Net Program
RARI	Regional Agricultural Research Institute
RBoA	Regional Bureau of Agriculture
REFAC	Research-Extension-Farmers Advisory Council
RELC	Research-Extension Liaison Committee

S	Sulfur
SACCO	Savings and Credit Cooperative
SLM	Sustainable Land Management
SME	Small and Medium Enterprise
SSHI	Supporting Soil Health Initiative
SSFR	Site-Specific Fertilizer Recommendation
SWC	Soil and Water Conservation
WUR-WENR	Wageningen University and Research – Wageningen Environmental Research
TRANSFORM	Transform Soil Fertility Management in Ethiopia
VSLA	Village Savings and Loan Association
WFP	World Food Programme

Executive Summary

The Transform Soil Fertility Management in Ethiopia (TRANSFORM) program, funded by the Kingdom of the Netherlands and the European Union, is a four-year initiative (2025-2028) aimed at enhancing soil fertility and agricultural resilience in Ethiopia by addressing critical challenges such as nutrient depletion and soil acidity. With the goal of rehabilitating 65,000 hectares of farmland and strengthening the capacity of 100,000 small-scale producers, the program consists of four interrelated components: (i) provision of customized soil fertility extension services designed to enhance farmers' technical knowledge, decision-making capacity, and adaptive management skills; (ii) development of a vibrant and efficient soil input sector to ensure the reliable availability and accessibility of high-quality soil amendments and fertilizers; (iii) strengthening of research-extension interfaces through participatory, farmer-led action research that promotes context-specific and evidence-based innovations; and (iv) creation of an enabling policy and institutional framework that supports coordinated, integrated, and sustainable soil health and fertility management in Ethiopia.

Implemented through a consortium led by the International Fertilizer Development Center (IFDC) in partnership with Wageningen University and Research – Wageningen Environmental Research (WUR-WENR), ISRIC – World Soil Information, Environment and Coffee Forest Forum (ECFF), and SOS Sahel Ethiopia, the TRANSFORM program, together with Ministry of Agriculture (MoA), Regional Bureaus of Agriculture (RBoAs), the Ethiopian Institute of Agricultural Research (EIAR), and other government institutions and partners, aims to institutionalize sustainable soil fertility and land management practices, thereby contributing to a resilient, productive, and climate-adaptive agricultural system in Ethiopia.

The implementation strategy follows a phased approach, starting with an inception phase to establish operational foundations. This is followed by an intensive implementation phase that utilizes the Participatory Integrated Planning (PIP) approach to foster community-driven visioning and inclusive household decision-making, cascading knowledge through Farmer Innovators and first-generation farmer households, and training Development Agents (DAs) to educate innovative producers in selected woredas within targeted regions. The strategy concludes with a scaling phase, where the PIP approach will expand to additional woredas, emphasizing collaboration at the watershed level, leveraging insights from earlier phases, and focusing on institutionalization for widespread impact and sustainability.

This report focused on progress made during the inception phase, highlighting the key achievements of program objectives and lessons learned.

Program Setup and Partnerships

Following up the recruitment of management and administrative and technical program staff, the TRANSFORM program was formally established through the signing of an Operational Agreement with the Government of Ethiopia, providing a robust legal and institutional framework for implementation. This was followed by the TRANSFORM National Inception Workshop convened February 2628, 2025, in Addis Ababa, Ethiopia, serving as a strategic platform to align stakeholders on the scientific, technical, and operational dimensions of the program. During the workshop, the Monitoring, Evaluation, Learning, and Sharing (MELS) framework, key performance indicators, and feedback mechanisms designed to support adaptive management and continuous program improvement were reviewed and refined. The workshop also served to create the basis for the establishment of the governance of the program among the consortium members. Contracts between IFDC and implementing partners were also signed at this time. The TRANSFORM program was officially launched at national level on April 3, 2025. To ensure proper governance and collaboration a multi-tiered structure was

created, with the Project Management Team handling day-to-day operations, the Steering Committee providing key decision-making, and the Supervisory Board offering strategic oversight, ensuring accountability and evidence-based execution across all administrative and partnership levels. The Advisory Board, chaired by IFDC's President and CEO, was also established for strategic alignment, coordination, and leverage at the program level.

Baseline and Complementary Studies

During the inception period (January-August 2025), national and regional launches of the TRANSFORM program were conducted, allowing engagements with different stakeholders that fostered stakeholder coordination and raised awareness of sustainable soil management practices, ensuring alignment with local priorities and promoting community involvement. In the same period, several studies and assessments were conducted, including a comprehensive baseline study in 12 woredas across Amhara, Oromia, and Central Ethiopia Regional State (CERS) to evaluate soil health and fertility management; nutrition; gender, youth, and social inclusion and smallholder livelihoods; climate change adaptation and mitigation; erosion and drought; conflict sensitivity, development of soil inputs and business cases, and gender equity. Data were collected from 1,248 households using structured surveys, key informant interviews, and focus group discussions, ensuring demographic balance through stratified random sampling. TRANSFORM used a participatory approach for community selection across the 12 target woredas, identifying 48 kebeles (communities) for implementation.

Key Findings

- The average age of household heads was 44 years in intervention areas and 42 years in control areas. Younger farmers (under 35) adopted innovations more rapidly than older farmers (over 55). The literacy rate was 69% in intervention areas compared to 62% in control areas, with formally educated households being 1.73 times more likely to utilize agricultural inputs. Average household income stood at 43,836 Ethiopian birrs (ETB), with male-headed households earning 56% more than female-headed households.
- Farm size averaged 1.21 hectares, with each additional hectare increasing income by approximately ETB 81,980. The average dependency ratio was 86, indicating significant economic pressure on households.
- Men participated in soil management activities at a rate of 70%, while women participated at a rate of 65%. Female-managed plots produced 23% less teff, primarily due to limited access to improved agricultural inputs.
- Agronomic practices such as crop rotation and intercropping varied by region, with crop rotation adoption rates ranging from 87% to 94% and intercropping from 47% to 82%. Approximately 62% of households in Amhara and 61% in Oromia were food secure, while only 25% in CERS met the food security threshold.
- The Household Resilience Index indicated that 49% of households were not resilient, with vulnerability highest in Oromia (75%) and CERS (85%).
- Only 43% of households received mineral fertilizers on time and only 27% accessed organic inputs promptly. Input diversity was narrow, dominated by urea (67%), and farmer satisfaction with organic soil input quality was very low (5-9%).

Main Lessons Learned

The baseline and complementary studies conducted during the inception phase provided relevant information for successful implementation of subsequent phases of the TRANSFORM program: the intensive phase (2025-2026) and the scaling phase (2027-2028). These studies confirm the program's Theory of Change on the importance of the four program components

(pathways to change) and the need to tailor interventions to the socioeconomic context. These insights allowed the program to refine the Result Framework.

Based on the lessons learned and implications for the way forward, the key findings suggest that while there is an opportunity to leverage the high local knowledge of adult farmers and the technology adoption potential of youth, especially given the favorable literacy rate, significant systemic challenges must be addressed to improve soil health and farm productivity. Specifically, there is an urgent need to bridge the severe literacy and resource gaps for female-headed households, mitigate the strain that high dependency ratios and small fragmented landholdings place on resources, and overhaul the current service delivery models. The existing extension services are characterized by an inclusivity gap and low participation, and the soil input sector is constrained by high costs, scarce credit, and minimal private sector engagement. The path forward requires a shift to equity-focused participatory extension methods that utilize social networks; targeted financial and input support for women and vulnerable groups; a focus on strengthening the fragmented policy, legal, and institutional linkages between research, extension, and education; and promotion of local, adaptive research to scale up soil health and fertility management practices.

1 Introduction

The Transform Soil Fertility Management in Ethiopia (TRANSFORM) program is a four-year initiative (2025-2028) funded by the Kingdom of the Netherlands and the European Union (EU). The program targets critical soil fertility constraints, including nutrient depletion, soil acidity, erosion, and declining soil organic matter, that diminish soil health, reduce crop productivity, and threaten the sustainability of farming systems, thereby constraining food security and the resilience of rural livelihoods in Ethiopia.

The overarching objective of the TRANSFORM program is to advance sustainable land management and enhance agricultural resilience across diverse agroecological landscapes in Ethiopia. The program aims to rehabilitate 65,000 hectares (ha) of farmland into sustainable land use systems, strengthen the adaptive capacity of 100,000 small-scale producers and their production systems, and catalyze systemic transformation among local and multi-sectoral actors through enhanced scientific knowledge and institutional capacity in soil fertility and health management. These objectives underpin an integrated framework of interventions that interlink soil health restoration, agricultural productivity enhancement, and community resilience building.

Key targets include enabling smallholder farmers and communities to take an active role in maintaining and enhancing soil resources; developing an efficient and resilient soil input delivery system through strengthened private sector engagement; promoting inclusive, participatory, and bottom-up approaches to soil fertility management; and operationalizing an integrated ecosystem-based framework for the coordination and implementation of soil health and fertility initiatives.

TRANSFORM is structured into four interrelated components: (i) delivering customized soil fertility extension services to empower farming households and communities through knowledge and capacity enhancement; (ii) developing a dynamic and efficient soil input sector to ensure reliable access to essential soil health resources; (iii) strengthening research-extension linkages through participatory, farmer-led action research that fosters context-specific, science-based innovations; and (iv) creating an enabling policy and institutional environment that promotes coordinated and collaborative action among stakeholders for sustainable soil health and fertility management.

The program is implemented through a consortium led by the International Fertilizer Development Center (IFDC), in partnership with Wageningen University and Research – Wageningen Environmental Research (WUR-WENR), ISRIC – World Soil Information, the Environment and Coffee Forest Forum (ECFF), and SOS Sahel Ethiopia. Collectively, these partners work to institutionalize sustainable soil health and fertility management practices, contributing to a resilient and productive agricultural landscape in Ethiopia.

The program outlines a comprehensive phase-based implementation strategy spanning four years (2025-2028). It is structured into three sequential phases: the inception phase (January-August 2025), the intensive implementation phase (2025-2026), and the scaling phase (2027-2028). Each phase is designed to build progressively on the achievements of the preceding stage, establishing a coherent, adaptive framework for realizing the program's overarching goals in sustainable soil fertility enhancement and integrated land management.

The inception period focused on establishing the institutional, technical, and operational foundations of the program. Key activities included finalizing agreements among consortium partners, signing an operational agreement with government entities, conducting official program launches at both national and regional levels, and setting up Monitoring, Evaluation,

Learning, and Sharing (MELS), alongside the recruitment of program staff. Baseline assessments were conducted to evaluate the status of soil fertility management, private sector participation, and sectoral coordination.

Collaboration with ongoing national and regional initiatives was prioritized to ensure alignment and synergy in soil fertility interventions. In addition, the inception phase included the development of a detailed implementation plan emphasizing gender equality, youth inclusion, and social innovation. Capacity development efforts focused on enhancing gender responsiveness, strengthening institutional capacity, and promoting innovative, science-based soil management practices.

2 Implementation Approach and Community Selection

The TRANSFORM program employed a structured, evidence-based, and participatory approach to community selection and implementation, operationalizing the Participatory Integrated Planning (PIP) model across 12 target woredas. In each woreda, four communities were identified, with implementation starting in three priority communities to allow iterative learning and adaptive management. In total, 48 kebeles were selected for implementation. Expansion to the remaining communities was guided by performance outcomes and lessons learned, ensuring representativeness, scalability, and contextual responsiveness.

Central to this strategy was the PIP Innovator (PI) model, which facilitated farmer-led innovation and knowledge diffusion. In each community, 30 PIs were trained in PIP creation, each mentoring 10 additional farmers, forming a first cohort of 300 first generation PIP farmers. Selected farmers from this cohort became trainers in subsequent rounds, creating a self-replicating mechanism for horizontal learning and accelerated adoption of improved practices, thereby fostering broader community transformation.

A baseline study was conducted across the 12 woredas and included three treatment communities and one control community per woreda. The control communities were deliberately located at a considerable distance from treatment sites to minimize spillover effects. This spatial separation ensured accurate attribution of observed changes in productivity, soil health, and farming practices to the program interventions.

Community selection was undertaken through participatory consultations with the Woreda Office of Agriculture and key stakeholders, integrating local knowledge with scientific criteria. The main selection criteria included the degree of soil fertility and land degradation challenges, absence of overlapping interventions, adequate household population size (>500 households), accessibility through all-weather roads, and representativeness across the woreda. Desirable criteria considered local leadership quality, community readiness for change, socioeconomic and biophysical diversity, potential for innovation adoption, and clear scaling pathways.

A community selection matrix was applied to assign quantitative scores to each criterion, ensuring transparent, objective, and well-documented decision-making. By integrating scientific assessment with participatory governance, the process strengthened local ownership, empirical rigor, and the sustainability of the TRANSFORM program's interventions.

3 Description and Integration of Program Components

The TRANSFORM program integrates four interdependent components within a cohesive implementation framework based on PIP principles, promoting behavioral change, institutional capacity strengthening, and evidence-driven decision-making to enhance soil health and agricultural productivity. These components operate as a coherent demand-driven system,

connecting farmers, extension, research, markets, and policy through iterative feedback and adaptive learning.

Component 1 serves as the foundational pillar, generating demand for improved soil management through participatory planning, localized extension, and farmer capacity building. By identifying site-specific soil fertility constraints and input requirements, it catalyzes behavioral transformation and provides essential field-level information to guide the implementation of the other components, fostering ownership and ensuring the sustainability of program activities.

Component 2 responds to these demands by developing a diversified, resilient, and market-oriented input supply ecosystem. It operationalizes locally identified needs by facilitating access to nutrient-rich organic fertilizers, mineral fertilizers, lime, and other soil amendments. Through participatory research and validation in coordination with Component 3, it ensures the agronomic efficacy and contextual relevance of inputs and technologies.

Component 3 acts as the program knowledge hub, co-generating evidence, validating farmer innovations, and refining technologies emerging from Components 1 and 2. By integrating field-level feedback with adaptive learning frameworks, it translates practical experiences into robust, scalable innovations and policy-relevant evidence that inform Component 4.

Component 4 provides the strategic, institutional, and policy framework to sustain and scale program outcomes. It coordinates multi-stakeholder platforms, harmonizes regulatory instruments, and institutionalizes soil fertility management practices within national and regional governance systems, while promoting bottom-up extension approaches to ensure systemic adoption, resilience, and long-term sustainability. It facilitates an enabling environment for the success of the other three components.

Collectively, the four components create a dynamic closed-loop system: Component 1 generates demand, Component 2 supplies context-appropriate solutions, Component 3 validates and refines innovations, and Component 4 institutionalizes and sustains them. Continuous feedback loops encompassing lessons learned, policy options, and recommendations enable iterative adaptation and resilience. Partners, including IFDC, SWR-WENR, ISRIC, ECFF, and SOS Sahel Ethiopia, contribute across multiple levels from supply and research validation to policy formulation, reinforcing the program's integrated, responsive, and scalable approach, as presented in Figure 1. This systemic integration advances soil productivity, promotes agroecological intensification, and strengthens resilience across Ethiopia's diverse agricultural landscapes.

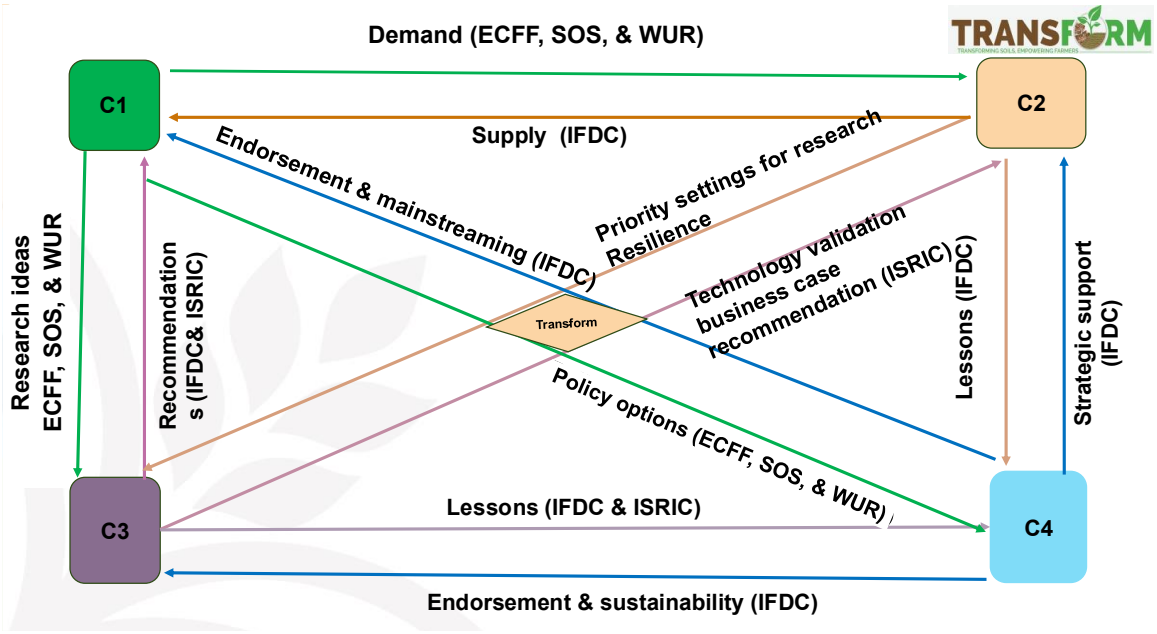


Figure 1. Functional integration and feedback loops among TRANSFORM program components and partners

4 Implementation and Results

The TRANSFORM program has made significant progress in setting up the governance and operational structures and advancement across the four components during the inception phase. These achievements will contribute to a set of foundational and refined planning documents and agreed-upon structures that formally transition the program from an approved proposal into an operational entity. The main output is the inception report, which synthesizes the results of all inception activities.

4.1 Management and Governance

4.1.1 Staffing and Office Operations

The TRANSFORM program has successfully recruited and trained all required personnel, achieving full operational capacity to implement activities across its targeted regions and woredas. The staffing structure includes the Program Director, Deputy Director, Component Leads, Gender and Youth Inclusion Specialists, Technical Specialists, MELS experts, and support teams for finance and procurement, complemented by collaboration with consortium partners and government actors, as presented in Figure 2.

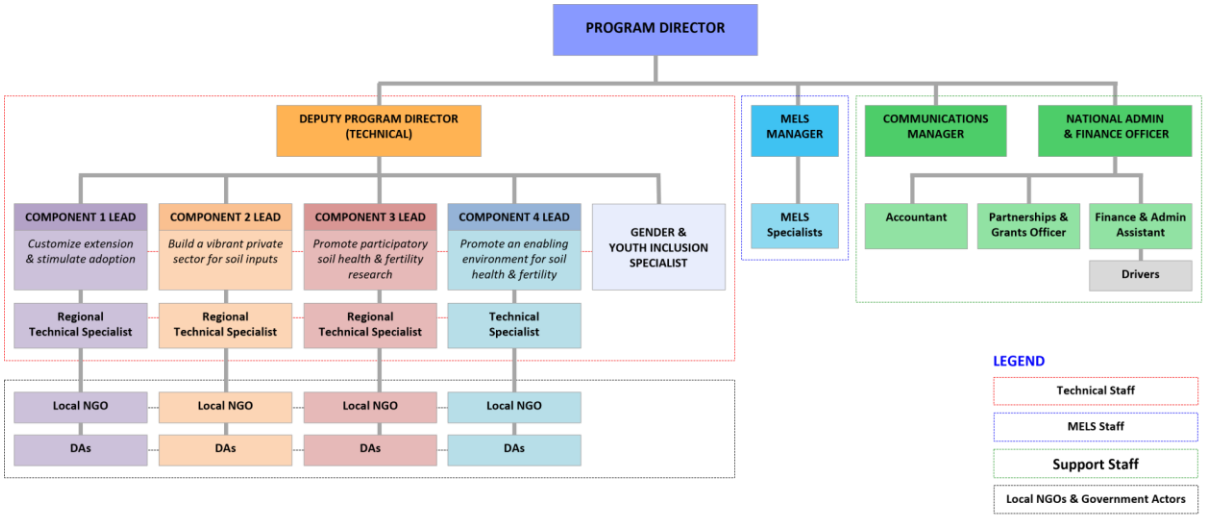


Figure 2. Organogram of the TRANSFORM program

The Program Director provides strategic leadership and oversight, ensuring alignment with program objectives and donor requirements. The Technical Team is led by the Deputy Program Director, who oversees program components. Component Leads (1-4) manage specific interventions, including customizing soil extension and adoption (Component 1), building a vibrant private sector for soil inputs (Component 2), promoting participatory soil health and fertility research (Component 3), and fostering an enabling environment for soil health and fertility (Component 4). Regional Technical Specialists provide field-level support, working directly with consortium partners and Development Agents (DAs) to ensure effective implementation. The Gender and Youth Inclusion Specialist ensures that program activities integrate gender-transformative approaches and youth engagement.

The MELS team is led by the MELS Manager, who directs monitoring, evaluation, learning, and sharing activities. MELS Specialists support data collection, analysis, reporting, and knowledge management, providing evidence-based insights to inform program decision-making. The support team includes the National Finance Officer, who oversees financial management and is supported by an accountant, as well as a Procurement Officer, who manages procurement and administrative operations.

Consortium partners and government DAs operate at the community level to deliver interventions directly to smallholder farmers, ensuring sustainability and local ownership of program activities. With all positions filled and staff fully trained, the TRANSFORM program is now operating at full capacity, enabling efficient and effective implementation across all target regions and woredas.

Staff capacity building involved comprehensive orientation on IFDC policies covering Human Resources, Talent Acquisition, Finance, Procurement, and UN Safety and Security, ensuring compliance and operational consistency. Gender-transformative training emphasized three pillars – Gender Lenses, Inclusive Mechanisms, and Dare to Be Bold – to promote equity and leadership. Additionally, a PIP Deep-Dive Workshop enhanced staff competencies in systems thinking, participatory planning, and adaptive program implementation.

A procurement and office operations component focused on establishing a functional and resource-efficient institutional infrastructure to support effective program implementation and coordination. The TRANSFORM program office was established and fully operationalized in Addis Ababa, utilizing existing IFDC office facilities to optimize resource use and ensure administrative efficiency. In parallel, three regional offices were established and operationalized in collaboration with consortium partners to strengthen decentralized

coordination, enhance field-level responsiveness, and facilitate stakeholder engagement. Essential equipment and supplies were procured to facilitate efficient program delivery; the procurement and installation of office furniture is in progress and scheduled for completion by December 2025 to finalize the full operational setup.

4.1.2 National Inception Workshop: A Unified Start

The TRANSFORM National Inception Workshop was successfully convened from February 26-28, 2025, in Addis Ababa, Ethiopia, serving as a strategic platform to align stakeholders on the scientific, technical, and operational dimensions of the program. The workshop brought together consortium partners, service providers, program staff, and key institutional stakeholders, fostering a unified understanding of the program objectives, components, and implementation strategies.

The event was officially opened by H.E. Prof. Eyasu Elias, State Minister of the MoA, who highlighted the program alignment with national agricultural transformation priorities. A keynote address was delivered by Dr. Oumou Camara, IFDC Vice President of Programs, emphasizing the consortium commitment to science-based implementation and collaborative learning.

Through structured discussions and interactive sessions, participants engaged in evidence-based discussions to strengthen coordination, facilitate knowledge exchange, and promote methodological coherence across all program components. The workshop successfully established a common framework for action, setting a solid foundation for collaborative, data-driven implementation across all consortium members.

The opening session established a collaborative and scientifically grounded backdrop for the workshop. Subsequent presentations elaborated on the program objectives, strategic components, and expected outcomes, with detailed discussions on methodologies, anticipated impacts, and operational considerations. The MELS framework session emphasized robust approaches for tracking progress, indicator definition, and data-driven monitoring, while adaptive feedback mechanisms and learning tools were discussed to strengthen evidence-based decision-making.

The workshop provided an opportunity to review and refine MELS frameworks, including baseline studies, key performance indicators, and feedback mechanisms designed to support adaptive management and continuous program improvement. Participants developed component-specific action plans, defining activities, timelines, resource allocations, and responsibilities, thereby operationalizing the program strategic vision across the inception, intensive, and scaling phases.

The PIP approach was introduced, highlighting farmer-focused planning methodologies designed to enhance extension services and support the adoption of best agroecological practices. Consortium partners provided updates on their roles, contributions, and planned interventions, reinforcing coordination and alignment.

Participants engaged in breakout sessions by program component to develop detailed action plans, including timelines, responsibilities, and resource allocations for all program phases. A subsequent plenary session consolidated and finalized these plans, ensuring integration across stakeholders and emphasizing the use of scientific evidence, technical expertise, and operational insights to maximize program effectiveness. Immediate next steps and accountability measures were established to ensure effective implementation across all program phases.

The workshop further addressed work plan refinement and operational considerations, including capacity building initiatives to enhance technical skills in soil health and fertility

management, strategies for community engagement to foster adoption of best practices, and the development of educational and extension materials to support farmer-led implementation. Partnership coordination was reinforced through a review of roles, responsibilities, collaboration mechanisms, and resource allocation among consortium members, while funding and resource distribution were examined to ensure transparency, accountability, and operational readiness.

Key outcomes of the inception workshop included following:

- Component-specific action plans were developed, detailing timelines, milestones, activities, and responsibilities for the inception, intensive, and scaling phases.
- The MELS framework was defined, including data collection methods, indicators, and feedback systems to support adaptive management and evidence-based decision-making.
- Capacity building and community engagement strategies were identified to ensure sustainable adoption of best agroecological and soil fertility practices.
- Consortium coordination mechanisms were strengthened, clarifying roles, responsibilities, and resource allocation among partners.
- Participants acquired a comprehensive understanding of the scientific, operational, and governance aspects of the program, enhancing readiness for efficient and effective implementation.

The workshop concluded with a plenary discussion summarizing key decisions, action items, and strategic alignment, providing a solid foundation for the effective implementation of the TRANSFORM program and supporting sustainable improvements in soil fertility management, agricultural productivity, and rural livelihoods.

4.1.3 Administrative Kickoff

The administrative kickoff focused on knowledge sharing on EU regulations and financial management, conducted by the Embassy of the Kingdom of the Netherlands in Ethiopia. The session provided the TRANSFORM team with a comprehensive understanding of the regulatory and financial governance frameworks that guide EU-funded programs, emphasizing compliance, accountability, and adherence to sound financial management principles in strict accordance with the Ministry of Foreign Affairs (MFA) General Conditions.

The session highlighted the Role of the MFA (Art. 2.5) in ensuring that obligations under the Contribution Agreement for Indirect Management Actions are fully met. Key discussion points included narrative reporting and financial reporting, supported by example formats for financial reports, as well as guidance on the eligibility of costs (Art. 16). Participants learned about the notional approach, under which costs ineligible for EU co-financing may be covered by the MFA or other co-financers, ensuring clarity in financial accountability. Error analysis was emphasized to categorize financial discrepancies, prevent irregularities, and reinforce evidence-based decision-making.

The session also addressed visibility requirements for EU-funded programs. Recipients are obligated to acknowledge the source of funding and ensure its visibility, primarily through the use of the EU logo, accompanied by a funding statement. Activities and costs related to visibility are considered eligible, and the EU retains the right to use communication materials produced by recipients.

In terms of consortium governance, it was noted that TRANSFORM is implemented through consortium partners. Partnership agreements must be established promptly, defining the roles and responsibilities of consortium members. All members are considered beneficiaries of the EU contribution. IFDC serves as the lead entity, responsible for receiving the formal

contributions, implementing project activities, and ensuring compliance of all consortium members with the obligations attached to the funding.

Finally, participants were directed to key reference documents for further guidance, including the Contribution Agreement Manual, the contribution contract between the MFA and IFDC and its annexes, and the European Commission's Communicating and raising EU visibility: Guidance for external actions. This comprehensive orientation reinforced the TRANSFORM team's understanding of the regulatory, financial, and operational obligations associated with EU-funded programs, ensuring transparent and accountable program implementation.

4.1.4 Program Setup and Partnerships

The TRANSFORM program was formally established through the signing of an Operational Agreement with the Government of Ethiopia, providing a robust legal and institutional framework for implementation. Complementing this agreement, formal engagement letters were issued to three RBoAs, facilitating coordinated interregional collaboration and ensuring alignment of program activities with regional agricultural development priorities. These arrangements enable structured communication, regulatory compliance, and efficient resource mobilization across administrative levels, thereby strengthening the foundation for evidence-based program implementation.

Consortium Governance

The Consortium Governance Agreement was fully signed, defining the roles, responsibilities, and obligations of all consortium partners, including IFDC, WUR-WENR, ISRIC, ECFF, and SOS Sahel Ethiopia. In addition, consortium-specific agreements were finalized between IFDC and individual partners, specifying operational modalities, reporting structures, and deliverables. A Service Provider Agreement with Resilience BV was also established to provide technical support and specialized services that complement program objectives. Collectively, these agreements create a comprehensive legal and operational framework to guide program implementation and ensure accountability.

Holistic Governance Framework

TRANSFORM operates under a multi-layered governance framework integrating the Project Management Team, Steering Committee, Supervisory Board, and Advisory Board. This framework provides strategic oversight, operational management, scientific guidance, and stakeholder engagement.

The governance bodies were activated as follows: the Project Management Team convened its fourth monthly meeting, with regular monthly sessions scheduled, and is responsible for day-to-day program management and operational execution; the Steering Committee held two meetings, with quarterly sessions planned, functioning as the primary decision-making body of the consortium and addressing key implementation issues; the Supervisory Board conducted its first biannual session, providing strategic direction and oversight, approving work plans, annual reports, and budgets; and the Advisory Board is scheduled to meet annually in mid-December 2025, offering strategic guidance, ensuring alignment with national policies, and representing consortium interests.

This multi-tiered governance framework integrates operational management, strategic decision-making, and scientific advisory functions, thereby promoting evidence-based implementation, accountability, and alignment with both national and regional development objectives.

4.1.5 Program Launch, Promotion, Awareness, and Sensitization

TRANSFORM was officially launched at the national level in Addis Ababa, attracting over 80 high-level leaders, experts, and stakeholders. The national launch convened senior officials, including H.E. Prof. Eyasu Elias, State Minister of Agriculture; Paula Schindeler, Deputy Head of Mission of the Embassy of the Kingdom of the Netherlands; Mercedes Marin Nortes, Senior Policy Officer of the European Union; Henk van Duijn, President and CEO of IFDC; and Prof. Nigussie Dechassa, Director General of EIAR. The event also included other senior representatives from the Ethiopian Agricultural Authority, Ethiopian Cooperative Commission, Agricultural Transformation Institute, and RBoAs, and research institutes from Oromia, Amhara, and CERS. In addition, high-level diplomats from Embassy of the Kingdom of the Netherlands and the European Union, representatives from CGIAR centers, international and local NGOs, and other development partners participated, providing a strategic platform to present the program objectives, scientific rationale, and expected outcomes, while fostering institutional and political commitment for sustainable soil health and fertility management in Ethiopia. The presence of national institutions alongside international collaborators underscored the program significance as an evidence-driven initiative with both global relevance and local applicability.



More than 80 leaders, experts, and stakeholders gathered in Addis Ababa for the national program launch, April 3, 2025

Following the national launch, regional program launches were conducted to contextualize the program's scientific agenda within local agroecological and socioeconomic realities. The Oromia launch was held in Adama and engaged over 75 participants; the Amhara launch in Kombolcha involved more than 70 participants; and the CERS launch in Halaba was attended by over 40 participants. These regional events provided platforms for interactive discussion with regional government representatives, research institutes, extension services, and farmer organizations, ensuring that program interventions are tailored to local conditions, responsive to regional priorities, and aligned with broader development strategies.

At the sub-regional level, the program implemented six zonal and 12 district-level promotional, awareness, and sensitization campaigns. These engagements employed participatory approaches, stakeholder discussions, and community-based outreach to disseminate knowledge on ISFM practices. The campaigns reinforced multi-tiered governance alignment from federal to regional, zonal, and district levels while mobilizing a diverse array of stakeholders, including farmer cooperatives, private sector actors, local agribusinesses, and civil society organizations.

Collectively, the national, regional, and sub-regional launch activities significantly enhanced program visibility, strengthened stakeholder coordination, and facilitated policy advocacy across governance levels. These initiatives fostered an enabling environment for cross-sectoral collaboration, evidence-based decision-making, and the scaling of sustainable soil fertility innovations. By integrating scientific, operational, and participatory approaches, the launch events established a robust foundation for both the scientific advancement and practical implementation of soil fertility management interventions throughout Ethiopia.

4.1.6 Strategic Stakeholder Engagement

TRANSFORM implemented a comprehensive stakeholder engagement strategy, targeting key governmental, research, and private sector actors to ensure alignment, collaboration, and synergistic impact in soil health and fertility management interventions.

Engagement with Government Agencies

Structured consultations and technical meetings were conducted with the MoA, RBoAs, EIAR, Ethiopian Agricultural Transformation Institute (ATI), ATVET institutes, and leading universities. These interactions are designed to facilitate policy alignment, co-development of soil fertility innovations, capacity building, and harmonization of program objectives with national and regional agricultural development strategies.

Engagement with Complementary Programs

The program strategically aligns its activities with ongoing complementary initiatives to leverage resources, enhance knowledge exchange, and avoid duplication:

- **MoA and EIAR:** Collaborative linkages established with the Food Systems Resilience Program (FSRP), the Productive Safety Net Program (PSNP), and the Climate-Action through Landscape Management (CALM) initiative.
- **ATI:** Engagement with the Agricultural Commercialization Cluster (ACC) to promote scaling of best-fit soil fertility technologies.
- **Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ):** Coordination with Integrated Soil Fertility Management Plus (ISFM+), Soil Matters, the Supporting Soil Health Initiative (SSHI), ETH-Soil, to integrate evidence-based interventions.
- **Gates Foundation-Funded Soil Health Projects:** Partnership with projects supported by the Gates Foundation to harmonize soil health research and extension.
- **CGIAR-EIAR-ISRIC:** Collaboration on soil landscape characterization and management through the Land Suitability Classification initiative.

Engagement with the National and Foreign Private Sector

Strategic alliances are established with leading national and foreign private sector entities, including Dutch companies, to foster public-private partnerships for technology dissemination, market integration, and value chain development. Key partners include Holland Dairy, Zuqualla Horti PLC, and Chico Meat. These collaborations aim to promote sustainable intensification, facilitate the adoption of ISFM practices, and strengthen linkages between research, extension, and the private sector. Collectively, these multi-tiered engagements enhance program visibility, strengthen stakeholder alignment, support evidence-based policy advocacy, and provide a robust foundation for scaling sustainable soil fertility innovations across Ethiopia.

4.2 Progress in Program Component Implementation

4.2.1 Component 1: Customized Extension Services

Component 1 of TRANSFORM focuses on customizing soil health and fertility management extension services through the empowerment of farmer households and communities, strengthening the capacity of Das, and enhancing institutional capabilities. The goal is to promote the adoption of practices to restore soil health and foster responsible stewardship of natural resources following the PIP approach. The central of this component is the PIP a bottom-up and demand-driven extension approach that forms the core of Component 1 and aims to build a foundation for sustainable change in rural communities by empowering smallholder producers to become proactive stewards of their land, fostering resilient and

sustainable farms and communities and emphasizing integrated soil fertility management (ISFM) for soil health and fertility restoration. The PIP approach comprises a set of comprehensive modules designed to address the multifaceted challenges of soil degradation through stakeholder awareness raising and capacity building. These modules are tailored to a bottom-up extension system and implemented sequentially at household, community, and landscape levels to foster sustainable land management at scale within the intervention woredas. The first five modules of the PIP approach are most relevant and are being customized to the contexts of the different regions where TRANSFORM will operate, with structured training materials that facilitate the successful implementation of the project. The five modules are: Module 1 – Awareness raising at kebele level; Module 2 – Creation of household PIPs with PIP Innovators (PIs); Module 3 – Creation of Integrated Plot Plans (IPPs) with PIs; Module 4 – Community-Led Land Restoration; and Module 5 – PIP Competition and Scaling.

During the inception phase, TRANSFORM program focused on Module 1, aiming at introducing the PIP approach to all community members and local leaders. It helped participants understand their local context, identify aspirations, and develop a shared vision for the future of the community, creating the community PIP.

Key achievements include:

Preparing a Participatory Approach: The TRANSFORM program successfully trained all its staff and key national and regional stakeholders in the PIP approach. The comprehensive training was conducted in two rounds for staff, including a separate session for the district-level Community Development Facilitators and Technical Specialists to ensure deep operational understanding. In total, over 119 male and seven female participants across staff and external stakeholders were oriented on the PIP methodology.

The TRANSFORM program conducted key capacity building activities, including training on gender-responsive extension, behavioral change, and facilitation skills for both TRANSFORM staff and 83 national/regional stakeholders. Concurrently, program tools were contextualized: the PIP module and image boxes were adapted with consortium partners, and soil health practices were tailored for women and youth with national and regional stakeholders. These preparatory steps culminated in the development of selection criteria and the successful selection of 48 kebeles across 12 woredas to launch program implementation. The DAs located at each kebele (75 male and 27 female) and subject matter experts were trained on the PIP approach and action research.

The implementation of PIP Module 1 started across all 48 selected kebeles. The preliminary meetings were conducted across all 48 kebeles with the participation of 1,711 farmers. The General Assembly, which involved a total of 10,824 farmers (225 farmers per kebele) across all woredas, was completed. The Assembly selected 40 PI farmers per kebele, selected the Kebele Vision Committee (KVC), developed a kebele vision, and selected one watershed for restoration through collective actions.

4.2.2 Component 2: Building a Vibrant Sector for Soil Inputs

Component 2 is designed to address critical bottlenecks in the agricultural input system by enhancing the availability, accessibility, and appropriate utilization of soil input, including mineral fertilizers, lime and biochar, and organic fertilizers. The current agricultural system is heavily reliant on imported mineral fertilizers (e.g., urea, diammonium phosphate [DAP], and nitrogen, phosphorus, and sulfur [NPS] products), which are subject to foreign exchange constraints and limited domestic production capacity. Component 2 aims to stimulate a diversified, resilient, and commercially viable soil input market, promoting private sector engagement and ensuring equitable access to smallholder farmers.

The objective of this component is to establish a self-sustaining soil input sector that delivers high-quality, context-specific fertilizers and soil amendments while supporting soil nutrient cycling, improved crop productivity, and environmental sustainability. Success is measured through eight specific results, including increased local production, enhanced market accessibility, and improved on-farm application practices (Figure 3).

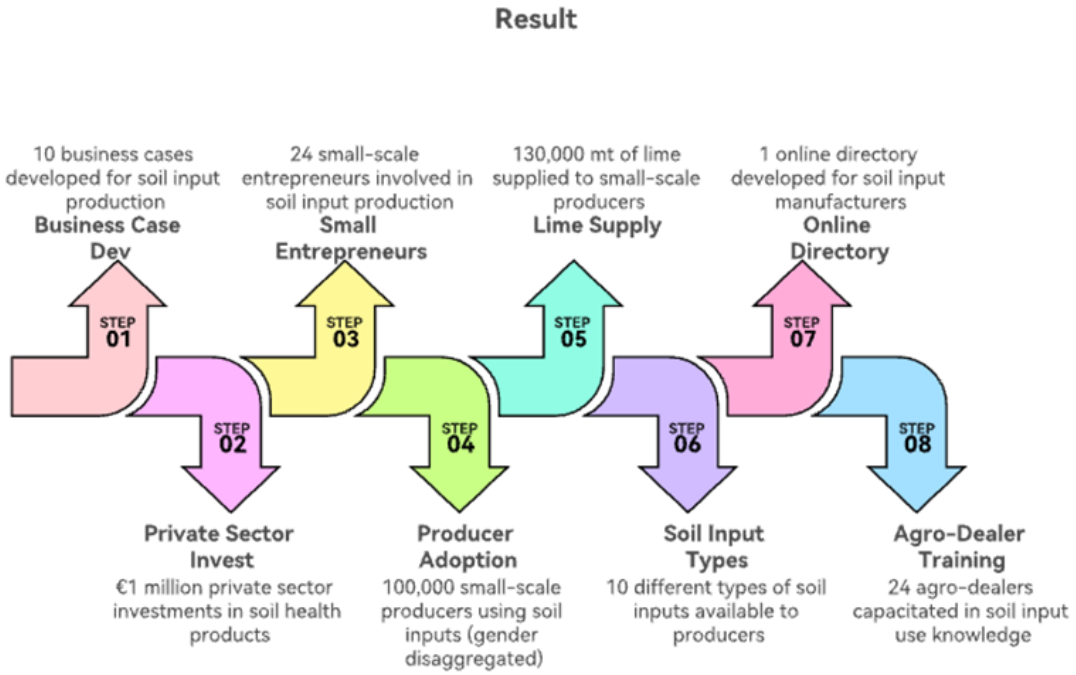


Figure 3. Stepwise pathway and key results of soil input production, adoption, and capacity building interventions

Key achievements include:

Development of soil inputs and business cases analysis was done for the domestic production of soil inputs. Analysis of key soil input products and market constraints, business case, and proposed support activities were conducted. Small and medium enterprises (SMEs) (276 males and 74 females) were organized and trained on the local production of soil inputs.

4.2.3 Component 3: Strengthening the Research-Extension Linkage

Component 3 aims to strengthen functional linkages among research, extension, and education systems to improve soil health management and agricultural productivity. It promotes the farmer-led action research approach that empowers farmers to co-identify challenges, test innovations, and develop context-specific solutions with researchers and extension agents.

The component addresses systemic constraints such as institutional fragmentation and weak coordination by fostering participatory research, institutional collaboration, and adaptive learning within the Agricultural Knowledge and Innovation System (AKIS) in Ethiopia.

The objectives of this component are to:

- Strengthen coordination and feedback between research, extension, and education institutions and farmers.
- Promote farmer-led demand-driven research for soil fertility and productivity improvement.
- Integrate participatory learning into university and ATVET curricula.
- Enhance evidence-based decision-making through data sharing and digital tools.

Key achievements include:

A high-level consultative workshop, featuring the TRANSFORM technical team, stakeholders, and Professor Eric Smaling, was successfully held to discuss the development of organo-mineral fertilizers. This consultation led directly to the planning of extensive training for 74 male and 7 female national and regional research institutes and agricultural extension workers. Furthermore, comprehensive training materials were developed for researchers, as well as for ATVET teachers and students, covering various soil health and fertility management practices.

4.2.4 Component 4: Enabling Environment for Soil Health and Fertility

The enabling environment for soil health and fertility management represents a strategic component of the TRANSFORM program aimed at establishing an institutional, regulatory, and operational ecosystem conducive to sustainable soil management. This component emphasizes systemic interventions that integrate multi-stakeholder coordination, policy, and regulatory support and institutionalization to enhance agricultural productivity, soil resilience, and long-term ecological sustainability.

The primary objective of this component is to foster a collaborative, evidence-driven, and policy-supported environment for soil health and fertility management. By engaging actors across public, private, academic, and civil society domains, this component aims to harmonize soil management initiatives, promote innovation, and strengthen the governance of soil resources at national and regional scales. Generally, Component 4 operationalizes a systems-based approach to soil health and fertility management. By integrating multi-stakeholder coordination, science-driven policy formulation, and institutional capacity development, the component aims to create a resilient enabling environment that enhances agricultural productivity, supports sustainable land management, and facilitates scalable innovations in Ethiopian agroecosystems.

Key achievements include:

Supported by consultancy services, the TRANSFORM program completed the mapping of existing platforms. This foundational work will facilitate the establishment of new multi-stakeholder platforms at the national and regional levels in 2025. These crucial platforms will serve as forums to discuss and resolve issues related to policies, regulations, and guidelines, ultimately working to create an enabling environment for the program's success.

5 Baseline Assessment

A baseline assessment of soil health and fertility management was conducted across 12 woredas in Amhara, Oromia, and CERS. These states were selected based on agroecological diversity, variability in soil conditions, socioeconomic differentiation, and inclusion of gender and youth perspectives. The study aimed to ensure a comprehensive understanding of agricultural practices and interventions by consulting with regional agricultural authorities and selecting kebeles that reflect diverse soil management scenarios.

A mixed-methods design was employed, integrating quantitative and qualitative data collection. Structured household surveys involving 1,248 smallholder farmers provided quantitative evidence, while key informant interviews and focus group discussions yielded complementary qualitative insights. Stratified random sampling ensured balanced representation across demographic groups, emphasizing gender and age inclusivity. The data collection process emphasized rigorous quality assurance measures to maintain data integrity and reliability. Quantitative data were analyzed using statistical software, whereas qualitative data were examined through systematic thematic coding to capture contextual and behavioral

dimensions. Ethical principles, including informed consent and participant confidentiality, were rigorously applied, particularly for vulnerable populations. This methodological framework established a scientifically credible baseline for monitoring and evaluation, underpinning evidence-based interventions aimed at enhancing soil fertility, sustainable agricultural productivity, and food security among smallholder farmers in Ethiopia.

5.1 Farm Household Analysis

A farm household analysis generated empirical insights into the socioeconomic and demographic characteristics of smallholder farming systems across 12 woredas in Amhara, Oromia, and CERS. It examined household composition, education level, landholding size, income structure, and dependency ratios to understand how these variables influence agricultural productivity, resource utilization, and adaptive capacity. The analysis highlighted key patterns shaping household livelihoods, including variations in farm size, income diversification, and labor allocation. It further explored relationships between demographic attributes and production outcomes, providing evidence on how household-level dynamics affect efficiency and resilience within farming systems. The findings offer a strong analytical basis for identifying structural constraints, designing targeted interventions, and informing strategies that enhance soil health, agricultural productivity, and sustainable livelihoods among smallholder farmers.

Age of the Household Head

The average age of household heads in intervention kebeles was 44 years, while in control kebeles, it was 42 years. Older farmers (over 55) tend to have lower productivity due to declining physical strength and limited access to resources, particularly for older women. Conversely, younger farmers (under 35) show higher adoption rates of innovative practices and technologies, which can enhance productivity.

Level of Education

Education plays a critical role in improving agricultural productivity. The literacy levels were 62% in control kebeles and 69% in intervention areas, with a significant difference favoring the latter. Educated farmers are more likely to adopt modern agricultural techniques, manage resources effectively, and access markets. Studies indicate that education significantly boosts farm productivity, with formally educated households being 1.73 times more likely to use agricultural inputs compared to uneducated ones.

Family Size of Rural Households

Family size impacts labor availability and resource allocation (Figure 4). The average family size in the study areas was 5.2. Households with larger family sizes may benefit from increased labor but often face lower land productivity due to fragmentation. The study found a negative correlation between family size and productivity, indicating that larger families might struggle to invest in improved agricultural technologies due to resource dispersion.

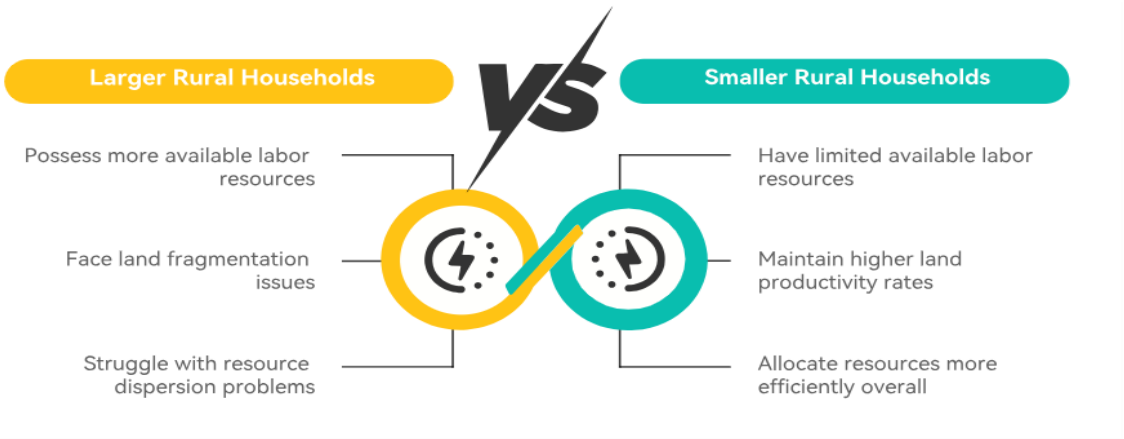


Figure 4. Rural family size impact

Farm Size

Farm size directly influences food security and productivity, with the average landholding in the study area being 1.21 hectares, compared to the national average of 0.96 hectares. The study revealed that larger farm sizes positively correlate with income, as each additional hectare increased income by approximately ETB 81,980. However, the study also highlighted the challenges of land fragmentation, which reduces efficiency and productivity.

Household Crop Productivity Level

Crop productivity varied across different crops and kebeles, with control areas showing slightly higher yields for certain crops such as wheat and teff, while intervention areas performed better in barley and maize. The average annual household farm income was ETB 43,836, with no significant difference between control and intervention groups.

Average Farm Income

Average farm income plays a crucial role in the use of high-quality agricultural inputs, thereby boosting productivity (Figure 5). The overall annual household farm income in the study area averaged ETB 43,836, coming from various sources such as crop and livestock production, off-farm activities, the PSNP, and remittances. Male-headed households earned 56% more than female-headed households, while youth households earned 26% more than adult households due to their quicker adoption of technologies and risk-taking. The study emphasized income diversification, with 71% of income coming from mixed crop-livestock farming, which is vital for minimizing risks and enhancing climate resilience. Notably, a 10% increase in farm income could result in a 6.5% increase in cereal yields, indicating a strong link between income and productivity.

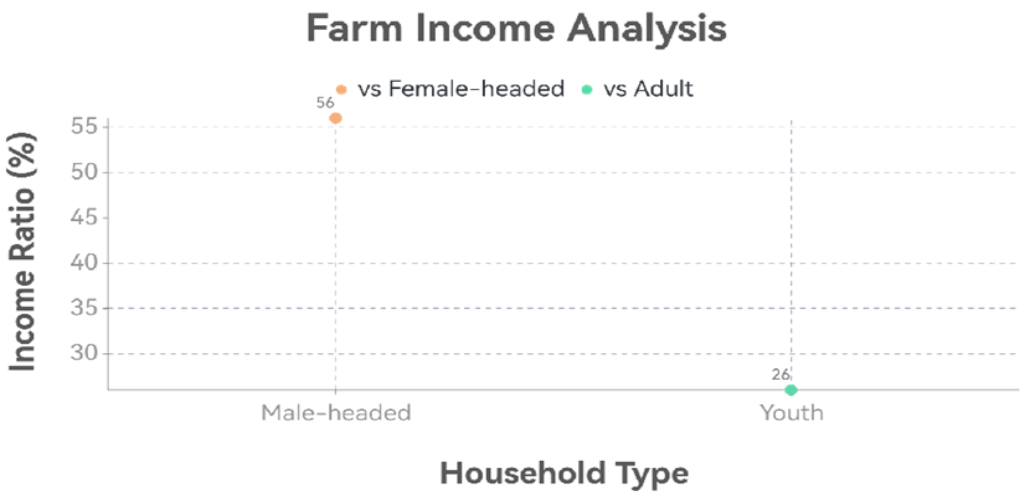


Figure 5. Farm income analysis by gender and age

Dependency Ratio

The dependency ratio compares the economically active population to dependents. The dependency ratio across the study areas was high, averaging 86. This reflects a substantial economic burden on households, particularly in regions where the ratio exceeds 100, increasing the risk of food insecurity. Households with higher dependency ratios often invest less in agricultural improvements, as most of their earnings are allocated to meeting the needs of dependents. Addressing these challenges requires integrated strategies to enhance productivity and provide targeted support to vulnerable households.

The farm household analysis led to the conclusion that maximizing agricultural productivity requires a targeted, inclusive approach. The following four strategic recommendations are proposed to close key gaps related to access, technology, and land use.

- **Prioritize Youth-Targeted Technology Bundles:** Integrate specialized technology and training for youth to capitalize on their high adoption rates and drive agricultural innovation.
- **Implement Female-Focused Input Credit:** Launch gender-sensitive credit programs to close the input access gap for female farmers and enhance their productivity.
- **Promote Cluster Farming Models:** Support cluster farming to reduce land fragmentation and increase productivity through collective action and optimized input use.
- **Integrate Disability-Inclusive Extension:** Embed accessible protocols into extension services to ensure farmers with disabilities benefit fully from agricultural improvements.

5.2 Cross-Cutting Themes

Household Decision-Making

Household decision-making in Ethiopia, traditionally shaped by patriarchal norms, exerts a significant influence on agricultural practices, including crop selection, labor allocation, and technology adoption, thereby affecting farm productivity (Figure 6). Gender-responsive interventions are promoting a transition toward joint decision-making. A study of male-headed households indicates that joint decision-making occurs in 56% of intervention households and 51% of control households, with the highest prevalence observed in the CERS (83%), highlighting the positive contribution of collaborative decision-making to agricultural

outcomes. These findings underscore the importance of actively engaging both men and women to enhance equitable participation and optimize productivity.

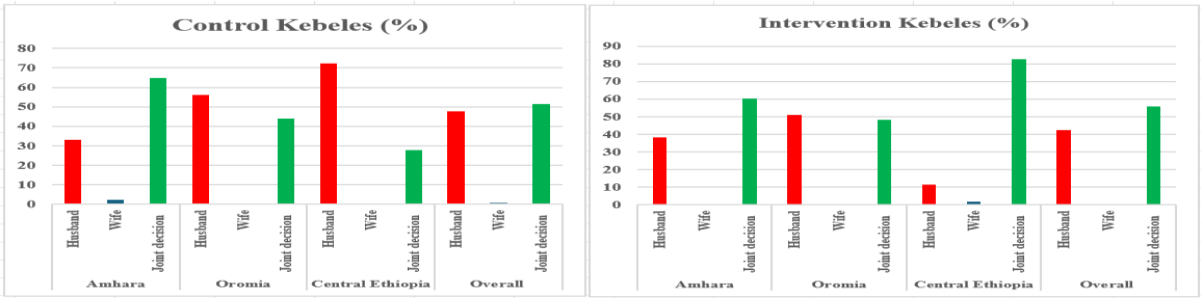


Figure 6. Household decision-making

Gender Roles and Access in Crop Production and Soil Fertility Management

In smallholder farming systems, both men and women play integral roles in soil health and fertility management, with participation rates of 70% for men and 65% for women in intervention areas (Figure 7). This finding is reinforced by the study's deliberate focus on including female-headed households. Despite their significant contributions to labor, women's productivity often lags behind that of the male counterparts; for instance, female-managed plots yield 23% less teff. This discrepancy is primarily attributed to limited access to essential improved agricultural inputs, such as fertilizers and high-quality seeds.

To mitigate this gender disparity and unlock the considerable economic benefits associated with women's empowerment, estimated by the World Bank to potentially increase the gross domestic product (GDP) by U.S. $5 billion annually, it is imperative for TRANSFORM to implement strategies that substantially empower women in agricultural practices.

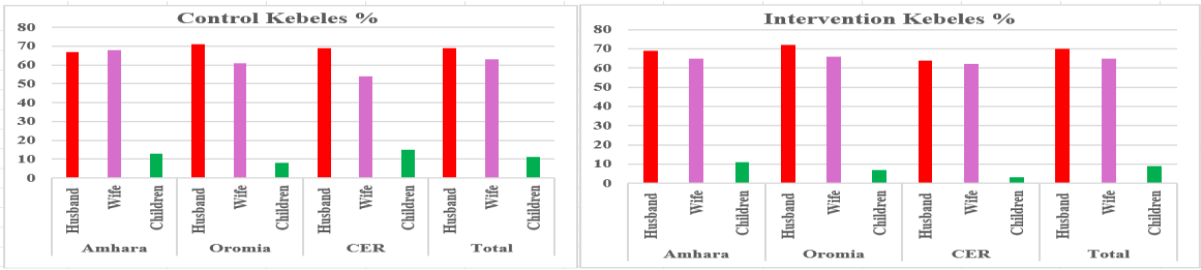


Figure 7. Gender roles in soil health and fertility management activities, 2025

Social Networks

Social networks consist of the intricate webs of relationships that farmers cultivate with peers, relatives, cooperatives, and extension agents. In the Ethiopian context, these networks are essential for sharing information, pooling resources, and facilitating collective action. In the study areas, approximately 70% of both men and women in intervention and control groups reported having established such networks (Table 1).

These networks serve as critical conduits for disseminating knowledge, particularly regarding new agricultural technologies, practices, and services. Recognizing the importance of these social structures, TRANSFORM has a substantial opportunity to leverage these networks to enhance the effectiveness of agricultural outreach and innovation dissemination.

Table 1. Farmers' participation in social networks

Region	Household Members	Control		Intervention	
		No.	%	No.	%
Amhara	Husband	88	68	262	67
	Wife/FHH	86	66	259	66
	Children (>18 years)	4	3	15	4
Oromia	Husband	109	70	321	69
	Wife/FHH	105	67	328	70
	Children (>18 years)	4	3	11	2
CERS	Husband	18	69	51	65
	Wife/FHH	19	73	60	77
	Children (>18 years)	1	4	2	3
Total	Husband	215	69	634	68
	Wife/FHH	210	67	647	69
	Children (>18 years)	9	3	28	3

FHH: Female-headed household.

Farmers Organizations and Social Capital

Farmer cooperatives and unions in Ethiopia, numbering over 80,000, are essential for boosting agricultural productivity. Membership is notable, with 55% of men and 39% of women in intervention kebeles involved, compared to 47% and 34% in control kebeles, respectively. These cooperatives provide significant benefits, such as 20-30% savings on bulk purchases and enhanced borrowing capacity, which improve economic stability for members. They also form a strong social capital network that facilitates quick information exchange, risk-sharing, and community mobilization. This network serves as an advantageous entry point for the TRANSFORM program, enabling effective dissemination and implementation of extension activities to promote sustainable agricultural practices.

Disability Inclusion and Accessibility

Disability, encompassing physical or mental impairments that limit major life activities, presents significant barriers to participation in socioeconomic spheres. In rural Ethiopia, national reports indicate a disability prevalence of 16% (Central Statistical Agency and ICF, 2017), while the study found a prevalence of only 5% in the study areas, highlighting potential discrepancies. To improve accessibility and inclusion, it is essential to enhance extension services by training DAs on the needs and rights of individuals with disabilities. This training should focus on fostering inclusive agricultural practices and removing physical barriers, thereby empowering individuals with disabilities to participate actively in agricultural productivity. Strengthening these services is vital for ensuring equitable access to resources and improving the livelihoods of marginalized populations.

5.3 Soil Management Practices

Soil Fertility Status

Across the 12 intervention woredas, soil conditions range from neutral to moderately acidic, with negligible salinity, indicating a generally favorable edaphic environment for agricultural production. Nonetheless, widespread macro- and micronutrient deficiencies were detected, particularly in phosphorus (P), sulfur (S), boron (B), and nitrogen (N). In the Amhara woredas, soils are predominantly neutral in reaction but exhibit critically low concentrations of these essential nutrients. In Oromia, soil acidity constitutes a major constraint in Gera and Tiyo woredas, whereas Sire displays slight alkalinity; however, all three sites are consistently deficient in P and B. In the CERS (Halaba/Weira), soils are largely neutral and non-saline but

characterized by very low P and S levels. These findings underscore the urgent need for systematic soil testing, site-specific nutrient management, and the adoption of ISFM approaches to restore nutrient balance and enhance soil productivity and resilience.

Agronomic Management and Crop Production Practices

A wide variety of crops are cultivated across the intervention regions, reflecting the heterogeneity of agroecological conditions, land resource endowment, and household livelihood strategies. Farmers typically grow a combination of cereals, legumes, root and tuber crops, and horticultural species, demonstrating mixed cropping systems adapted to local biophysical and socioeconomic contexts. The adoption of soil and crop management practices varies considerably across the three regions in both intensity and diversity (Table 2). In Amhara, there is a high prevalence of crop rotation (91.5%) and intercropping (82%), while the use of fallowing (6.3%) and alley cropping (17.9%) remains limited. Similarly, in Oromia, moderate adoption levels are observed, with widespread implementation of crop rotation (87%) and intercropping (47%) and moderate practice of fallowing (32.1%) and alley cropping (22.6%). In contrast, the CERS exhibits relatively higher diversification, characterized by extensive use of crop rotation (94.3%) and intercropping (69.8%), alongside moderate application of alley cropping (55.6%) and fallowing (24.5%). This pattern illustrates the influence of agroecological suitability, resource availability, and knowledge diffusion on the adoption of sustainable land management practices.

Table 2. Adoption of agronomic management practices by region (%)

Region	Adoption of Agronomic Management Practices (%)			
	Crop Rotation	Fallowing	Alley Cropping	Intercropping
Amhara	91.5	6.3	17.9	82.0
Oromia	87.0	32.1	22.6	47.0
Central Ethiopia Regional State (CERS)	94.3	24.5	55.6	69.8

Farm-level Cost of Production

Farm-level cost assessments revealed pronounced spatial heterogeneity in labor investment across regions and woredas for crop production. In Amhara, control households exhibited the highest labor expenditures in Kalu (ETB 43,329/ha) and Tehuledere (ETB 30,320/ha), reflecting substantial labor allocation to soil fertility management and field operations. In contrast, Albuko (ETB 17,711/ha) and Dessie Zuria (ETB 14,421/ha) demonstrated comparatively lower labor investments. In Oromia, labor costs exhibited wider variability, ranging from as low as ETB 2,995/ha in Abaya to ETB 126,576/ha in Digelu Tijo, indicating diverse levels of production intensity and labor input efficiency. In CERS, Weira recorded moderate control household labor expenditures (ETB 14,612/ha). However, relatively low expenditures persisted in Omo Nada, Gera, Abaya, and Weira, suggesting potential constraints related to labor availability, access to productive resources, and household capacity. Overall, the interventions appear to be catalyzing higher labor investment in Amhara and selected Oromia woredas, yet targeted measures remain essential to promote inclusive participation particularly among female- and youth-headed households and to ensure equitable and sustainable soil fertility management across all intervention areas.

Adoption of Sustainable Land Management

The baseline survey revealed substantial yet uneven adoption of sustainable land management (SLM) practices across Amhara, Oromia, and CERS. On average, the percentage of land under SLM practices was comparable between intervention (25.8%) and control (26.4%) households

(Table 3), suggesting similar baseline engagement levels. However, significant woreda-level disparities were observed: Kalu and Abaya reported relatively moderate SLM coverage, whereas Basona Werana, Tiyo, Omo Nada, Gera, and Weira exhibited limited adoption.

Households primarily practiced organic soil fertility enhancement (compost, manure, household waste, mulching), mineral fertilizer application, soil and water conservation (SWC) structures, water harvesting, crop rotation, agroforestry, and gully rehabilitation. Despite high willingness to invest in SLM, participation in labor-intensive SWC activities was limited. Focus group discussions revealed fragmented land management, localized conflicts, and persistent gully erosion, indicating systemic implementation gaps. Strong household motivation provides a foundation for scaling SLM interventions. Strengthening coordination, improving input access, delivering targeted capacity development, and offering site-specific technical support especially in low adoption woredas are essential for effective and sustainable SLM practices.

Table 3. Land area (hectares) covered by sustainable land management practices in the 2024 cropping season

Woreda	Control				Intervention			
	No.	Average Land Size (ha)	Average Land Covered by SLM (ha)	Land Covered by SLM (%)	No.	Average Land Size (ha)	Average Land Covered by SLM (ha)	Average Land Covered by SLM (%)
Kalu	26	0.52	0.16	36.5	78	0.73	0.38	57.4
Albuko	26	1.11	0.32	33.4	78	0.78	0.2	26.0
Desse Zuria	26	0.75	0.28	40.7	78	0.9	0.29	36.0
Tehuledere	26	0.74	0.24	32.0	78	0.81	0.19	27.7
Basona Werana	26	1.47	0.11	8.0	78	1.49	0.16	12.6
Sire	26	1.98	0.35	18.1	78	1.49	0.24	17.5
Tiyo	26	1.6	0.06	5.0	78	1.69	0.27	18.0
Digelu Tijo	26	1.67	0.37	26.9	78	1.64	0.43	27.9
Omo Nada	26	1.22	0.14	8.3	78	1.42	0.16	16.6
Gera	26	0.97	0.09	19.5	78	1.36	0.09	8.6
Abaya	26	0.56	0.37	72.9	78	1.14	0.49	51.1
Weira	26	1.28	0.16	15.4	78	1.03	0.09	10.5
Total	312	1.16	0.22	26.4	936	1.21	0.25	25.8

Farmers' Perceptions of Soil Degradation

Farmers' perceptions of soil degradation exhibited marked regional variability, with Amhara demonstrating the highest level of awareness while Oromia and CERS showed generally lower sensitization. In Amhara, 88.5% of control and 78.7% of intervention households identified soil degradation as a serious concern, with universal acknowledgment in woredas such as Albuko and Tehuledere reflecting visible erosion, declining crop yields, and historical extension activities. Conversely, in Oromia, concern was considerably lower, with only 48.1% of control and 46.6% of intervention households reporting degradation as significant.

Focus group discussions identified soil erosion, gully formation, declining fertility, waterlogging, and unmanaged runoff as the principal drivers of degradation, often compounded by inadequate or poorly maintained SWC measures. Awareness also differed by household demographics: male-headed households (64.9%) exhibited slightly higher recognition than

female-headed households (62.9%), while adults (66.0%) were more aware than youth (61.3%), with the lowest youth perception recorded in Digelu Tijo (25.6%).

Overall, these findings reveal substantial regional and demographic disparities in awareness, shaped by local environmental conditions, the visibility of land degradation, and prior extension interventions. They underscore the critical need for targeted awareness raising, participatory land degradation diagnostics, and youth-focused engagement to enhance recognition and adoption of SLM practices.

Farmers' Participation and Adoption of SWC and Soil Health Practices

Farmers' engagement in biophysical land management exhibited considerable regional variability, with the highest participation in Amhara (86.9%), moderate participation in CERS (61.5%), and substantially lower participation in Oromia (36.5%). Albuko and Basona Werana woredas reported near universal engagement, likely reflecting strong local institutions, social norms, and extension support, whereas Tiyo demonstrated minimal participation (3.8%), highlighting systemic constraints including limited advisory services, labor scarcity, and competing livelihood demands. Predominant SWC practices include terracing, soil/stone bunds, trenches, and improved tillage, while labor- and resource-intensive techniques such as gabions, micro-basins, and fanya juu (the process of throwing the soil up the slope) remain limited due to technical and capacity barriers. Female-headed households exhibited relatively higher adoption of certain practices, and adult-headed households generally participated more than youth, although youth engagement was notable in manageable interventions such as trench terracing.

Regarding soil health and fertility management, awareness and adoption were high for traditional practices including SWC, composting, and in-situ moisture retention, particularly in Amhara and intervention kebeles, often exceeding 90% adoption. Male-headed households demonstrated slightly higher awareness of advanced techniques, whereas female-headed households excelled in labor-intensive practices such as composting and moisture management. Adoption of advanced soil health and fertility management interventions, including biochar application, liming, and precision nutrient management, was below 40%, indicating a need for targeted technical support and capacity building.

Overall, the findings highlighted strong engagement in SWC practices among intervention households, with participation influenced by gender and age dynamics. They also underscore the potential to leverage simple, labor-based practices as entry points for scaling more complex sustainable land management interventions.

Strategic Recommendations and Interventions for Soil Management Practices

The baseline assessment of the 12 intervention woredas revealed diverse soil fertility challenges, heterogeneous agronomic practices, and uneven adoption of SLM practices. While overall household motivation for improving soil health is high, critical gaps remain in nutrient management, awareness, labor allocation, and participation in labor-intensive conservation practices. Targeted interventions are needed to enhance soil productivity, resilience, and sustainable land use.

Recommendations

A comprehensive approach is recommended, focusing on four key areas.

1. **Site-Specific Soil Fertility Management**
   - Conduct systematic soil testing and mapping to identify macro- and micronutrient deficiencies and soil acidity constraints across woredas.
   - Promote ISFM practices, including balanced fertilization, organic amendments, liming, and precision nutrient application.

- Develop locally adapted guidelines for soil fertility interventions to optimize crop productivity under diverse agroecological conditions.

2. **Agronomic Practices and Crop Diversification**
   - Strengthen adoption of crop rotation, intercropping, alley cropping, and fallowing based on regional suitability and household capacity.
   - Promote context-specific agronomic interventions that align with mixed cropping systems and local resource endowment.
   - Facilitate knowledge transfer through FTCs, demonstration plots, and peer learning networks to support practical implementation.

3. **Sustainable Land Management and Soil and Water Conservation**
   - Expand adoption of labor-based SWC structures such as terracing, soil/stone bunds, trenches, and micro-basins, tailored to local labor availability and resource access.
   - Support gully rehabilitation, water harvesting, and moisture retention techniques, with particular attention to female- and youth-headed households.
   - Integrate participatory land degradation diagnostics and community-based planning to strengthen ownership and long-term maintenance of SLM interventions.

4. **Awareness, Capacity Development, and Inclusive Participation**
   - Implement targeted awareness campaigns to increase understanding of soil degradation, nutrient management, and sustainable land practices, with an emphasis on youth and female farmers.
   - Build the capacity of households through practical training, demonstration plots, and site-specific technical support.
   - Encourage equitable participation by addressing labor constraints and providing incentives for adoption of advanced soil health practices such as biochar application, liming, and precision nutrient management.

The Way Forward: Refined Implementation Priorities

To enhance soil fertility, increase the adoption of SLM, and improve crop productivity, the following actions are prioritized:

- **Scale Site-Specific Soil Interventions:** Expand soil testing and ISFM adoption across all woredas, prioritizing regions with severe nutrient deficiencies and acidity constraints.
- **Strengthen Agronomic Practices:** Promote crop diversification, rotation, intercropping, and alley cropping tailored to agroecological and household conditions.
- **Expand Sustainable Land Management:** Increase the adoption of SWC structures, water harvesting, and gully rehabilitation, leveraging simple labor-based practices as entry points for more complex interventions.
- **Enhance Awareness and Capacity:** Conduct targeted training, demonstration plots, and participatory planning to improve farmer knowledge, engagement, and equitable participation.
- **Target Technical Support:** Provide site-specific guidance for advanced soil health practices to address low adoption of biochar, liming, and precision nutrient management.

5.4 Building a Vibrant Sector for Soil Inputs

This section synthesizes the key findings, critical gaps, and essential recommendations from the baseline study, providing a comprehensive overview necessary for refining the TRANSFORM program's Component 2 strategy. The study employed both quantitative (household survey) and qualitative (key informant interviews and focus group discussions) methods to assess the availability, access, diversity, quality, and affordability of soil inputs in

Ethiopia. The soil input sector in Ethiopia is fundamentally constrained by a fragmented supply chain, weak last-mile delivery, and a critical failure to adopt essential non-traditional inputs.

Soil Inputs Supply System and Financial Constraints

- **Fragmented Supply Chain:** The system is dominated by cooperatives and public suppliers, with negligible engagement from the Agricultural One-Stop Shops (AOSSs) and other private actors such as agro-dealers (Figure 8). This results in weak coordination and limited investment in last-mile delivery.
- **Logistical and Timeliness Issues:** Only 43% of households surveyed received mineral fertilizers on time (one month before planting), dropping sharply to 27% for organic inputs. Geographical coverage is uneven, with a significant minority (20%) of households traveling 11 kilometers (km) to access inputs.
- **Affordability and Credit Crisis:** Affordability is a major barrier, with only 17% of households finding mineral fertilizers affordable. Access to credit is severely limited, reported by only 9% of households for inorganic fertilizers and virtually none for lime.

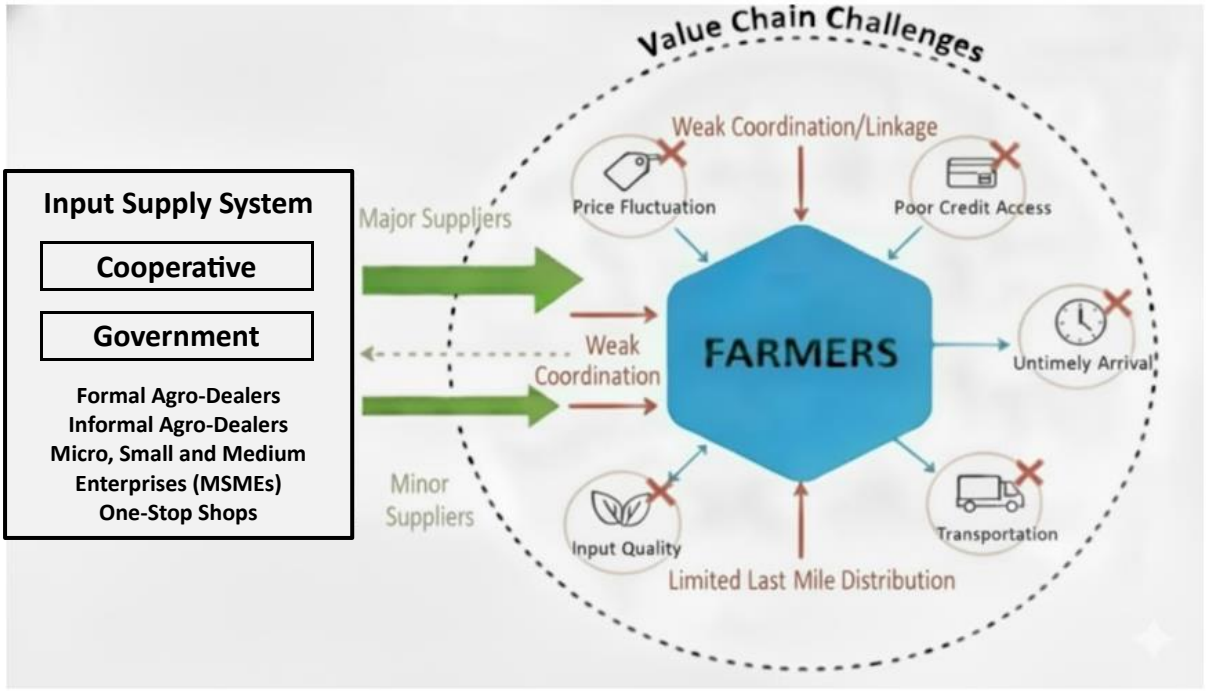


Figure 8. Soil inputs value chain map showing suppliers and challenges for farmers

Soil Input Diversity, Quality, and the Role of the Private Sector

- **Critical Diversity and Usage Gap:** Farmer input use is highly conventional, dominated by urea (67%) and common organic sources (manure/compost). A critical finding is the near-zero adoption of essential soil amendments such as lime and biofertilizers, despite widespread soil acidity.
- **Quality and Trust Crisis:** There is a severe lack of trust in product quality. Farmer satisfaction with the quality of certain inputs is extremely low, notably 5-9% in woredas like Gera, exacerbated by exposure to unstandardized products in informal markets.
- **Limited Private Sector and Data:** Private sector engagement, including micro, small, and medium enterprises (MSMEs), is minimal, highly localized, and secondary to public supply. Only a small fraction of respondents (9.1%) reported the presence of local input producers, and many woredas reported having none. This systemic lack of private engagement results in no quantifiable data on their production volumes and investment capacity.

The Lime Paradox and Organic Market Viability

- **The Lime Paradox:** Despite a high national target of 900,000 metric tons (mt) of subsidized lime for 2024, the actual on-the-ground application by smallholder farmers reached only 3.5% of this target. Availability is extremely limited to zero in most acid-prone woredas (e.g., Gera and Dessie Zuria). This massive failure stems from the supply chain's inability to deliver, compounded by the lack of quantifiable production data from both public and private sources.
- **Organic Market Immaturity:** The formal market for standardized organic inputs is nascent. It is constrained by inconsistent supply, logistical challenges for bulky materials, intense competition from imported inorganic inputs, and a fundamental lack of clear quality standards and legal definitions.

Knowledge Transfer and Linkages for a Vibrant Soil Input Sector

Ethiopia is attempting to build a vibrant soil input sector through a "Digital Agriculture Roadmap" that includes several key initiatives such as the Ethiopian Digital Input Tracking System for quality assurance, a nationwide digital database for direct farmer connection to suppliers and finance, and the digital support of AOSSs. However, the effectiveness of these platforms is severely limited by critical systemic challenges, notably poor digital infrastructure and capacity gaps, fragmented data and uncoordinated efforts, and a persistent weakness in research-extension-farmer linkages, all of which collectively impede efficient knowledge transfer and raise concerns about the long-term sustainability of these ambitious digital projects.

Strategic Recommendations and Intervention for Soil Inputs

The baseline findings underscore that the current TRANSFORM Component 2 proposal, while highly aligned conceptually, requires specific, data-driven, and actionable refinements to directly target the most severe quantifiable gaps.

Recommendations

The study recommends a comprehensive approach focusing on three main areas:

- **Supply Chain and Logistics:** Improve last-mile delivery by incentivizing private partners and cooperatives; facilitate market linkages to streamline distribution and connect producers with markets; establish a coordination platform for key stakeholders; and focus on quantifying and tracking progress for key inputs, especially lime.
- **Input Adoption and Knowledge:** Expand the input portfolio (e.g., lime, biofertilizers); promote location-specific strategies (e.g., lime microdosing and the 4Rs of Nutrient Stewardship [right source, right place, right time, and right rate); and enhance extension services with targeted training for women and youth based on soil-test recommendations.
- **Credit, Quality and Private Sector:** Establish a Quality Assurance and Certification System for all inputs; Develop Integrated Credit Schemes linked to cooperatives and microfinance; and Formalize Partnerships with private agro-dealers and MSMEs, providing them with technical and financial support.

The Way Forward: Refined Implementation Priorities

To move beyond general support and directly resolve the critical gaps (e.g., 3.5% lime use, 5-9% satisfaction, 2-9% credit access, 3-8% last-mile reach), the following four specific, targeted interventions should be integrated into Component 2:

- **Formalize Lime Supply and Tracking:** Establish binding private sector partnerships and co-develop a system to quantify and verify the distributed volume of lime; and implement

a temporary, targeted lime subsidy in highly acid-affected areas to address immediate affordability barriers for the highest-impact product.

- **Implement Mandatory Quality Assurance:** Introduce a mandatory quality assurance and certification program to rapidly establish farmer trust in new and diverse inputs.
- **Pilot Integrated Credit In-Kind:** Develop and pilot an integrated scheme where capacitated agro-dealers and cooperatives provide short-term credit in-kind directly tied to the delivery of high-quality inputs.
- **Upgrade Logistics and Testing:** Provide financial and technical assistance to upgrade AOSS/agro-dealer logistics infrastructure, and mandate/subsidize basic soil acidity testing at FTCs to ensure all extension advice is science-backed.

5.5 Research and Extension through Farmer-Led Action Research

The overarching goal of Component 3 is to strengthen the linkages between agricultural research and extension to enhance practical farming outcomes. This is pursued through bottom-up and farmer-led action research, an approach that actively involves farmers in identifying their challenges, testing innovations, and co-developing solutions with researchers and extension agents. The baseline assessment highlights persistent institutional, operational, and systemic barriers that continue to limit the effectiveness of Ethiopia's agricultural knowledge and innovation system at the national and regional levels.

At all levels, a major constraint to agricultural performance is the weak integration among research, extension, and education systems. Fragmentation and limited coordination among key institutions, such as EIAR and RARIs, MoA and RBoAs, agricultural universities, and ATVET colleges, have resulted in duplication of efforts, gaps in technology transfer, and low adoption rates. Collaboration remains mostly informal, driven by individual initiatives rather than institutional mechanisms. Contributing factors include a top-down approach that marginalizes farmer input, limited digitalization, insufficient funding, and the absence of a unified monitoring and evaluation framework.

The existing research-extension relationship is characterized by a linear "pipeline" model, in which technologies developed by EIAR and RARIs are handed over to MoA and RBoAs for dissemination. While these institutions play key roles in coordinating federal and regional research, the resulting technologies are often not sufficiently localized or affordable for smallholder farmers. Although efforts are emerging to adopt bottom-up approaches in problem identification, technology dissemination remains limited and farmers' reach low. The institutional separation of research and extension under different administrative and budgetary frameworks reinforces a "blame game," with research institutions citing low adoption and extension services pointing to impractical or costly technologies.

Higher learning institutions, including agricultural universities and vocational colleges, are expected to produce the next generation of researchers and extension professionals. However, curricula remain overly theoretical and disconnected from field realities, leading to graduates with limited skills in adaptive research and participatory methods. Despite Ethiopia's extensive extension network, DAs face challenges such as high turnover, low incentives, and inadequate logistics, weakening the feedback loop between farmers and researchers.

Since the 1990s, multi-stakeholder platforms such as the Agricultural Development Partners Linkage Advisory Council (ADPLAC), the Research-Extension-Farmers Advisory Council (REFAC), and the Research-Extension Liaison Committee (RELC) have aimed to bridge these institutional gaps. Among these, ADPLAC, established in 2008, provides a promising platform for coordination but faces limitations related to addressing soil health and fertility sector,

farmers representation, funding, and legal mandate. Nonetheless, its decentralized presence at regional and woreda levels offers an opportunity to strengthen coordination among the research and extension through promotion of farmer-led action research, local demonstrations, and knowledge exchange, particularly if supported by dedicated funding, a clearer mandate on soil health and fertility issues, and the creation of thematic sub-platforms (e.g., soil coordination networks).

Effective agricultural transformation also depends on robust partnerships across research institutes, universities, ATVETs, farmers, private sector actors, NGOs, and development partners. Participatory on-farm trials can ensure locally adapted technologies, while postgraduate research should focus on region-specific soil health and fertility challenges. ATVET institutes play a central role in training DAs to deliver these innovations, which facilitate community-level implementation. Continuous capacity development, gender and youth inclusion, and investment in soil laboratory infrastructure are essential to sustain collaboration and ensure that research outcomes translate into measurable on-farm impact and improved livelihoods.

In general, the research-extension-education linkage at national and regional levels remains weak, constrained by fragmented institutions, limited collaboration, and minimal farmer participation. Strengthening this system requires a shift toward a demand-driven, collaborative framework, featuring national knowledge hubs, digital platforms, and local innovation networks that promote continuous learning and two-way communication.

Participatory and Farmer-Led Soil Research Practices

At the national level, soil health and fertility research in Ethiopia continues to address enduring challenges such as land degradation, nutrient deficiencies, soil acidity, and the promotion of ISFM practices. Historically, research emphasized N and P deficiencies, resulting in blanket fertilizer recommendations. However, findings from the Ethiopian Soil Information System (EthioSIS) revealed more complex and spatially variable nutrient limitations, prompting a shift toward balanced nutrient management. While blended fertilizers were once widely promoted, current national policy prioritizes DAP and urea imports, with long-term plans for domestic fertilizer production to enhance self-sufficiency and reduce import dependency.

Regional research priorities mirror local contexts and challenges. In Amhara, the focus is on combating severe land degradation and nutrient depletion through ISFM and SLM. Oromia emphasizes soil test-based fertilizer recommendations, acid soil reclamation, and participatory on-farm trials, while CERS promotes climate-smart agriculture, organic input production, and balanced fertilization to address soil acidity and erosion.

Participatory research and farmer research groups, introduced in the late 1990s with development partner support, were designed to strengthen farmer engagement in agricultural innovation. These approaches empower farmers to identify problems, test technologies, and adapt solutions to local conditions. Complementary initiatives such as participatory rural appraisal, FTCs, and farmer field schools further reinforce learning and knowledge exchange within farming communities. International collaborations have also enhanced participatory soil research, improved soil information systems, and strengthened research-extension-farmer linkages.

Good participatory practices emphasize farmer empowerment, context-specific innovation, and the integration of indigenous knowledge with scientific approaches. Implementation varies regionally: Oromia institutionalizes farmer research groups around ISFM; Amhara prioritizes participatory SLM to combat degradation; and CERS focuses on climate-smart agriculture and organic input development. Despite these gains, the scaling and institutionalization of participatory approaches remain limited by weak financial, institutional, and technical

capacity. Strengthening participatory research and farmer research groups as the foundation of a demand-driven agricultural innovation system requires formalized partnerships among EIAR, RARIs, and MoA/RBoAs, integration of participatory mechanisms into regular operations, and continuous capacity building for researchers and extension agents.

Farmer-led action research – conceptually aligned with participatory approaches – remains at an early stage in most regions. Only a few soil input trials and demonstration plots have been established in selected intervention kebeles. In Amhara, assessments found minimal farmer-led action research and low participation, particularly among adult males. Oromia showed comparatively higher engagement (around 17% participation), while in CERS (Weira), participation reached 33% in control kebeles but there was none in intervention areas. Overall awareness of participatory action research remains low (about 10%), reflecting limited exposure rather than lack of interest. The small number of on-farm trials largely results from institutional and logistical constraints within research and extension systems, not farmer reluctance. A few Decisions Support Tool plots were identified but unevenly distributed across the 12 target woredas, underscoring the need for better coordination and resource allocation.

Strategic Recommendations and Interventions for Research and Extension through Farmer-Led Action Research

The baseline assessment indicates that the current TRANSFORM Component 3 concept is broadly aligned with participatory research principles but requires targeted, actionable refinements to strengthen research-extension-farmer linkages and enhance adoption of improved soil health and fertility practices.

Recommendations

A comprehensive approach is recommended, focusing on four main areas.

1. **Demand-Driven, Participatory Research:**
- Expand farmer-led action research and farmer research groups (FRGs) to increase farmer engagement in identifying challenges, testing innovations, and co-developing solutions.
  - Integrate participatory methods into regular research and extension operations, ensuring gender and youth inclusion.
  - Strengthen linkages between national (EIAR, RARIs) and local actors to formalize collaboration and reduce duplication.

2. **Extension Capacity and Knowledge Transfer:**
   - Modernize ATVET curricula and postgraduate training to equip DAs and extension staff with skills in adaptive, participatory, and field-relevant research.
   - Institutionalize knowledge exchange platforms at national and woreda levels to facilitate two-way communication between farmers and researchers.
   - Promote localized demonstrations and context-specific practices, including ISFM, SLM, and climate-smart interventions.

3. **Infrastructure, Data, and Digital Systems:**
   - Upgrade soil laboratory infrastructure, field testing equipment, and data management systems to support applied and adaptive research.
   - Establish digital knowledge platforms to track research outputs, adoption rates, and feedback from farmers.
   - Implement region-specific soil health monitoring, soil testing, and decision support tools to inform extension advice.

4. **Multi-Stakeholder Collaboration:**
   - Strengthen formal partnerships among research institutions, universities, ATVET institutes, farmers, NGOs, and private sector actors.

- Facilitate coordinated on-farm trials, demonstration plots, and thematic networks (e.g., soil coordination platforms) to scale context-specific innovations.
- Ensure dedicated funding and clear mandates for farmer-led research and soil health initiatives.

The Way Forward: Refined Implementation Priorities

To overcome systemic gaps such as weak research-extension integration, low farmer participation, and limited adoption of improved practices, the following interventions should be prioritized:

- **Scale Farmer-Led Research:** Expand farmer-led action research and farmer research groups across all target woredas with clear monitoring and feedback mechanisms.
- **Strengthen the Capacity of Extension Agents:** Provide continuous, practical training and support to DAs, ensuring field-level implementation of research outputs.
- **Enhance Knowledge Platforms:** Develop national and regional digital and physical hubs for real-time data sharing, learning, and problem-solving.
- **Institutionalize Participatory Mechanisms:** Formalize collaboration frameworks linking EIAR, RARIs, MoA/RBoAs, and universities to coordinate research priorities, resources, and extension support.
- **Invest in Soil Laboratories and Applied Research:** Ensure availability of resources for soil analysis, localized trials, and adaptive research programs to inform evidence-based interventions.

5.6 Enabling Environment for Soil Health and Fertility in Ethiopia

The enabling environment for soil health and fertility management in Ethiopia plays a crucial role in ensuring sustainable agricultural productivity and food security. The baseline assessment conducted during the inception phase of the TRANSFORM program identified key policy, institutional, and implementation gaps that constrain progress toward achieving national soil health goals. Despite strong policy commitments, including the Agricultural and Rural Development Policy and the Soil Fertility and Health Improvement Strategy, implementation remains fragmented and inconsistent across regions. The findings emphasize the importance of strengthening coordination, capacity building, stakeholder engagement, and technological innovation to create a more supportive and coherent enabling environment.

Policy Framework and Regulatory Gaps

Ethiopia has established a solid policy foundation recognizing agriculture as a driver of economic transformation. These frameworks prioritize soil fertility management, capacity building, and institutional coordination. However, implementation has been weak due to inadequate financing, limited enforcement, and a lack of region-specific guidelines. The baseline assessment indicates that a critical policy gap lies in the absence of detailed regulations tailored to diverse agroecological conditions, such as soil acidity in the highlands and nutrient depletion in the drylands. Furthermore, there is no comprehensive national system for quality assurance and registration of organic and biofertilizers. Weak communication and coordination among institutions have led to fragmented implementation. Strengthening the regulatory framework, developing locally adapted soil management guidelines, and ensuring sectoral coherence are essential steps in achieving sustainable soil fertility management.

Stakeholder Engagement and Multi-Stakeholder Platforms

Sustainable soil health management depends on the collaboration of multiple stakeholders, government institutions, research bodies, NGOs, and the private sector. While Ethiopia has

established several multi-stakeholder platforms, many remain inactive due to weak participation, limited funding, and unclear mandates. This has resulted in duplication of efforts and limited shared learning. Revitalizing multi-stakeholder platforms through structured dialogues, technical working groups, and joint action plans is critical. Establishing clear governance frameworks, ensuring sustainability, and using digital communication tools can enhance coordination and broaden participation, thereby strengthening the overall soil health ecosystem.

Capacity Building for Extension Services

Agricultural extension agents serve as a bridge between research and farming communities. However, many agents lack technical knowledge, up-to-date training, and resources required to promote science-based soil management. Gaps are especially evident in composting, organic fertilizer use, lime application, and soil testing. Institutionalizing regular professional development, establishing peer learning networks, and utilizing digital platforms for training can enhance their effectiveness. A capable and well-equipped extension system will ensure consistent and practical farmer guidance, leading to improved soil health and productivity. To this end, the collaboration between extension and farmer-led action research requires the involvement of both recipients of the research findings

Private Sector Participation and Incentives

The private sector is playing a growing role in Ethiopia's soil fertility landscape, particularly in producing organic and biofertilizers. Successful enterprises, such as vermicomposting initiatives, have created employment opportunities and provided affordable, eco-friendly inputs. However, limited access to finance, weak regulatory clarity, and poor market linkages hinder further investment. Expanding financial incentives, such as tax breaks and concessional loans, and strengthening public-private partnerships for technology transfer and quality assurance will attract greater private participation. Public awareness initiatives can also stimulate demand for organic fertilizers, supporting innovation and sustainable soil management.

Community Awareness and Education Initiatives

Community-level awareness is vital for the adoption of sustainable soil practices. Many farmers still lack knowledge of soil conservation methods, leading to continued degradation. Effective awareness programs should combine demonstration plots, radio programs, farmer field schools, and mobile platforms to reach diverse audiences. Engaging local leaders and model farmers as advocates enhances credibility, while equipping DAs with communication and training skills ensures that advice is localized and actionable. Continuous feedback from communities will foster long-term behavioral change and stronger ownership of soil conservation efforts.

Adoption of Innovative Agricultural Practices

Innovative agricultural practices such as composting, agroforestry, intercropping, and cover cropping have shown measurable improvements in soil structure, fertility, and resilience. Case studies show that organic composting has increased yields and improved soil quality, while intercropping systems have enhanced organic matter and reduced erosion. Scaling these practices requires broader farmer training, demonstration sites, and integration into national agricultural policies. Strengthening public-private partnerships for biofertilizer production will accelerate the adoption of these sustainable techniques, contributing to long-term climate resilience and soil health.

Integration of Technology in Soil Health Management

Digital innovation is rapidly transforming Ethiopia's soil management landscape. Platforms such as Lersha, Digital Green, and the 8028 Farmer Hotline provide farmers with real-time,

customized recommendations based on local soil and crop data. Decision support systems developed by EIAR enable precise fertilizer recommendations and monitoring. The next step involves integrating artificial intelligence and mobile technologies for predictive soil monitoring. However, challenges such as limited connectivity and digital literacy must be addressed through targeted investments and capacity building initiatives. Expanding digital tools and data-driven solutions will enhance decision-making, improve extension efficiency, and modernize soil management practices nationwide.

Strategic Recommendations and Interventions for an Enabling Environment for Soil Health and Fertility

The baseline assessment highlights that while Ethiopia has established a strong policy foundation for soil health and fertility management, critical gaps remain in implementation, coordination, and institutional capacity. Strengthening the enabling environment is essential to support sustainable soil management practices, improve agricultural productivity, and enhance food security.

Recommendations

A comprehensive approach is recommended, focusing on four key areas.

1. **Policy and Regulatory Strengthening**
   - Develop detailed agroecology-specific guidelines for soil management addressing soil acidity, nutrient depletion, and land degradation.
   - Establish a national system for quality assurance, certification, and registration of organic and biofertilizers.
   - Ensure coherent enforcement of existing policies, improve financing mechanisms, and align national and regional strategies for sustainable soil management.
2. **Stakeholder Engagement and Multi-Stakeholder Platforms**
   - Revitalize existing multi-stakeholder platforms through structured dialogues, technical working groups, and joint action plans.
   - Clarify governance frameworks, mandates, and funding mechanisms to ensure sustainability and broader participation.
   - Utilize digital communication tools to enhance coordination and knowledge sharing among government institutions, research and extension systems, NGOs, private sector actors, and farmers.
3. **Private Sector Participation and Incentives**
   - Expand public-private partnerships to improve production, distribution, and quality assurance of organic and biofertilizers.
   - Introduce financial incentives such as tax breaks, concessional loans, and technical support to attract investment in sustainable soil inputs.
   - Implement public awareness initiatives to stimulate demand for eco-friendly soil management products.
4. **Community Awareness, Education, and Technology Integration**
   - Promote farmer training, demonstration plots, farmer field schools, and mobile platforms to increase awareness and adoption of sustainable soil practices.
   - Engage local leaders and model farmers as champions to strengthen credibility and encourage behavioral change.
   - Integrate digital tools, decision support systems, and predictive monitoring to enhance extension services, support science-based recommendations, and modernize soil management practices.

The Way Forward: Refined Implementation Priorities

To create a supportive enabling environment, the following targeted interventions should be prioritized:

- **Strengthening Policy and Regulation:** Develop locally adapted guidelines, enforce existing frameworks, and institutionalize quality assurance for soil inputs.
- **Revitalize Multi-Stakeholder Platforms:** Enhance coordination, ensure sustainability, and promote inclusive participation across all relevant actors.
- **Enhance Private Sector Engagement:** Expand partnerships, provide incentives, and improve market linkages for sustainable soil inputs.
- **Scale Awareness and Technology Adoption:** Promote community-level education, demonstration plots, and digital decision support tools to improve adoption of innovative soil management practices.

6 Component Gap Assessment

A component gap assessment was conducted by the program to identify key challenges and opportunities for strengthening soil fertility management through evidence-based, inclusive approaches. Findings from Oromia, Amhara, and CERS highlight that while extension systems are central to promoting ISFM, their implementation remains uneven due to weak coordination, limited capacity, and inadequate resources.

ATVET institutes, such as those in Holeta and Kombolcha, play a vital role in training DAs and farmers, yet curriculum gaps, gender imbalance, and inconsistent practical training persist. Moreover, top-down knowledge transfer models, limited digital integration, and sociocultural barriers continue to restrict farmer participation, particularly among women, youth, and people with disabilities.

Addressing these gaps requires a context-specific and participatory extension system guided by PIP principles that empower farmers to identify local challenges, design on-farm solutions, and co-create innovations. Such an approach integrates research, digital tools, and farmer-led experimentation to enhance learning, ownership, and accountability. Strengthening these systems is essential for achieving the TRANSFORM program's goal of sustainable, science-driven, and inclusive agricultural transformation in Ethiopia.

6.1 Customized Extension Services and Farmers Empowerment

Component 1 of the TRANSFORM program focuses on customized extension services and farmers empowerment, aiming to enhance agricultural productivity, resilience, and sustainability through farmer-centered advisory approaches. The success of this component hinges on the relevance, accessibility, and effectiveness of extension services, as well as the active participation and empowerment of farming communities.

This study aimed to systematically identify constraints, opportunities, and knowledge gaps in the current extension system, particularly in delivering tailored, inclusive, and participatory services. It examined the extent to which existing advisory mechanisms address local soil fertility, crop management, climate-smart practices, and socioeconomic realities of smallholder farmers. By highlighting critical gaps in service delivery, outreach, and farmer engagement, the study provides evidence-based recommendations to strengthen the capacity of extension systems, promote inclusive participation, and foster sustainable farmer empowerment. The findings will directly inform the design and implementation of targeted interventions under Component 1, ensuring that extension services are contextually relevant, scientifically informed, and aligned with the priorities and needs of farmers.

The assessment revealed notable regional differences in extension coverage, access, participation, and the use of information and communication technology (ICT) across Oromia, Amhara, and CERS (Table 4). Oromia demonstrates strong farmer-extension collaboration, high participation in decision-making, and advanced ICT use through tools like Digital Green, facilitating effective knowledge transfer. Amhara shows robust grassroots mobilization and youth engagement but faces cultural barriers that limit participation, despite having active programs for women and youth. In contrast, CERS struggles with weak coordination, low participation, and limited ICT use, primarily relying on weak platforms. Inclusion efforts for women, youth, and people with disabilities are notably weak in CERS, while Oromia is making strides in this area. Research-extension linkages are strong in Oromia; formal but weak collaboration exists in Amhara and very limited connections in CERS, highlighting the need for better communication systems and collaborative frameworks.

The performance indicators for extension services reveal significant disparities among the regions of Oromia, Amhara, and CERS (Tables 4 and 5). Oromia stands out with very strong performance in extension coordination and ICT adoption, as well as strong farmer participation and research linkages. Amhara demonstrates moderate strength, particularly in gender and youth inclusion, but lags in ICT adoption and coordination. CERS, on the other hand, shows weak performance across all indicators, especially in research linkages and farmer participation, indicating a critical need for improvement. While efforts have improved farmer awareness and productivity, implementation remains uneven due to limited coordination, resources, and capacity. The analysis also emphasizes the role of ATVET in training DAs and farmers.

Table 4. Regional highlights of extension coverage, access, participation, and ICT use

Thematic Area	Oromia	Amhara	CER
Extension coverage and participation	Strong farmer-extension collaboration; active FTCs and farmer field schools	Strong grassroots mobilization; youth engagement	Weak coordination; low participation
Farmer decision-making	High participation in planning and monitoring	Moderate participation	Limited participation
ICT use	Advanced (Digital Green, 8028 Farmer Hotline)	Moderate (ATI messaging systems	Limited (mainly WhatsApp/Telegram)
Inclusion (women, youth, people with disabilities)	Improving; gender gaps persist	Active youth/women programs, but cultural gaps persist	Weak inclusion
Research-extension linkages	Strong coordination	Formal but weak collaboration	Very limited

Table 5. Regional highlights of key extension performance indicators

Key Indicators	Oromia	Amhara	CERS
Extension coordination	5	4	2
ICT adoption	5	3	2
Farmer participation	4	3	2
Gender and youth inclusion	3	4	2
Research linkages	4	3	1
Research linkages	3	3	2
ATVET capacity	4	3	3

5 = very strong performance, 4= strong performance, 3= moderate performance, 2= weak performance, and 1 = weak performance.

Role and Current Status: ATVET Institutes

Holeta and Kombolcha deliver soil fertility- and ISFM-related training for DAs and youth. Holeta provides a fuller ISFM course with practical composting demos; Kombolcha focuses more on crop production with limited soil-health content.

Strengths

Practical demonstrations, engagement with youth/farmers, some digital tool use (Holeta).

Weaknesses

Uneven curriculum coverage, inconsistent instructor training, limited follow-up and practical student engagement, gender imbalance among DAs, and funding gaps (especially in CERS).

Challenges and Opportunities

Barriers include limited extension access, inconsistent demonstrations, resource constraints, and sociocultural norms restricting female and youth participation. Opportunities for improvement involve inclusive, practical training, accessible input provision (lime, compost resources), participatory research and trials, stronger collaboration between farmers, extension agents, and researchers, and targeted awareness campaigns. Tailored approaches combining organic and inorganic inputs, terracing, and ISFM methods can enhance soil health, productivity, and SLM.

Opportunities to Enhance Soil Health and Fertility Management

Districts show strong potential for improving soil fertility through the adoption of integrated practices such as crop rotation, terracing, composting, and vermicomposting. Crop residues and tree leaves provide sustainable organic inputs, while geographical advantages such as suitable landscapes and groundwater access support diversified cropping and conservation efforts. Farmer willingness, cultural collaboration, and proximity to advisory services create a foundation for successful adoption. Fair input pricing, political commitment, expert support, and targeted training, particularly for women and youth, can amplify impact. Scaling these practices via integrated technical guidance, community engagement, and policy support can significantly boost productivity and soil sustainability.

Key Gaps Identified from the Study

- Uneven access to extension services, with near absence in many kebeles (e.g., Chefa Gugesa, Sire, Tiyo, Tehuledere) versus good coverage in select kebeles (Dindin, Asgedo).
- Irregular and occasional training on soil health, composting, and resource management.
- Inconsistent extension focus; limited farmer-to-farmer knowledge transfer.
- Fragmented watershed and land management, incomplete SWC structures, and a lack of agroforestry in some kebeles.
- Persistent soil degradation, erosion, and waterlogging affecting 50-60% of households.

- Low youth engagement in SWC, though female-headed households show higher participation.
- Food insecurity and low resilience in areas such as Weyira, Sire, and Tiyo woredas.

Recommendations

- Increase year-round extension service delivery in underserved kebeles.
- Institutionalize farmer-to-farmer training, prioritizing youth and women.
- Implement landscape-level planning and coordinated SLM/SWC strategies to reduce fragmentation.
- Scale up successful practices (biochar, manure, lime application, agroforestry) via awareness campaigns and demonstration plots.
- Target low-resilience areas with integrated soil conservation, nutrition-sensitive agriculture, and social protection programs.
- Expand watershed management, including gabion construction and infiltration works.
- Strengthen agroforestry and in-situ moisture management in erosion-prone kebeles.
- Incentivize youth participation while ensuring gender equity in SWC and SLM interventions.
- Tailor communication and technical support regionally, reflecting awareness differences between Oromia (low) and Amhara (high).
- Institutionalize localized ISFM modules across ATVET colleges (add practical composting, soil testing, and lime application).

6.2 Building a Vibrant Soil Inputs Sector

This study employed a qualitative approach to analyze the soil-input landscape of Amhara, CERS, and Oromia, with the core objectives of identifying systemic gaps, assessing existing opportunities, and formulating strategic recommendations necessary to foster a vibrant soil input sector and ensure robust private sector engagement. To gather in-depth, contextualized insights into the current status and challenges, data were collected primarily through key informant interviews and FGDs. This method facilitated a rich understanding of the experiences and perspectives of various critical stakeholders, including farmers, extension agents, private sector actors, and policymakers, directly informing the strategies needed for sustainable sector transformation.

Soil Input Use, Sourcing, and Farmer Demand

Farmers in the target regions utilize a mixed approach to soil fertility management, primarily driven by affordability and access.

Current Practices and Regional Variability

- **Inorganic Inputs:** Urea, DAP, and NPS remain essential for staple crops but are used below the recommended rates due to rising costs. Access is predominantly through cooperatives, though concerns about poor quality and unreliability persist in alternative local markets.
- **Organic Inputs:** Compost and manure are produced on-farm using family labor and are widely used. Vermicompost is emerging, particularly in Oromia where its adoption is linked to active extension support. However, the cost of starter worms limits uptake among the poorest farmers, and commercial purchase remains limited across all regions. By contrast, farmers in Amhara and CERS still rely predominantly on mineral fertilizers, with vermicompost uptake being more localized, though bioslurry is also starting to emerge in Amhara.
- **Specialized Inputs (Lime/Biofertilizers):** The use of lime is limited, despite high demand in acid-prone highlands, due to highly inconsistent access. Biofertilizers and liquid

fertilizers are generally restricted to pilot areas. Oromia shows greater adoption of supplementary inputs such as biofertilizers in certain woredas (e.g., Omo Nada, Gera).

Gender and Logistical Constraints

- **Gender Dynamics:** Women face greater labor and transport constraints for bulky organic inputs and encounter more hurdles in accessing formal supply channels and inclusive training. Women in Oromia, however, demonstrate enthusiasm for home composting with adequate support.
- **Key Barriers:** The most cited barriers are rising fertilizer prices and logistical challenges, including last-mile transport of bulky organic materials and delays in cooperative supply. Farmers demand expanded access to affordable local, quality-assured inputs, often seeking initial subsidization.

Supply Chain, Regulation, and Financial Gaps

The soil input market is constrained by a fragile supply chain, underutilized production capacity, and insufficient financial support for organic inputs. While the MoA oversees the production and supply of inorganic fertilizers and lime, organic fertilizers are managed by a separate entity. Despite recent government initiatives to allocate significant resources for lime provision and technical capacity building within extension services, systemic gaps persist.

Lime Market Contradiction

- **Capacity vs. Sales:** High-capacity producers, such as Mugher Cement Factory (up to 20,000 mt per year), are underutilized due to cited "demand shortages."
- **Structural Flaw:** This paradox exists because sales are restricted to budget-dependent institutional buyers (regional governments). There is a critical lack of a stable commercial supply chain through cooperatives or agro-dealers, and producers offer no logistical support. Despite significant government subsidies for transport, the overall supply of lime meets less than 4% of the demand in acidic areas.

Private Sector, Quality, and Financing

- **Standards and Enforcement:** While Ethiopia has over 30 soil input standards, the major challenge is enforcement and monitoring. Many local producers of organic inputs operate outside required standards, leading to the circulation of substandard products and low farmer trust.
- **Private Production:** Local agro-dealers and SMEs lack the capital and outreach for commercial scaling of organic inputs beyond internal use or limited demonstrations.
- **Financing Gap:** Microfinance institutions (MFIs) and banks overwhelmingly prioritize credit for mineral fertilizers, machinery, and livestock. Credit access for natural fertilizers and lime is minimal (2-9%), highlighting a systemic failure to prioritize soil health in financial products.

Extension Services for Soil Inputs

Mechanisms and Regional Effectiveness: Demonstration plots and FTCs are the core mechanism for knowledge transfer, enabling practical learning and accelerating the adoption of inputs such as compost, vermicompost, and lime. Extension services for soil inputs are inconsistent and limited due to varying resource allocation across regions. In Amhara and CERS, reliance on these methods is high for teaching practices such as composting and vermicomposting, but resource limitations constrain overall reach. In Oromia, effectiveness is mixed; some areas have active high-impact comparative demonstrations, while others are hampered by budget and logistical challenges, resulting in limited facilities and hindering widespread adoption.

- **Addressing Knowledge Gaps:** Extension services utilize diverse methods, including practical demonstrations, cascade training, diagnostic studies, and media outreach, but their impact is hindered by systemic deficiencies.
- **Key Outreach Challenges:** Training frequency is often insufficient (typically once per year). This issue is compounded by outdated extension packages, limited soil-chemistry expertise among agents, uneven material distribution, and a lack of practical soil testing tools.

Critical Systemic Gaps and Strategic Priorities

The study revealed robust policy direction but pervasive implementation failures due to funding, logistics, and market fragmentation (Table 6).

Table 6. Systemic gaps and strategic priorities highlight policy coherence and weak implementation in soil health input systems

Systemic Gaps	Strategic Priorities (Recommendations)
Access and Affordability: Fragmented supply, high prices, minimal credit, and poor last-mile delivery.	**Market and Financial Incentives:** Incentivize MSMEs and the private sector for local, quality-controlled production. Lower credit barriers and offer tailored financing for non-inorganic inputs.
Quality and Timeliness: Low farmer satisfaction with quality; delayed delivery; informal market full of non-standardized products.	**Logistics and Supply:** Guarantee timely, affordable, and quality-controlled distribution by developing robust last-mile logistics and transport.
Technical Knowledge: Extremely low adoption of advanced practices (e.g., 4R Principles of Nutrient Stewardship, acidity management).	**Data-Driven Extension:** Mandate and expand the role of soil testing to ensure site-specific nutrient management using EthioSIS data. Strengthen knowledge transfer in extension services.
Market Immaturity: Underdeveloped and unfinanced commercial market for local, standardized organic/bio-inputs.	**Regulatory Strengthening:** Formalize registration, standards, and marketing of biofertilizers and organic amendments. Strengthen enforcement to eliminate substandard products.

The Way Forward: Refined Implementation Priorities

The project must strategically integrate the specific systemic failures identified in the gap assessment (the lime paradox, weak quality enforcement, and lack of precision advice) into the existing goals of market development, diversification, and capacity building. The implementation priorities are:

- **Pivot to Precision:** Move beyond general capacity building to mandate and train agro-dealers and cooperatives on translating site-specific fertilizer recommendations (EthioSIS) into custom blended product packages, directly addressing the knowledge gap.
- **Enforce Quality and Certify Local Inputs:** Immediately partner with the Ethiopian Agricultural Authority (EAA) to implement mandatory quality standards and a simple certification process for local organic inputs (vermicompost, lime) to address low farmer trust and poor market quality.
- **Commercialize Integrated Blends:** Fund and pilot business cases for organo-mineral blends (e.g., vermicompost + NPS) to simplify integrated nutrient management and stimulate the underdeveloped commercial market for quality organic inputs.
- **Resolve Lime Logistical Paradox:** Establish a coordination and commercial mechanism (not just a subsidy/transport focus) between lime producers (e.g., Mugher Cement Factory)

and regional buyers to ensure stable commercial demand and a reliable last-mile supply to acid-prone areas.

- **Diversify Distribution and Finance:** Introduce public-private partnership models for last-mile distribution of government-imported inorganic fertilizer and strengthen MFIs/banks to develop dynamic site-specific fertilizer recommendation-linked credit products for all input types.
- **Target Inclusivity:** Prioritize women and youth groups for financing and certification support in local vermicompost and biochar production to meet the target of 24 small-scale entrepreneurs and address gender-specific labor/access constraints.

6.3 Strengthening the Research-Extension Linkage

Current Coordination Status

The TRANSFORM program seeks to strengthen existing linkages by promoting participatory, farmer-led, bottom-up action research that empowers rural communities, enhances technology adoption, and supports sustainable agricultural and land management practices. Achieving these goals requires strong and effective linkages between research and extension services, which are crucial for improving soil health and fertility management. However, the current landscape of collaboration shows considerable regional variation. In the Amhara Region, positive examples include Bosona Werana, where the Amhara RARI actively involved farmers in designing and implementing trials for improved seed varieties, fostering the adoption of innovations. In contrast, in South Wollo (Kalu woreda), farmers reported limited access to new practices and weak communication with researchers, highlighting persistent outreach gaps.

In Oromia, collaboration is uneven. Farmers in Digelu Tijo expressed frustration at receiving technologies that were unsuitable or introduced too late. Sire partners with the Awash Melkassa Research Centre, but farmers feel that research agendas are poorly aligned with local needs. In Abaya, research prioritizes coffee and maize, leaving soil health largely under-addressed. More promisingly, Omo Nada collaborates with EIAR and Jimma Agricultural Research Centre to advance practices such as biofertilizer use and crop rotation. Gera works with Jimma University to promote vermicomposting and lime application, and Tiyo partners with Kulumsa Agricultural Research Center and Arsi University to implement zero-tillage and organic soil management methods. Despite these initiatives, gaps in farmer support and limited soil testing (e.g., Digelu Tijo) remain persistent challenges. In CERS, although farmer-led research is recognized as valuable, extension agents often lack the capacity to adapt findings to local contexts.

Coordination between research and extension teams also varies widely across districts. In Oromia, districts such as Omo Nada, Digelu Tijo, Tiyo, Sire, and Gera hold biannual coordination meetings with research centers, often supported by NGOs and project funding. In contrast, coordination is weaker in Amhara and CERS, particularly in Weyira, Albuko, Dessie Zuria, and Kalu, where formal mechanisms are limited or absent.

In general, communication and collaboration remain irregular in many districts. Strengthening formal coordination platforms, holding regular meetings, and prioritizing discussions on soil health are essential to improve research and extension linkages and ensure the effective adoption of soil fertility technologies.

Communication and Translation of Research Findings into Extension Packages

Effective communication of research findings and the integration of farmer feedback are critical for strengthening research and extension linkages and promoting the adoption of soil health and fertility practices across Ethiopia. Approaches vary widely in Amhara, CERS, and Oromia, with both promising practices and persistent gaps.

In Oromia, Omo Nada stands out, where DAs and subject matter experts actively collect farmer feedback during field visits and field days, reporting it to woreda offices. Digelu Tijo and Tiyo facilitate farmer-researcher exchange through annual events and field visits. However, challenges remain in Gera, where farmer-researcher meetings are infrequent; in Abaya, where no soil research centers exist; and in Sire, where farmer innovations are rarely shared, leaving communication fragmented.

In CERS, feedback systems are generally weak. Weyira is still establishing formal channels, while farmers in Halaba report delayed and fragmented communication, limiting their influence on research priorities. In Amhara, Bosona Werana uses platform meetings to share farmer concerns; Albuko employs diverse channels such as reports, meetings, phone calls, and Telegram; and Dessie Zuria leverages subject matter experts to relay farmer input. Still, in Kalu and Tehuledere, feedback communication remains largely absent. At the national level, EIAR disseminates findings through workshops, field days, and digital platforms. Despite these efforts, fragmented information, technical jargon, and limited accessibility continue to constrain knowledge sharing and collaboration.

Translating research findings into actionable extension packages also shows uneven progress. In Omo Nada, research is applied through on-farm and cluster demonstrations, supported by capacity building programs for DAs. Gera effectively adapts lime application and vermicomposting practices to local conditions with NGO support. Tiyo actively implements lime research, benefiting from government supply and guidance. In contrast, Abaya largely relies on top-down directives, with limited integration of research findings into soil health activities. Digelu Tijo struggles with consistent implementation. Sire conducts intercropping and vermicomposting demonstrations, but weak monitoring limits impact. In Weyira, dissemination occurs mainly through leaflets and training materials, whereas Bosona Werana compiles regional research findings for annual training sessions. Albuko employs fragmented approaches via training clusters and field days, lacking a coordinated mechanism, and Kalu demonstrates minimal engagement with soil health research.

While diverse methods including demonstrations, training packages, and NGO-supported initiatives exist to bridge research and practice, challenges persist. Weak monitoring, fragmented dissemination, and low institutional commitment in some districts hinder the effective translation of research into actionable extension packages. Strengthening formal coordination, developing context-specific adaptation strategies, improving monitoring systems, and fostering inclusive, user-friendly communication platforms are essential to ensure soil health innovations are relevant, practical, and widely adopted across TRANSFORM intervention areas.

Farmer Involvement in Research and Extension

Farmer involvement is increasingly recognized as critical for improving soil health and fertility management in Ethiopia, yet participation remains limited and uneven across regions. At the federal level, EIAR has introduced programs to integrate farmer perspectives, but most farmers engage primarily at the problem-identification stage, with minimal influence on proposal development, trial design, or technology validation.

In Amhara, the RARI promotes participatory approaches such as farmer research groups. While these provide some structure, inclusivity gaps persist, with limited representation of women. Farmers in woredas like Kalu have expressed an interest in more active roles, yet influence over research agendas remains constrained, limiting ownership and adoption of new technologies. In Oromia, collaboration is stronger in areas such as Arsi, where farmers participate in vermicomposting and improved crop trials, but institutional actors continue to dominate decision-making. Remote areas face communication barriers. For instance, in CERS, farmers in areas such as Halaba and Weyira participate in trainings and demonstrations but

rarely shape research priorities. Across regions, weak feedback mechanisms hinder iterative improvements, contributing to mistrust between farmers and research institutions.

Across intervention areas, the persistence of a top-down, researcher-driven model limits meaningful engagement. Farmers often serve as passive contributors, with minimal involvement in on-farm trials and validation of soil fertility technologies. Institutional separation between research bodies (EIAR and RARIs) and extension services (MoA and RBoAs) further hampers collaboration, resulting in mismatches between research outputs and practical needs. Inclusivity remains a major gap, as women, youth, and people with disabilities are underrepresented despite policy targets. The decline of multi-stakeholder research and extension linkage platforms has further reduced opportunities to align research agendas with farmer priorities.

Farmers consistently expressed a desire for more problem-driven, hands-on engagement. They advocate for collaborative approaches that address specific land and soil challenges while integrating training and capacity-building. Models such as PIP offer pathways to embed farmers throughout the research cycle, ensuring inclusive, context-specific, and demand-driven research. Strengthening structured participation, feedback mechanisms, and coordination between research and extension systems is essential to empower farmers and improve soil fertility management across Ethiopia.

Participation in on-farm trials and demonstrations varies widely across districts. Omo Nada demonstrates strong engagement, supported by Jimma University and continuous expert follow-up, while Gera relies on committed development agents and role model farmers to promote practices such as coffee agroforestry. Abaya shows low but growing involvement, with training for selected participants and plans for wider inclusion. Tiyo reports around 38% engagement, including innovators testing lime, compost, and vermicomposting, whereas Sire records only limited volunteer participation.

In Weyira, visible benefits of vermicomposting have encouraged peer adoption, while Bosona Werana shows very limited participation, signaling the need for targeted training. Albuko farmers experiment with compost, farmyard manure, and lime despite limited technical knowledge, whereas in Dessie Zuria, some farmers independently adopt practices that improve soil fertility and crop resilience. Kalu supports vermicomposting through extension activities, but resource constraints limit scale. Tehuledere faces challenges where farmers' own fields often outperform official demonstration plots, weakening confidence in formal trials.

Participation is strongest where structured training, expert follow-up, and visible demonstration benefits exist. Districts with weak support structures, limited resources, or poorly designed demonstrations show lower engagement. Scaling up adoption requires more structured farmer-led participatory trial design, targeted training, and stronger extension support to ensure farmer confidence and sustainable soil health management.

Collection and Sharing of Soil Fertility Data

The collection and sharing of soil health and fertility data varies significantly across intervention areas, with some woredas employing structured systems and others relying on informal or outdated methods. For instance, in Omo Nada, experts and DAs collect soil data from kebeles, compile it at the woreda level, and report to the zonal office. Gera uses soil pH testers to guide lime applications. Abaya depends on manual data collection by DAs and oral reporting, while Tiyo demonstrates more advanced practices by training agents and selected farmers to share soil data digitally via Telegram with research centers.

In contrast, Sire lacks the tools and capacity for systematic data collection, relying instead on outdated external datasets. Weyira gathers soil information informally through kebele heads and agricultural experts. Bosona Werana has recently shown progress through project-based

initiatives despite limited historical data collection. Albuko emphasizes crop productivity data more than soil fertility. Dessie Zuria collects soil samples only when acidity is suspected, often sharing results via phone or Telegram. Kalu has minimal soil fertility data, relying mostly on national meteorological information. Tehuledere shows very limited involvement in data collection or sharing.

While districts like Omo Nada, Gera, and Tiyo have relatively strong systems for soil data collection and sharing, most others rely on informal, ad hoc, or outdated approaches. Strengthening local capacity, providing appropriate tools, and developing standardized reporting systems are critical for improving soil fertility data management, which in turn supports evidence-based decision-making for soil health and fertility management in TRANSFORM intervention areas.

6.4 Promoting an Enabling Environment for Soil Health and Fertility

This study highlighted that despite the government's strong commitments, such as the Agricultural and Rural Development Policy and the Soil Fertility and Health Improvement Strategy, implementation remains fragmented and uneven. Limited enforcement of soil-related regulations, combined with weak coordination between institutions, has hindered progress. The study also referenced other research, indicating that many farmers remain unaware of available resources, best practices, and government support mechanisms. This points to deeper systemic gaps in agricultural extension services, insufficient capacity building, and a lack of consistent communication among policymakers, researchers, and communities.

Addressing these challenges requires not only stronger regulatory frameworks and financing but also a comprehensive approach that integrates local knowledge, technology, and inclusive participation. These findings reaffirm the TRANSFORM program's focus to establish or strengthen multi-stakeholder platforms in the soil sector aimed at fostering collaboration and enhancing implementation effectiveness.

Policy Framework and Regulatory Gaps

Ethiopia has established a comprehensive policy framework recognizing agriculture as a key driver of economic transformation, emphasizing ISFM, capacity development, and institutional coordination. However, the operationalization of these policies is constrained by insufficient financing, limited enforcement, and the absence of region-specific guidelines. Critical gaps include a lack of context-specific regulations addressing diverse agroecological challenges, such as soil acidity and nutrient depletion in highlands and soil salinity in drylands, as well as the absence of national frameworks for organic fertilizer quality assurance and biofertilizer registration. Farmers' limited awareness of soil policies and weak communication channels further hinder adoption of best practices. Strengthening sectoral coordination, developing locally adapted soil management guidelines, and ensuring policy coherence across agriculture, environment, water, and land-use sectors are essential to achieve TRANSFORM program objectives.

Stakeholder Engagement and Multi-Stakeholder Platforms

Sustainable soil health management in Ethiopia requires coordinated engagement of diverse actors, including farmers, government agencies, research institutes, NGOs, and private sector stakeholders. Farmers contribute indigenous knowledge, the private sector provides technologies and inputs, and NGOs facilitate capacity building and community mobilization. Despite the recognized value of collaboration, many existing multi-stakeholder soil sector platforms, such as the ADPLAC, remain underutilized due to weak participation, limited funding, and unclear mandates, resulting in fragmented interventions and missed opportunities

for collective learning. The gap assessment underscores the need to revitalize multi-stakeholder platforms through structured stakeholder dialogues, technical working groups, and knowledge-sharing workshops. Institutionalizing these platforms requires clear governance frameworks, sustained financing from government and development partners, and the integration of digital communication tools to enhance participation and expand the TRANSFORM program's reach and impact.

Capacity Building for Extension Services

Effective soil health management in Ethiopia hinges on a multi-pronged approach involving extension services, private sector participation, community education, innovative practices, and digital technology integration. Agricultural extension agents serve as critical intermediaries between research institutions and farmers; however, gaps in technical skills, training, and resources limit their ability to deliver science-based guidance on organic fertilizers, composting, lime application, and soil testing. Continuous professional development, peer learning networks, field demonstrations, and digital training platforms are essential to enhance extension capacity and ensure consistent adoption of sustainable soil practices.

Private Sector Participation and Incentives

Private sector engagement remains pivotal for scaling eco-friendly inputs and promoting green growth. While initiatives such as vermicomposting and small-scale biofertilizer production demonstrate potential, constraints in finance, regulatory clarity, and market linkages hinder expansion. Strengthening public-private partnerships, providing financial incentives, and conducting awareness campaigns can drive innovation, increase resource mobilization, and improve market access for sustainable soil management technologies.

Community Awareness and Education Initiatives

Community awareness and education initiatives are critical to long-term adoption of soil conservation practices. Integrating multi-channel communication, such as farmer field schools, demonstration plots, radio, mobile platforms, and social media, with local leadership and cooperative networks can enhance credibility, knowledge uptake, and adaptive feedback between farmers and research institutions.

Adoption of Innovative Agricultural Practices

Innovative agricultural practices, including organic composting, agroforestry, intercropping, and cover cropping, have demonstrated measurable improvements in soil structure, nutrient balance, and water retention. Scaling these interventions requires robust training, demonstration plots, knowledge exchange, and integration into national agricultural strategies and subsidy schemes, thereby enhancing climate resilience and sustainable productivity.

Integration of Technology in Soil Health Management

Digital technologies offer transformative potential for soil health management. Platforms such as Lersha, Digital Green, and the 8028 Farmer Hotline provide real-time, site-specific advisory services, while decision support systems leverage geospatial soil data to optimize fertilizer recommendations. Future integration of artificial intelligence, data analytics, and mobile applications can enable predictive soil monitoring, but adoption is limited by connectivity, digital literacy, and localized content. Targeted investments, capacity building, and public-private collaboration are essential to harness digital innovation, modernize extension services, and strengthen climate adaptation for smallholders, women, and youth.

In summary, the key findings of this study reinforce the TRANSFORM program's initial proposal to establish or reform multi-stakeholder platforms focused on the development of policies, regulations, and standards for organic fertilizer quality assurance and biofertilizer registration. Additionally, the findings underscore the necessity of addressing soil health and

fertility challenges through a coordinated, holistic, and inclusive 15-year national vision. This approach aims to ensure long-term sustainability and alignment among various stakeholders in the soil input sectors.

7 Complementary Assessments

The TRANSFORM program aims to enhance agricultural productivity and resilience in Ethiopia through a series of complementary assessments designed to strengthen evidence-based decision-making and ensure contextual relevance. These assessments, covering community selection, conflict sensitivity, climate adaptation and mitigation, geographic pilots on erosion and drought, innovation and indigenous knowledge, input supply systems and value chain actors, development of soil inputs and business cases, and gender, were undertaken to generate comprehensive, cross-cutting insights that go beyond the scope of the baseline survey and component gap analyses. Their primary objective was to examine the social, institutional, and environmental dimensions influencing soil fertility and agricultural transformation within the program landscape. While the baseline survey established initial biophysical and socioeconomic conditions and the component gap analyses identified technical and institutional limitations, the complementary assessments provide cross-cutting analyses on community engagement, inclusivity, conflict dynamics, local innovation, climate resilience, and gender equity. Collectively, these studies ensure that TRANSFORM interventions are scientifically grounded, socially responsive, and environmentally sustainable, fostering adaptive management and long-term impact.

7.1 Community Selection

The TRANSFORM program employed a structured, evidence-based, and participatory approach to community selection and implementation, operationalizing the PIP model across 12 target woredas. In each woreda, four communities were identified, with implementation starting in three priority communities to allow iterative learning and adaptive management. In total, 48 kebeles were selected for implementation. Expansion to the remaining communities was guided by performance outcomes and lessons learned, ensuring representativeness, scalability, and contextual responsiveness.

Central to this strategy was the PI model, which facilitated farmer-led innovation and knowledge diffusion. In each community, 30 PIs were trained in PIP creation, each mentoring 10 additional farmers, forming a first cohort of 300 first generation PIP farmers. Selected farmers from this cohort became trainers in subsequent rounds, creating a self-replicating mechanism for horizontal learning and accelerated adoption of improved practices, thereby fostering broader community transformation.

A baseline study was conducted across the 12 woredas and included three treatment communities and one control community per woreda. The control communities were deliberately located at a considerable distance from treatment sites to minimize spillover effects. This spatial separation ensured accurate attribution of observed changes in productivity, soil health, and farming practices to the program interventions.

Community selection was undertaken through participatory consultations with the Woreda Office of Agriculture and key stakeholders, integrating local knowledge with scientific criteria. The main selection criteria included the degree of soil fertility and land degradation challenges, absence of overlapping interventions, adequate household population size (>500 households), accessibility through all-weather roads, and representativeness across the woreda. Desirable criteria considered local leadership quality, community readiness for change, socioeconomic and biophysical diversity, potential for innovation adoption, and clear scaling pathways.

A community selection matrix was applied to assign quantitative scores to each criterion, ensuring transparent, objective, and well-documented decision-making. By integrating scientific assessment with participatory governance, the process strengthened local ownership, empirical rigor, and the sustainability of the TRANSFORM program's interventions.

7.2 Conflict Sensitivity Analysis

From the outset of initial proposal design, the TRANSFORM program acknowledged the presence of civil unrest in Amhara and Oromia. It emphasized that the final selection of intervention woredas would be made in consultation with the MoA. As part of its risk mitigation strategy, the program committed to conducting a conflict sensitivity analysis to minimize potential harm to staff and partners and ensure that program activities do not inadvertently contribute to conflict.

As a core component of the program's approach, TRANSFORM aims to build the capacity of DAs in each selected kebele including those specializing in crops, livestock, and natural resource management. The goal is to foster a shared understanding of local challenges and promote integrated household-level solutions through the development of family action plans.

Accordingly, the conflict sensitivity analysis provided a comprehensive understanding of the potential sources of conflict, their triggers, and the key actors involved both in general and specific to the selected woredas. The study covered 11 woredas, with an in-depth geographic pilot analysis in Abaya, located in the West Guji Zone of Oromia, to deeply explore conflict dynamics.

Key Conflict Drivers

The conflict sensitivity analysis identified several interrelated drivers of localized conflict:

- **Resource Competition:** A primary driver of tension arises from competition over resources, notably regarding insecure land tenure and disputes over access to water, pasture, and agricultural inputs.
- **Political and Governance Issues:** Challenges related to governance, including perceptions of marginalization, the absence of inclusive governance frameworks, and a weakened rule of law, intensify long-standing grievances. These issues often manifest along ethnic or identity lines, reinforcing divisions within the community.
- **Ethnic and Clan Identities:** Ethnic and clan identities serve as significant axes of division, particularly in regions where resource scarcity coincides with contested administrative boundaries. Such identity-based fault lines can lead to escalated tensions and conflict.
- **Youth Unemployment and Internal Displacement**: High rates of youth unemployment, coupled with substantial internal displacement, contribute to increasing insecurity and social fragmentation. This vulnerable demographic is particularly at risk of radicalization, further exacerbated by the proliferation of unregulated and unverified misinformation, often propagated by influential figures on social media platforms.

Impacts on Communities

The conflict sensitivity analysis identified five key conflict impacts on communities: livelihood disruption, displacement, gendered impacts, youth vulnerability, and erosion of trust. These findings are essential for understanding the program-conflict nexus in agricultural interventions, as they reveal both the risks of exacerbating existing vulnerabilities and inequalities, as well as the opportunities for inclusively designed interventions to mitigate these impacts by promoting cooperation and rebuilding trust over shared resources.

The rationale for conducting the conflict sensitivity analysis was twofold:

- To **avoid harm** by ensuring that program activities do not unintentionally fuel tensions.
- To **foster peace** by proactively identifying opportunities to support **social cohesion**.

The study generated two sets of actionable recommendations: one at the **strategic level** and another at the **operational/programmatic level**.

Strategic-Level Recommendations:

- Embed conflict sensitivity into the TRANSFORM core operational principle of "Do No Harm."
- Conduct regular multi-level conflict analyses to inform adaptive program decisions.
- Invest in staff expertise and promote a strong internal culture of conflict-sensitive practices.
- Enhance social cohesion by actively involving communities in the co-creation of interventions.

Operational-Level Recommendations:

- Establish transparent mechanisms for input distribution to build trust and reduce perceptions of bias.
- Design and implement equitable, inclusive, and trauma-informed capacity building interventions.
- Promote participatory approaches for the management of land, water, and natural resources.
- For logistics and procurement, ensure supplier vetting and conduct geographic risk assessments to mitigate operational risks.

Based on these findings and recommendations, the TRANSFORM program now has a wealth of contextual information and insights that directly inform its 2026 annual work plan, as well as subsequent annual planning and implementation efforts. These insights enable the program to design and deliver interventions that are both responsive and adaptive to the broader conflict dynamics and the localized factors identified in each targeted woreda, ensuring that implementation remains conflict-sensitive, effective, and aligned with the program overarching goals of resilience and social cohesion.

7.3 Climate Adaptation and Mitigation: Geographic Pilot on Erosion and Drought

Climate Risk and Vulnerability Profile

Ethiopia's climate is becoming increasingly variable, characterized by erratic rainfall, recurrent droughts, floods, and a steady rise in temperature (0.02-0.05 °C per year). Across the 12 TRANSFORM intervention woredas, these changes have disrupted agricultural systems, with farmers reporting shorter and unpredictable rainy seasons, delayed onset and early cessation of rains, and more frequent heavy downpours. In Tiyo and Sire, unseasonal rainfall has worsened soil erosion, reduced crop yields, and increased pest infestations, while in the northern highlands (Tehuledere, Dessie Zuria, Albuko, and Kalu) rainfall trends are mixed, showing localized variability. Women, particularly female-headed households, are disproportionately affected by climate impacts, facing greater workloads, water scarcity, and food insecurity. Spatial analysis confirmed wide disparities in rainfall, ranging from 815 millimeters (mm) in Sire to 1,760 mm in Gera and a consistent warming trend (Figure 9) that heightens crop heat stress and irrigation demand. Flood risks are highest in humid highlands such as Gera, Omo Nada, and Kalu, while droughts are most severe and recurrent in Sire, Abaya, and Basona Werana. Composite Drought Index results reinforce these findings, identifying Abaya and Sire as drought hotspots. Projections for the 2050s under high-emission scenarios suggest temperature increases of 0.78-1.3°C and uneven rainfall shifts rising in Abaya and Basona Werana but declining in Sire, Omo Nada, and Gera. Overall, the analysis reveals diverse location-specific climate vulnerabilities: drought-prone lowlands require drought-tolerant crops and water-harvesting measures, flood-prone highlands need stronger soil and water conservation, and all districts must prepare for intensifying heat stress through climate-smart adaptation strategies.

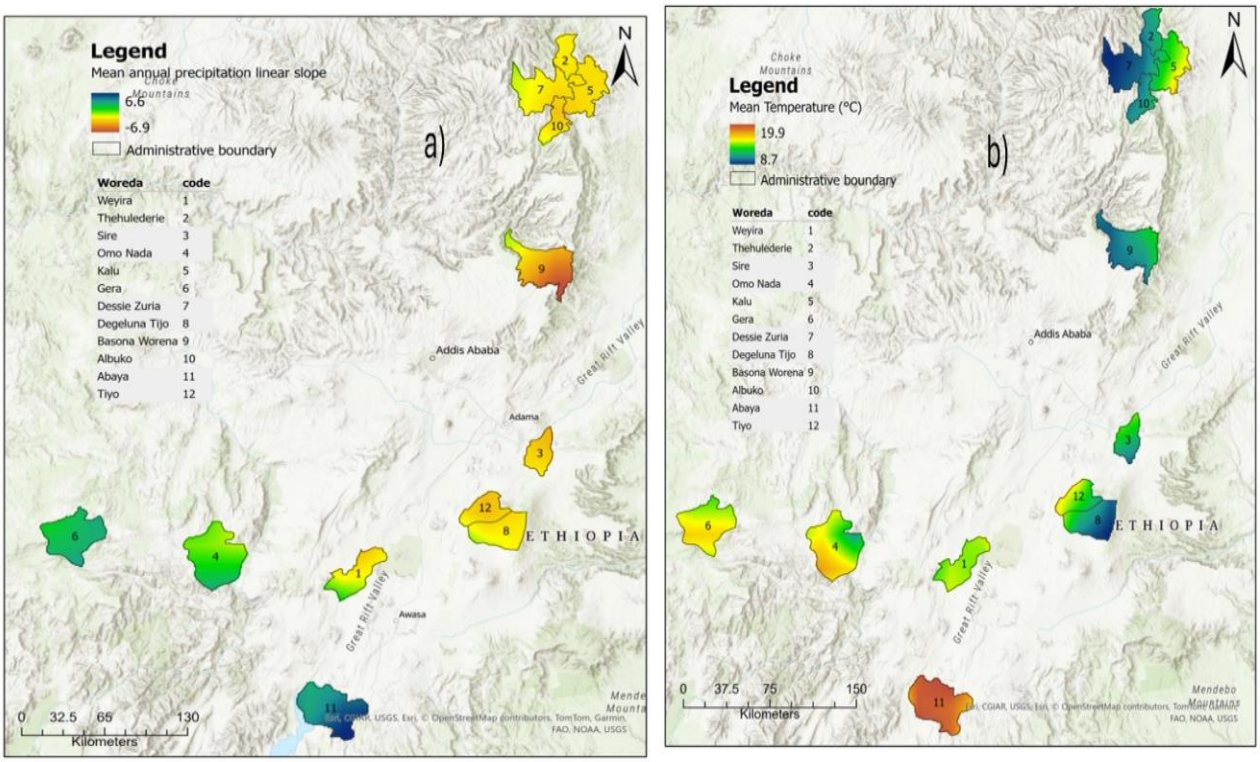


Figure 9. Mean annual precipitation (a) and mean annual temperature (b) across the 12 intervention woredas

Vulnerability Assessment

Exposure

Climate and environmental exposure were high across all 12 TRANSFORM woredas (index = 0.72), reflecting frequent droughts, rainfall variability, and land degradation (Table 7). Oromia faced recurrent droughts and livestock losses, Amhara highlands suffered severe erosion, and the central midlands experienced erratic rainfall and shorter growing seasons. With over 90% of households relying on rainfed farming, even small climatic shifts cause major livelihood disruptions. Location-specific climate-smart agriculture measures such as drought-tolerant crops and water harvesting in Oromia, agroforestry and soil conservation in Amhara, and crop diversification in the central midlands are urgently needed.

Table 7. Composite vulnerability (multiple woredas)

Contributing Factor	Index Value
Exposure	0.72
Sensitivity	0.72
Adaptive Capacity	0.46
Livelihood Vulnerability Index—Intergovernmental Panel on Climate Change (LVI–IPCC) Score	**0.33**

Sensitivity

Sensitivity was also high (index = 0.72), driven by dependence on degraded, rainfed systems and declining soil fertility. Steep-slope cultivation, overgrazing, and soil acidity or salinity are major drivers across the regions. Most households face two to three months of annual food shortages, with uneven use of coping practices such as composting and intercropping. Weak

institutional capacity and limited adoption of soil fertility management perpetuate food insecurity and land degradation, calling for integrated soil and livelihood interventions.

Adaptive Capacity

Adaptive capacity of the farming households was low (index = 0.46), constrained by limited access to inputs, finance, and extension support. The extension-to-farmer ratio (1:700-900) far exceeds the standard, while poor roads and markets restrict diversification opportunities. Oromia showed slightly better adaptive capacity due to off-farm options, but erosion-prone Amhara and central highlands scored below 0.40. Strengthening institutional support, credit access, and climate-smart technologies, especially for youth and women, is vital to enhance resilience and reduce vulnerability.

The Climate Risk Index across the 12 intervention woredas reveals marked spatial variability in precipitation, temperature, and climate extremes, indicating differentiated exposure and sensitivity to climatic stressors. Mean annual precipitation ranges from 815.2 mm in Sire to 1,760.9 mm in Gera, reflecting pronounced hydroclimatic gradients, while mean temperatures vary between 9.7°C in Dessie Zuria and 18.7°C in Abaya, signifying distinct thermal regimes along altitudinal and agroecological zones. Flood-related risks, proxied by r20mm indices, are highest in Gera (21.4) and lowest in Abaya (8.12), suggesting localized patterns of extreme rainfall events. Drought risks, assessed through consecutive dry days (CDD), peak in Albuko (41.1) and Sire (37.6), indicating higher susceptibility to prolonged moisture stress. Heatwave intensity, captured by the warm spell duration index, shows consistent positive trends across all woredas, with the highest magnitude observed in Kalu (5.2) and the lowest in Omo Nada (2.6). Collectively, these indices demonstrate a mosaic of climatic vulnerabilities where drought, flood, and heat extremes interact, underscoring the need for site-specific climate adaptation and resilience-building strategies.

Soil Degradation and Climate Linkages

The assessment across the 12 TRANSFORM woredas showed that soil degradation and climate variability are interlinked, jointly reducing agricultural productivity and ecosystem resilience. Major degradation issues include soil acidity, nutrient depletion, organic matter loss, biodiversity decline, and erosion (Figure 10).

Soil acidity is a major constraint in high-rainfall areas such as Gera, Omo Nada, Tiyo, and Digelu Tijo, where pH levels below 6.0 limit crop response to fertilizers. Nutrient depletion and low organic matter driven by continuous cereal cropping, residue removal, and limited compost use have reduced soil fertility and water-holding capacity. Soil erosion remains widespread, ranging from 0.59 mt/ha annually in Gera to over 7 mt/ha annually in Albuko, with highland woredas such as Dessie Zuria, Kalu, and Basona Werana as erosion hotspots.

Overall, degraded soils both worsen and result from climate stress. ISFM through liming, organic inputs, crop diversification, and SWC is essential to restore soil health and build climate resilience across Ethiopia’s diverse agroecologies.

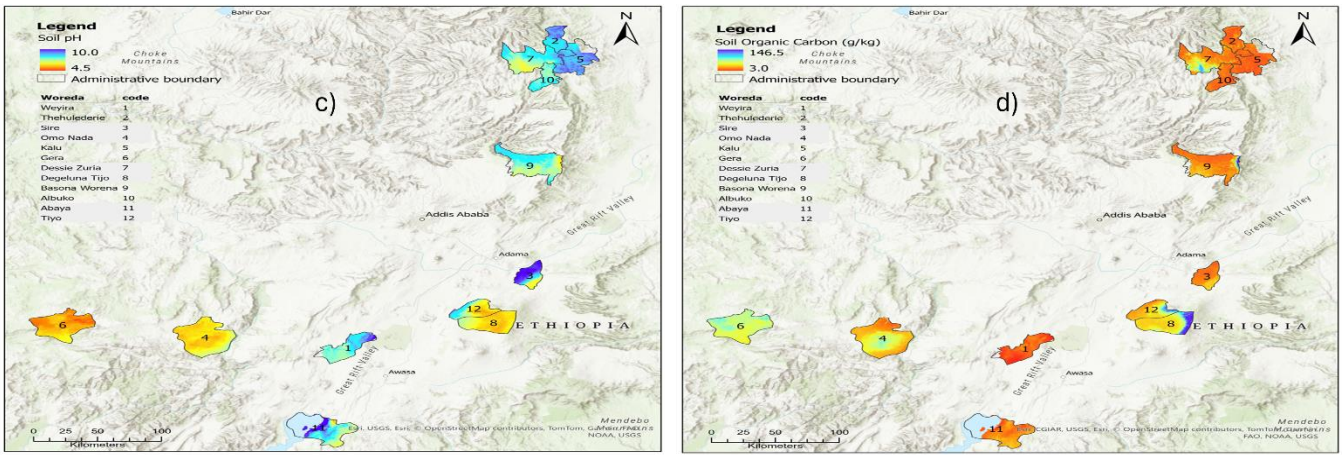


Figure 10. Soil pH map (c) as proxy for soil acidity indicator, and soil organic carbon (d, in g/kg) across 12 intervention woredas

Geographic Piloting Erosion and Drought in Basona Werana Woreda

Soil erosion and land degradation remain persistent challenges in Basona Werana, constraining agricultural productivity and threatening household livelihoods. The severity, distribution, and drivers of degradation are shaped by an interplay of topography, climate variability, socioeconomic pressures, and institutional capacity, underscoring the need for integrated and locally adapted soil conservation strategies.

Soil loss estimation using the Revised Universal Soil Loss Equation (RUSLE) reveals that Basona Werana is not uniformly at risk; instead, erosion is concentrated in specific *pockets* or *hotspots*. In these high-risk zones (Figure 11), soil loss reaches up to 42.03 mt/ha annually, posing a serious threat to agricultural productivity and land health. This spatial variability highlights the importance of micro-level conservation planning, enabling targeted resource allocation to the most vulnerable areas while recognizing that other zones maintain relatively stable soil conditions. Further, the findings underscore the highly variable nature of soil erosion across the district, demanding a site-specific, strategic approach to land management. Hence, conservation interventions and resources should therefore be prioritized for critical hotspots, particularly in the northern highlands and vulnerable pockets within central and southern areas.

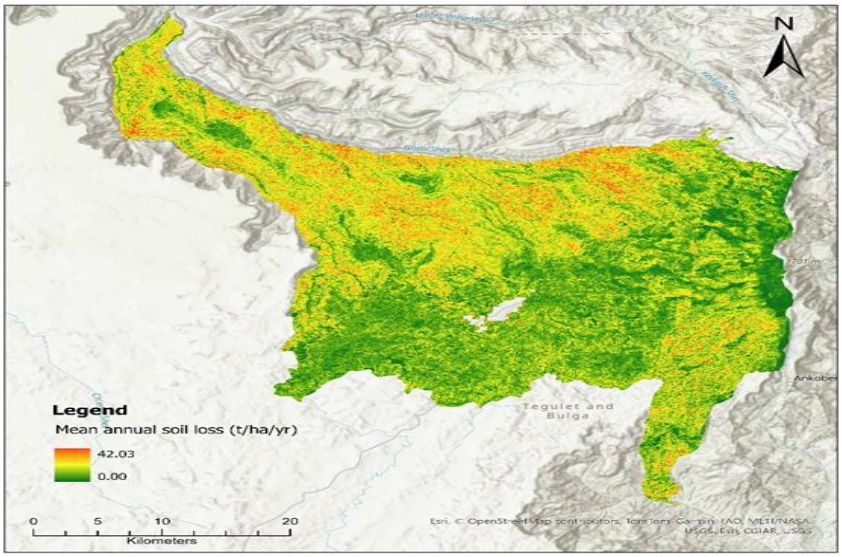


Figure 11. Soil loss map of Basona Werana

Farmers across Basona Werana consistently emphasize that drought and rainfall variability are among the most pressing challenges undermining their livelihoods, agricultural productivity, and food security. Their testimonies reveal how climate variability interacts with soil degradation and economic vulnerability, creating a compounded risk environment that affects both short-term crop performance and long-term land sustainability.

In Abamote and Gudoberet kebeles, communities reported that delayed rainfall onset disrupts planting schedules, shortens growing seasons, and reduces crop yields. Although no recent severe droughts have occurred, elders recall drought events from four to nine years ago that caused major crop and livestock losses. To mitigate these risks, households have adopted measures such as terracing, composting, and tree planting, which enhance soil fertility and moisture retention. In Debele, young farmers highlighted the combined impacts of delayed summer rains, floods, and pest infestation shocks that frequently devastate cereal crops, reduce household income, and increase the risk of financial distress for smallholder farmers. Similarly, in Muticherkos, farmers linked rising temperatures and low rainfall to declining crop productivity and livestock performance. These pressures often force temporary labor migration as a coping strategy. Across kebeles, farmers noted that communal and marginal lands are especially vulnerable, where drought interacts with land degradation, soil erosion, and nutrient depletion. Common coping strategies include composting, ISFM, terracing, tree planting, and seasonal migration. However, these efforts remain constrained by limited resources, lack of irrigation access, knowledge gaps, and weak institutional support, particularly affecting youth and women. These local experiences highlight not only the biophysical dimensions of drought and heat but also the socioeconomic dimensions of vulnerability in rural communities.

The Composite Drought Index provides further spatial insight into drought patterns, showing that risk is not uniform across the woreda but concentrated in central zones, where magnitudes peak at 0.45 compared to 0.26 in peripheral areas (Figure 12). Drought frequency reaches 44.04% in central zones, contrasting with only 7.93% in outer regions. This spatial variability underscores the importance of location-specific adaptation planning, focusing resources and interventions on the most drought-prone kebeles rather than applying uniform strategies across the woreda.

Detailed climate mapping adds further nuance to these patterns. Rainfall distribution is highly heterogeneous, shaped by elevation and topography. The eastern and southern parts of the woreda receive over 1,100 mm of rainfall annually, while the northern and western areas are drier, with less than 952 mm. Long-term trends reveal a significant decline in precipitation ($p < 0.05$) across much of the central and western zones, raising concerns about the sustainability of rainfed agriculture and future water availability. Temperature mapping shows a similar pattern of variability, ranging from approximately 9.8°C in the cooler northern and western zones to about 13°C in the warmer eastern and southern areas. All zones display significant warming trends, with increases of up to 0.03°C per year. The warm spell duration index confirms more frequent heatwaves – up to five days per year, increasing at a rate of 0.53 days annually ($p \approx 0.00$) – posing serious risks to crop and livestock productivity.

Heavy rainfall patterns are most pronounced in the eastern and southern zones, where up to 25 heavy rainfall days (≥20 mm) per year are recorded. Spatially, trends are mixed: while western zones show a slight decline, the eastern zones display statistically significant increases ($p < 0.05$), indicating a rising risk of flash floods and soil erosion in areas already vulnerable to degradation. The CDD index further reveals prolonged dry spells in the central and western zones, reaching up to 48 days annually. Interestingly, even some wetter eastern areas show increasing CDD trends, creating a paradoxical situation of being “wetter but also drier” where rainfall occurs in fewer, more intense events. This emphasizes the importance of water storage, rainwater harvesting, and small-scale irrigation as critical resilience measures.

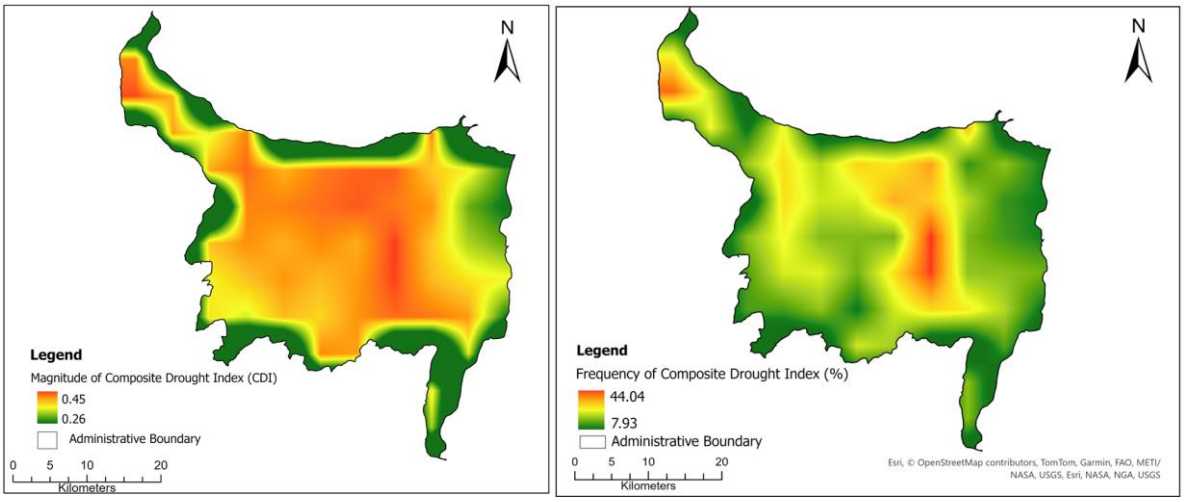


Figure 12. Basona Werana climate risk maps

Looking ahead, climate model projections (GFDL-CM4, GFDL-ESM4, NorESM2-MM, CESM2) under a high-emission scenario (SSP5-8.5) indicate worsening conditions across all zones of Basona Werana. Projections suggest rising temperatures, longer and more frequent heatwaves, and greater rainfall variability, with both heavier rainfall events and extended dry periods. These changes are expected to impose compounding stresses on soil fertility, water resources, and agricultural productivity, particularly in already fragile areas.

In general, historical analysis and future projections align with farmers lived experiences, painting a clear picture of increasing climate-induced risks. Addressing these challenges requires targeted site-specific adaptation strategies that combine SWC, livelihood diversification, and climate-smart agriculture practices. Building resilience in Basona Werana will depend on integrating local knowledge with scientific data to guide planning, prioritize vulnerable kebeles, and ensure sustainable resource management in the face of a changing climate.

Recommendations

- **Policy-Level:**
  - Strengthen implementation of national soil fertility and climate frameworks via localized, budgeted ISFM/climate-smart plans.
  - Institutionalize soil and climate data management using geospatial tools.
  - Enhance monitoring systems with clear outcomes and gender- and age-disaggregated indicators.
  - Revitalize multi-stakeholder coordination for integrated soil and climate management.
  - Regulate uncontrolled grazing and mitigate expansion of invasive species (e.g., eucalyptus).
  - Promote soil fertility-enhancing tree and fodder species.
  - Deliver localized agro-weather advisories through coordinated public-private platforms.
- **Programmatic and Site-Specific Interventions:**
  - Prioritize erosion control, soil fertility restoration, and climate-smart practices tailored to local conditions.
  - In high-erosion areas, implement contour bunds, terraces, gully check-dams, vegetative barriers, and apply lime and compost.
  - Establish watershed-level demonstration plots to showcase best practices.

- Promote gender- and youth-inclusive strategies, e.g., women-led compost cooperatives and youth SWC groups.
- Enforce rotational grazing and establish fodder banks.
- Provide timely, practical agro-weather advisories to support decision-making.

Expected Outcomes

- Strengthened soil and water management.
- Enhanced livelihoods and productivity of vulnerable groups.
- Increased climate resilience at kebele and woreda levels.

7.4 Innovation and Indigenous Knowledge Analysis

The TRANSFORM program aims to enhance soil fertility management in Ethiopia, focusing on the regions of Oromia, Amhara, and CERS. This initiative recognizes the critical synergy between innovative agricultural practices and indigenous knowledge systems, particularly in the context of organic fertilizer management and sustainable soil fertility practices.

Indigenous Knowledge Systems

Farmers in these regions possess a rich repository of indigenous knowledge regarding soil fertility management. This knowledge encompasses traditional practices, local crop varieties, and ecological insights that have evolved and refined over generations. Key aspects include:

- **Soil Assessment Techniques:** Farmers utilize observational methods to assess soil fertility, including texture, color, and moisture content. This empirical knowledge guides their decisions on crop selection and fertilizer application.
- **Organic Fertilizer Management:** Indigenous practices often involve the use of organic fertilizers, such as compost, manure, and crop residues. Farmers understand the benefits of these materials in enhancing soil structure, moisture retention, and microbial activity.
- **Crop Rotation and Intercropping:** Many farmers engage in crop rotation and intercropping to enhance soil fertility. These practices help prevent nutrient depletion, control pests, and improve overall soil health.
- **Fallowing Practices:** The use of fallowing periodically leaving land uncultivated serves to restore soil nutrients and improve soil structure. This practice helps mitigate soil degradation and enhances long-term agricultural productivity.
- **Local Adaptation Strategies:** Farmers adapt their practices based on local climatic conditions and soil types. This adaptability is crucial for maintaining soil fertility in the face of environmental changes.

Innovative Practices

While indigenous knowledge forms the foundation of soil fertility management, the integration of innovative practices is essential for enhancing agricultural productivity. Innovations can include:

- **Nutrient-Rich Organic Fertilizers:** The development and use of nutrient-rich organic fertilizers derived from composting agricultural waste and animal manure can significantly enhance soil fertility and promote sustainable agricultural practices.
- **Organo-Mineral Fertilizers:** The incorporation of organo-mineral fertilizers, which combine organic matter with mineral nutrients, can provide a balanced nutrient supply to crops while improving soil structure and health.
- **Biofertilizers:** The introduction of biofertilizers, microbial inoculants that enhance nutrient availability, can complement traditional organic fertilizers. This technology can improve nutrient cycling and increase crop yields.
- **Soil Health Monitoring Technologies:** The adoption of soil health monitoring tools (e.g., soil moisture sensors and nutrient testing kits) can provide farmers with precise data,

enabling them to make informed decisions regarding fertilizer application and soil management.

- **Training and Capacity Building:** Providing farmers with training on sustainable agricultural practices can enhance their ability to integrate indigenous knowledge with modern innovations. Workshops and field demonstrations can facilitate the exchange of knowledge and promote best practices.
- **Community-Based Approaches:** Engaging community members in participatory research and development initiatives can foster collaboration and knowledge sharing. These approaches empower farmers to experiment with new techniques while drawing on their indigenous knowledge.

The successful implementation of the TRANSFORM program necessitates a holistic analysis of both indigenous knowledge and innovative practices. Key recommendations include:

- **Documentation of Indigenous Practices:** Systematically documenting indigenous soil fertility management practices can provide valuable insights for developing context-specific interventions.
- **Integration of Knowledge Systems:** Promoting the integration of indigenous knowledge with modern agricultural innovations can enhance the resilience of farming systems. This can be achieved through collaborative training, discussion, and knowledge exchange platforms.
- **Policy Support:** Policymakers should recognize the value of indigenous knowledge in agricultural development. Supporting initiatives that promote local practices alongside scientific advancements can lead to sustainable soil fertility management.
- **Monitoring and Evaluation:** Establishing a robust monitoring and evaluation framework will help assess the effectiveness of integrated approaches, ensuring that both indigenous and innovative practices are contributing to improved soil fertility and agricultural productivity.

The TRANSFORM program presents a unique opportunity to leverage the strengths of both indigenous knowledge and innovative practices in soil fertility management. By fostering a collaborative environment that respects and incorporates local practices, the program can enhance agricultural sustainability and resilience in Oromia, Amhara, and CERS. This dual approach not only empowers farmers but also contributes to the broader goals of food security and environmental sustainability in Ethiopia.

7.5 Input Supply Systems and Value Chain Actors Analysis

The soil input supply system in Ethiopia is fundamentally dualistic, consisting of a centrally controlled chain for inorganic fertilizers and a nascent, highly decentralized local system for lime and organic inputs. This structure has fostered deep-seated issues of fragmentation, quality inconsistency, and a critical mismatch between what is supplied and what smallholder farmers truly need. This section presents an analysis of the specific value chains for inorganic fertilizers, agricultural lime, and organic inputs, concluding with a synthesis of the major systemic gaps and strategic cross-cutting recommendations for the program.

Soil Input Value Chain Actors and Analysis

Inorganic Fertilizer Value Chain (Urea, DAP, NPS)

The inorganic fertilizer supply chain is centrally organized, operating with an "implicit monopoly at each stage," which creates systemic inefficiencies and poor service delivery for smallholder farmers (Figure 13).

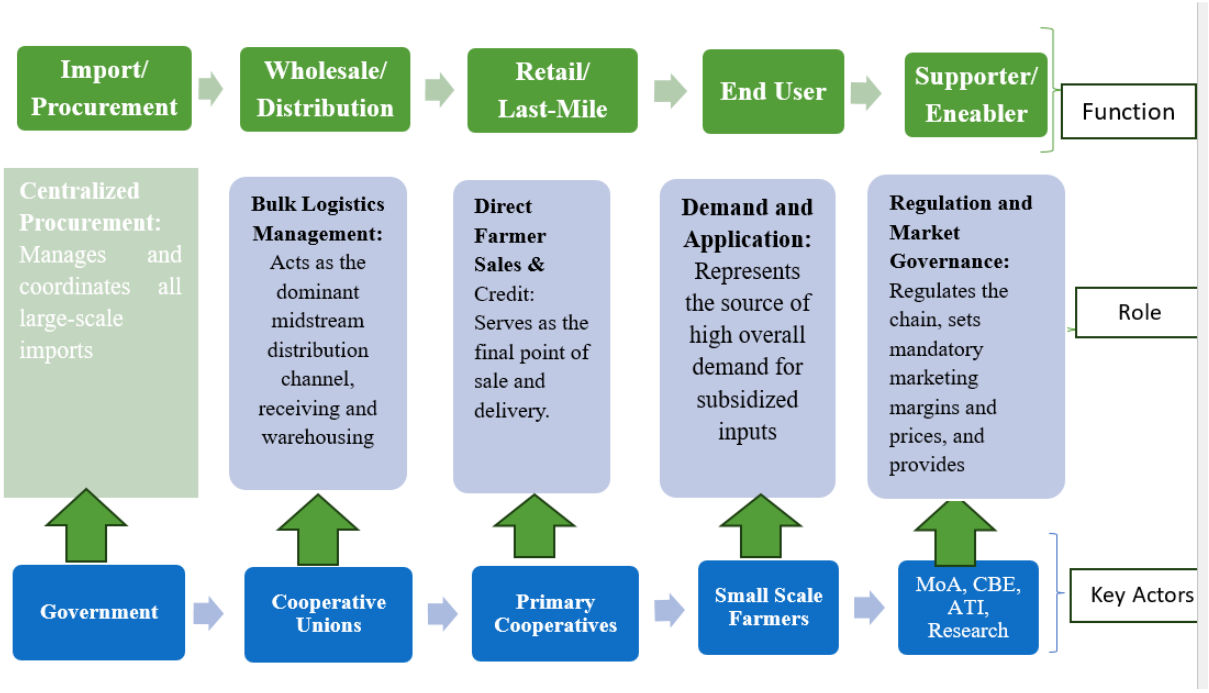


Figure 13. Inorganic fertilizer value chain map

The key challenges include:

- **Supply and Import Rigidity:** A central monopoly makes procurement slow and inflexible, resulting in chronic delays (often 6 months or longer) and stockholding issues.
- **Distribution Failures:** Low institutional capacity among distributors (cooperative unions/primary cooperatives) and poor logistics cause untimely distribution, leading to delayed fertilizer application.
- **Financial and Retail Constraints:** Primary cooperatives face liquidity constraints and transport hurdles. Their credit-focused model limits retail flexibility and farmer choice.
- **Farmer Access and Affordability:** Farmers suffer from high prices (unfavorable cost-to-output ratio) and the chronic late arrival of inputs.
- **Planning Gaps:** Supply planning is centralized and is not driven by critical analysis of actual farmer demand.

Agricultural Lime Value Chain

The agricultural lime value chain is critical for addressing soil acidity but remains highly subsidized, inefficient, and fragmented. The chain relies heavily on public and private factories utilizing local limestone deposits (Figure 14). Key challenges include:

- **Production and Market Disconnect:** Factories experience severe under-capacity utilization (e.g., producing 10% of max capacity) because production is not market-driven; they only produce the quantity contracted by the government, creating a disconnect from actual farmer demand.
- **Logistical and Access Barriers:** There is no stable commercial supply chain. Logistics and transport are major hurdles, resulting in supply that is far below regional need.
- **Minimal Farmer Adoption:** Adoption is minimal due to poor last-mile access, high transport costs, and farmer reliance on inconsistent subsidized delivery.
- **Private Sector Exclusion:** Private sector engagement is minimal due to a fundamental lack of market certainty and a clear commercial enabling environment.

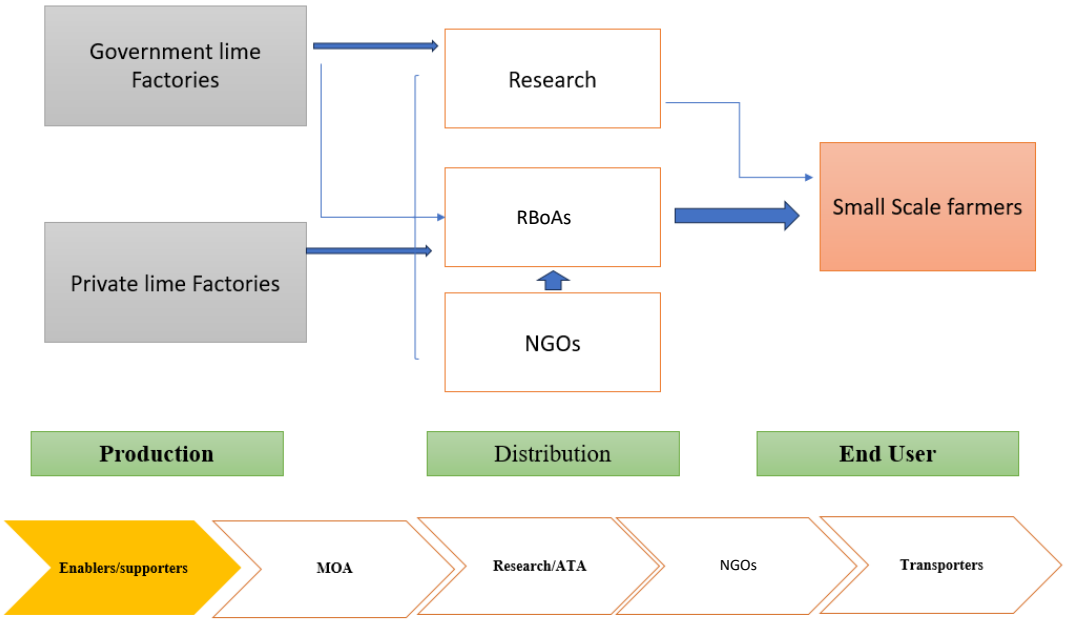


Figure 14. Lime value chain map

Organic and Biofertilizer Supply (Emergent/Local)

The organic input sector in Ethiopia is an emergent and highly localized supply system primarily characterized by decentralized farmer-led production of amendments such as compost, bioslurry, and vermicompost, supported by farmer-to-farmer knowledge transfer and local demonstrations (Figure 15). This is complemented by a localized supply chain for specialized biofertilizers produced in regional laboratories and distributed via RBoAs, with private organizations playing a supplementary role, particularly in the production of bio-compost.

Major challenges in the organic input value chain include:

- **Lack of Commercial-Scale Production:** Production is mostly for on-farm use (subsistence) and is hindered by a lack of financial capital to scale up production into a commercial supply.
- **Credit and Quality Deficiencies:** Formal distributors receive minimal credit (less than 10% of input loans), leading to a dominance of informal markets that circulate substandard, unstandardized products.
- **Weak Quality Enforcement:** Despite the existence of national standards, enforcement is minimal, severely undermining farmer trust in the quality and efficacy of purchased organic inputs.
- **Labor and Trust Barriers for Farmers:** Farmers face high labor requirements for applying bulky organic inputs and are reluctant to adopt commercial products due to uncertainty regarding quality consistency.

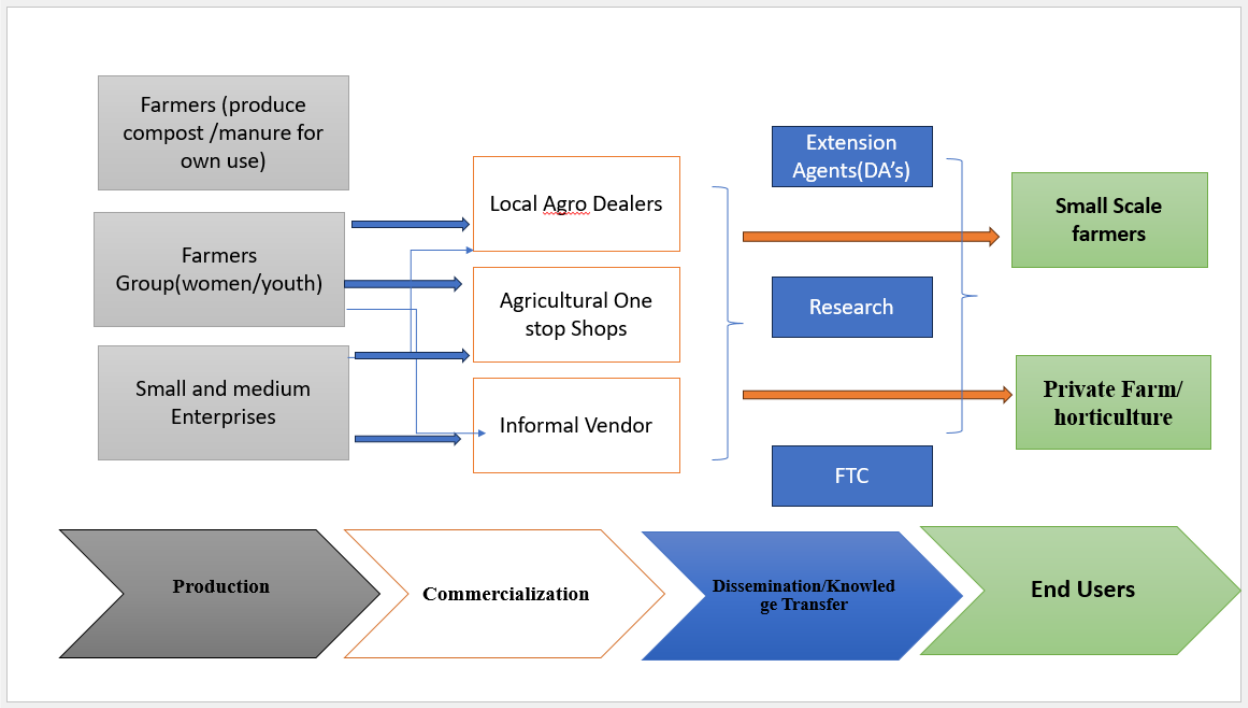


Figure 15. Organic fertilizer value chain map

Strategic Opportunities and Recommendations

To strengthen the entire soil input system, strategic interventions must be tailored to address the systemic gaps and foster market integration.

- **Reform Input Logistics and Finance:** Establish a multi-stakeholder platform to improve supply chain transparency and incentivize private/cooperative partners to enhance last-mile logistics and stock rotation, ensuring timely delivery.
- **Scale Domestic Lime Production:** Secure long-term supply contracts with private producers (e.g., the cement industry) to provide stable demand signals, while strengthening extension services to drive farmer adoption and efficient use (e.g., microdosing).
- **Catalyze Private Organic MSMEs:** Provide targeted technical and financial support (e.g., matching grants, working capital) to local MSMEs to scale up the standardized production of biofertilizers and certified organic inputs.
- **Establish Quality Assurance:** Harmonize and rigorously enforce quality standards for all inputs (mineral, lime, and organic) and implement an affordable third-party testing and certification program to build farmer trust and combat counterfeiting.
- **Develop Integrated Credit and Data:** Pilot integrated credit schemes through financial institutions and cooperatives for high-impact inputs, supported by a robust market intelligence system to replace rigid supply planning with data-driven procurement and market signals.

7.6 Development of Soil Inputs and Business Cases

The agriculture sector in Ethiopia is facing significant challenges due to widespread soil degradation and low adoption of locally sourced soil inputs, despite the availability of resources such as lime and organic waste. This situation is largely attributed to the absence of an effective, affordable, and quality-assured market system. To address these issues, a dual-track intervention is proposed, consisting of an accelerator facility to support early-stage enterprises, such as biofertilizer producers, in achieving formal structures and quality consistency, and a scale-up facility to assist established firms, such as lime producers, in enhancing operational

efficiency and securing larger investments. This strategic approach aims to overcome market failures, improve product quality, facilitate access to finance, and drive systemic policy changes, ultimately expanding smallholder farmers' access to a cost-effective range of domestic soil inputs.

Key Soil Input Products and Market Constraints

Lime

Soil acidity is a significant challenge in Ethiopia, with over 20 million hectares of farmland affected. Despite the proven benefits of agricultural lime, its actual use in Ethiopia remains very limited. Various studies have analyzed and outlined the challenges explaining why farmers rarely apply lime, pointing to a combination of factors: high upfront costs, limited farmer awareness, seasonal demand spikes, weak last-mile distribution logistics, and a lack of incentives for private producers to invest in the market. In essence, even though Ethiopia has abundant limestone resources and both public and private factories with the capacity to produce enough lime to treat all acidic soils, demand has been too uncertain and the supply chain too inefficient to develop a sustainable market. Therefore, the main constraint is not the physical availability of lime but the absence of a functioning market system to deliver it affordably to farmers.

Organic Liquid Fertilizer

Organic liquid fertilizer is an emerging soil input in Ethiopia, with considerable potential to enhance soil fertility and boost crop productivity. Because it is produced from locally available waste resources, it requires minimal cash outlay, an important advantage for smallholder farmers. Despite these benefits, the current scale of organic liquid fertilizer use in Ethiopia is still very limited. Production is mostly small scale and fragmented, often driven by community groups or small entrepreneurs in peri-urban areas. Adoption by farmers has been slow due to several challenges. Awareness is low, as many farmers are not familiar with liquid fertilizers or their proper use. Supply and quality control are additional issues, since producing a reliable product depends on steady sources of organic waste and consistent fermentation practices, which can be difficult on a small scale. Moreover, there is little formal regulation or standardization for these products, meaning quality can vary. Overall, while still in its infancy, organic liquid fertilizer is highlighted as a promising homegrown solution for Ethiopia's farmers. With greater awareness, quality assurance, and support to producers, this input could grow rapidly and complement conventional fertilizers in improving crop yields sustainably.

Compost

Compost, the product of decomposed organic matter such as crop residues, animal manure, and household waste, is a cornerstone of sustainable agriculture, valued for its ability to improve soil fertility, structure, and moisture retention. In Ethiopia, the landscape of compost production is complex and segmented between urban and rural contexts. A combined approach is needed to fully develop the sector. In urban areas and larger cities, the focus should be on supporting and replicating successful commercial composting models. This requires ensuring that enterprises have continued access to organic waste inputs through effective municipal waste collection and sorting, as well as providing technical assistance and investment to upgrade processing capacity. At the rural and community level, the emphasis should be on empowering small producers. This calls for detailed resource mapping at local (woreda and kebele) levels to identify untapped sources of organic waste. Capacity building is also necessary, with training for farmers, youth groups, and cooperatives on improved composting techniques to increase quality and consistency. Simple interventions such as better pit design and mixing methods can greatly enhance compost quality. Building partnerships between established urban composters and rural enterprises would further enable knowledge transfer and help rural producers access broader markets, thereby significantly expanding the use of compost as a natural fertilizer.

Biofertilizer

Biofertilizers are biological soil inputs, typically containing live beneficial microorganisms, that enhance soil fertility by increasing the availability of nutrients to plants. Common examples include rhizobium inoculants for legumes, which fix atmospheric N, and other microbial products that solubilize P or stimulate plant growth. In Ethiopia, interest in biofertilizers has been rising as an innovative, low-cost alternative to synthetic fertilizers. However, adoption remains very limited and the industry is still in its infancy. A major challenge is regulatory: existing fertilizer regulations and standards are not well-suited to microbial products. Distribution and awareness are additional problems. Many farmers do not know about biofertilizers or have never used them, and extension services have provided little guidance on these inputs. The supply chain is weak, as the few producers struggle with logistics and agro-dealer networks remain underdeveloped. Even cost, which is relatively low per hectare for effective rates, can be a concern for smallholders, as the product requires an upfront cash outlay (one popular inoculant costs around ETB 1,200 per hectare).

Animal Manure (including Biodigesters)

Using animal manure as fertilizer is a traditional practice that offers clear benefits for soil health and crop productivity. With Ethiopia's poultry sector growing in response to rising demand for chicken and eggs, the volume of chicken manure available is increasing, turning what could be a waste problem into an opportunity for sustainable fertilizer. At present, there is no effective large-scale system to collect, process, and distribute chicken manure as fertilizer. Most poultry farms treat manure as a disposal issue rather than a resource. There are no formal marketing or distribution channels, and the costs of handling are prohibitive. Chicken manure is bulky and wet, making it expensive to transport and store, and it is usually only economical to move it within about a 20 km radius of its source. On the demand side, many farmers have little awareness or experience in using processed manure as a fertilizer. This results in a catch22: without evidence of strong demand, poultry producers do not invest in processing manure, and without reliable supply and quality, farmers do not demand it. The manure market thus remains largely informal and underdeveloped.

Biodigesters as a Special Case

Biodigesters offer a dual solution by breaking down manure anaerobically to produce both clean energy (biogas) and a high-quality organic fertilizer (bioslurry), with potential annual benefits estimated at 1 million. Despite this compelling economic case, past development programs for biodigesters often failed due to bureaucratic top-down implementation, inadequate technical training, and poor after-sales service. Future success requires learning from these failures by ensuring private sector leadership and strong commercial incentives, supported by financing schemes and robust technical services, to make biodigesters a practical tool for sustainable livestock farming.

The soil input sector in Ethiopia is highly diverse and fragmented by maturity and capacity. On one end are a few well-established industrial-scale players such as lime producers delivering high-quality inputs to multiple industries and established markets. On the other end are early-stage innovators and startups developing biofertilizers or liquid inputs, characterized by strong technical innovation but limited sales, distribution networks, or formal business structures. Between these extremes lies a broad middle of SMEs, many semi-formal or informal, such as local compost makers or cooperatives, working on smaller scales with ongoing improvements but facing quality control and market-access challenges. Some related larger players in fields such as poultry farming could also enter the soil input space by valorizing organic waste. Overall, while domestic production capacity and promising innovations exist, many producers struggle to reach farmers consistently or operate sustainably.

To address this heterogeneity, a tailored, two-track approach is recommended, involving an Accelerator Facility for smaller nascent enterprises and startups and a Scale-Up Facility for more established medium- to large-size companies that have proven concepts but need support to expand impact. The Accelerator Facility would build business skills, technical know-how, and market access for early-stage players, while the Scale-Up Facility would assist growth-oriented firms with scaling production, quality assurance, and financing. Together, these parallel tracks aim to strengthen the entire ecosystem, transforming small initiatives into formal, viable businesses and helping promising firms achieve broad commercial reach. If implemented, Ethiopia could enable widespread access to affordable, locally produced soil inputs – lime, compost, biofertilizers, liquid nutrients, and manure-based products – thereby boosting agricultural productivity and sustainability at scale.

Business Case and Proposed Support Activities

The primary objective of this intervention is to achieve significant market impact: enabling private firms to expand smallholder farmers' access to quality inputs, targeting 100,000 farmers, and enhancing the sustainable use of 65,000 hectares of farmland by 2028. While the exact support package will be tailored to each company's needs based on a needs assessment, a comprehensive overview of high-level support activities that translate strategic objectives into operational action can be defined. To account for the heterogeneity of the sector, activities will be delivered through two complementary tracks: the Accelerator Facility for early-stage and growth-phase SMEs, and the Scale-Up Facility for more established enterprises (Table 8).

Table 8. Support areas of the Accelerator and Scale-Up facilities for business, market, financial, technical and regulatory advancement

Support Area	Accelerator Facility	Scale-Up Facility
Business Support	Basics, business model development, organizational professionalization	Limited, only where needed, focus on efficiency and expansion planning
Market Linkage	Internal, building marketing capacity, farmer outreach, demonstrations	Primary focus, large-scale facilitation, distribution networks, adoption in intervention woredas
Access to Finance	Readiness, financial literacy, bankable plans, early-stage financing	Capital, larger financing growth and capital investments
Technical Support	Foundational, product quality basics, introducing technologies	Advanced, process optimization, technology upgrading
Policy and Regulatory	Navigation, licensing for new products	Systemic, addressing bottlenecks, streamlining processes

Business Support: Under the Accelerator Facility, companies may receive tailored support to strengthen their business models, operations, and strategy. This may include coaching on refining their value proposition and revenue model, optimizing production processes, improving quality control, and managing costs. For example, support might involve redesigning a distribution strategy to reach more farmers in intervention woredas or implementing lean manufacturing techniques to increase output with expert advice. Additionally, activities may include organizational development, such as instituting better recordkeeping, inventory management, or Human Resources practices to professionalize the

enterprise. For Scale-Up companies, business advisory will be more context specific and dependent on the specific needs of each company. The primary focus may be on operational efficiency and expansion planning leveraging expertise advice, given that their basic systems are already in place.

Market Linkage Support: For Scale-Up companies, this is the primary activity, focusing on large-scale market development and adoption by organizing joint promotional campaigns, hosting demonstration plots with extension services, and directly connecting firms to agro-dealers and distributors to significantly expand commercial reach. For Accelerator participants, the support emphasizes internal capacity building for farmer outreach, including training on marketing techniques, demonstrating product benefits through on-farm trials, and developing local language informational materials to build initial customer segments.

Access to Finance: Almost all these companies experience limited access to capital as a barrier to scaling (for working capital, purchasing equipment and raw materials, or expanding facilities). The program will include a finance component to help companies become investment-ready and connect with financing. Supporting activities under the financial product may include training and mentoring on financial planning, recordkeeping, and preparing bankable business plans (improving their ability to engage lenders or investors).

Technical Support: Accelerator companies receive targeted training focused on quality foundation and consistency at an early stage, covering best practices in compost enhancement or microbial stability for biofertilizers. For Scale-Up companies, support is more advanced, leveraging experts (like those from IFDC) to focus on process optimization and technology upgrades, such as efficient lime crushing techniques, advanced quality management systems, and organo-mineral formulation.

Policy and Regulatory Support: Accelerator firms receive help navigating licensing and documentation for new products. Scale-Up firms receive assistance through coordinated engagement with regulatory bodies (like the MoA) to address systemic bottlenecks and streamline processes. In both cases, the program compiles evidence to inform broader advocacy for policy reforms, thereby enhancing the enabling environment.

7.7 Gender

The gender assessment establishes the analytical foundation for a transformative gender agenda within the TRANSFORM program. It identifies structural constraints, highlights opportunities for equitable participation, and outlines actionable pathways to institutionalize gender responsiveness across all program components and implementation stages. The assessment applied a structured five-domain analytical framework integrating literature review, program document analysis, consultations with consortium staff and external experts, and a review of the baseline assessment and program design.

Objectives, Scope, and Deliverables

The gender assessment aimed to operationalize TRANSFORM commitment to move beyond gender sensitivity toward gender transformation. Its specific objectives were to: (i) build a contextual understanding of gender relations in the program operational areas; (ii) identify systemic barriers and opportunities for women and youth inclusion; and (iii) formulate evidence-based and actionable recommendations. The scope encompassed all four components of TRANSFORM, and the key deliverables included a summary for the inception report, literature and program review, validation and awareness workshops, and a gender-responsive action plan.

Methodology

The methodology combined secondary data analysis with participatory inquiry. Core methods included literature and baseline report reviews, program document analysis, and structured consultations with staff and technical partners. Direct engagement with farming communities was intentionally deferred to prevent respondent fatigue before tangible program benefits could be established. Consortium partners were engaged through meetings and participatory action planning. The gender assessment followed five sequential steps: contextual gender analysis, qualitative gap identification, synthesis of findings, formulation of actionable recommendations, and development of a gender action plan.



Key Findings

The assessment revealed persistent gender disparities across all four program components, reflecting systemic inequalities in access to resources, participation, and decision-making within the agriculture sector. Regarding extension services, only 19% of female-headed households received support compared to 38% of male-headed households, and women accounted for just 11% of DAs; these constraints are largely shaped by disproportionate time burdens and restrictive social norms. Regarding soil input systems, women owned less than 20% of registered land, limiting access to credit and cooperatives; only 14% used inorganic fertilizer versus 29% of men, 9% accessed improved seeds versus 25% of men, and 21% held cooperative membership. Regarding research and education, women comprised just 14% of researchers, 26-28% of ATVET students, and less than 20% of farmer research group members, often in supporting roles rather than decision-making roles. Within the enabling environment, gender policy implementation remained weak: only 15% of women participated in soil-related committees compared to 41% of men and 12% were aware of soil input subsidies versus 28% of men, demonstrating entrenched inequalities in access, representation, and information.

Program Review, Preliminary Conclusions, and Action Plan

The program review highlighted both challenges and opportunities to advance gender and youth inclusion across all components.

- **Extension Services:** Women's participation remained low (19% versus 38% of men). Recommended actions include dual household registration, flexible training modalities, and gender targets of 30% women and 20% youth in PIP and farmer field schools.
- **Soil Input Systems:** Structural barriers in land tenure and finance limited women's engagement. Priority actions include women-focused financial products, establishment of 25 women and youth groups in soil input production, support for 30% women-owned SMEs, and channeling 20% of fertilizer distribution through women association.
- **Research and Innovation:** With women representing only 14% of researchers and 26-28% of ATVET students, the program should promote inclusive eligibility criteria, mentorship schemes, and gender-responsive technologies.
- **Policy and Enabling Environment:** Given that only 15% of women participate in soil-related committees and 12% are aware of soil input subsidies, key actions include ensuring at least 40% women and youth representation in platforms, embedding gender expertise in governance structures, and integrating gender considerations into the 15-year Soil Vision.

Cross-cutting measures include establishing a Gender and Youth Taskforce, institutionalizing gender-disaggregated data systems, and operationalizing safeguarding mechanisms. Collectively, these interventions provide a robust framework for embedding gender equity and social inclusion at the core of TRANSFORM implementation and outcomes.

8 Household Food Security Measures

Food security is a multidimensional concept encompassing food availability, access, utilization, and resilience. Recent studies have identified the Food Consumption Score (FCS) and Household Dietary Diversity Score (HDDS) as key indicators of household food security and resilience. Since the TRANSFORM program's interventions in soil health and fertility management may affect these dimensions, FCS and HDDS were used to assess the current food security and resilience status of households in the intervention kebeles.

Food Consumption Score

Developed by the World Food Programme (WFP), the FCS measures food security based on dietary diversity and frequency of consumption. Data were collected through a structured questionnaire asking respondents how often their households consumed 16 food items over the previous seven days and the primary and secondary sources of each (e.g., purchase, own production, or trade). The consumed foods are grouped into eight categories, such as staples, pulses, vegetables, fruits, meat/fish, dairy, oils, and sugar and each weighted according to nutritional value, with higher weights assigned to nutrient-dense foods like animal products.

We estimated the percentage of food-secure households using the WFP's recommended cutoff points: food insecure (0-21), borderline (21.5-35), and food secure or acceptable (>35). The WFP applies the FCS within its Comprehensive Food Security and Vulnerability Analysis framework to assess food security and vulnerability in crisis-prone populations. Similarly, as shown in Figure 16, the TRANSFORM baseline study indicates that a considerable proportion of households in the intervention kebeles of Amhara (73.1%) and Oromia (66.2%) are food secure, while 61.5% of households in CERS fall within the borderline category.

Household Dietary Diversity Score

The HDDS, introduced in 2006 under the second phase of the Food and Nutrition Technical Assistance (FANTA) project, provides a method to measure household food access. It reflects the number of food groups consumed by a household over a given reference period, usually 24 hours. The HDDS serves as a population-level indicator of household food access and is widely used to assess food security. It captures dietary diversification, which is positively associated with nutritional and health outcomes such as improved child anthropometry and hemoglobin levels. However, because the HDDS is determined at the household level, it does not capture individual dietary diversity or intra-household food distribution.

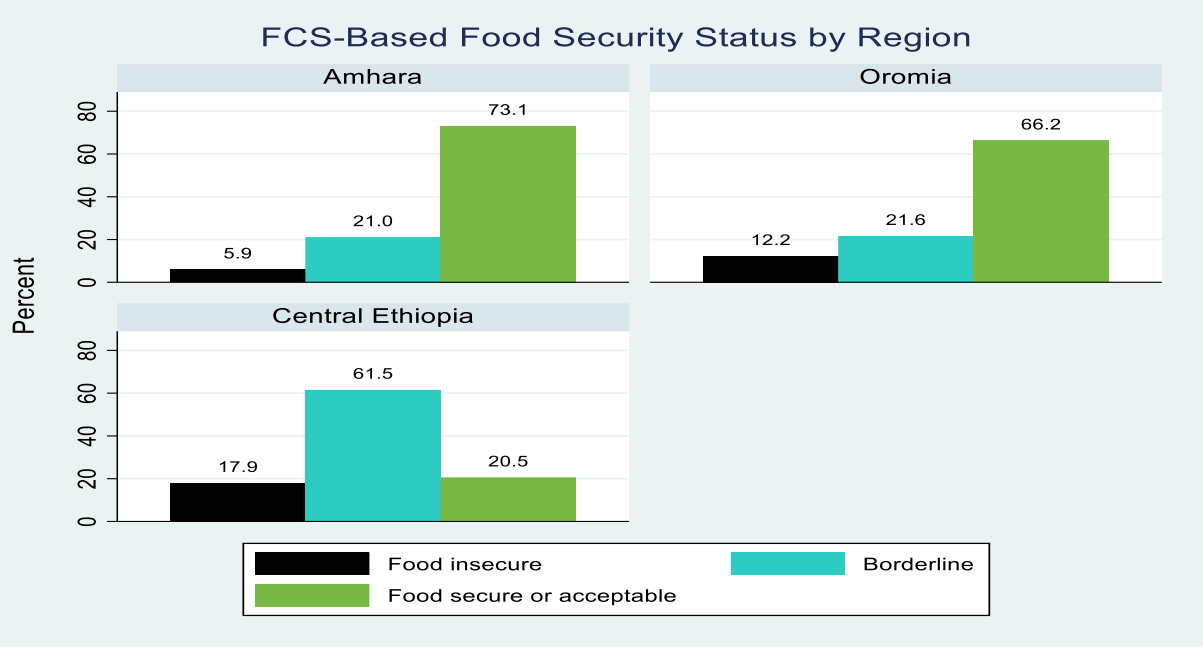


Figure 16. Household food security measure based on food consumption score (FCS)

To estimate HDDS, data were collected on 12 local food groups consumed by households during the previous 24-hour period, ensuring that the reference day was normal for the household. As shown in Figure 17, a considerable proportion of households in the program intervention kebeles of Amhara (59.7%) and Oromia (49.8%) are food secure, while 82.1% of households in CERS are moderately food insecure.

Overall, the FCS and HDDS findings suggest that household food security varies considerably across regions. While most households in Amhara and Oromia demonstrate relatively better food access and dietary diversity, a large proportion of households in CERS remain in the borderline or moderately food-insecure category. These results highlight regional disparities and indicate the need for targeted interventions to improve household nutrition and food resilience, particularly in areas showing lower dietary diversity and consumption frequency.

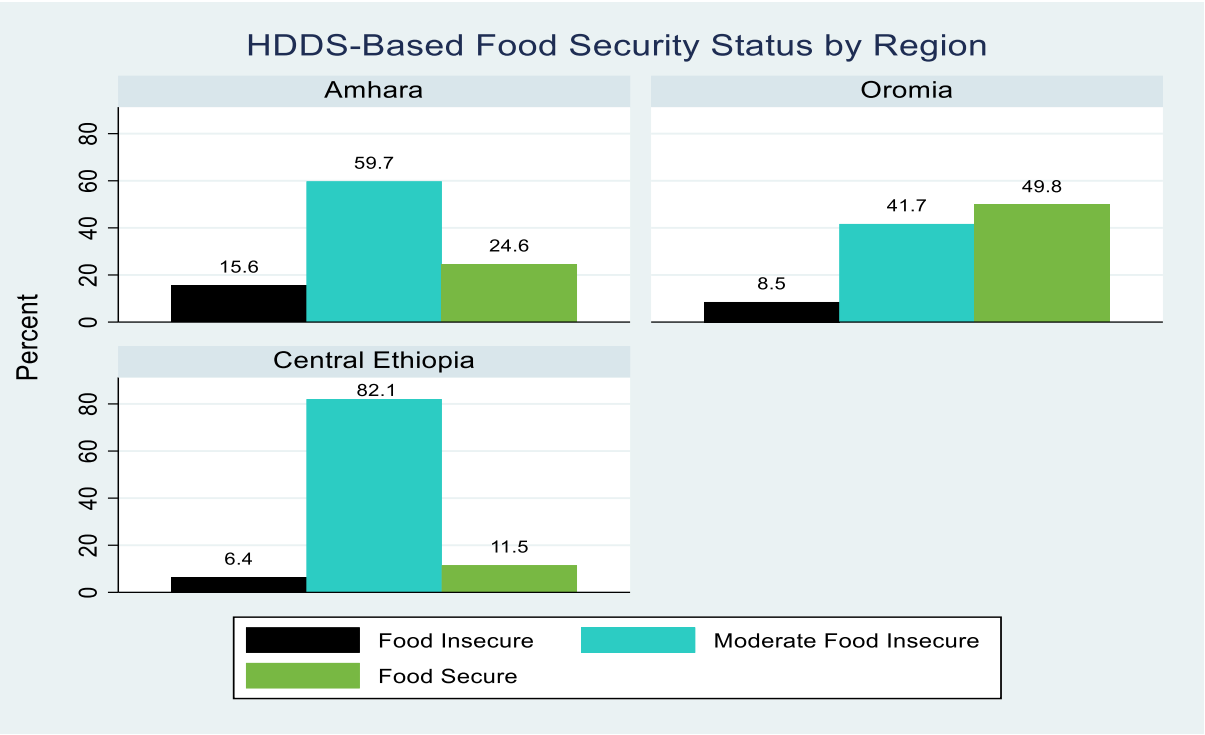


Figure 17. Food security measure based on household dietary diversity score (HDDS)

9 MELS

The inception period MELS focused on a range of key activities, such as validating and operationalizing the program theory of change, defining the result chain indicators with consideration for the context of the program implementation regions and scientific rigor, conducting the baseline study, and developing a comprehensive MELS framework and plan including development of data collection tools.

Operationalizing the Theory of Change

The program's theory of change is structured around four integrated impact pathways outlining key activities, outputs, outcomes, and development impacts. The first pathway focuses on empowering smallholder farmers by strengthening public extension systems, introducing the PIP approach, and institutionalizing an adapted extension model for sustainability. The second pathway develops a vibrant soil input sector by supporting domestic production and improving small-scale producers' access to diverse soil inputs. Building on these, the third pathway strengthens research-extension linkages through farmer-led action research and validation of soil health practices, while the fourth pathway fosters an enabling environment via sector coordination and supportive policies and regulations.

Collectively, these pathways aim to convert 65,000 hectares of agricultural land to sustainable use, enhance the resilience of 100,000 smallholder farmers and their agroecological systems, and drive systemic transformation by strengthening local partners' capacity in soil health and fertility management. From the outset, the theory of change was operationalized through a rigorous consultation and validation process, including inception workshops and working sessions with consortium members, which refined and adapted it as the guiding framework for the program's first intensive implementation phase.

Developing a Practical MELS Framework

Through rigorous consultation and engagement of all program teams, a comprehensive MELS framework was developed. This framework provides a structured approach for tracking progress, measuring outcomes, and assessing the overall impact of interventions aimed at achieving substantial transformation in soil health and fertility management across the country. Specifically, it outlines the program's results indicator matrix, complete with indicator definitions, technical notes, calculation methods, data sources, and data collection frequencies. It also specifies quality control measures and monitoring and evaluation protocols and clarifies the roles and responsibilities within the program's MELS activities.

This analytical summary focuses on the impact and outcome result areas and corresponding indicators presented in the indicator matrix of the framework. It provides clear definitions, calculation methods, and interpretive analysis to demonstrate how each indicator contributes to measuring progress toward the program's goal of ensuring small-scale food producers in the Amhara, Oromia, and CERS sustainably manage soil health and fertility for improved food production and resilient farming systems. While the impact indicators capture long-term, systemic changes resulting from strategic interventions, the outcome indicators measure intermediate results that signal progress along the impact pathways. Together, these indicators form the foundation for evidence-based monitoring, learning, and adaptive management within the program.

Impact-Level Result Areas

Hectares of Agricultural Farmland Converted to Sustainable Use

This result area focuses on farmland converted to sustainable use. The indicator for this result area will measure the total area of agricultural land transitioned from conventional practices to socially acceptable, economically viable, and environmentally sustainable systems. It will cover regenerative and climate-resilient agriculture, agroecological farming, SWC, and ISFM.

The indicator will be calculated by adding the total hectares of farmland where farmers demonstrably adopt one or more sustainable, regenerative, or climate-resilient practice within the reporting period. Data will be collected through farmer surveys, project records, geospatial mapping, and field verification, ensuring only verified transitions are counted. Measurement will apply the Sustainable Agricultural Index, a composite index based on proxy indicators such as soil health, water efficiency, biodiversity and rotation, optimum input use, yield stability, and farmer knowledge and capacity.

This indicator will also capture the highest level of environmental and land-use transformation, demonstrating the program's contribution to SLM and climate adaptation. Its measurement will require coordination among extension services, satellite data verification, and field-level assessments. Despite potential challenges in maintaining consistent verification standards and definitions across regions, continuous improvement in this indicator will provide strong evidence of landscape-level transformation and long-term environmental impact.

Hectares of Agricultural Land that Become Resilient to Climate Shocks

The second impact-level result area focuses on enhancing the capacity of agricultural land to withstand and recover from environmental and climate-related stresses, such as droughts, floods, and soil degradation. Resilience is defined by improved soil health through ISFM, SWC measures (e.g., terracing, rainwater harvesting, and trenches), diversified cropping systems (e.g., intercropping and agroforestry), use of drought-resistant crops, conservation agriculture, in-situ water conservation, watershed management, supplementary irrigation, and reduced dependence on synthetic inputs. Collectively, these practices will strengthen ecosystem stability, promote sustainable productivity, and contribute to long-term food security.

The indicator will be measured by calculating the total or proportion of agricultural land (in hectares) under climate-resilient practices based on verified farmer reports and field measurements. Calculation will employ the Climate Resilience Index, incorporating dimensions such as soil health and fertility (e.g., ISFM, soil organic matter, and erosion control), water resilience (e.g., rainwater harvesting and irrigation coverage), crop diversity (e.g., intercropping and agroforestry), and adoption of stress-tolerant varieties. This indicator reflects how the program interventions enhance productivity and ecological resilience, requiring longitudinal monitoring, soil testing, and farmer participation. Increasing values will indicate steady progress toward resilient farming systems and climate-proofed livelihoods.

Small-Scale Food Producers Whose Livelihood Become More Resilient to Shocks

This result area will target small-scale food producers, aiming to strengthen their capacity to withstand and recover from climate, economic, and environmental shocks. Resilience will be promoted through diversified farming systems, improved soil and water management, access to climate-adaptive seeds and inputs, sustainable agroecological practices, and better market access. These measures are expected to improve food security (e.g., households moving from severe to moderate or secure food-security status), Household Food Insecurity Access Scale (HFIAS) scores which measure households' access to sufficient and nutritious food, income stability, and long-term sustainability, reducing vulnerability to droughts, price fluctuations, and other shocks.

Resilience will be measured by counting producers who meet defined criteria, such as adopting diversified farming, sustainable soil and water practices, climate-adaptive inputs, and non-farm livelihoods, based on survey and field verification data. This indicator will reflect both immediate household coping capacity and broader systemic resilience, providing insight into the anticipated impact on sustainable livelihoods and guiding areas for further support or scaling.

Systemic Transformation of Multisectoral Actors' Capacity for Soil Health and Fertility

TRANSFORM also aims to promote an enabling environment for soil health and fertility management. This result area focuses on building the capacity of multisectoral actors to improve their knowledge and skills and mobilize resources to develop, promote, and enforce sustainable soil health and fertility management practices. This impact-level result area will be monitored by two indicators. The first indicator assesses the enabling environment for transformation, showing how effectively TRANSFORM fosters collaboration across ministries, value chain partners, and service providers. The second indicator reflects how systemic coordination translates into concrete results, highlighting institutional maturity and shared accountability.

Growth in these indicators signals improved policy coherence and joint ownership of transformation goals. However, measuring collaboration quality beyond mere participation remains a methodological challenge, requiring qualitative assessments and institutional mapping. Indicators will be measured by counting the total number of concrete actions such as policies enacted, training sessions delivered, demonstration sites established, or conservation practices adopted that align with the priorities and targets of the 15-year national vision for soil health and fertility, alongside tracking the drafting, discussion, ratification, and implementation of relevant policies and guidelines.

Outcome-Level Result Areas

The MELS framework demonstrates three outcome-level result areas with their corresponding indicators, definitions, technical notes, and calculation methods. The first outcome-level result area focuses on empowering small-scale food producers and communities, making them resilient and stewards of their agricultural land. The second emphasizes creating a vibrant and functional soil input system through private sector engagement. The third result area targets

promoting an integrated and holistic approach, enabling stakeholders to coordinate soil health and fertility management initiatives at all levels through active engagement.

Small-Scale Producers and Communities Are Empowered to Become Resilient and Stewards of Their Agricultural Land

This specific outcome-level result area will be monitored through three interrelated indicators. Together, these indicators provide a comprehensive measure of progress toward promoting sustainable soil and land management practices that enhance productivity, resilience, and ecological restoration.

The first indicator measures the number of farming households adopting sustainable soil management practices such as composting, crop rotation, agroforestry, and the use of organic fertilizers to maintain soil fertility and productivity. This indicator tracks adoption rates while considering gender and age to ensure inclusivity in sustainable agriculture initiatives. The calculation employs an adoption index related to soil health and management practices, which is equal to the number of practices a household has adopted divided by the total number of promoted practices. Such practices may include the use of organic amendments (manure and compost), ISFM, cover cropping or mulching, crop rotation or intercropping, agroforestry or perennial integration, soil testing and nutrient management, erosion control measures (terracing, bunds), and the proportion of organic soil input use.

The second indicator focuses on the total area of agricultural land where at least two SLM practices, such as terracing, agroforestry, crop rotation, mulching, or water harvesting, are implemented and institutionalized within specific kebeles. This includes both areas directly influenced by program interventions and those indirectly impacted through farmer-to-farmer knowledge transfer and policy adoption, contributing to improved soil health, water retention, and climate resilience. It will be calculated by adding the total number of hectares of verified farmland in targeted kebeles where at least two integrated soil conservation practices have been implemented and maintained.

Finally, the third indicator emphasizes the number of watershed areas and restoration sites where SLM interventions are implemented to prevent soil erosion, enhance water retention, and restore ecosystem balance. These practices may include terracing, reforestation, gully rehabilitation, agroforestry, and community-based watershed management efforts, contributing to improved agricultural productivity, climate resilience, and sustainable livelihoods. The calculation involves counting the total number of distinct watersheds where verified SLM practices have been implemented and maintained according to predefined criteria.

A Vibrant and Functional Soil Input System through Private Sector Engagement

Creating a vibrant and functional soil input system through private sector engagement is another core outcome-level result area of the program. The progress and direction of this result will be monitored through systematic and valid data collection using two distinct result indicators.

The first indicator measures the number of small-scale entrepreneurs, including cooperative enterprises, involved in the production and distribution of soil inputs such as compost, vermicompost, biochar, biofertilizers, and organic fertilizers. It will be calculated by counting the total number of certified producers and verified small-scale entrepreneurs actively engaged in producing these specified soil inputs according to agreed criteria. To avoid double-counting, a unique identifier system (e.g., registration IDs or global positioning system (GPS)-tagged production sites) will be used to ensure that each small-scale entrepreneur is counted only once, even if they produce multiple input types.

The second indicator focuses on measuring the quantity of agricultural lime (in metric tons) supplied and used for acid soil management. It will be estimated by adding the total metric tons

of agricultural lime supplied and applied in targeted woredas, verified by cross-referencing supplier records with farmer surveys or field audits.

Integrated and Holistic Approach of Stakeholders to Coordinate Soil Health and Fertility Management

TRANSFORM also aims to achieve measurable results in the national soil system by promoting an integrated and holistic approach among stakeholders to coordinate soil health and fertility management. This outcome-level result area will be monitored through four interrelated indicators.

The first indicator measures the number of small-scale producers actively engaged in testing, evaluating, and refining soil health and fertility practices on their own farms through structured, participatory research processes. It will be calculated by counting the total number of verified small-scale producers conducting action research on their farms during the reporting period, with results disaggregated by gender. The framework includes strategies to mitigate double-counting by assigning each small-scale producer a unique identifier (e.g., registration ID, national ID, or GPS-tagged farm location) to track participation across activities, regions, or reporting sources. This ensures that each producer is counted only once, regardless of the number of research activities or data sources. A centralized database links each producer's ID to their action research activities, preventing duplicate entries.

The second indicator measures the number of ATVET students who gain practical experience through apprenticeships and/or conducting field-based action research on soil health and fertility management, with gender-disaggregated data. To ensure data quality and consistency, verification methods such as instructor evaluations, research reports, and field supervisor logs are employed, alongside minimum participation criteria such as completion of a full research cycle.

The third indicator focuses on process monitoring of the development of a comprehensive national vision document outlining goals, priorities, pathways, and actions for sustainable soil health and fertility management over a 15-year period through inclusive stakeholder consultation. The program supports and monitors this process by documenting progress and confirming the completion of the national vision document with active engagement of relevant stakeholders.

The fourth indicator tracks the progress of developing an operational, government-endorsed system with clear procedures, standards, and guidelines for registering, testing, approving, and labelling biofertilizer products to ensure quality, safety, and transparency in the market. This will be measured through process documentation and verification of whether a functional, government-endorsed biofertilizer registration and labelling system with defined procedures and standards is in place.

In conclusion, the TRANSFORM program's MELS framework provides a rigorous, evidence-based foundation for tracking progress toward sustainable soil health and fertility management. It integrates impact and outcome indicators that capture both long-term systemic transformation and short-term behavioral, institutional, and environmental outcomes. The framework's participatory design grounded in data integrity, inclusivity, and continuous learning ensures that progress is not only measured but meaningfully understood and acted upon. By operationalizing the theory of change through structured pathways, robust data systems, and clear accountability mechanisms, TRANSFORM establishes the groundwork for adaptive management, enabling stakeholders to make informed decisions, refine interventions, and scale proven solutions. Ultimately, the MELS framework positions the program to demonstrate tangible results in soil restoration, farmer resilience, and institutional capacity, contributing significantly to Ethiopia's broader agenda for sustainable agricultural transformation.

10 Lessons Learned and Implications for the Way Forward

- **Farm Household Analysis**

  Analysis of the 12 intervention woredas indicates that farm households possess substantial indigenous knowledge and farming experience, with an average household head age of 44 years. Youth-headed households demonstrate comparatively higher receptivity to novel agricultural technologies. Literacy levels are moderately favorable at 69% overall, providing a foundation for technology adoption; however, a pronounced gender gap exists, with male literacy at 82% versus female literacy at 40%. The average household size is 5.2, and regression analysis reveals a negative correlation between family size and farm productivity, suggesting that larger households face constraints in resource allocation and investment in innovative farm technologies. The total dependency ratio remains high at 86, exceeding the critical risk threshold of 70. Landholdings are small (mean 1.21 hectares), highly fragmented (average 2.8 plots), and spatially dispersed (mean distance 1.3 km), contributing to operational inefficiency and increased production costs. Male-headed households control, on average, 26% more land than female-headed households.

  Implications for the Way Forward

  The program should leverage the extensive farming experience of adult household heads while actively engaging youth through PIP approaches to introduce and adopt innovative soil health and fertility management technologies. The existing literacy levels provide a strategic entry point for scaling up technology adoption. Targeted interventions are urgently required to bridge knowledge and literacy gaps among female-headed households. Integrated PIP-guided strategies should prioritize productivity per unit area through improved soil health, thereby mitigating the negative impacts of high dependency ratios. Special focus is warranted for households in higher-risk woredas (e.g., Weyira, Omo Nada, Abaya), which require tailored, participatory support. Enhancing food security on small and fragmented plots necessitates maximizing productivity via sustainable soil fertility management, complemented by off-farm employment opportunities for land-constrained youth.

- **Cross-Cutting and Inclusion Strategies**

  Joint decision-making between men and women on farm management and resource allocation occurs in 56% of intervention households and is positively correlated with enhanced agricultural productivity. Despite women's high participation rate (65%), their productivity remains constrained by inequitable access to critical resources, including inputs and training. Households that include people with disabilities (5%) face significant limitations in labor availability and access to inputs. Social capital is relatively high, with nearly 70% of households engaged in social networks and 55% participating in farmers cooperatives, offering potential platforms for knowledge dissemination.

  Implications for the Way Forward

  The program should substantially empower women by facilitating equitable access to improved soil health and fertility management technologies, guided by PIP principles, and coupled with targeted capacity building initiatives. Providing input loans and financial services will strengthen women's economic agency. Disability-inclusive extension approaches should be implemented, including training DAs in supportive techniques, providing subsidized tools, and establishing inclusive farmer training centers. Leveraging existing social networks and cooperative structures within the PIP framework presents a cost-effective mechanism for disseminating evidence-based soil fertility practices and promoting participatory, community-driven learning.

- **Customized Extension Services and Community Empowerment**

  Across the 12 intervention woredas, soils exhibit generally favorable conditions for crop production, yet widespread macro- and micronutrient deficiencies, particularly N, P, S, and B, limit productivity. Soil fertility constraints vary regionally, including acidity issues in Oromia and nutrient depletion in Amhara and CERS, highlighting the need for site-specific nutrient management and ISFM approaches. Farmers demonstrate diverse cropping systems, including mixed cropping, intercropping, and crop rotation, reflecting adaptation to local agroecological and socioeconomic contexts. Adoption of SLM practices is uneven, influenced by labor availability, social norms, institutional support, and access to extension services, with female-headed households often engaging more in labor-intensive interventions. Farmer awareness of soil degradation is highest in Amhara and lower in Oromia and CERS, emphasizing the importance of participatory diagnostics, targeted awareness campaigns, and youth-focused engagement. A key lesson is the pronounced inclusivity gap in extension services: participation among the most vulnerable households in inclusive, participatory soil fertility interventions remains low (20.7%), with wide variation across woredas, ranging from 46.2% in Basona Werana, Albuko, and Omo Nada (Amhara) and 38.5% in Abaya and Digelu Tijo (Oromia) to very limited participation in Tiyo and Sire.

Extension systems play a critical role in promoting ISFM and soil fertility practices, but coverage, coordination, and capacity remain inconsistent across regions. ATVET institutes provide limited practical training, yet curriculum gaps, limited follow-up, and gender imbalances reduce effectiveness. Opportunities exist to enhance soil health and productivity include farmer-to-farmer learning, localized adaptive trials, and participatory approaches tailored to local conditions. Scaling sustainable practices requires context-specific, participatory approaches, equitable inclusion of women and youth, strengthened institutional coordination, and targeted technical support, coupled with continuous monitoring and adaptive management to ensure lasting adoption and improved agricultural resilience.

Implications for the Way Forward

Interventions must transition from broad outreach models to equity-focused, participatory approaches, guided by PIP principles and tailored to local engagement baselines. High-participation areas should focus on advanced soil fertility management techniques, while low-engagement areas require foundational extension capacity building and trust development. Scalable mechanisms such as participatory planning, peer-to-peer learning, and localized, bottom-up demonstration plots should be prioritized over top-down approaches to promote collaborative, inclusive decision-making. Extension messages must be aligned with agroecological conditions and delivered through multiple channels such as FTCs, model farmer networks, subject matter expert advisories, multimedia platforms, and hands-on follow-up, ensuring adaptive learning, farmer empowerment, and maximized adoption of improved soil fertility practices.

- **Building a Vibrant Soil Input Sector**

  Input utilization is largely limited to mineral fertilizers (urea and NPS), with critical gaps in essential soil amendments. Affordability and access constraints, including prohibitive costs and lack of credit, impede technology adoption. Soil acidity is compounded by poverty, limiting farmers' ability to procure lime. Supply chains rely predominantly on government and cooperative channels, with minimal private sector engagement, constraining farmer choice and accessibility. National lime production capacity is largely undocumented, highlighting a significant value chain gap. Farmer-led on-farm trials remain minimal, reflecting weak farmer-research linkages and low awareness of sustainable practices such as composting and terracing, which are labor intensive.

Implications for the Way Forward

Targeted support mechanisms guided by PIP principles, including subsidies, input loans, cooperative supply centers, and community-based distribution, are essential to improve access to key inputs, such as lime, nutrient-rich organic fertilizers, and locally produced organo-mineral fertilizers. Strengthening cooperative unions and agro-dealer networks through one-stop shopping models will enhance last-mile distribution, including to remote areas, ensuring that all farmers can access critical soil inputs. Extension services should emphasize practical, hands-on demonstrations, farmer-to-farmer knowledge exchanges, and digital advisory tools integrated with credit and input supply, all within a participatory framework. Strengthening policy and regulatory frameworks and improving market linkages will enable farmers to reliably access inputs and sell outputs. Incentivizing practices such as agroforestry through input support (e.g., seedlings) can further promote soil health and strengthen farm resilience.

- **Strengthening Research-Extension Linkages**

  The agricultural innovation system demonstrates weak coordination among research, extension, and vocational education. Farmer-led research trials and participatory learning platforms are virtually absent in Amhara and minimally present in Oromia, limiting co-learning and technology validation. Constraints include insufficient extension support, a lack of site-specific soil recommendations, inadequate access to inputs, and weak market integration. Policy and regulatory frameworks remain fragmented and poorly enforced.

  Implications for the Way Forward

  The program should prioritize strengthening institutional coordination and promoting localized PIP-guided research, including farmer-led action research to translate scientific findings into farmer adoption. The ATVET institutes should be capacitated to provide practical hands-on outreach within a participatory framework. Modernizing soil health and fertilizer legislation, enhancing soil testing capacity, and fostering integrated innovation platforms are critical to addressing the fragmented system and facilitating widespread adoption of improved practices.

- **Promoting an Enabling Policy and Institutional Environment**

  Fragmented policy and legal frameworks continue to undermine the soil health and fertility sector. Institutional coordination is weak, and linkages among research, extension, and ATVET institutes remain limited. Poor access to inputs, weak extension coverage, and inadequate market linkages restrict technology adoption. Farmer-led research and participatory learning platforms are sparse, reducing opportunities for co-learning and participatory validation.

  Implications for the Way Forward

  It is imperative to modernize the policy environment, addressing regulatory bottlenecks, and to strengthen governance structures through participatory PIP-guided approaches. Aligning national soil health and fertilizer laws with global frameworks, such as the African Fertilizer and Soil Health Action Plan (2023-2033) will provide coherence and facilitate adoption. Strengthening national and regional soil sector platforms is critical to coordinate stakeholders, guide policy implementation, and promote knowledge exchange. Development of a 15-year national soil vision will provide strategic direction for sustainable soil management and resilience. Strengthened linkages between research, extension, and ATVET institutes, guided by participatory planning, are essential to translate evidence into actionable, farm-level interventions. Localized adaptive trials, integrated advisory services, and innovation systems, implemented within a PIP framework, are needed to ensure scalable adoption of sustainable soil health and fertility practices.

11 Impact and Outlook for Next Phases

Program Foundation and Early Impact

TRANSFORM has established a scientifically rigorous and operationally robust platform through strategic deployment of technical expertise, structured institutional partnerships, and systematic capacity building. It integrates multidisciplinary knowledge from soil science, agronomy, socioeconomics, GIS, extension services, and policy frameworks to support evidence-based decision-making and sustainable agricultural transformation. Early achievements include strengthened coordination and knowledge exchange with government agencies, private sector actors, research institutions, and farming communities, enhancing stakeholder ownership and the enabling environment for soil health and fertility management. Preliminary outcomes indicate strong potential for scalable interventions that leverage locally adapted technologies, farmer-centered learning platforms, and cross-sector collaboration.

Key Insights and Adaptive Approaches

Implementation highlights the critical importance of adaptive planning, continuous learning, and context-specific execution. Flexibility in operational design allows effective responses to dynamic field conditions and institutional variations. Strong cross-sectoral collaboration linking governmental, private, research, and community stakeholders emerges as a key enabler of systemic, sustainable impact. Integrating participatory approaches ensures local relevance, collective ownership, and iterative refinement of program strategies.

Key Milestones and Achievements

During inception and early implementation, the program achieved multiple foundational milestones:

1. Formalization of institutional partnerships through Memorandums of Understanding (MoUs) and agreements.
2. Operationalization of program activities via contractual engagement with implementing organizations.
3. Development of comprehensive work plans with defined milestones, deliverables, and performance indicators.
4. Establishment of governance, coordination, and quality assurance structures.
5. Recruitment and training of technical and administrative personnel across key thematic domains.
6. Completion of a gender analysis to guide gender-transformative interventions.
7. Development of the MELS framework.
8. Execution of the baseline survey, component studies, and complementary assessments to inform evidence-based planning.
9. Creation of collaborative frameworks with complementary initiatives to enhance synergies and collective impact.

These achievements provide a robust platform to advance validated models, institutionalize best practices, and achieve measurable improvements in soil health, agricultural productivity, and system resilience.

Strategic Priorities for the Intensive Phase (2025–2026):

The program's strategic priorities integrate scientific evidence, participatory approaches, and systems-based interventions across four interlinked components:

- **Customized Soil Extension Services:** Capacity building at multiple levels targets 544 DAs, 48 agricultural experts, 60 subject matter experts, 25 ATVET instructors to deliver localized, science-based soil advisory services, and 30 PI farmers who train 300 first

generation farmers, who in turn reach 30,000 second generation farmers through demonstrations, peer-to-peer learning, and action research.

- **Building a Vibrant Soil Inputs Sector:** Strengthening production, commercialization, and distribution of soil amendments involves training 10 soil input companies and 48 SMEs; development of 10 business cases; and establishment of financial linkages for small scale farmers through VSLAs, SACCOs, and MFIs, supported by private sector partnerships and agro-dealer networks.
- **Farmer-Led Action Research:** Evidence generation is advanced by training 75 researchers and 34 government staff in action research methodologies, organic fertilizer formulation, and soil analysis. Integration of curricula with universities and ATVET institutes, coupled with spatial data systems and decision-support tools, optimizes context-specific planning and soil fertility interventions.
- **Promoting an Enabling Environment:** Institutionalization of soil health governance occurs through national and regional platforms, a 15-year soil health vision, private sector registration of fertilizer products, and assessment of agro-input subsidy programs to improve strategic targeting and impact.
- **Cross-Cutting Enablers:** Systemic success is reinforced by multi-sector partnerships, evidence-based policy guidance, gender- and youth-focused interventions, innovation in soil input technologies, climate adaptation and mitigation strategies, and alignment with national and donor-funded programs. These enablers ensure sustainability, scalability, and resilience of soil management interventions across program regions.

Annexes

The following documents are being sent separately as annexes to this inception period report:

1. Baseline Study Report
2. Component Gap Analysis Report
3. Climate Change Adaptation and Mitigation Analysis: Erosion and Drought Geographic Pilot Study Report
4. Soil Input and Business Case Development
5. Conflict Sensitivity Analysis
6. Gender Assessment
7. MELS Framework