Sustainable Farming Program

Full design document

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List of acronyms

ACIAR: Australian Center for Agricultural Research.

Africa RISING: Africa Research in Sustainable Intensification for the Next Generation.

AfricaRice: Africa Rice Center

AGRA: Alliance for Green Revolution in Africa.

AI: Artificial Intelligence.

AICCRA: Accelerating Impacts of CGIAR Climate Research for Africa.

Alliance: Alliance of Bioversity International and CIAT.

AoW: Area of Work (refers to the Program's key areas of work).

ARIs: Advanced Research Institutes.

ASSAP: Agronomy Science and Scaling Accelerator Platforms.

BMGF: Bill and Melinda Gates Foundation.

CA: Comparative advantages.

CAADP: Comprehensive African Agricultural Development Programme.

CapSha: Capacity sharing for development

CIAT: International Center for Tropical Agriculture.

CIMMYT: International Maize and Wheat Improvement Center.

CIP: International Potato Center.

CIRAD: French Agricultural Research and International Cooperation Organization.

CoAs: Clusters of activities.

DST: Decision support tools.

EiA: Excellence in Agronomy Initiative.

EIAR: Ethiopian Institute of Agricultural research.

ESG: Environmental and Social Governance.

EU: European Union.

FAIR: Findable, Accessible, Interoperable, and Reusable (referring to data).

FAO: Food and Agricultural Organization of the United Nations.

FFO: Farmer facing organizations.

GAIA: Guiding Acid Soils Management Investments in Africa

GHG: Greenhouse gas emissions.

GIZ: German Development Cooperation.

HCD: Human-centered design.

HLO: High level outputs.

ICARDA: International Center for Agricultural Research in the Dry Areas.

ICRISAT: International Crop Research Institute for the Semi-Arid Tropics.

IFAD: International Fund for Agricultural Development.

IFDC: International Fertilizer Development Center.

IFI: International Financial Institutions.

IITA: International Institute of Tropical Agriculture.

ILRI: International Livestock Research Institute.

ILSSI: Innovation Lab for Small Scale Irrigation.

IMM: Integrated mycotoxin management.

IPDWM: Integrated pest, disease and weed management.

IPG: International Public Goods.

IRRI: International Rice Research Institute.

ISFM: Integrated soil fertility management.

ISRIC: International Soil Reference and Information Centre.

IWMI: International Water Management Institute.

KPIs: Key performance indicators.

LLMs: Large Language Models.

LTE: Long term experiments.

MEL: Monitoring, evaluation and learning.

MELIA: Monitoring, evaluation, learning and impact assessment.

MFS: Sustainable Intensification through Mixed Farming Systems Initiative.

NAP: National Adaptation Plans.

NARES: National Agricultural Research and Extension Systems.

NDC: National Determined Contributions.

NGOs: Non-Governmental Organizations.

NPPO : National Plant Protection Organizations.

PDW: Pests, diseases and weeds.

PH: Plant Health Initiative

QFFD: Quatar Fund for Development

R&D: Research & Development.

ROI: Return on investment.

RPPO: Regional Plant Protection Organizations.

RQ: Research questions.

RUFORUM: Regional Universities Forum for Capacity Building in Agriculture.

RUTF: Ready-to-use therapeutic foods.

SAM: Scale-appropriate mechanization.

SME: Small and medium enterprises.

SOP: Standard operating procedures.

SSNM: Site-specific nutrient management.

TAAT: Technologies for African Agricultural Transformation.

USAID: U.S. Agency for International Development.

WFP: World Food Program.

WorldVeg: The World Vegetable Center.

WP: Work Package.

1. Executive Summary

The Sustainable Farming Program simultaneously addresses pressing challenges to evolving agri-food systems including the need for efficient production of more nutritious foods while protecting the environment, translating this growth into decent and equitable employment opportunities, while countering the combined threats posed by changing climate, inefficient production systems, soil degradation, pests, diseases, weeds, environmental degradation and desertification. In response, the Program will co-develop and validate a stream of integrated agronomic, plant health, and farming system solutions, catalyzing adaptation and scaling through a coherent approach to data management, prioritization tools, capacity sharing, and partnerships built around contextualized demands.

The Program addresses farmer and community needs through co-creation principles and systems integration. It prioritizes bundled agronomic, plant health, and farming system solutions and socioeconomic innovations in a collaborative, integrated manner backstopped by CGIAR and partners' expertise. By co-developing solutions with partners and leveraging public, civil society and private sector capacities and investment, it promotes agricultural transformation towards productive, resilient, and sustainable farming systems. Its planned Outcomes provide over five million farmers, only considering pooled investment and significatively more when Center bilateral projects are aligned, with integrated farming solutions advancing socially equitable and sustainable agricultural gain across at least two million hectares of land, better allowing public and private sector partners to effectively invest in farming communities and rural development. Capacity building, primarily for NARES, will address the urgent need for broader expertise in sustainable farming systems science and data systems infrastructure along FAIR principles to increase accessibility of knowledge generated. This work builds upon the substantial progress made by three CGIAR Initiatives, namely Excellence in Agronomy, Plant Health, and Mixed Farming Systems. It will further create efficiencies among these Initiatives and frees up resources to invest in new science challenges.

Program goals are achieved by developing and disseminating a series of Global Public Goods, promoting local adaptation and realizing delivery at scale with stakeholders in over 30 countries in the Global South with pooled and bilateral investments. The Program operates through eight interrelated Areas of Work: (i) Climate adaptation and mitigation, (ii) Precision nutrient management, (iii) Resilient soils, (iv) Plant Health and mycotoxin-safe crops, (v) Integrated water management, (vi) Scale-appropriate mechanization, (vii) System integration through co-creation, and (viii) Program efficiency and delivery. These actions are forwarded in an integrated and inclusive manner that effectively synergizes the work of twelve CGIAR Centers and interfaces with other planned Programs and Accelerators. In terms of human capital, the Program brings together a diverse pool of agronomists, soil scientists, plant health specialists, systems integrators and modelers, data and policy specialists, socio-economists, and co-creation and gender-aware experts. The program builds on deep experience of working with public and private partners across Africa, Asia and Tropical America for more than four decades. It offers unique physical resources, including globally distributed experimental farms, long-term experiments and advanced laboratories within its well-distributed CGIAR Centers.

2. High-level vision in response to challenges and megatrends

2.1. Challenges and megatrends

The Sustainable Farming Program addresses demographic, environmental, economic, and social (e.g. growing inequalities) challenges and megatrends by providing a stream of carefully composed and integrated agronomic, plant health, and farming system solutions over the next six years. Population growth in the Global South strongly impacts upon current agri-food systems. By 2050, it is imperative that we increase the production of more nutritious food by 60% to meet the demands of an expanding population, and to translate this economic growth into decent employment opportunities. At the same time, agricultural production gains are threatened by changing climate, land and environmental degradation and devastating pests, diseases and weeds (PDW). Evidence exists that climate change has reduced agricultural productivity growth by 20-40% in Africa and Asia since 1960 (Ortiz-Bobea et al., 2021). The agricultural environmental footprint is responsible for about one-third of annual greenhouse gas emissions directly from farms and through land use change (Crippa et al., 2021). Over 3.2 billion people are negatively impacted by land degradation caused, for example, by soil erosion, deforestation, desertification, etc. (IPBES, 2018). Extreme poverty remains high in too many countries, particularly in sub-Saharan Africa. Social inequities persist and the agricultural labor force is aging. To achieve greater equality and social inclusion, we must create avenues for engaging diverse groups, particularly youth in agriculture and increase the productivity of women and marginalized communities (Abdisa et al., 2024).

2.2. High-level vision

The Sustainable Farming Program seeks to ***realize productivity, resilience, and sustainability at scale through widespread dissemination of science-based socio-technical innovation bundles that offer integrated agronomic, plant health, and system-level advantages to farmers helping to redesign their farming systems*.** It achieves this goal by developing a series of global and regional public goods and delivering them through engagement with key stakeholders, particularly National Agricultural Research and Extension Systems (NARES). Collaborative research-for-development with a full spectrum of partners will result in the delivery of proven and contextualized innovations that bundle agronomy, plant health, and farming system options. Partnership and scaling approaches will consider the context-specific needs of small- and medium-scale farmers, particularly women and youth, and the characteristics of the national and regional innovation systems. This work builds upon the substantial progress made by CGIAR's Initiatives on Excellence in Agronomy (EiA), Plant Health (PH), and Sustainable Intensification through Mixed Farming Systems (MFS) between 2022 and 2024.

Through our work, farmers, and particularly women, youth, and marginalized communities will realize productive, profitable, resilient, and sustainable farming systems through the delivery of agronomic gain at scale, defined as profitable yield increases, yield stability, adaptation to climate change, enhanced nutrient and water-use efficiencies, increased labor productivity, improved soil health, and reduced losses caused by PDW and mycotoxins; as well as sustainability KPIs, including: profitability for farmers, environmental benefits at farm and landscape levels, GHG mitigation and climate resilience, and improved social equity. Agronomic gain is achieved through single or combined agronomic and farm system practices under specific environments and social contexts. We will advance these goals through the integrated management of crops, trees, livestock and fish when appropriate. All solutions will

consider economic, environmental, and social dimensions. The Program contributes towards CGIAR vision of *"…sustainable and resilient food, land, and water systems that deliver diverse, healthy, safe, sufficient, and affordable diets, and ensure improved livelihoods and greater social equality, within planetary and regional environmental boundaries"*. In this way, the Program targets all five of CGIAR Impact Areas; (i) increasing income, improving livelihoods, and creating jobs; (ii) increasing climate resilience and yield stability while reducing the environmental footprint; (iii) increasing environmental health and protecting biodiversity by reducing agricultural land expansion and pollution; (iv) reducing hunger and improving nutrition, health, and food security by intensifying and diversifying farming systems; and (v) reducing gender and social inequality gaps through responsive solutions.

2.3. What is new in this Program?

There are new research areas in the Program, which are identified and described in greater detail in Section 6. The Program's first innovative aspect is the aim to integrate agronomy, plant health, farming system solutions, as well as technologies and practices developed by other programs, through whole-farm and human-centered perspectives. This holistic approach will enhance resource use efficiency—encompassing human, financial, data, knowledge, and physical resources—for the 12 CGIAR Centers and their research and scaling partners. The second innovative aspect is the application of a coherent, program-wide approach to the delivery of solutions at scale. This includes working through demand partnerships, the use of harmonized data generated in the research areas of work to fuel prioritization tools which recommend options for specific contexts. Other new areas include, but are not limited to, applications of big data and artificial intelligence (AI) to evaluate interventions aiming at enhancing adaptive capacity and at reducing GHG emissions at different scales; tailor agro-advisories towards soil health, precision nutrient management and water use; modelling and decision support tools (DST) for better integration of crops, trees, shrubs, livestock, fish, and orphan crops into farming systems that can increase diversity and thus resilience; developing technological and innovative solutions aimed at enhancing the key elements of soil resilience at scale; AI-supported PDW risk analysis and management; increased understanding of plant-microbe interactions on plant health, including cost-effective genotyping platforms, remote sensing and multispectral imaging to monitor and manage crop growth, soil and water status; exploring alternative water resources and circular approaches for agricultural use in water scarce contexts such as under desert farming ; exploring public-private business models and options for scale-appropriate machinery including potential use in precision agriculture; combining biophysical systems modelling and behavioral sciences to better understand priorities and support stakeholders' decisions and capabilities for bundling and scaling farm innovations. These new areas will be continuously updated during engagement with research and scaling partners, resulting in a co-creation process that leads to meaningful agricultural solutions.

3. Prioritization

Technologies in crop, soil, water, PDW, mycotoxin and machinery are required and are demanded by country stakeholders, but they need to be integrated towards whole-farm management, because small-scale producers cannot solve many problems they face with their available resources (e.g. information, knowledge, technologies), some of which may not contribute to sustainability or build climate resilience. The Sustainable Farming Program aims at co-developing innovations that assist farming communities to cope with new and changing conditions, and to meet the demands of rapidly evolving food systems in ways that productivity of crops and livestock is increased, raising their incomes, and improving their diets and health. For this, farmers need "technology bundles" (Woomer et al. 2021). These technologies

include reliable and more affordable production inputs, soil fertility, PDW and water management strategies, harvest and post-harvest management, and scale-appropriate mechanization to reduce drudgery. Widespread digital applications are changing approaches to agricultural extension and product marketing. These technologies often represent Public Goods that offer recognizable benefits, as well as the opportunity for the private sector to develop new and more potent commercial production inputs based upon them. Technological options need to be contextualized to respond to the priorities set by country stakeholders.

It is important to emphasize that innovations to be co-designed with partners, should not include only technologies but scalable socio-technical innovation bundles which could include the technical part, but also the information, knowledge, financial, social and cultural components according to contexts and farming systems (Barret et al., 2020). A detailed review of agronomic, digital, genetic, institutional, and mechanical innovations led to the conclusion that existing and imminent technologies are equally constrained by sociopolitical factors. Potent technologies must navigate a complex array of political, economic and sociocultural obstacles, which vary with time and space, before they may be adopted at scale. This situation is best addressed by coupling technical advances with social, economic and policy changes through the formulation of "socio-technical innovation bundles" that need to respond to country demands. Creation of these bundles necessarily requires dynamic multi-party cooperation across the developmental, financial, public and private sectors in order to accelerate their acceptance, diffusion and scaling, and the design of the Sustainable Farming Program takes this complexity into account.

A growing approach to technology bundling involves the critical role of Innovation Platforms and their linkage to agricultural research, extension providers, agro-dealers and markets (Mandlenkosi et al., 2024). These Platforms, which will be strengthened at country level, seek bundled technologies that work together to overcome production constraints and that raise farming system production to new levels. These platforms can support scaling of suitable technical innovations according to contexts and demands. It also provides members with the opportunity to process their harvests to commercial standards and to market their surpluses through collective action. Devising means to assemble and disseminate the technology packages on a cost recovery basis will be key to their sustainability, and will open opportunity for creative service provision.

These perspectives were reinforced by the results of CGIAR Listening Sessions recently conducted in late 2023 and early 2024 in 25 countries. These sessions revealed that agricultural sustainability is a high priority among more than 50% of country stakeholders. These concerns included the need for integrated farm solutions, enhanced soil and water management advice, diversification of crops and production systems, a wider range of options in the management of PDW), and improved post-harvest options that increase food safety and reduce losses. Other consultations and prioritization exercises were conducted by CGIAR EiA and PH Initiatives between 2022 and 2023. These actions indicated that adaptation to climate change and sustainable intensification of cropping systems are high priorities across 18 countries, mostly in Africa and Asia. Furthermore, strengthening capabilities for surveillance and monitoring of priority pests and diseases was assigned a high priority by national partners in 26 countries in Africa, Asia and Latin America. The MFS Initiative also identified the need to better target, compose and deliver integrated farm system innovations in a more site-specific manner.

Following a partial prioritization, a preliminary list of 34 priority countries was developed based upon exercises conducted by the EiA, PH and MFS Initiatives (Figure 3.1) combined with bilateral project interventions. These countries include (from West to East) Mexico, Guatemala, Peru, Colombia (in Tropical America); Senegal, Morocco, Mali, Cote d'Ivoire, Ghana, Benin, Niger, Nigeria and Egypt (in Northern and West Africa); DR Congo, Zambia, Zimbabwe, Mozambique, Malawi, Tanzania, Rwanda, Burundi, Uganda, Kenya, Ethiopia, and Madagascar (in Central, Southern and East Africa); Uzbekistan, Pakistan, India, Bangladesh,

Nepal, Laos, Cambodia, Vietnam and the Philippines (in Asia). This prioritization recognizes the presence of activities funded by CGIAR as pooled, bilateral and W3 funded projects that are implemented by 12 CGIAR Centers and their partners. A second map of countries is shown in Figure 3.2, which results from the analysis of the countries using 22 indicators relevant to the Sustainable Farming Program related to food security, population, poverty, gender, youth, soil erosion pesticide use, etc. This Figure shows potential countries of intervention based on needs. The targeted countries shown in Figures 3.1 and 3.2, however, are subject to change, when CGIAR-level priority setting is completed with a focus on farming systems, more specific indicators relevant to the Program AoWs are included, and improved alignment with other evolving CGIAR Programs is refined over the Inception Phase.

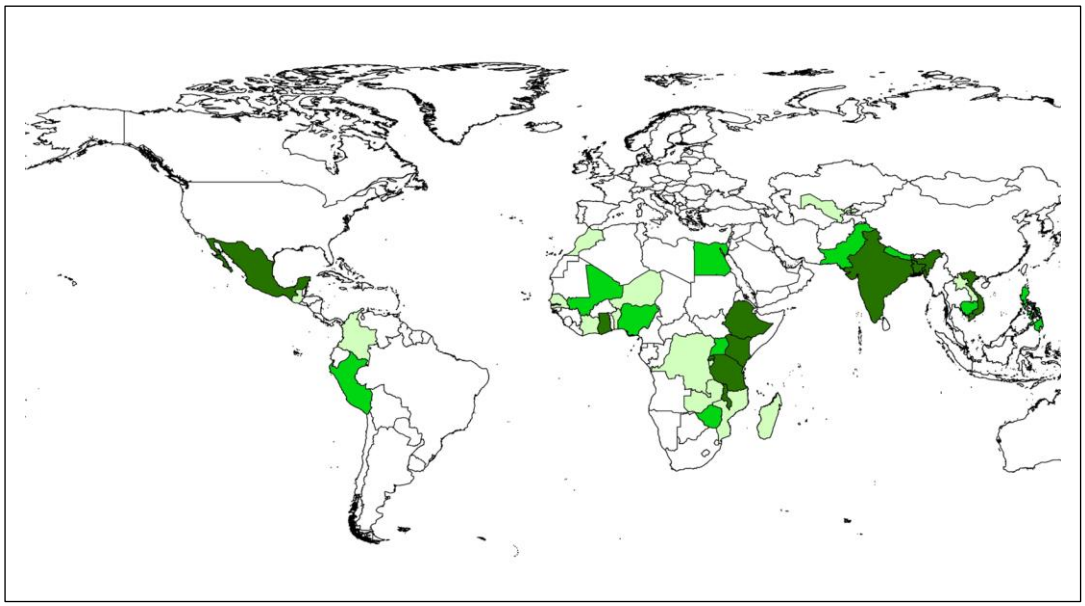

Figure 3.1. Preliminary, non-exclusive list of countries where Sustainable Farming activities will be focused. Intensity of colors indicate previous prioritizations and presence of activities financed by CGIAR pooled, bilateral and W3 projects**. Note:** the list of countries will be finalized during the Inception Phase in the first quarter of 2025, by including indicators relevant to the Program's AoWs.

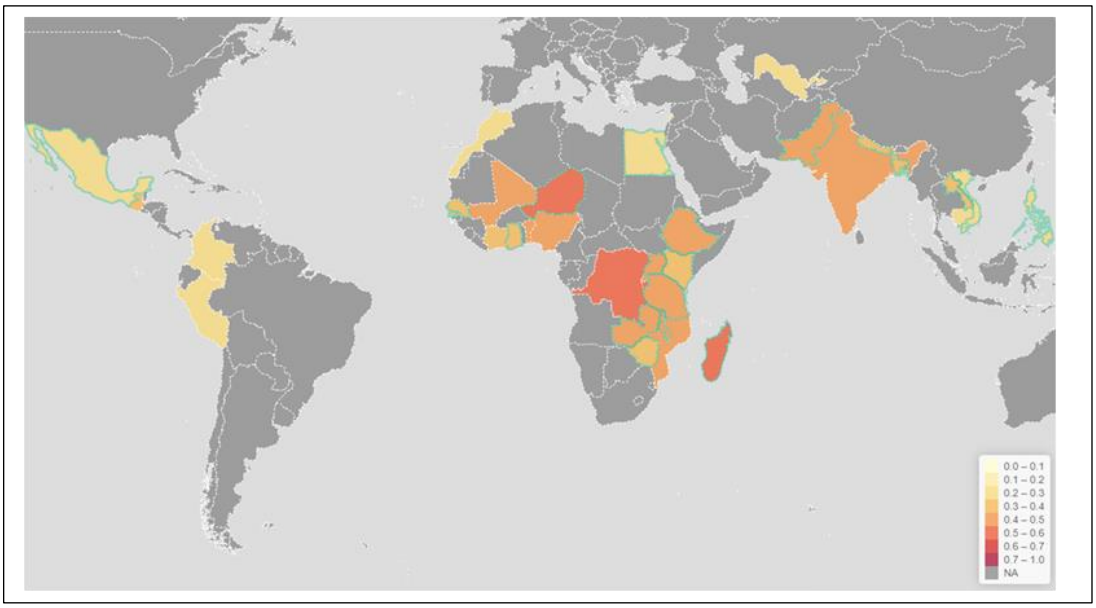

Figure 3.2. Preliminary, non-exclusive list of countries where the Sustainable Farming Program will focus its work. This heat map uses an average composite indicator of 22 indicators[1] relevant to the Program. Averages were calculated converting each indicator to a scale from 0-1 (lowest and highest values) and then averaging indicators with equal weight for each country. Missing values for some countries (those lacking green outline) were ignored. The intensity of the color reflects higher needs of the countries for Program interventions. **Note:** the list of countries will be refined during the Inception Phase.

4. Comparative Advantage

The greatest source of comparative advantage of the Sustainable Farming Program is that it is addressing smallholders' needs for bundled technologies and innovations at farm and farming system level in a collaborative, integrated manner backstopped by CGIAR and partners operating principles and expertise. Solutions and innovation bundles are viewed in a novel, more holistic context that appeals to the broader agricultural development community, whose strengthened agendas then serve to deliver management solutions to millions of farm households in prioritized farming systems. The Sustainable Farming Program identified 36 high-level outputs (HLOs) essential for achieving objectives in eight Areas of Work (AoWs). These areas consider climate change response at farm level, precision nutrient management, resilient soil systems, plant health and mycotoxin-safe crops, integrated water management, scale-appropriate mechanization, system integration through co-creation, and program efficiency and delivery. Each of these AoWs are further described in Section 6. The High-Level Outputs can be classified into five broad categories: innovation (17 outputs); capacity sharing (8 outputs); policy and investment information (8 outputs); as well as project support activities related to monitoring and evaluation (1 output), data and analytics (1 output), and partnership management (1 output). A table with the full description of outputs and comparative advantage analysis is included in Annex 4.1.

CGIAR and its participating Centers hold a strong capacity and experience in organizing and coordinating an international program around the future sustainability of agricultural systems and require quality contributions across the agricultural research and development sector, implying that comparative advantage is also held by others as well. Experience within international efforts suggest that irreplaceable key advantages are held by NARES, Advanced Research Institutes (ARIs), the private sector, non-government organizations (NGOs), government policymakers and regulators, universities, inter-governmental organizations, finance institutions, and farmer organizations. NARES have a comparative advantage in relation to local farm management research capabilities and extension agent networks and collaborative links with farmers and local communities. ARIs are often more advanced in the areas of PDW crop, soil and farm modelling, data science, and next-generation technologies. The private sector holds expertise and financial resources in relation to agro-input and output market functioning, private extension, equipment engineering, market research, regulatory and industrial aspects, and business development. Through the environmental, social and governance (ESG) regulations, private sector plays a pivotal role in ensuring sustainable food systems from production to consumption. NGOs offer established mechanisms for community engagement and experience in scaling interventions and hold logistical advantages through their networking. Government organizations are necessary partners in relation to policy

[1] Key indicators considered for the composite include: Food Insecurity Experience scale, % stunting, % wasting, % without healthy diet, hidden hunger (hh), hh/capita, gender weighted hh, gender weighted population with <$1.9/day, youth unemployment, Gini coefficient, Population with < $2.15/day, population below national poverty line, Relative Deprivation Index, Multidimensional Poverty Index, share of population in MP, population in MP, share agriculture forestry and fisheries in gross domestic product, projected population growth 2030, soil erosion rate, pesticide/ha, Nitrogen use efficiency. Other indicators relevant to the Program will be added to the prioritization process during the Inception Phase.

innovation and the regulatory approval and cross-border movement of new farm management technologies. Universities open their higher education curricula to new areas of knowledge and manage the MSc and PhD programs that often backstop CGIAR and partner research projects. International Financial Institutions (IFI) drive sustainable farming technology scaling through the loans and grants offered to countries, and national and local banks offer loans that allow for farm improvement. These institutions also hold expertise in the formulation and improvement of agribusiness models. Farmers' organizations and their grassroots subsidiaries provide support for widespread technology adoption, hold local knowledge of farming conditions and opportunities, and provide insight into local adaptation of farm innovations.

Based on a partial analysis, and given the recognized essential contributions from its partners, the sources of comparative advantage of CGIAR Sustainable Farming Program in delivering High-Level Outputs may be summarized across four categories related to its human, physical and social capital, and strong incentives for the formulation and recognized release of next-generation International Public Goods (IPG).

- In terms of human capital, the Program boasts a diverse pool of agronomists, soil scientists, plant health specialists, desert farming specialists, crop modelers, data scientists, policy scientists, co-creation and gender experts, with experience and presence in at least 45 low and middle-income countries across Tropical America, Africa and Asia. The expertise allows the Program to lead in developing IPGs that can be translated into global, regional and context-specific innovative agricultural solutions, including research products delivered to the private sector. Additionally, there is the needed experience in the design and implementation of comprehensive training and capacity-building programs to NARES, NGO and other development partners. The Program has capabilities to synthesize local, regional and global scientific evidence and provide policy-ready information, to influence the design of agricultural policies and strategies that enable more sustainable farming systems.

- The Program has extensive physical resources within its CGIAR Centers, including research stations, field sites, laboratories, germplasm health units, manufacturing facilities, and long-term experiments located across priority countries. For the most part, this physical infrastructure currently operates in close working association with NARES and other government organizations through networks of field offices. These assets support research and multi-stakeholder development activities, and enable the design, implementation, scaling and assessment of agricultural innovations.

- The Program also has a global network and established relationships with a wide range of stakeholders in 45 countries. This network positions the Program as a neutral facilitator and broker of South–South and South–North collaboration. This role helps in coordinating multi-stakeholder efforts, identifying, assessing farm technology bundles, and ensuring the effective delivery of outputs and outcomes.

- The Program team is driven by the mission and commitment to develop a series of IPGs and work with partners to translate scientific research into whole-farm solutions and innovations for achieving transformation of food, land and water systems aligned to CGIAR 2030 Research and Innovation Strategy.

In summary, the analysis indicates that this Program would excel in several research and delivery areas, and its planned partnership will offer complementary strengths. Thus, CGIAR Sustainable Farming Program will play a key brokering and catalytic role bringing together diverse stakeholders together to co-develop, promote and validation of a series of scientific, farm-level solutions, while partners support local adaptation, technology deployment, policy integration, and community engagement towards scaling. By co-developing solutions with

NARES and ARIs, leveraging developmental and private sector investment, and maximizing broad-based network capabilities, the Program will systematically achieve impact at various levels towards sustainable farming system solution. A full comparative analysis will be carried out during the first year of the Program.

5. Program-level theory of change

The Sustainable Farming Program responds to pressing demographic, climatic, environmental and social trends and challenges. There will be significantly more people to feed in the future, extreme weather will likely continue, and agricultural resources will degrade in absence of corrective action. Economic and social inequalities between and within countries must be narrowed through multifaceted approaches including technological, policy, institutional, and governance innovations. By promoting more productive and profitable agriculture while reducing natural resource use, this program can contribute to rural prosperity. These challenges include the need to (i) increase crop and total farm productivity, providing more nutritious food and higher incomes for farmers; (ii) increase farm resource use efficiencies, avoiding environmental degradation, pollution and biodiversity loss whilst improving productivity; (iii) tackling climate hazards by developing context-specific climate-resilient farming practices and systems; and (iv) the need for equitable solutions that enable better livelihoods for all farmers and agribusinesses, particularly among women and youth.

In response to these challenges, the Sustainable Farming Program aims to contribute to the five CGIAR Impact Areas through the co-developing and scaling of whole-farm solutions that deliver agronomic gain at scale (Figure 5.1). The expected gains are: (i) increased productivity and production of nutritious food, (ii) improved soil health, (iii) enhanced efficiencies of water, nutrient, and labor use, (iv) reduced crop losses to expanding and emerging PDWs, and (v) more stable yields through adaptation to climate change. Sustainability considerations must be met, which include profitability for farmers, environmental benefits at farm and landscape levels, GHG mitigation and climate resilience, and improved social equity.

The Program commits to co-developing and delivering the above in the geographies covered through its sphere of influence (see Section 3), and will work with other Programs, Accelerators and partners to create the circumstances in which these lead to impacts within the five Impact Areas, acknowledging that this will depend on many factors beyond the control of this Program and CGIAR. To contribute to the above impacts, **2030 Outcomes** have been defined using the average investment of pooled funds over the last three years (average annual investment of about US $35 million projected across 2025-2030). Once the figure of total investment including bilateral projects is estimated, the figures could be significantly increased. The Program outcomes are: (i) at least five million farmers adopt and/or benefit from bundles of innovations for integrated farm management, with positive impacts on socially equitable and sustainable agronomic gain across two million ha of land; and (ii) at least fifty public or private development partners are facilitating the scaling of solutions to farming communities and integrating innovations in their investments, independent of Program support. In support of the above, efficiency and continuity aspects will be addressed by: (iii) at least twenty-five national science partners become able to gradually drive new research, initiatives, including advancing their capabilities in farm systems science, building on skills learnt through Program support; and (iv) all CGIAR Centers and their partners optimize the sharing of data, tools, system methods, and research products, resulting in better design of pooled and bilaterally funded projects into the future.

Three pathways combine to deliver the program outcomes. The **innovation pathway** draws upon validating a framework that includes contextualized prioritization, needs assessment,

integrating farm-level solutions through co-design and data-led learning, integration of multiple innovations to address whole-farm challenges, and bundling with enabling innovations or services. Areas of Work (AoWs), see Section 6, will generate solutions to address locally appropriate combinations of issues, including climate adaptation, precision nutrient management, soil health restoration, reduction of crops losses due to PDWs, integrated water management, scale-appropriate mechanization, and farm system integration. Iterative design and monitoring will be enabled by state-of-the art data and analytical processes, and co-creation and participatory approaches. We will create a compendium of sustainability-validated, gender- and youth-positive farm innovation bundles linked to prioritization tools and big datasets to unlock the scaling potential of solutions to new locations. The High-Level Outputs facilitate the delivery of the Intermediate Outcomes: (i) whole-farm innovation bundles are co-developed and promoted by partner organizations, (ii) CGIAR Centers and NARES share and use data and analytics tools, (iii) partner organizations adopt new tools and methods, and (iv) partner organizations scale validated innovation bundles. Existing delivery and scaling platforms, such as the Agronomy Science and Scaling Accelerator Platforms (ASSAPs), by EiA, will be strengthened and expanded to accommodate the complete solution space of the Program. The **capacity sharing pathway** operates through translating scientific outputs to provide training and materials for farmers and extension workers related to the contextualized solutions; through providing training and materials to partner organizations for the use of data and process tools, and through novel capacity sharing models to enhance the research and scaling capacity of actors within NARES. The **policy change pathway** builds on outputs consisting of evidence for policymakers to enable the uptake of integrated farm solutions; the establishment of multi-stakeholder platforms for designing, delivering and scaling demand-responsive bundles of innovations; and engagement with international dialogue fora. These, in partnership with the Policy and Scaling Programs, will facilitate the delivery of the policy-related Intermediate Outcomes of increased engagement and widespread investment in the delivery of farm innovation bundles.

To facilitate the validation and delivery of integrated agronomic, soil, water, plant health, and farming system solutions, discussions have been initiated with **strategic partners** who are also starting up new programs, aiming at identifying areas of common interest for co-investment from both sites. With GIZ/BMZ, discussion focusing on (i) the relationship between agricultural practices and soil health; (ii) methodologies for monitoring changes in soil and plant health; (iii) strategies to incentivize investments in soil and plant health; and (iv) policy frameworks to facilitate reinvestment in soil health. With AGRA, discussions are focussing on: (i) data/digital tools; (ii) evidence-based policy advice; (iii) deployment of knowledge products/solutions for scaling; and (iv) creating capacity of countries in agricultural technologies and practices for addressing immediate and future climate challenges. With the Sustainable Agriculture Initiative , discussions are focussing on (i) a global indicator framework for Regenerative Agriculture; (ii) SOPs and assessment solutions to implement the indicator framework; (iii) approaches to Regenerative Agriculture and practices that fit the reality of smallholder farming systems; and (iv) mobilization of private sector investment and engagement in smallholder supply chains. With the Sustainable Intensification Innovation Lab , discussions are focussing on: (i) climate adaptation and mitigation; (ii) resource use efficiency; (iii) soil fertility and soil health management; (iv) circular bioeconomy; and (v) digital and decision tools. With UAE government and BMGF discussion are focusing on (i) Red palm weevil management (ii) integrated desert farming system (IDFS). All the above discussions are planned to result in joint work plans for implementation in 2025.

The AoWs underpin all high-level outputs (see Section 6). AoWs focus either on component research addressing prioritized thematic constraints within prioritized farming systems and geographies; or on integrative research that assembles and appraises component innovations within farming system contexts and higher system levels; and on support actions facilitating program efficiency and delivery towards more integrated interventions within the Program and across CGIAR Programs. The component AoWs are: (AoW 2) precision nutrient management, (AoW 3) resilient soils, (AoW 4) plant health and mycotoxin-safe crops, (AoW 5) integrated

water management, and (AoW 6) scale-appropriate mechanization. The integrative AoWs are: (AoW 1) climate adaptation and mitigation, and (AoW 7) system integration and, there is an AoW focusing on building synergies across AoW, which is (AoW 8) program efficiency and delivery. AoWs also provide docking points for the Breeding for Tomorrow, Sustainable Animal and Aquatic Foods, Multifunctional Landscapes, Better Diets and Nutrition, Climate Action, Policy Innovations, and Scaling for Impact Programs, the three Accelerators, and Genebanks. AoW 8 consists of five expertise areas that will support the work of the other AoW: prioritization, data and analytics, capacity sharing, partnership platforms and integrated policy relevant evidence, as well as containing management and MELIA functions. The overall **programmatic research questions** (RQ) are:

1. Which farm integrated and bundled innovations result in increased sustainability, resilience and agronomic gain in prioritized farming systems?
2. What are the inter-relationships between the various components of sustainable farming (profitable yields, yield stability, resources use efficiency, soil and plant health) over time and space?
3. Which leadership skills, services, knowledge, policies and investments need to be assembled in partnership platforms to facilitate design and scale of bundled farm innovations at scale according to contexts?
4. To what extent do whole-farm innovation bundles lead to agronomic gain, and to what extent do they translate into gains across various Impact Areas?

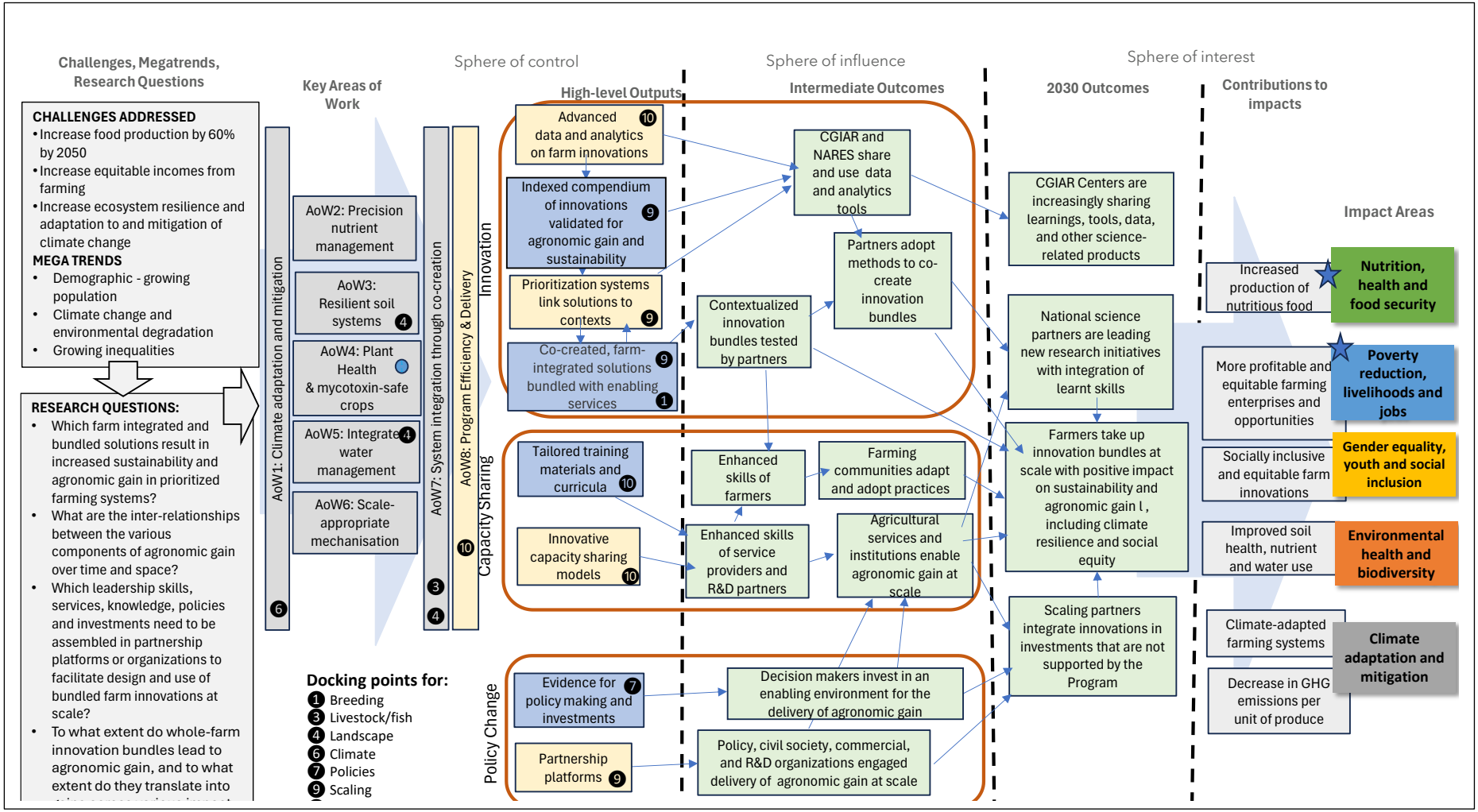

Figure 5.1. The overall Theory of Change that drives the Sustainable Farming Program.

6. Areas of Work

6.1. Climate adaptation and mitigation on farms (AoW 1)

A third of the global crop production is at risk due to changing climate. Evidence indicates that climate change has already reduced productivity growth by 20-40% in Africa and Asia since 1960 (Ortiz-Bobea et al., 2021). With the increasing variability of climate conditions and severity of impacts, agricultural producers must be prepared for multiple threats. While some solutions exist to help producers cope with climate risks (Rosenstock et al., 2024), existing strategies are generally predicted to be less effective under future climate scenarios (Lissner et al., 2024). Meanwhile, agricultural activities account for approximately one-third of annual GHG emissions (Crippa et al., 2021). Therefore, an urgent need exists for new and more potent farm integrated solutions that simultaneously reduce negative impacts of climate change on farming (adaptation), reduce agriculture's contribution to GHG emissions (mitigation) and enhance community's capacity to recover quickly from negative impacts (resilience) in the future.

This AoW is prepared to deliver climate-resilient farming system innovations, in some cases with mitigation co-benefits, to at least five million farmers using the program's solutions by 2030. These innovations will enhance resilience to floods, droughts, cold stress, rising temperatures, variable rainfall patterns, and lead to a 15% reduction in GHG emissions compared to current levels (per participating farm). Intermediary outcomes support this by strengthening the enabling environment in collaboration with farmer-facing organizations (FFOs) (Outcome 1.1); government bodies (Outcome 1.2); and public and private sector investors for developing climate-responsive agriculture (Outcome 1.3). We foresee collaboration with Climate, Policy, Landscape and Scaling Programs as well as other AoWs within the Sustainable Farming Program, and emerging partnerships such as the Integrated Desert Farming Program addressing the needs of adaptation and mitigation in dryland areas. Facilitating these changes requires addressing the following key research questions (RQ), see Figure 6.1.1:

- How can innovative tools and information be best developed to enhance climate adaptiveness of sustainable farming systems?
- When, where, and under what climate conditions can sustainable farming innovations be most effective in assisting small-scale producers to adapt, while also reducing GHG emissions now and in future warmer worlds?
- How can we overcome the key determinants restricting resilient low emission farming at scale?

Over the past two years, the EiA Initiative conducted listening sessions and prioritizing exercises to better co-develop, design, test, and scale such solutions in the future. One of the Program's sources of comparative advantage (CA) is its network, which includes 170 partners currently co-developing, testing and scaling 67 climate related agronomic innovations. The presence of multi-disciplinary teams, research facilities and partner networks across different geographies allows for a systematic, agile approach to co-developing and evaluating a stream of climate adaptation and mitigation interventions using a combination of climate homologs, long-term trials, state-of-the-art data science, and analytics with partner-inclusive participatory approaches to target climate resilience for smallholder farmers.

Based on quantified effects of climate-related hazards on agronomic gains (Output 1.1), we will co-develop inclusive and hazard-specific agronomic, soil and plant health, and farming system innovations with robust evidence on adaptation and mitigation potential (Output 1.2). Digital platforms and targeted outreach products will better inform the design, implementation, and investment of resilient, low-emission farming systems, in collaboration with CGIAR Climate and Policy Programs. By providing training materials and technical support for assessing, innovating, and implementing potent solutions toward climate security, FFOs' capacity will be enhanced (Output 1.3). These partners will facilitate feedback loops among producers and researchers, allowing for continuous improvement and customization of solutions to local conditions and decision needs. By translating the evidence in policy and investment-ready information (Output 1.4), will strengthen the enabling environment to enhance resilient low-emission farming at scale. To achieve these High-Level Outputs, we foresee the following three Clusters of Activities (CoA).

6.1.1 Data and information to climate proof sustainable farming. This CoA ensures that the design, implementation, and scaling of farming practices address the risks of climate change. This CoA contributes to AoW 8. Activities include the incorporation of climate risk analysis and DST into the targeting of adaptation and mitigation interventions; the integration of local climate information (in collaboration with Climate Program) with agronomic as well as soil and plant health advisory services (including diversification of crops, forages, fish feed and trees) (e.g. moving planting windows, weather-based fertilizer application); and analytics to co-create frontier solutions in a future climate. New lines of work include developing a prioritization and targeting tool for attuning proven adaptation measures to other geographies.

6.1.2 Establishing the effectiveness of sustainable farming toward climate adaptation and mitigation now and in the future. This CoA enhances and evaluates the climate effectiveness of single or combined farming practices (across AoWs 1 to 7) against current and future single or multiple hazards, and GHG reduction and potential risks for maladaptation. Activities include development of approaches for assessing yield and livelihood resilience, use of data science and modelling to enhance the adaptive capacity during co-design and -testing; evaluation of agronomic practices aimed at enhancing adaptive capacity (e.g. solar-based irrigation, use of nature-based solution principles), and at reducing GHG emissions (e.g. dry direct seeded rice, conservation agriculture). New lines of work include quantifying carbon capture through resilient soils practices under different crop-livestock systems (with AoW 3), evaluation of potential maladaptation risk for the future, and evaluating and categorizing the adaptive and mitigative limits of farming systems across agro-ecologies and time.

6.1.3 Accelerating resilient low-emission farming at scale. This CoA accelerates resilient low-emission farming solutions from CoA 1.1 and 1.2 at scale in collaboration with AoW 8 (particularly CoA 8.4 in collaboration with the Scaling Program) by addressing the key determinants preventing adoption at scale. Activities include the use of behavioural science to assess gendered climate risk perceptions to farming practices, access to climate information and adoption of adaptive/mitigative innovations; evidence synthesis for policy and investment partners (linked to CoA 8.5); development of training materials along the co-creation process of climate interventions; and technical assistance to FFOs and others in low emission farming (linked to CoA 8.3). New lines of work include assessing returns on investment in climate resilient low emission farming at the project level; developing tools to evaluate benefits, synergies and trade-offs of interventions (together with the Climate and Landscapes Programs), identifying social and institutional innovations that enhance the adaptive/mitigation capacity of sustainable farming practices, developing climate resilient scaling pathways based on farmer and partner risk profiles with the Scaling Program.

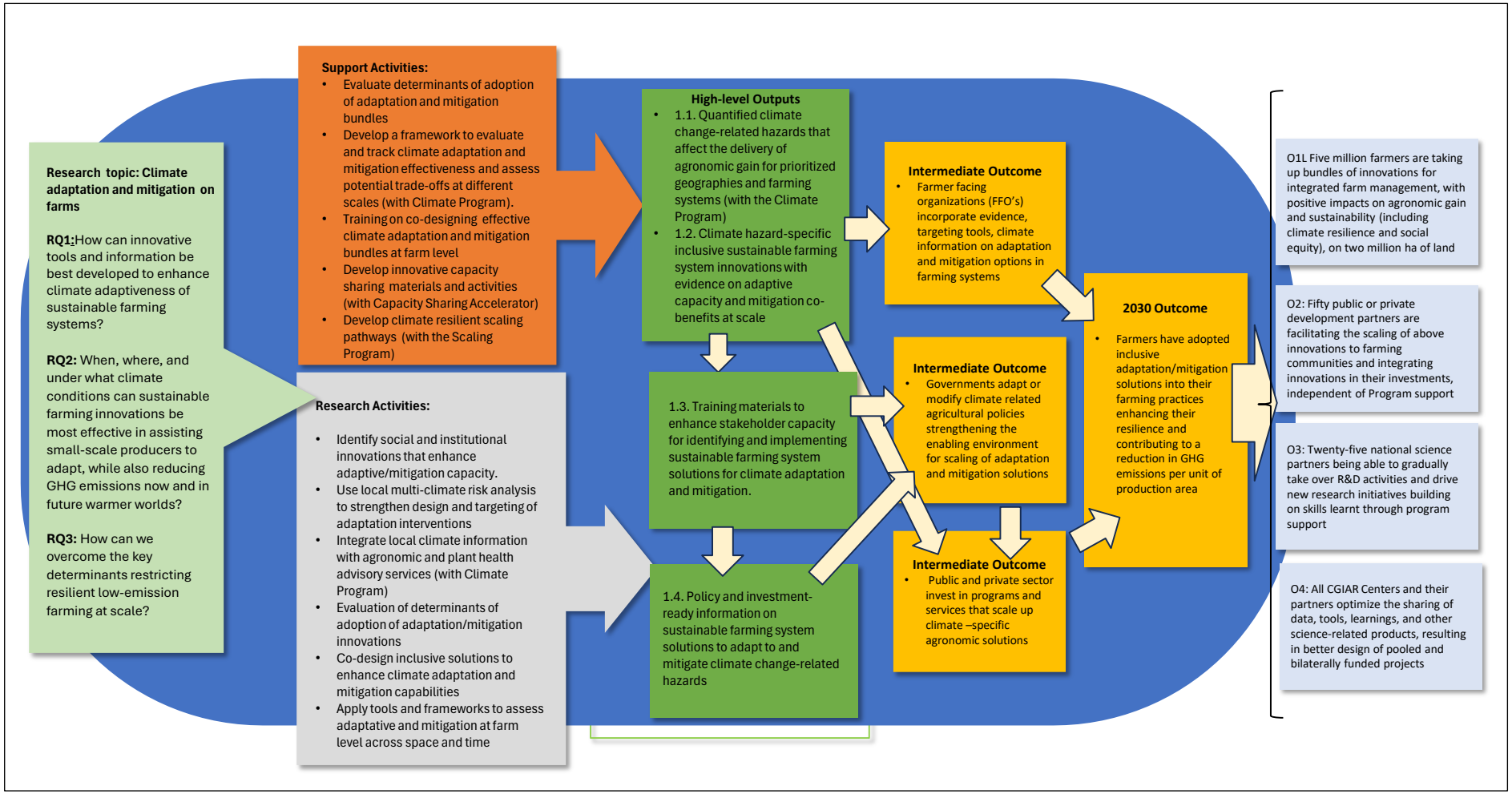

Figure 6.1.1. Contributions by Area of Work 1 (Climate Adaptation and Mitigation) to the Sustainable Farming Program.

6.2. Precision nutrient management (AoW 2)

Farmers often lack access to relevant recommendations for optimal management of available plant nutrients. Furthermore, the amount of available external and recycled nutrients is often insufficient to raise crop yields to levels required for improved livelihoods. Confounding this shortage is a paucity of validated, site-specific, easily accessible information on nutrient management that is dynamically tied to weather forecasts and bundled with other crop management practices. These difficulties hinder decisions related to the selection of appropriate crop varieties, required fertilizer inputs and their appropriate use, co-application of organic inputs, application of good agronomic practices, and management of other crop-limiting factors such as soil acidity, as assembled through the Integrated Soil Fertility Management (ISFM) approach (Vanlauwe et al, 2010 and 2015). In some areas, other problems include overuse or unbalanced use of fertilizers. The management of crop nutrients must become more accurate and precise, and widely available solutions must be developed toward this purpose.

By working together with partners to address concerns over nutrient access and use through 2030, the Program will release a framework containing a series of DST for guiding tailored nutrient recommendations for at least 15 priority crops identified by EiA (Figure 6.2.1). These tools shall be used by extension specialists and over three million farmers in at least 15 countries, achieving at least 25% increase in crop productivity and profitability for participating farmers, due to improved input and recycle use efficiency. Agronomic data and information generated over years of research will be transformed into user-friendly tools through an advanced analytics and human-centered design (HCD) process. This work builds on the AgWise modelling framework being developed and used through the EiA Initiative, which in turn leverages earlier approaches for site-specific nutrient management (Chivenge et al., 2021) to establish nutrient recommendations, but with greater attention to HCD contextualization (Muller et al., 2024). AgWise is heavily dependent on high-quality, standardized data and computing infrastructure available through AoW 8 and the Digital Transformation Accelerator. This next-generation framework will be advanced to dynamically use short and long-term weather forecasts, soil nutrient balances, management solutions for acidity and salinity, and cropping system considerations such as rotation, perennial crops, residue management and use of organic fertilizers. The framework will consider integrated nutrient management to address yield gap over space for optimized nutrient uses. It will be steadily expanded and adapted to more countries and crops within CGIAR focus regions.

Partnering with domain partners (e.g., FAO, IFDC, ISRIC) and technology actors (e.g., Google, Microsoft) coupled with an open data and open science approach is especially critical to harness AI and other advanced technologies that promise faster, more accurate solutions based on large amounts of quality data. Thus, private sector engagement is integral to meeting stakeholder expectations and complementing the institutional capacities of NARES. An explicit youth and gender lens through HCD will assure that partners and solutions respond to the needs and constraints of these oft-marginalized stakeholders, with special attention to actions that ameliorate the digital divide. We will respond to three key research questions through co-creation with research and scaling partners that work with many thousands of farmers, and in partnerships with private sector, ARIs and local universities.

- What is the appropriate spatial scale and resolution of soil information for developing tailored nutrient recommendations associated with optimal return on investment (ROI), beyond which extra investment costs are no longer associated with meaningful economic gain?
- How, and which tailored soil and crop management solutions can be developed and improved in response to farmer needs and preferences within complex cropping systems in priority geographies?

- How can solutions that support decisions for agronomic gain be efficiently and sustainably co-created and integrated into the advisory services of scaling partners?

To respond to these research questions, the following four Clusters of activities (CoA) are planned:

6.2.1 Improved modelling framework using integrated soil fertility management (ISFM) and site-specific nutrient management (SSNM) principles. This CoA aims to improve nutrient recommendations, building on ISFM and SSNM principles (Vanlauwe et al., 2015) through integration of additional functionalities into AgWise. It will include development and integration of (i) spatially explicit acid and saline soils management recommendations modules including refining fertilizer recommendations based on lime and crop nutrient interactions; (ii) functionalities that allow accounting of previous crop and organic resource availability in generation of recommendations, following SSNM approaches; and (iii) weather forecast data to optimize input application, sowing and other management decisions while minimizing weather-related risk and maximizing profit with AoW 1. It will explore integration of both area-based and farm-level indices related to financial risks and crop insurance support. It will also evaluate appropriate spatial scales of soils input data for developing the recommendations, and assess potential trade-off among KPIs related to productivity, environment, and climate change mitigation (e.g. profit vs. soil nutrient mining or GHG emissions). It will include development and improvement of process-based models and their validations in new geographies, which have had little attention over the last decade.

6.2.2 Guiding nutrient management for perennial systems. This CoA addresses nutrient management as a key determinant of on-farm yields of perennials such as bananas, cocoa, coffee, forages, and date palm. It will synthesize current knowledge on perennial systems into decision support systems to guide practitioners on best practices. Based on an adaptation of ISFM for perennial systems, activities include developing and delivering tools that support good agricultural practices for nutrient management, density and shade solutions, and addressing soil-borne pest and disease constraints. It will also, working with AoW 7, develop solutions to diversify the perennial systems by identifying crop mixtures with reduced competition and enhanced complementarity. The CoA will also include providing training to extension agents on the use of the tools.

6.2.3 Integrating proven solutions into agro-advisories. Solutions and evidence generated through the modelling framework will need to be integrated into agro-advisory delivery frameworks of scaling partners and used to support policies for smarter fertilizer subsidies and soil health investments (in collaboration with AoW 3). A system where multiple actors can access or link to agronomic solutions, and associated algorithms and data (where national sensitivities allow) will be developed and tested as a potential business opportunity for the private sector and to develop collaborations with a wider set of domain and technology actors. In collaboration with the Policy and Scaling Programs, evidence will be provided to design policies that support smart fertilizer subsidies through use of precision nutrient advisories guided by ISFM and SSNM principles. This CoA assures more widespread adoption and implementation of advisory content.

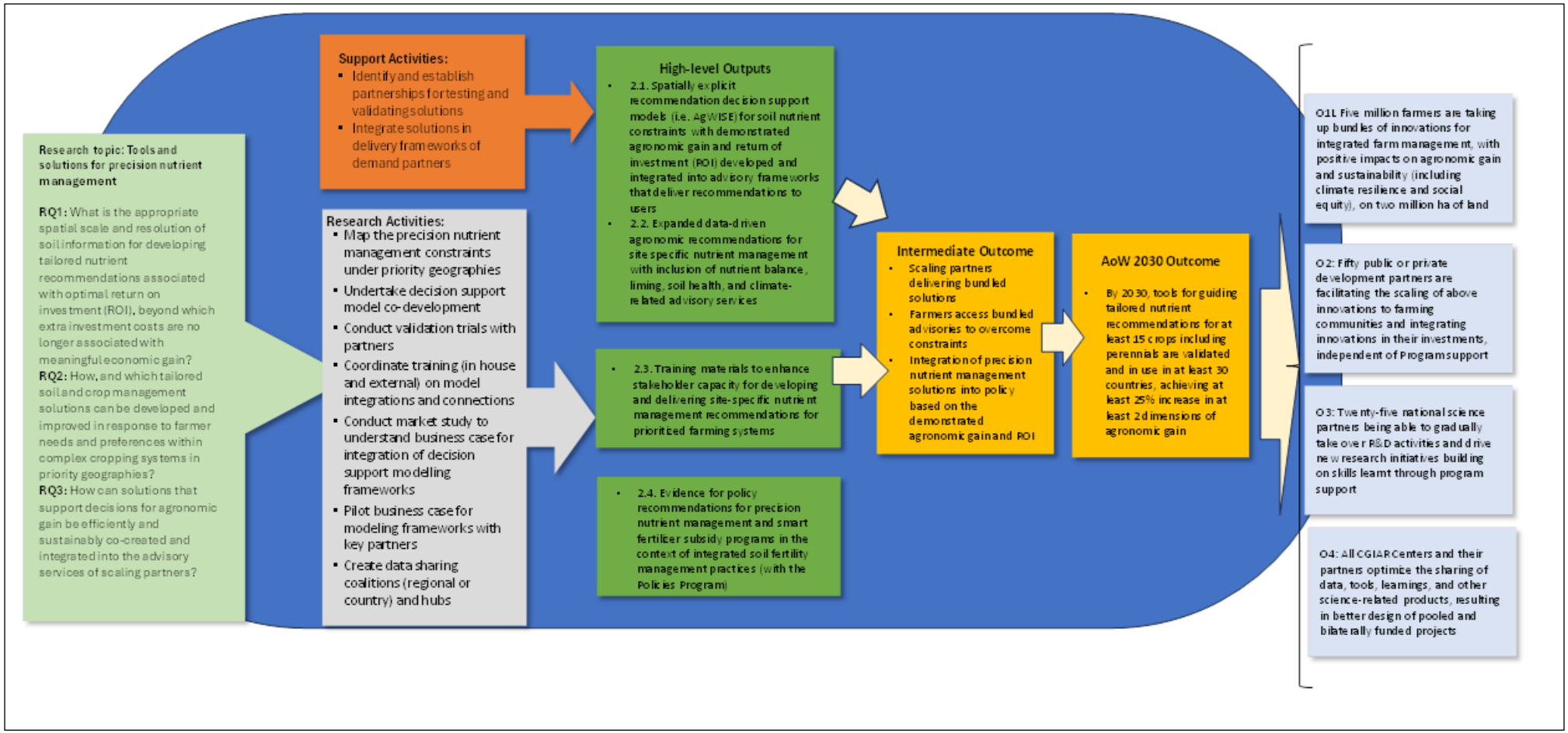

Figure 6.2.1. Contributions by Area of Work 2 (Precision Nutrient Management) to the Sustainable Farming Program.

6.2.4 Application of Artificial Intelligence (AI) as a pathway to improve development of agro-advisories. This CoA addresses AI as a rapidly emerging topic (Tzachor et al., 2023). Large Language Models (LLMs) will explore massive volumes of literature and identify and translate the key information into messages understandable to farmers and extension advisors. Integration of Chatbots into knowledge and data systems enables human-AI conversations in real time. However, LLMs must be trained to distil accurate, location-relevant information and generate agro-advisories and this will require collaboration among AI experts, scientists, scaling partners and experienced field staff. Other emerging area address use of high-resolution remote sensing to guide and adjust in-season nutrient management decisions and integration of both process-based and AI models to provide precision solutions beyond data-defined temporal and spatial scales. We envision this CoA to be implemented in collaboration with AoW 6 (e.g. unmanned vehicles) and the Digital Transformation Accelerator.

From this AoW, the expected intermediary outcomes (Figure 6.2.1) are (i) scaling partners delivering bundled solutions, (ii) farmers access bundled advisories delivered through scaling partners to overcome constraints and (iii) Integration of precision nutrient management solutions into policy based on demonstrated agronomic gain and ROI.

6.3. Resilient soils (AoW 3)

A healthy soil demonstrates favorable soil physical, biological and chemical properties critical for multiple ecosystem services, including, organic carbon storage and climate change mitigation, prevent desertification, nutrient cycling and retention, and water retention and provision, while also providing habitat for diverse and beneficial soil organisms. However, soil degradation (primarily due to human activities including deforestation, intensive agricultural practices and overgrazing; due to climate change, dust storm and drought) has become a threat to global food security and environmental health. Due to drought and land degradation, about 23 hectares of land are turning into desert every minute globally, leading to a loss in the potential to produce 20 million tons of grain annually (UNCCD, 2017). This degradation is exacerbated by land clearance, nutrient mining, organic matter depletion, and soil erosion and compaction. Soil erosion is the most widespread form of soil degradation, severely limiting the ability of soil to provide critical ecosystem services including those that sustain agricultural production (Vågen and Winowiecki, 2019). Building soil resilience at farm and landscape levels is needed to reverse the trends that compromise soil health in its many ecological and agronomic functions (Tenywa et al., 1999). This AoW will co-develop technologies and other innovative solutions aimed at enhancing soil health in relation to soil fertility, hydrologic functions, soil-borne pest and disease control, biomass productivity and carbon sequestration essential for building more resilient farming systems and prevent land degradation caused by erosion, deforestation or desertification. The AoW will work with farmers, farmer organizations and other stakeholders to reverse land degradation and enhance ecosystem services, informed by context-specific information on soil health indicators as part of a monitoring framework. This AoW addresses the following research questions.

- What is the impact of various agricultural management practices and interventions on soil health, as assessed within a soil health monitoring framework and how does soil health affect resource use efficiency, carbon sequestration, soil moisture dynamics, and beneficial biodiversity?
- Which indicators and frameworks can best enable evidence-based decision making at farm and national levels to catalyze and target investments in soil health?
- What is the best way to manage, share and visualize soil health data in a recipient-oriented and efficient manner?

- What are the potential contributions of introduced micro-organisms in delivering agronomic gain?

The Resilient Soils AoW plans to deliver several outcomes. By 2030, science-based tools and methods to assess, monitor and interpret soil health status are deployed across a network of long-term monitoring sites managed by at least 10 public or private sector partners to support decision-making investments in sustainable farming (Outcome 1). Over 500,000 farmers will implement targeted practices that restore and enhance soil health, also meeting net carbon emission and water conservation targets (Outcome 2). These farmers will support practices that conserve and promote above- and below-ground biodiversity that enhance farm productivity and sustainability, in collaboration with the Landscapes Program (Outcome 3). At least five stakeholders in cooperating countries will include achievable soil health targets in national policies, and strategies in collaboration with the Policy Program (Outcome 4). It operates through the following four CoAs:

6.3.1 Better understand and promote resilient soil ecosystems. Current knowledge gaps around soil degradation limit the adoption of sustainable farming practices and need to generate and apply newfound evidence to decision making at farm level. This CoA will maintain and/or establish a network of long-term monitoring sites including existing long-term experiments managed by CGIAR Centers as the basis for identifying a suite of soil health indicators fitted to the contexts and needs of smallholder farming systems. Ultimately, the CoA will use this information to implement a robust monitoring framework of these indicators to set benchmarks and track soil health changes across time and scales.

6.3.2 Promote the implementation of validated soil health practices. This CoA focuses on optimizing farm resource use by implementing validated soil health practices to positively impact net carbon emissions, plant health, and water conservation across landscapes. The validated solutions will be bundled and tailored to demands of target partners including farmers, private and public scaling partners, business enterprises. In collaboration with the Landscapes Program, it will identify a suite of positive soil health guidelines and practices, emphasizing the integration of leguminous crops, trees, organic inputs, perennials, livestock, and fish. Activities will also focus on establishing relationships between agronomic, plant health, and farming system practices, and changes in soil health indicators, as affected by inherent soil properties, in support of soil health monitoring systems.

6.3.3 Provide strategies and incentives for sustainable investment in soil health. Sustainable soil health management is essential for profitable farming, yet current investment remains insufficient for transformative change. This CoA will focus on developing strategies for targeted and profitable investments in soil health to boost productivity, reduce degradation, and address food security. It will provide policy advisory with an emphasis on increasing investment, offering inclusive incentives, and fostering collaboration between smallholders and agribusiness to achieve long-term soil health benefits. A particular role will be through providing scientific evidence to the Fertilizer and Soil Health Action Plan of the African Union.

6.3.4. Generate evidence on the role of microorganisms towards supporting the delivery of agronomic gain. Many discussions nowadays focus on the role of introduced micro-organisms on crop growth, nutrient availability, and access to soil moisture. While a large number of such bio-fertilizers are already available in the Global South, many questions on their efficiency and contributions to crop production, resource use efficiency, and soil health remain unanswered. It is critical to (i) develop procedures to generate unequivocal evidence on their potential contributions to the delivery of agronomic gain, preferably supported by an understanding of their mode of action, (ii) work with regulatory agencies in the target countries to get such procedures adopted, (iii) to work with the private sector on adapted delivery systems for bio-fertilizers with proven functionality.

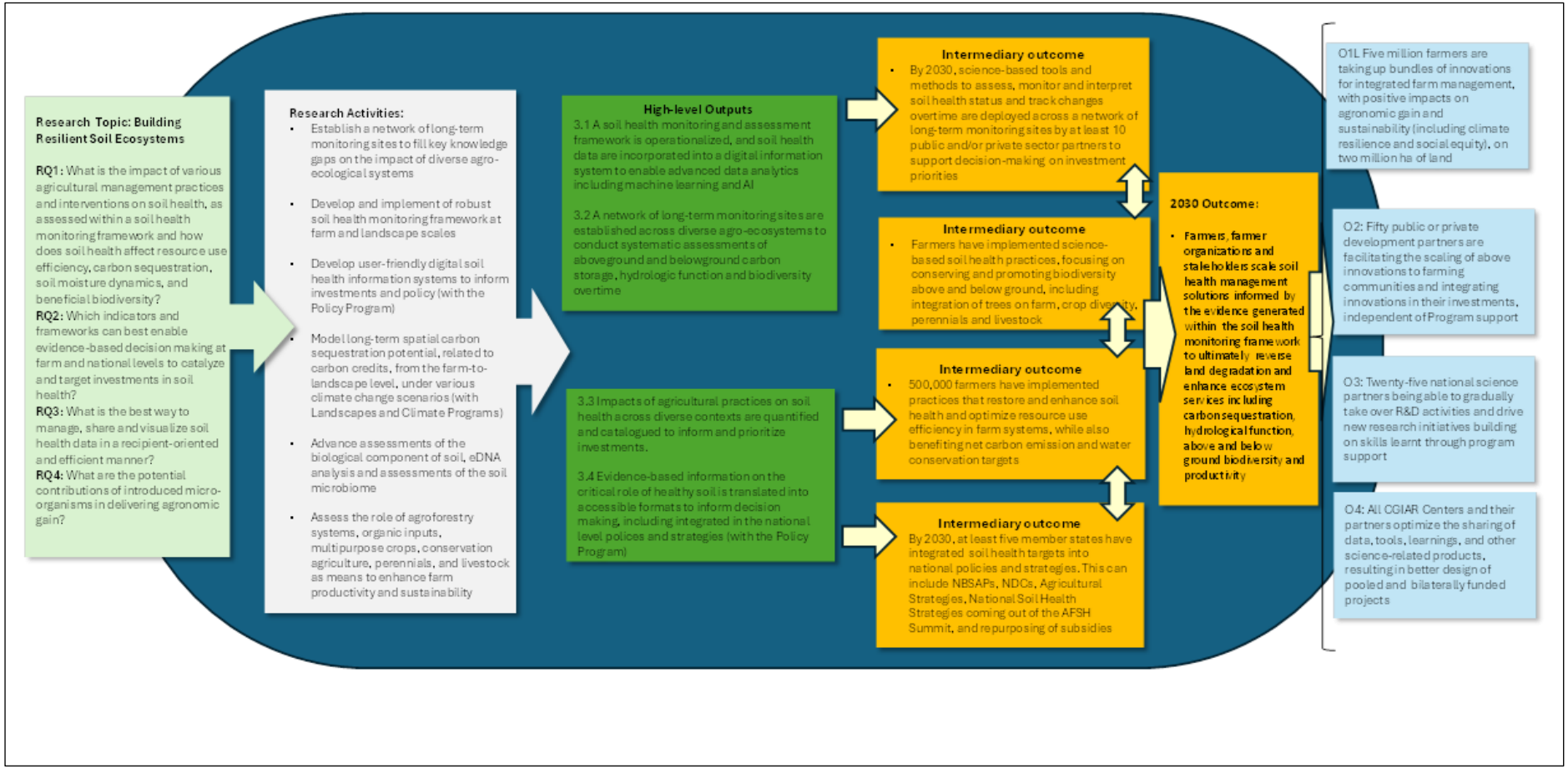

Figure 6.3.1. Contributions by Area of Work 3 (Resilient Soils) to the Sustainable Farming Program.

AoW 3 will deliver the following High-Level Outputs (see Figure 6.3.1): (i) A soil health monitoring and assessment framework is operationalized and soil health data are incorporated into a digital information system to enable advanced data analytics including machine learning and AI; (ii) a network of long-term monitoring sites are established across diverse agro-ecosystems to conduct systematic assessments of aboveground and belowground carbon storage, hydrologic function and biodiversity overtime; (iii) impacts of agricultural practices on soil health across diverse contexts are quantified and catalogued to inform and prioritize investments; (iv) evidence-based information on the critical role of healthy soil is translated into accessible formats to inform decision making, including integrated in the national level polices and strategies. This AoW will engage with research organizations and civil society to co-develop evidence-based and applicable tools for monitoring soil health at scale, including soil health assessment frameworks with validated benchmarks and digital information and advisory systems. Establishing long-term monitoring sites will require support from Centers and partners to identify the locations and practices that need to be considered to fill current knowledge gaps. This will include the modelling carbon sequestration potential of various agricultural management practices at farm and landscape levels. Moreover, the knowledge around the soil microbiome to understand functional diversity of micro-organisms and their role in nutrient, carbon and hydrologic cycles will be advanced. The AoW will further engage with decision-makers and investors, providing advisory and strategies for policy reforms and investment incentives aimed at restoring and promoting soil health.

6.4. Plant health and mycotoxin safe crops (AoW 4)

Effective plant health management plays a crucial role in sustaining and enhancing the productivity, profitability, and resilience of agrifood systems. It also contributes to realizing genetic improvements from enhanced crop varieties. Yet, many farming communities continue to grapple with various PDW outbreaks. Each year, crop PDW result in losses ranging from 10% to 40% of major food crops, amounting to a staggering US $220 billion globally (IPPC Secretariat, 2021). These losses severely affect food and feed security, safety, and nutrition (Rizzo et al., 2021). Regions facing food deficits and rapid population growth experience the highest losses due to uncontrolled plant health threats. PDWs impact all aspects of food security, including production, quality, access, and utilization. Additionally, mycotoxin contamination of food and feed too often exceeds safe limits, posing a substantial health burden and reducing market opportunities (Eskola et al., 2020). This AoW aims to strengthen plant health systems in target countries through enhanced diagnostics and surveillance for problem identification and scaling of innovations to counter PDW and mycotoxins (Figure 6.4.1). It will use frontier technologies and continue investing in discoveries essential to effective monitoring, risk prediction, and integrated management, with a focus upon ecofriendly solutions.

The outcome is that by 2030, over one million additional farmers use integrated PDW management that reduces the crop losses caused by biotic threats, improves environmental and human health due to reduced pesticide and mycotoxin exposure, and increases the availability of safe and nutritious food and feed to consumers and livestock, respectively. Major research questions follow.

- How to improve global diagnostics and surveillance in the global south involving NARES, enabling better PDW management?
- Which approaches can improve cost-effective PDW management and risk prediction under current and future climate scenarios to improve preparedness and response?

- How to reduce crop losses, and protect food and nutritional security from major biotic threats by developing and scaling sustainable, gender responsive and socially inclusive integrated PDW management (IPDWM)?
- What approaches allow converging technological, institutional, and policy actions towards integrated mycotoxin management (IMM) to better recognize and reduce mycotoxin contamination at scale?

This AoW offers sources of CA because of recent and ongoing achievements by the PH Initiative, and its strong network of 180 partners. The network operates across major food staples, forages, and horticulture crops across many countries. Furthermore, CGIAR Centers have a track record of co-creating fit-for-purpose solutions in collaboration with national and regional partners to ensure successful, ecofriendly management of PDW and mycotoxins, influencing policymakers and capacity building that successfully countered several recent plant pandemics including Maize Lethal Necrosis, Fall Armyworm and others (Kreuze et al., 2023), in addition to having a 22-year program working on aflatoxin biocontrol across Africa and expanding to other regions. The geographic penetration of CGIAR research, offers strong sources of CA for preventing and managing the transboundary nature of plant health, cases of virus, bacteria or insects such as the red palm weevil or potato psyllid that can be transmitted through vegetative planting material. The research activities will be organized into CoA as follows.

6.4.1 Continued focus on developing state-of-the-art and cost-effective tools to enhance surveillance and early warning systems. These tools include methods for PDW diagnostics and surveillance, data management, modeling, risk prediction and forecasting, and phenotyping. These activities will be supported by frontier technologies in data science and AI to support modeling and predictive tools in collaboration with Climate Program. Emerging areas of work will include researching the roles of citizen science in collaboration with Digital Transformation Accelerator.

6.4.2 Developing gender-responsive IPDWM and IMM options with partners and stakeholders in target countries. This will include the identification of priority PDWs with partners, assessment of state-of-the art of management strategies, development, testing and scaling of IPDWM and IMM using co-creation and participatory approaches, particularly gender responsiveness. Using a case-study approach, we will develop IPDWM packages for specific farming systems where PDWs represent major constraints. These include links with soil health, water management and mechanization AoWs. We will also co-develop host-plant resistance (HPR) and deploy seed-based solutions in collaboration with the Breeding Program. We also intend to support public-private partnerships in collaboration with the Scaling Accelerator. Regarding IMM, priority will be placed upon developing a comprehensive traceability system to enhance food safety decision-making. We will provide new and better solutions for mycotoxin management in collaboration with the Better Diets for Nutrition & Health Program.

6.4.3 Designing inclusive, equitable, and context-specific IPDWM and IMM scaling approaches for achieving greater impacts. This CoA evaluates plant health options in ways that inform and influence policymaking decisions and dialogue. Supporting these efforts, key activities include strengthening networks and infrastructure, influencing policymakers to foster a favorable environment for converging technological, institutional, and policy actions that will lead to plant health improvements, and developing suitable value chains to enhance the acceptance and adoption of new technologies and strategically bundled practices. The continuation of scaling of plant health innovations and those in the process of reaching the scaling stage will be done in collaboration with the Scaling Program, which will support organizing a coordinated response to, for example, emerging PDWs that are of concern to

specific agroecosystems, case of the potato zebra chip disease in the Andes, the fall army worm in Africa and Asia or the red palm weevil in dryland areas. We also intend to strengthen and expand public-private partnerships in collaboration with the Scaling Accelerator Program for both IPDWM and IMM.

These CoAs and combined efforts will result in several key HLO (Figure 6.4.1) that address (i) enhanced capacity and strengthened networks of plant health practitioners; (ii) improved and more cost-effective tools for monitoring, data management, and modeling; and (iii) provision of surveillance data, prevention strategies, and (iv) policy briefs for decision-makers for relevant policy changes, and (v) mycotoxin prevention and traceability systems. The initiative will deliver eco-friendly, inclusive, affordable, and scalable technology packages to partners, contributing to more resilient and sustainable agricultural production systems as well as cost effective traceability systems for ensuring food safety.

Meaningful collaboration with regional and national plant protection organizations is particularly important to this AoW. Key partners also include NARES, NGOs, farmers' organizations, aggregators and private sector actors, with some of them already having investments to manufacture and distribute plant health innovations at scale. ARIs and universities are important research partners. Note that the PH Initiative provided an average of US $800,000 annually to 40+ partners during 2022-2024 to foster meaningful collaboration which future activities could build on.

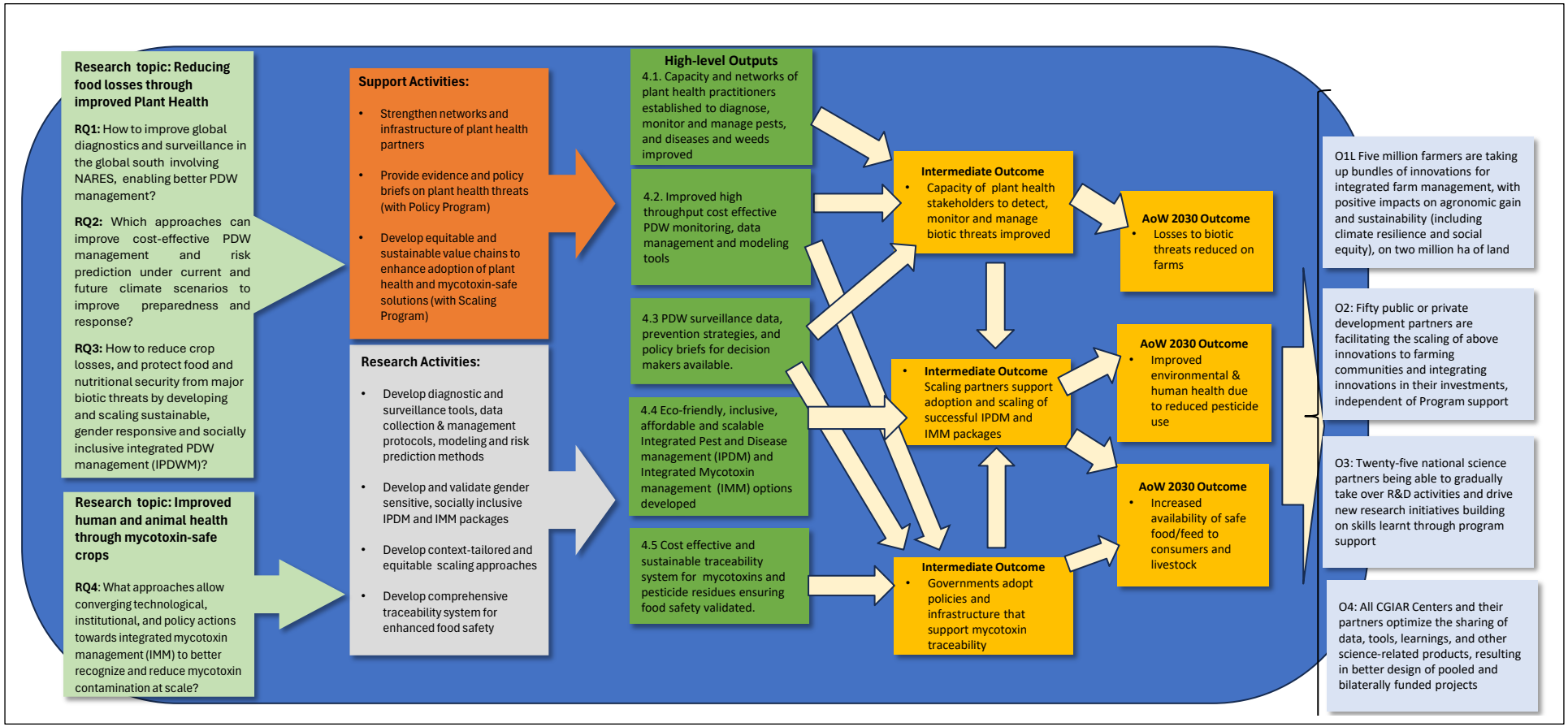

Figure 6.4.1. Contributions by Area of Work 4 (Plant Health and Mycotoxin Safe Crops) to the Sustainable Farming Program.

6.5. Integrated water management (AoW 5)

Improved water management is key to increasing crop productivity, necessitating its inclusion as a separate Program AoW. Agriculture accounts for 70% of the global freshwater withdrawals (UN-water, 2024), while 3.2 billion people live in areas where agriculture production exhibits high levels of water stress due to climate change (FAO, 2020). This highlights the urgency of effective water management strategies to mitigate the water-related risks to and from food systems. Irrigation requirements are increasing due to more erratic rainfall leading to severe water insecurity and desertification, yet there is a potential to move 200 million hectares of rainfed cropland into sustainable irrigation (Rosa et al., 2020). In water-scarce areas, practices that improve water storage and sustainable access are required to address water-related risk to food systems. In areas where agriculture overuses and contaminates freshwater, use must be reduced, water productivity and quality enhanced. Poor water management hampers sustainable agricultural gains, leading to salinization, land degradation, water pollution, and increased greenhouse gas emissions. In water-scarce areas, alternative water resources and recycling used water should be explored for safe agricultural production, which is the intention of emerging partnerships such as the Integrated Desert Farming. The need to focus on water scarcity and improved water management practices was mentioned in two thirds of the listening sessions conducted by CGIAR in 25 countries during late 2023 and early 2024.

The overall ambition is to contribute to water-resilient farming systems for at least three million producers by 2030. The adoption of water innovations and integrated management practices will mitigate water-related risks and address the unsustainable use of water resources (Figure 6.5.1). Achieving this target requires the Program to work with diverse partners including FFOs such as NGOs, private sector entities and local extension to accelerate adoption of proven technologies and management practices; NARES and government bodies to refine, adopt and enforce recommended water management practices and policies; and public and private sector investors to facilitate the scaling of water-resilient farming. The integration of farm level water management practices with watershed level interventions will provide the basis for collaboration with the Landscape Program. To achieve these Outcomes, we raise the following three research questions.

- Where, when, and with which magnitude do water-related risk to and from agronomic gain occur?
- What inclusive water innovations and management practices at the field and farm level address the water-related risks to and from agronomic gains? Under what conditions are these solutions effective?
- How can we overcome key determinants preventing water-resilient farming at scale?

The Program's sources of CA include decades of expertise in co-delivery of water solutions across diverse cropping systems and geographies; strong public and private sector networks to scale cutting-edge water innovations and practices; advanced data analytics and models to assess water-related risks and impacts; and available facilities offering methodological expertise in measuring water availability, use and soil-plant interaction. We aim to co-create tools to enhance site-specific prioritization of proven water interventions address water-related risks to and from agronomic gain (Output 5.1), ensure that socially inclusive water management solutions are integrated into sustainable farming (Output 5.2). Through evidence-based research with national partners, capacity-sharing activities (Output 5.3), and targeted outreach, we will inform policies and investment to support scaling of validated water solutions at the field and farm levels (Output 5.4), in collaboration with the Landscapes and Policy Programs. Three interactive CoA are designed to achieve water-resilient farming systems at scale.

6.5.1 Addressing water-related risks to and from agronomic gain. This CoA aims to enhance the prioritization and evaluation of site-specific suitable field/farm level water innovations and integrated water management practices to address the water-related risks to and from agronomic gains under current and future climatic conditions. We aim to do this by developing tools to quantify the spatial and temporal variability of water-related risks to (e.g. economic and physical water scarcity) and from (e.g. over-irrigation, agro-chemical pollution) agronomic gain; enhance the site-specific quantification of water availability, use (e.g. high resolution remote sensing based consumptive use) and limitations (together with the landscape program); use crop water modeling and state of the art data science to evaluate the potential of water solutions for current and future climates; and frameworks that assess KPI's of water solutions within whole-farm situations (AoWs 6.1. to 6.7). New lines of work include state-of-the-art sensing techniques and analytics for early soil and water stress response, evaluating current on-farm water management practices and assessing water quality risks impacting agronomic gain

6.5.2 Socially inclusive, effective and scalable integrated water management solutions for diverse production ecosystem. This CoA aims to co-create socially inclusive water solutions aimed at addressing the identified site-specific water-related risks in rainfed and irrigated systems including desert area. Specific activities include innovations that enhance water storage (e.g. water harvesting and fishponds), access and productive use in rainfed systems (e.g. agronomic practices, low-water requiring crops and varieties, soil and water conservation in collaboration with AoW 6.3); or that optimizes water use in irrigation systems (e.g. crop diversification, application methods, cost effective soil moisture sensor based advisories, multiple- use services); integration of water management solutions with agri-inputs and management practices suitable for diverse environments (including desert farming); incorporating gendered and socio-cultural preferences and norms throughout the co-creation process. New lines of work include exploring potential alternative water sources and circular principles and their impact on productivity, plant and soil health and food safety.

6.5.3 Water-resilient farming systems at scale. Working closely with CoA's 6.8.3 (Cap-SHA), 6.8.4 (docking to the Scaling Program) and 6.8.5, this CoA will explore options to remove barriers that hinder farmer adoption, public and private sector investment, and the design of programs for water-resilient farming systems at scale. Main activities include identifying determinants of improved water productivity; develop inclusive business and service mechanisms and incentives to achieve water-resilient farming systems at scale; tailoring agricultural water management advice to different value chain actors; providing policy recommendations (with CoA 6.8.5) on agricultural water management; and offering technical assistance to public and private sector investment programs. New lines of work in collaboration with CoA 6.8.5 include the evaluation of innovative agricultural water stewardship models and repurposing subsidies to reduce unsustainable freshwater use.

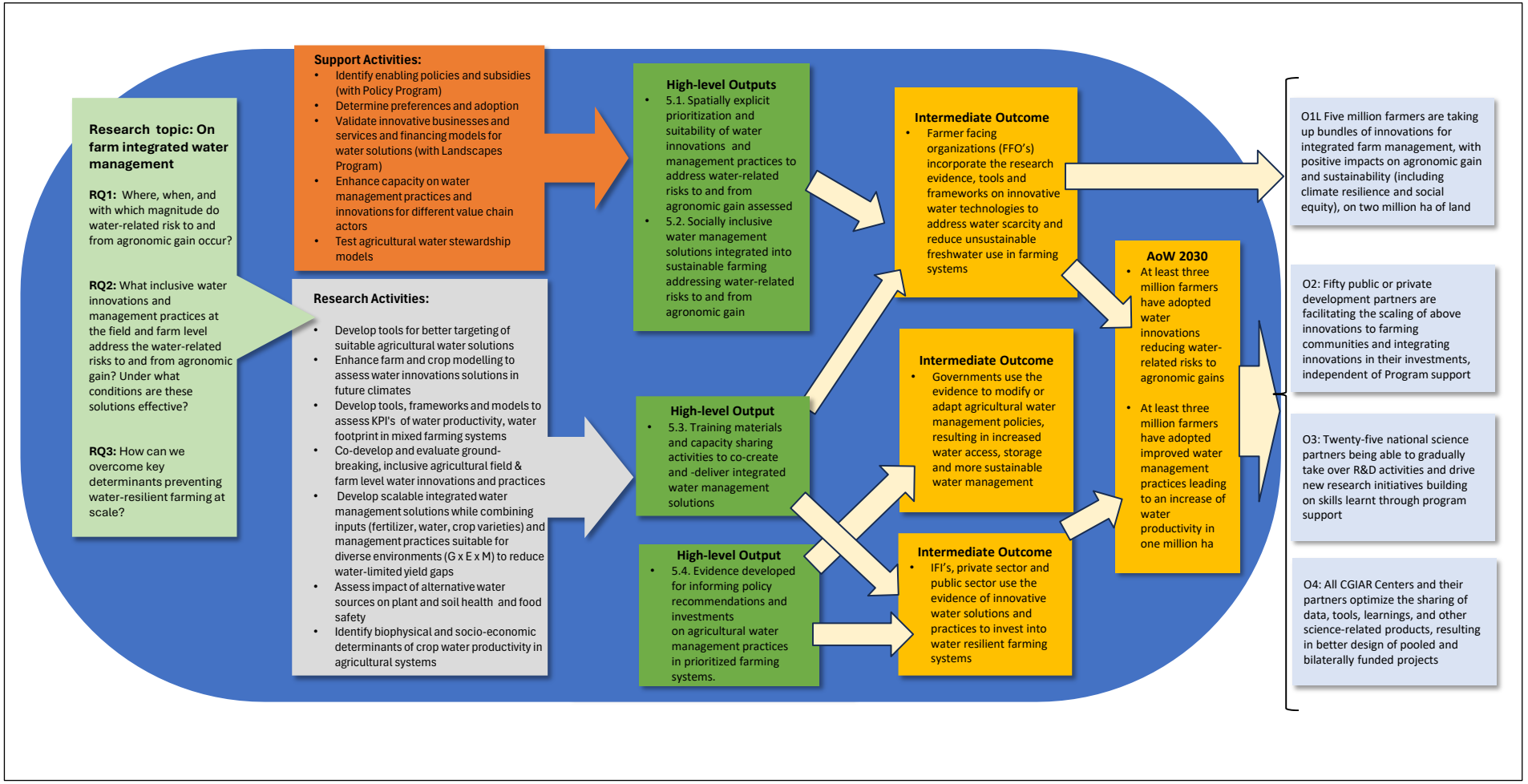

Figure 6.5.1. Contributions by Area of Work 5 (Integrated Water Management) to the Sustainable Farming Program.

6.6. Scale appropriate mechanization (AoW 6)

Smallholder farmers face difficulties in crop production because of poor access to technologies that relieve drudgery and labor bottlenecks. Sub-Saharan Africa has the world's lowest level of agricultural mechanization as 65% of farm power is provided by humans (Sims & Kienzle, 2016, 2017). However, agriculture absorbs labor as agricultural workers in areas with high population density, so the role of scale-appropriate mechanization (SAM) to be placed in context and tailored to local conditions. During peak labor demand periods, labor shortage may delay agriculture operations (e.g. land preparation, crop establishment, weed management, harvesting etc.) leading to significant losses. Rising temperatures reduce the capacity of manual labor due to heat stress. Urban migration has resulted in labor scarcity, and the aging of agricultural labor force. Availability of right machinery service helps to address labor shortages, reduces drudgery, improves resource use efficiency, reduces the climatic risk and open transformative opportunities for youth through rural employment in service provision, spares and repairs, and aligned small industries; but machines must be commercially available, affordable, easy to operate and repairable under local conditions. Lastly, mechanization reduces labor requirements, allowing more time for other income-generating activities or leisure, and could be an entry point for sustainable intensification and precision management.

The AoW's outcome ambition is that by 2030, over one million additional smallholders will benefit from increased access to machinery services, improving labor productivity by at least 25%. These machines include, for example, an assortment of tillers, planters, weeders, power sprayers, irrigation pumps and water delivery systems, harvesters, choppers, shellers, threshers, and bailors etc. This target will be realized by creating an enabling environment that allows farmers to better understand, access and utilize these machines, and promotes mechanization service and entrepreneurship. This environment includes policy support to manufacturers and distributors of these machines. These actions raise the following research questions.

- What are all the human centered design SAM options and workable methods to co-develop gender-responsive, socially inclusive SAMs with stakeholders for improved labor productivity and reduced carbon footprint?
- What will be the implications and tradeoffs of introducing SAMs on intra-household decision-making, labor dynamics, productivity at farm and community level?
- What factors influence the adoption of SAMs and what type of context specific scaling approaches (including policy interventions) will lead to wider adoption of SAM by different stakeholders including women & youth?

The Program has sources of CA to lead this effort for several reasons. CGIAR Centers have interdisciplinary expertise including mechanization experts, agronomists, and social scientists, enabling holistic approaches to establish partnerships with private sector, universities and other organizations. CGIAR research facilities and infrastructure supports multi-locational testing of mechanization options and behavioral studies to evaluate enablers of adoption. It has strong working relationships with partners including national governments and private sector to facilitate mechanization efforts. At the same time, balanced partnership is required because CGIAR Centers do not have sources of CA in the commercialized manufacture and market distribution of prioritized machinery.

The AoW and its High-Level Outputs are presented Figure 6.6.1. We aim to achieve these by following human-centered design approaches based upon knowledge of various SAM options identified for target beneficiaries, promotion of SAMs that most improve labor productivity and reduce carbon footprint developed, and the development and distribution of tools that facilitate the design, testing and scaling of vetted equipment through mechanization stakeholder platforms. Four CoA are planned to address these issues.

6.6.1 Developing SAM options. Several mechanization options are known and available, and also new options emerging, therefore, standard operating procedures (SOPs) for those options are needed for potential users to better understand the equipment. Continued efforts will take place for improvement and adaptation of these innovations across target sites through assessment of synergy and trade-off among a suite of standardized KPIs including labor, energy use efficiency, and carbon footprint.

6.6.2 Assessing SAM responsiveness to gender and youth needs. Special attention will be paid to gender equity and women's and youth empowerment through greater access to mechanized operations, and how this impacts labor dynamics. The equipment will be assessed in term of client constraints, needs, and preferences, labor dynamics, and through their targeted inclusion of women in capacity development activities.

6.6.3 Assessing drivers of SAM adoption. Prevailing biophysical and socio-economic factors influence the adoption of mechanization options that need to be addressed through site-specific scaling models and strategies. Approaches include demand mapping of machines based on need and appeal and promoting conducive policies regarding financial incentives and market regulations. In regions where farmers are most unable to afford recommended machines, various service provision options will be assessed.

6.6.4 Developing SAM business models. This Cluster supports the capacity of entrepreneurs, local fabricators, engineers and students to design, develop and repair machinery generating employment opportunities, particularly for youth. This situation will be addressed by building the capacity of these actors through knowledge exchange programs. Other supporting activities include developing scaling-out mechanisms, multistakeholder platforms that strengthen linkages among value-chain actors, financial services, business model development, and market incentives.

Emerging areas of work include assessing unmanned vehicles that are gaining attention for various farm operations and precision agriculture including seeding and the application of fertilizers and crop protection materials. Mechanized assessment of crop growth, yield, plant health, and soil and water status requires attention for precision agriculture (linking with AoWs 1 to 5). For example, developing SOPs for drone applications ensures safe and widespread future use in agriculture. While this AoW does not cover post-harvest mechanization at this moment, there are significant opportunities in this area. Mechanizing post-harvest operations, such as threshing, milling, and storage, could improve efficiency, reduce losses, and enhance overall value chains. Thus, this area will also require attention, and area for collaboration with Better Diets and Nutrition Program.

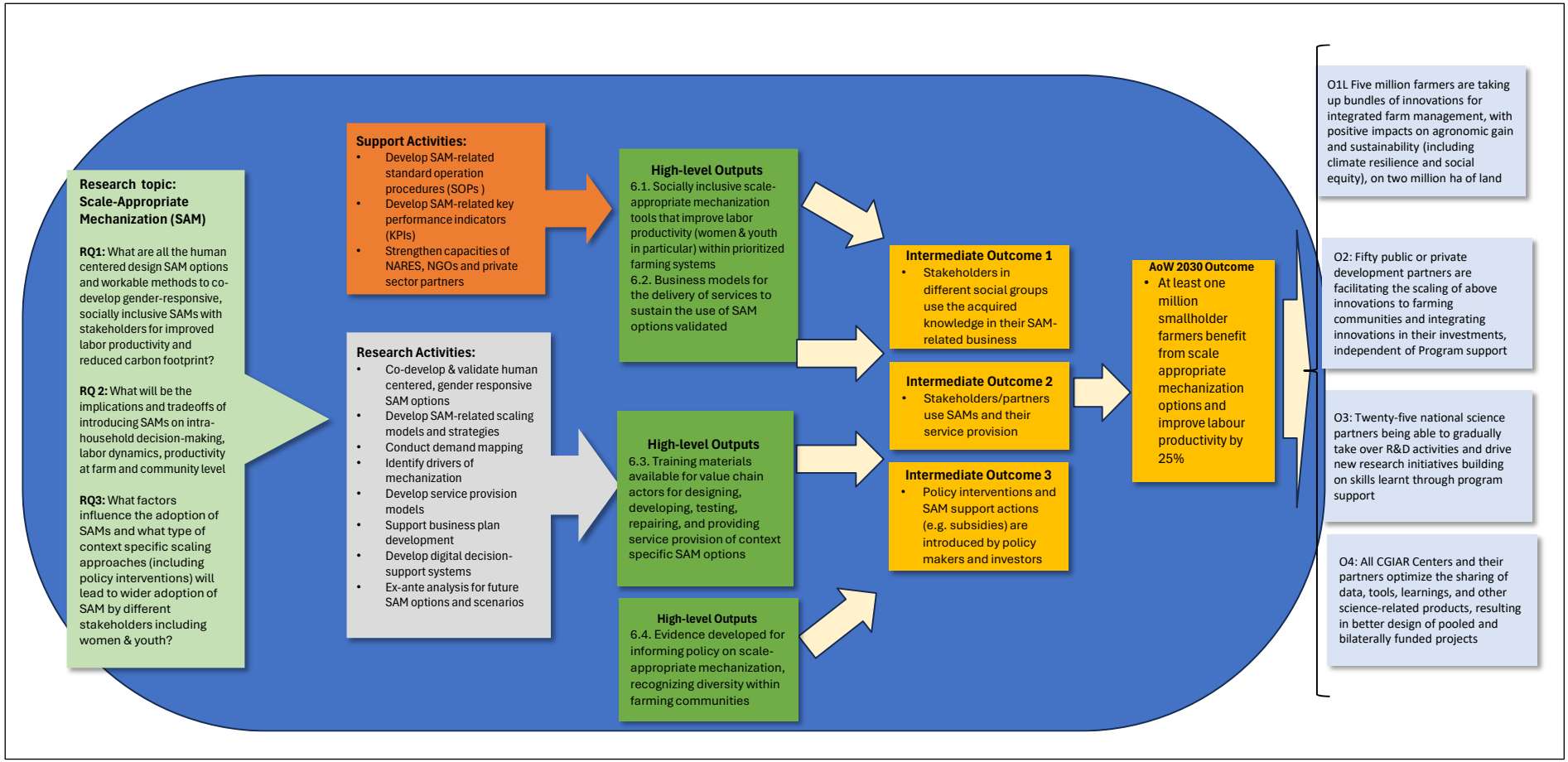

Figure 6.6.1. Contributions by Area of Work 6 (Scale-appropriate Mechanization) to the Sustainable Farming Program.

6.7. System integration through co-creation (AoW 7)

This AoW fulfils a vital role in the Program, addressing the problem of bridging between farm component research (crops, livestock, trees, fish, etc.) and the farmer's whole-farm perspective, and integration of that with other levels of systems analysis. Through co-designing with partner organizations, co-creation with farmers, the use of system modelling approaches, and sustainability assessment, highly scalable socio-technical innovation bundles will be designed, tested, monitored, and prioritized for specific contexts. These bundles will be composed of multiple on-farm technologies or practices and enabling services or support measures that can come from the policy and institutional levels (Barret et al., 2020). The development, validation, and scaling of methods for designing and appraising these bundles is also a key objective of the AoW, and will draw upon human-centered design (HCD), behavioral sciences, systems science, and data and DST developed across the Sustainable Farming Program in collaboration with the Scaling for Impact Program.

The planned 2030 outcome for the Area of Work is that five million small and medium-scale farmers adopt and benefit from bundles of farm system innovations (same outcome as the Program), from which particularly women, youth, or other disadvantaged groups will benefit (Figure 6.7.1). There are four intermediate outcomes. Two are related to stakeholder organizations scaling the Program's products: scaling innovation bundles (IO7.2) and scaling methodologies for bundle design and appraisal (IO7.1). These are contingent upon the high-level outputs of validated, co-designed bundles (HLO7.1) and the bundle design and targeting methodologies, which draw on co-creation methods, system sciences, sustainability assessment, and HCD, and enable local people to define feasible and context-specific transition pathways to sustainability. Intermediate Outcome 7.3 supports the innovation pathway (IO7.1 and IO7.2), via short- and long-term capacity development. Training materials will be prepared to enable the use at scale of prioritized bundles, and to enable the use of co-creation and system science approaches and bundle design methodologies by stakeholders and partner organizations (HLO7.3). Long-term capacity sharing involves the development of curricula and other diverse mechanisms toward the intermediate outcome oriented to enhance the ability of current and future agricultural professionals to engage with better integrated systems and behavioral sciences. Intermediate outcome 7.4 aims for governments, private sector, and international organizations to invest in scaling innovation bundles and in the mainstreaming of co-creation and system sciences methods in their institutional approaches. Evidence to support this (HLO7.4) will come from evaluation of the farm bundles at scale, and the evaluation and use of bundle design methodologies. Collaborative work is envisioned with the Breeding for Tomorrow, Multifunctional Landscapes, Sustainable Animal and Aquatic Foods, Policy Innovations, Better Diets and Nutrition, and Scaling for Impact Programs, as well as with the Accelerators.

Three research questions underpin this agenda.

- What are the most promising integrated farm-level innovation bundles to improve sustainability, equity, and agronomic gain at scale within the selected geographies of the program?
- How can co-creation and systems science methods contribute to prioritizing and designing highly desirable, sustainable, and equitable farm system innovation bundles?
- How can co-creation and systems science methods accelerate the scaling of farm innovation bundles, and what evidence is needed to design enabling policies and influence investments in mainstreaming these methods in organizational strategies and educational efforts?

The Program team has a long experience in developing, validating and adapting participatory research methods (Ortiz et al., 2019; Ortiz et al., 2020), from the seminal paper "farmer back to farmer" (Rhoades and Booth, 1982) through participatory breeding, crop management, and

value chain creation. Systems science is applied at many levels within CGIAR from plant, through farm (Hammond et al. 2017; 2020), landscape (Hammond et al. 2021), and macro-economic levels (Giller et al 2021). Often these efforts have been applied to component technologies, not to design or evaluate integrated and bundled solutions, which is now required to address sustainable development challenges at the required pace to meet 2030 SDG targets. The research questions will be addressed via transdisciplinary action research using focus sites and innovation platforms through which to co-develop, test, and iterate solution bundles and integrative methodologies. This will include the following CoA:

6.7.1 Co-designing, testing and integrating multi-component farm innovation bundles with enabling services to increase adoption. These activities will involve collaborative research with partners, other AoWs and Programs, which develop farm-level innovations that include crops, livestock, trees, fish, etc. that would need to be integrated according to contexts, and supporting an enabling environment (case of Breeding for Tomorrow, Multifunctional Landscapes, Policy Innovations, Scaling for Impact, Sustainable Animal and Aquatic Foods, Better Diets and Nutrition, and the Accelerators). Co-investment and co-location of activities is planned to design, test, and appraise integrated context-specific solutions, maximize efficiencies, and learning opportunities.

6.7.2 Developing, applying, and testing co-creation methods for the design and integration of farm innovation bundles. This CoA builds upon on previous experiences of participatory, co-creation research and HCD to include the farmer perspectives and participation in monitoring, particularly from women and youth and connect with system sciences (see 6.7.3).

6.7.3 Developing, applying, and testing system science methods for the design and targeting of innovation bundles. This CoA combines the human perspective gathered through co-creation methods with the biophysical and socio-economic systems-oriented modelling, aiming for enhanced decision-making at multiple levels. It also includes developing the multi-variate sustainability appraisal to be applied to all farm-level solutions and considers the need to adapt over time. This work will be in collaboration with the Policy, Landscapes, and Scaling Programs to explore the factors that influence adoption of innovation bundles in the wider political, institutional, and cultural contexts.

6.7.4 Capacity sharing towards institutional change for using co-creation and systems science methods and stimulating policy investments. This is achieved in collaboration with the Policy and Landscapes Programs and the Capacity Sharing Accelerator to define and address capability gaps for the short- and long-term across different stakeholder groups. This will build in the progress made by the MFS Initiative, French Organizations, and the SYSTEMS Group of the SUSTAIN-LIFE European University (https://www.sustainlife-university.eu/), and the results of a workshop organized in May 2024 about how to strengthen system sciences in CGIAR. This collaboration will expand involving additional relevant partners to continue enhancing CGIAR and partners' system science skills.

These clusters of activities will build upon the methods, sites, platforms, and processes established in the EiA, PH and MFS Initiatives (as well as bilateral projects), including an inventory of systems science tools and a virtual institute for systems science.

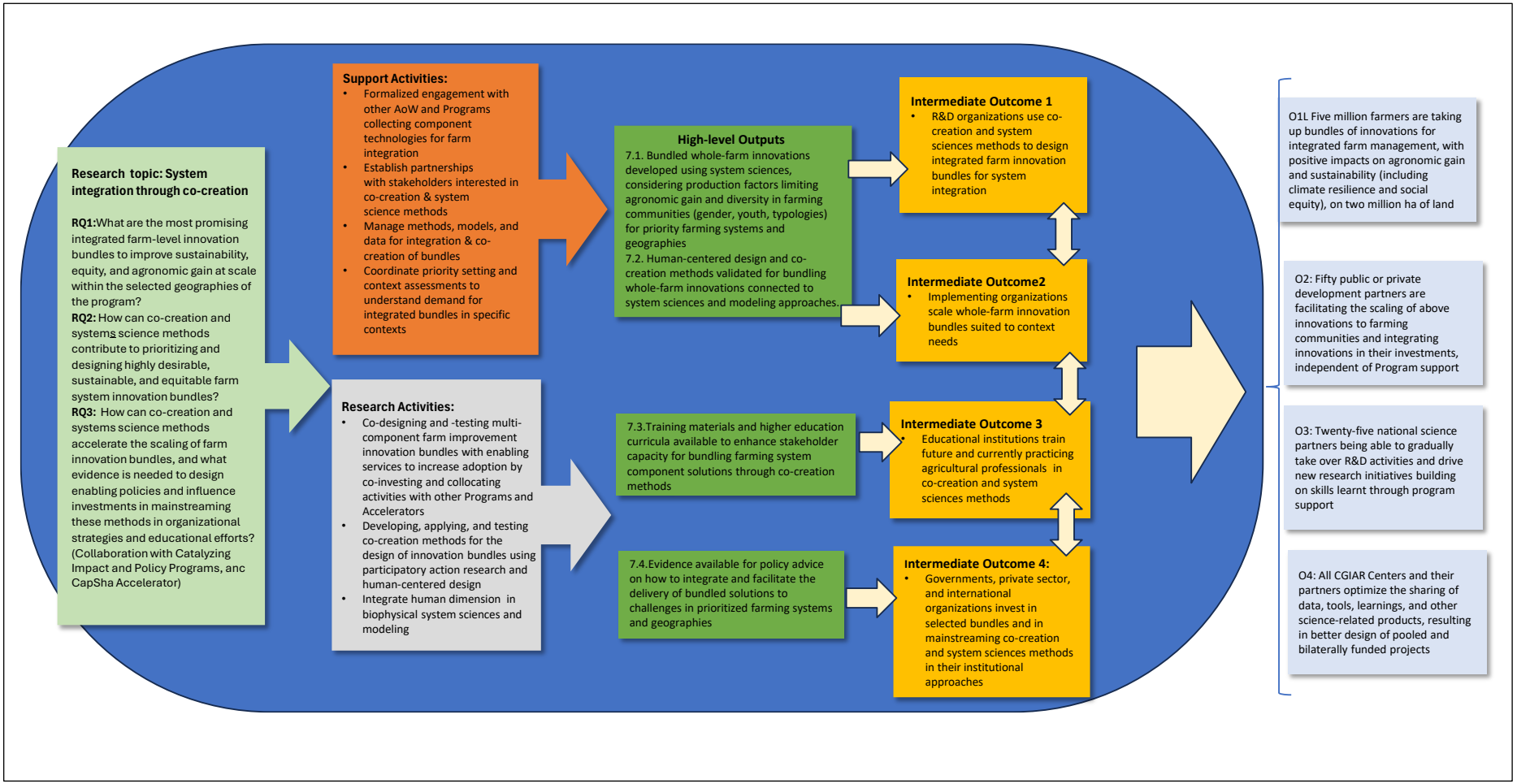

Figure 6.7.1. Contributions by Area of Work 7 (System Integration through co-creation) to the Sustainable Farming Program.

6.8. Program efficiency and delivery (AoW 8)

AoW 8 supports common functions across all component-based areas of work (AoWs 2-6), and the integrative AoWs (1, 7), creating a coherent, programmatic delivery model. AoW 8 will increase efficiencies in cross-cutting data science and analytics, prioritization, MELIA, scaling and delivery partnerships, capacity sharing, and evidence-based policy support. Achieving efficiencies in these aspects common to all technical AoWs is one of the key benefits of building a sole Sustainable Farming Program instead of three independently implemented Initiatives on agronomy, plant health and farming systems, and disconnected bilateral projects (as in the past). This AoW assembles those cross-cutting skills, services, and partnerships that support the development, validation, and delivery of solutions hosted by the other AoWs; and it also represents a mechanism for coordinated engagement with other Programs and Accelerators.

The AoW 2030 Outcome will flow from three Intermediary Outcomes (IO), focusing on changes in the way Program integration occurs between all AoWs, and how evidence-based decisions are made, and in the way CGIAR staff and partners contribute to shared data and analytical processes, and in the way partnership platforms focus AoW activities on the complex challenges that need to be resolved on the path towards sustainable farming systems (Figure 6.8.1). Through IO 8.1, interventions and locations are prioritized based upon expected returns-on-investment and where needs are greatest. A real-time MELIA system will support the assessment of progress towards the delivery of agronomic gain at scale, and the impact assessment of the integrated solutions. Through IO 8.2, integrated data management and new analytical tools generate substantial value, ensuring that data and analytical processes are standardized and FAIR, and analysis of 'big' data provides insights across AoWs. Through IO 8.3, partnership platforms engage with other AoWs and Programs to input on the design and bundling of farm level innovations, and that through this process they are ready to invest in or scale proven bundles. Bundling partners ensure that key services allow efficient scaling over time and space. Research questions (RQ) underlying the delivery of these Outcomes follow.

- How can better integrated science and delivery services create more agile and efficient Program operations?
- What mechanisms and incentives are needed for CGIAR and partner staff to engage with those services?
- How can partnership platforms be most efficiently organized around key operational units, integrating some of the above services?

The Program is well placed to address these research questions because of its staff expertise, facilities and partnership mechanisms, including cooperation with other Programs and Accelerators, and building on previous work under the Initiatives. In relation to RQ 8.1, qualitative approaches will be used to quantify the investments made in the suggested cross-cutting services to document the interactions such service units have with other Program teams and activities. In relation to RQ 8.2, survey procedures will be applied that document what drives people to spend the extra effort required to share data, analytics, and solutions towards more integrated solutions. In relation to RQ 8.3, existing partnership platforms with proven successes in delivering and scaling integrated innovations (across AoWs and with other Programs) will be evaluated, and their internal organization analyzed. Critical business units, in relation to technical support services, business development support, or resource mobilization will be identified and assembled in a playbook for effective partnership platforms. The AoW's five Clusters, which aim at integrating and building synergies across the AoWs, are:

6.8.1 Implementing a prioritization and agronomic gain MELIA system. Development of a prioritization logic, highlighting farming systems and areas where agronomic gain and/or

sustainable farming options are needed supported by a digitally enabled Program-wide MELIA strategy, focusing on assessment of agronomic gain at scale, potentially by other CGIAR Programs and external research and scaling partners.

6.8.2 Developing data and analytical infrastructure. Development of infrastructure for standardizing and 'FAIRifying' data and assembling advanced analytics across AoWs 1 to 7, including identification of incentives for sharing of data and analytical tools, thus allowing to generate benefits from Artificial Intelligence and other advanced analytical tools. This CoA will cooperate with the Digital Transformation Accelerator, and build upon the substantial progress made in the Initiatives.

6.8.3 Operationalizing novel capacity sharing models. Identification and operationalization of effective and integrated capacity sharing models for all AoWs and stakeholders engaged in the Program, including assembly of state-of-the-art and bespoke training materials, with a particular focus on national system scientists and last-mile delivery staff. This CoA will cooperate with the Capacity Sharing Accelerator.

6.8.4 Facilitating multi-stakeholder platforms for the delivery and scaling of solutions. Identification and facilitation of stakeholder platforms that assemble the necessary expertise and services to enable the demand-led design, delivery and scaling of bundled Program solutions, supported by critical business units, including the ASSAPs established through EiA facilitation, and plant health innovation hubs and innovation platforms set by the PH and MFS Initiatives. This CoA will cooperate with the Scaling Program to assess stakeholder demand, strategic locations for intervention, and alignment with partners' agendas.

6.8.5 Assembling evidence-based information for policy formulation. Summarizing and availing evidence regarding the suitability of bundled solutions and the enabling conditions for their uptake at scale in support of policy formulation, including repurposed fertilizer subsidy programs and incentives for farmers to invest in soil health and water management practices, influence NDCs/NAPs with relation to climate adaptation and mitigation, repurpose subsidies to disincentivize over-irrigation and stimulate agricultural water stewardship. This CoA will integrate AoW relevant evidence and cooperate with the Policy and Institutions Program

Three of the four high-level Outputs (HLO 8.1, 8.2, and 8.3) are related to tools, methods, and approaches to generate efficiencies across all Program AoWs, while a fourth HLO 8.4 refers to the establishment of partnership platforms and HLO 8.5 focusses on policy support enabling the delivery of integrated and bundled solutions. Most these Outputs build upon efforts initiated by the Initiatives on which the current Program is built, and some novel tools will be integrated into them in relation to AI or human-centered design (HCD) approaches, two scientific topics that require specific attention in this Program. The partnership platform will be constructed primarily on the ASSAPs, established by the EiA Initiative, and amenable to also accommodate broader soil and plant health, water management, mechanization and farming system solutions, in addition to the agronomic solutions. This AoW will foster tangible cooperation with the Digital Transformation Accelerator, the Capacity Sharing Accelerator, the Scaling for Impact Program, and the Policy Program to facilitate the delivery of HLO 8.2, HLO 8.3, HLO 8.4, and HLO 8.5, respectively. The list of high-level outputs, outcomes and partner roles are presented in Annex 6.8.1.

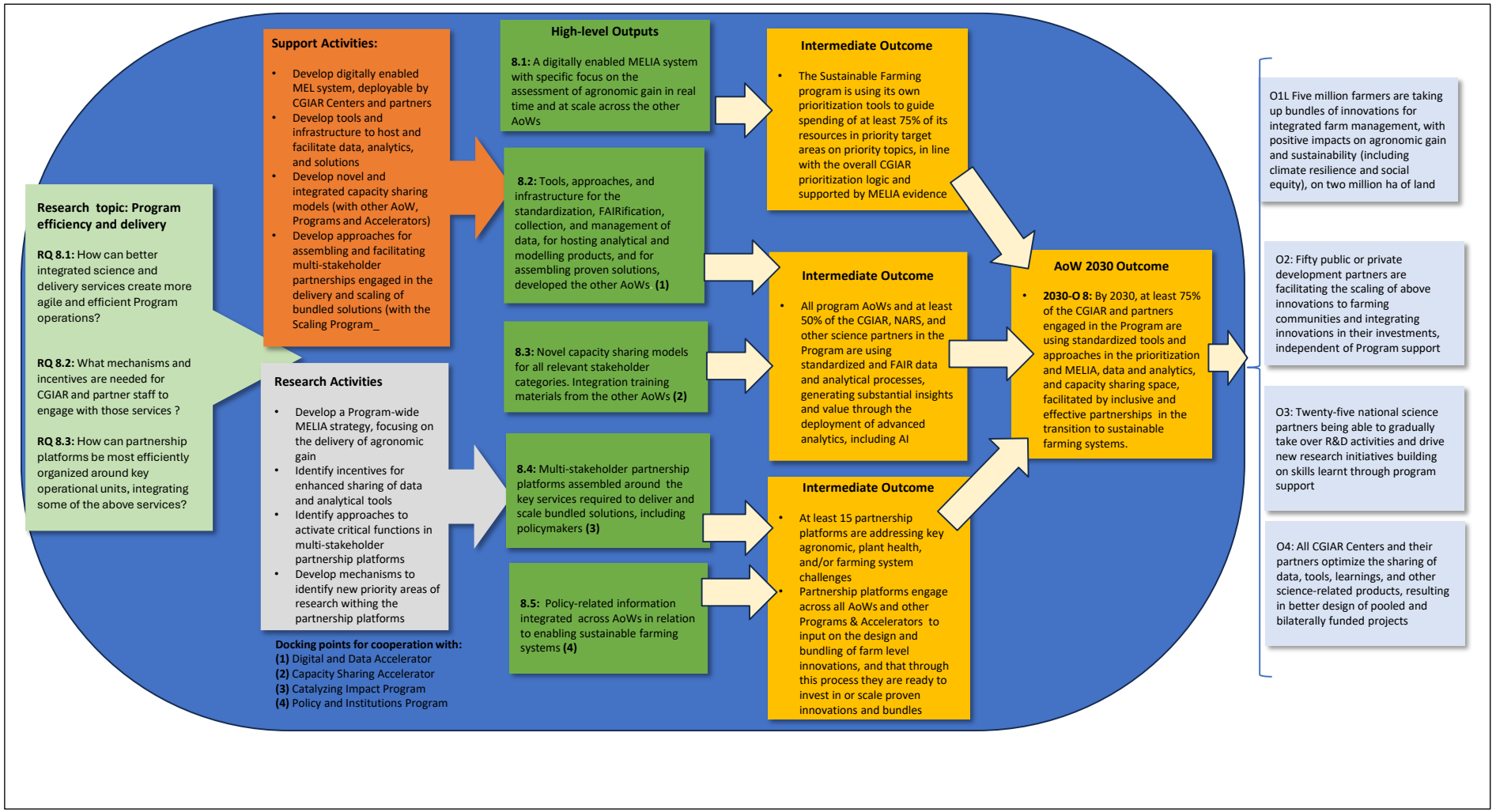

Figure 6.8.1. Contributions by Area of Work 8 (Program Efficiency and Delivery) to the Sustainable Farming Program.

7. Country integration

7.1. Example of Program country integration in Ethiopia

The Sustainable Farming Program co-design with key stakeholders and the Scaling for Impact Program to respond to local demand: There are three main avenues for stakeholder input into the program design. First, it responds to the needs articulated by Ethiopian stakeholders through CGIAR listening sessions, and through Initiative consultations including: a consultation of 288 science and delivery partners from over 18 countries (including Ethiopia) by the EiA Initiative, a diagnosis of capacity gaps in surveillance and monitoring of priority pests and diseases among national partners in 26 countries (including Ethiopia) by the PH Initiative, and six country level stakeholder consultations conducted by the MFS Initiative. Second, during Program design, stakeholders were consulted through an online event (183 attendees globally), with key stakeholders invited to review and provide input to the proposal, including 17 experts on Ethiopia representing NARES and NGOs. Third, during the Inception Phase and during program operation, a national advisory group will be assembled to guide development of the country workplan, steer the program implementation, and respond to evolving national demands and opportunities, in close collaboration with the Scaling Program. Furthermore, the EiA Initiative has significantly advanced Ethiopia's engagement in decision support efforts. By uniting various CGIAR Centers, other International Centers (IFDC, ISRIC), and national bodies such as the Ethiopian Institute of Agricultural research (EIAR), various Ethiopian regional research Centers), EiA has facilitated the development of a harmonized Decision Support Framework for site-specific fertilizer recommendations across key crops (maize, wheat, teff and sorghum). This collaborative approach, supported by major donors, such as BMGF, USAID, GIZ has streamlined data aggregation and curation, made use of advances in data analytics and modeling possible, and fostered a more efficient use of agronomic expertise and resources.

Sustainable Farming Program work embedded in national and/or regional policies, strategies, programs, priorities, and processes: Ethiopia agricultural policies have prioritized grain production, watershed management and reducing soil degradation, and food and nutritional security as key areas in response to key trends: increasing population, changing diets, land degradation, climate change. Sustainable farming practices are identified priorities in strategic documents such as The Vision 2030: Transforming Ethiopia's Food Systems, in existing policies such as Ethiopia's Agricultural Transformation Agency Strategy, as well as the regional priorities of Africa Union's Soil Initiative for Africa and Agenda 2063 continental Initiative [CAADP]). These are well aligned with the program's focus on whole-farm productivity of mixed systems, diversification, resource use efficiency, soil health, appropriate mechanization, and the development of agricultural jobs and equitable income creation. The national environmental targets of Ethiopia's Ten Year Perspective Plan of reduction of annual soil pollution, raising the rate of annual increase of soil carbon content, and enhancing the reduction of greenhouse gas emissions are core to Sustainable Farming Program. While Sustainable Farming Program is integrating AI into decision frameworks, Ethiopia has at the same time taken significant steps to define AI policies and establish institutions to drive AI development (African Union, 2024). CGIAR team in Ethiopia is highly integrated into national systems, with all CGIAR Centers represented on a single campus, and long-term engagement through delivery of major projects including TAAT, AICCRA, Community-based Breeding Program, ILSSI, Africa RISING, and GAIA, as well as previous Initiatives based on joint planning with the National Soil Information Service , EiA, Regional research institutions and Regional Bureaus of Agriculture. The Program will complement the Ethiopian Soil Information System where digital soil maps are linked to soil management practice. Through its

membership of the Rural Economic Development and Food Security Sector Working group, a platform bringing together the Government of Ethiopia, with its Agriculture Sector Development Partners, CGIAR will continue to embed this program into national programs and policies including the 10-year Perspective Plan.

C**ountry lessons from the 2022-2024 Portfolio (including regional/country partnership and engagement structures) integrated into the Sustainable Farming Program:** Key gaps identified during the EiA Initiative include the need for consideration of soil acidity, previous farm management, organic resources, seasonal weather and human centered designs (HCD) in farm intervention design. These are included within the Sustainable Farming Program. HCD integration across the Program underscore solution design informed by grassroots feedback. The approaches of the Program provide opportunities for placement of bundled farming solutions across farming systems and landscapes. In the past, both EiA and MFS Initiatives conducted collaborative efforts in Ethiopia. Tools developed by CGIAR Initiatives are readily applied across the country, and the 2022-24 Portfolio offers further opportunity for South-South learning and transfer of information.

Developing conflict-sensitive operational modalities such as having coordinators on project sites and regular security monitoring is important for supporting field operations and developing functional partnerships for successful implementation amid security concerns and recurrent travel restrictions. Having multiple sites, aligning field activities with periods of relative peace, relocating field activities to safe areas, and using remote data collection methods such as using android-based data collection tools and capacitating grassroots partners such as field exchange agents in data collection are key learning integrated in the program planning in Ethiopia.

Program work alongside specific local and other partners: The Program will build on existing trusted partnerships. A multi-stakeholder platform approach will be operationalized to set national, regional, and local priorities, identifying priority value chains and use-cases. This logic builds on the EiA and MFS Initiatives, and the Africa RISING program. Platforms will be composed of stakeholders from various sectors, including governmental, commercial, research, NGO, finance, and civil society. In collaboration with the Scaling Program, platforms will co-develop and scale technology bundles attractive to farmers, and evidence will be translated into DST available across Ethiopia through EIAR, Ministry of Agriculture, NGOs, Community Organizations, and extension networks. We will extend the ongoing partnerships within Initiatives and Bilateral projects (QFFD, CapSha, AICCRA, GAIA). Such partnerships include the Coalition of the Willing that continues to build data assets supporting development and tailoring of sustainable farming interventions.

Different components of the Program working together: All Program AoWs are relevant in Ethiopia. AoW 8 (efficiency and delivery) will be responsible for identifying needs and platforms through the establishment of a national advisory group, leading to multi-stakeholder operations within prioritized geographies and themes, where other relevant AoW will participate. Focus geographies are selected for research and development of component and integrated farm solutions. Within the highlands, soil and plant health, watershed management, precision nutrient management, and mechanization form the basis of farming system improvement. AoW 7 (system integration) will combine technologies into bundles with enabling services through partnership networks. Capacity sharing activities operate over both the short- and long-term term, building technical capacity and intellectual capital.

Program link with other Programs and Accelerators for more effective scaling and impact in Ethiopia: The Sustainable Farming Program will interact extensively with many other CGIAR Programs and Accelerators. The Programs on Breeding, Animal and Aquatic Foods, Landscapes, and Climate will supply proven options into the Sustainable Farming

delivery pipeline. The Nutrition and Climate programs will inform on underutilized crops and foods and climate hazards. Living labs for on-farm innovation testing and bundling will be co-designed, co-located, and co-invested in with the Programs on Animal and Aquatic Foods, and Landscapes. Cross-scale interactions between farming practices, landscape management practices, and landscape outcomes will be strengthened through the Landscapes Program. Building the evidence base for investment in enabling environments will be co-implemented with the Policies and Scaling Programs.

Compilation of evidence and translation into accessible information tools will be supported by the Digital Transformation Accelerator, as well as the design of large-scale prioritization tools drawing on multiple big data sources. Appraisal of innovation bundles for sustainability, climate resilience, equity implications, and scalability, will be done in collaboration with the Climate Action and Scaling for Impact Programs and the Gender Equality and Inclusion Accelerator. Mainstreaming, scaling, and south-south learning will be done in collaboration with the Scaling for Impact Program. The Gender Equality and Inclusion Accelerator and the Better Diets and Nutrition Program will also collaborate on the impact assessment of agronomic gain leading to equity and nutrition impacts. The Capacity Sharing Accelerator will assist in tracking the achievement, outcomes, and impacts or capacity gains, and assist in the design of innovative engagement models for capacity development, such as university curricula, virtual, or accredited courses for trainee or established agricultural professionals.

7.2. Overview of selected work in top countries

In Section 3, and based on a partial priority analysis, a preliminary list of countries and maps was presented to describe the geographic scope of the Sustainable Farming Program. Annex 7.2.1 provides additional information of a sub-set of countries including the farming systems and/or districts where the Program will intervene, the AoW that will participate, the intended collaboration with other CGIAR Programs and Accelerators and a preliminary list of key partners in each country.
A tiered approach is planned for country engagement, with major R&D investments in a smaller number of countries addressing specific challenges with wider relevance. From these, validated interventions and operational models can be scaled to a larger number of countries. A small number of countries with a high impact-potential, but under-developed CGIAR presence will also be selected, and additional working locations will be driven by the acquisition of W3 and bilateral funding. The exact list of countries to be prioritized will be refined during the Inception Phase when the priority setting process is completed at CGIAR level.

8. Boundaries and linkages with other components of the Portfolio

8.1. Boundaries with other components of the Portfolio

The Sustainable Farming Program focuses its activities at the field- and farm-levels toward delivering farm-level bundled solutions to a wide range of recognized agricultural constraints. This effort includes management of crops, soil, water, PDWs, mechanization, livestock, and climate response, and the integration of these options. These same elements necessarily feature in the actions of other CGIAR Programs and Accelerators. For example, other CGIAR Programs such as Landscapes focus its efforts on a higher level of agricultural systems, while the Policy and Scaling for Impact Programs focus their work at the institutional and developmental levels, but all stand to benefit from contributions from field and whole-farm solutions developed by the Sustainable Farming Program.

8.2. Linkages across the Portfolio

Because different CGIAR Programs and Accelerators will be looking at diverse components of agri-food systems, close collaboration with them is expected. The Sustainable Farming Program will cooperate with other Programs by following three different modes of engagement: (i) co-investing in terms of staff time and operational funds in areas of common interest, delivered through complementary skills and expertise; (ii) through providing joint solutions in the agronomy, soil and plant health, and farming systems arenas with other Programs; and (iii) by the adoption of common approaches, particularly in relation to the assessment of key performance indicators. This inter-Program collaboration is described briefly as follows, recognizing that more specific plans will be defined during the upcoming CGIAR Program Inception Phase.

8.2.1 Linkages with the Breeding for the Future Program. Collaboration involves providing information on cropping system and phytosanitary conditions that better inform Program breeding objectives. This leads to advanced breeding material to optimize input and management (G x E x M) recommendations for advanced and released cultivars, and basing crop management recommendations around this improved performance. Collaborative activities with the Plant Health AoW will support screening of new breeding materials for tolerance to biotic constraints. Data collected will be used to better predict improvements, at the system level following adoption of these improved varieties and guide for developing breeding product profile.

8.2.2 Linkages with the Sustainable Animal and Aquatic Foods Program. Collaboration will be on designing and evaluating innovation bundles, drawing on technologies and practices developed within Sustainable Animal and Aquatic Foods Program and bundled for different whole-farm contexts. The generated evidence will also inform the Sustainable Farming Program compendium, prioritization, and decision support tools, which the Sustainable Animal and Aquatic Foods Program can later capitalize on. This Program works on value chains, food consumption, and localized theory of change can inform Sustainable Farming Program scaling, impact, and innovation platform processes. This will be achieved through co-investment in activities within common sites, systems modeling work, and potentially staff with complementary roles in both programs.

8.2.3 Linkages to the Landscapes Program. While the scope of both Programs is different with Sustainable Farming Program seeking entry points at the field, farm and community level, and Multifunctional Landscapes operating at the landscape level, the delivery of key CGIAR Impact Areas require co-investments in solutions at landscape, community, farm, and field level. Three specific topics of common interest for collaboration, co-location and co-investment are: (i) assessment of the productivity and ecosystem service status of landscapes with varying degrees of natural ecosystems to generate data in support of the land-sharing vs land-sparing approach towards sustainable farming landscapes; (ii) integration of watershed-related investment to capture more rainfall with farm and field-level investments to increase the use efficiency of more available water; and (iii) assembling evidence-based policy documentation in support of targeting investments in sustainable intensification and/or agro-ecological approaches for specific contexts. Secondly, both programs will cooperate in the space of soil (micro)biology and soil health, with Sustainable Farming Program focusing on the relationship between specific farm- and field-level agronomic, soil and plant health, and farming system practices, including the use of effective bio-inputs and changes in soil health, and the Multifunctional Landscapes focusing on the generation of extra biomass within landscapes as means of investing in soil health and (micro)biology. Lastly, both Programs will develop a joint set of critical KPIs in relation to productivity and other community and ecosystem dimensions.

8.2.4 Linkages to the Climate Action Program. Sustainable farming systems will use climate hazard and climate-induced stress information from Climate Action Program to prioritize climate adaptation and mitigation solutions at the farm level. The Sustainable Farming Program will deliver a range of climate adaptation and mitigation solutions for various production systems, which will be evaluated for their adaptation and mitigation effectiveness in collaboration with Climate Action Program. By leveraging climate data, evaluating adaptation and mitigation solutions, and collaborating across programs, this integrated approach will enable Sustainable Farming Program to develop and implement effective, context-specific strategies to enhance the resilience of farming systems while reducing GHG emissions where possible in the face of climate change.

8.2.5 Linkages with the Policy Program. Together, these Programs will co-invest in areas of common interest: for example, with the soil-related AoW of the Program to upgrade fertilizer policies and subsidies to facilitate farmers to not only increase crop yield but also to rehabilitate soil health, and second to identify incentive schemes for farmers, extension agents, and other stakeholders to invest in soil health over time, including but not limited to soil carbon sequestration as a public service. All AoWs within the Sustainable Farming Program have a High-level Output specifically referring to the generation of evidence in support of policy formulation related to agronomic, soil and plant health, and farming system needs that will be integrated by the Efficiency and Delivery AoW for consideration by the Policies and Institutions Program and its clients.

8.2.6 Linkages to the Scaling for Impact Program. The Sustainable Farming Program will partner with the Scaling Program to assess stakeholder demands, co-design agronomic, plant health, and farming system innovations, and co-develop scaling pathways via stakeholder platforms. They will evaluate and adapt these bundles for improved scaling impact. Promising bundles will be amplified through evidence-based pathways, including integration into IFI investments, country policies, development programs, and commercial enterprises. Both programs will collaboratively set principles to validate, refine, and scale innovations through multi-stakeholder networks and hubs.

8.2.7 Linkages to Better Diets for Nutrition & Health. Common interests between Programs include reduced pesticide use and consequent residues, mycotoxin control, diversification and greater reliance upon lesser known, highly nutritious and biofortified crops. The Nutrition Program ensures that these advantages reach consumers, considering marketing and distribution structures beyond the farm gate. Joint activities connecting farmers and consumers in pursuit of healthier diets are foreseen to examine the role of market incentives, consumer demand, and food safety on the production of more nutritious foods. Other important considerations include the promotion of post-harvest practices that reduce food loss, the effects of agronomic gain on food quality, and the impact of increased farm incomes on household diet and health.

8.2.8 Linkages to the Capacity Sharing Accelerator. Among other responsibilities, this Accelerator supports countries and partners build capacities to assess, innovate and implement bundled and integrated sustainable farming solutions. Together these Programs will identify and support joint training needs at the country-level as related to Sustainable Farming, and then track resulting outcomes. The Program and Accelerator will co-design tools that advance the understanding and cause of sustainable agriculture. In addition, the Accelerator will identify novel capacity sharing models for different stakeholder categories useful to the Sustainable Farming Program. An important topic for collaboration will be about strengthening system sciences within CGIAR and partners building on the progress made by the MFS Initiative in collaboration with European universities.

8.2.9 Linkages to the Digital Transformation Accelerator. Sustainable Farming will prioritize developing digital tools and models, including FAIR databases, AI use and citizen science, to support farm-level decision making and prioritized investments. This will include tools for AoWs 1-7, and will build upon digital systems developed under EiA, PH, and MFS. For the next several years, close collaboration with the Digital Transformation Accelerator will connect the Sustainable Farming Program to the rapidly evolving global digital arena in ways compatible with the larger CGIAR infrastructure.

8.2.10 Linkages to the Gender Equality and Inclusion Accelerator. From the design of the Sustainable Farming Program, gender specialists have been included to make sure that the Program AoWs include developing gender and youth responsive solutions related to climate adaptation options, soil, water, PDW management, mechanization options and integrated farm bundles of innovations. The collaboration with the Gender Equality and Inclusion Accelerator will continue to enhance capabilities of the Program and partners towards developing and scaling equitable and inclusive solutions.

8.2.11. Linkages with Genebanks. The Sustainable Farming Program, especially the Plant Health AoW, will engage Germplasm Health Units (GHUs) of the Genebanks for (i) co-development, validation, and scale diagnostics for germplasm health monitoring; (ii) engage GHUs as hubs to anchor and facilitate subregional and crop-specific diagnostic networks; (iii) strengthen phytosanitary capacity to prevent the transboundary spread of pests and diseases; and (iv) long-term maintenance of reference isolates for diagnostics and phenotyping.

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

9.1. Monitoring, Evaluation, and Learning (MEL)

Monitoring, evaluation, and learning (MEL) activities will be housed within AoW 8 and report to program leadership. The MEL and Impact Assessment teams will be combined, standardizing study design and data collection across other AoWs. A Program MELIA expert will be appointed with other experts embedded in each AoW and key countries. A MELIA plan will be developed with key performance indicators (KPIs) for each AoW and across the program assessing sustainable agronomic gain, to maximize opportunities for adaptive management and learning. Bilateral/W3 projects will participate in and contribute to these standardized MELIA team activities through common KPIs and reporting against the program ToC. Program delivery will be evaluated against the TOC, with annual reporting of outputs and outcomes. An annual internal evaluation of management implementation and working culture will be conducted using surveys and interviews and reported to the Program Steering Committee. Monitoring data will also track the performance of innovations against the KPIs defined for agronomic gain and sustainability. These KPIs include economic profitability and feasibility, equity implications and accessibility for less advantaged groups. Monitoring tools will interface with those developed by other Programs and during the Initiatives to collect data on bundled innovations in relation to the numbers and roles of partner and scaling organizations, policy engagements, investment potential, and equitability considerations. This monitoring will primarily be performed by partners following standardized collection procedures and tools.

9.2. Impact Assessment (IA)

The Sustainable Farming Program plans a programmatic approach to Impact Assessment, going beyond evaluation of individual technologies or farming practices. This necessitates a mixed methods approach, making use of monitoring data on the use of innovations by the Program and its partners, as well as targeted impact evaluations, benchmarking studies, projections, and validations. Impact assessment studies will be questioning whether or not the Program is delivering integrated on-farm solutions that generate agronomic gain, and whether these result in anticipated impacts across the Impact Areas, and how readily these benefits are assimilated into others' agendas, enabling diffusion. In this way, the Program establishes and assesses its delivery pipeline approach toward sustainable agriculture.

Impact assessment studies will focus on three impact pathways: on-farm component and bundles of innovations, institutional capacities and behaviour change, and policy change. On-farm innovations will be assessed for agronomic gain, for sustainability, and for Impact Area contribution. At different stages of the R&D pipeline, different studies will be appropriate, including proof-of-concept efficacy and learning studies for component and integrated innovations, behavioural studies to design enabling components of bundles, adoption and efficacy studies during scale-up phase, and ex-post impact evaluations towards the end of the program for big-win innovation bundles. Policy influence will be evaluated for potential impact and reach, and most promising cases subject to rigorous evaluation. These studies will be adapted and conducted within each AoW, and some will be conducted at Program level. Focus geographies will be selected for rigorous establishment of impacts, with implications drawn for expansion and replication. Studies evaluating the causal mechanisms between increased sustainability will often be conducted in partnership with other Programs and Accelerators.

10. Capacity sharing

The Sustainable Farming Program will work closely with the Capacity Sharing Accelerator to promote understanding and acceptance of innovations that support more sustainable agricultural systems. Capacity development clients include governments, NARES, NGOs, and the private sector. While implementation will support the priority countries of the Program, outputs will be made available as global or regional public goods. The objectives of the capacity sharing activities of the Program are to (i) support countries and partners to develop capacities to assess, co-create, innovate and implement bundled and integrated sustainable farming solutions considering climate and production constraints, gender and social inclusivity and (ii) support the integration of new science perspectives, including human-centered design processes, systems science and data-driven evidence approaches as new ways of working that are mutually beneficial to partners. The main topics across the Program include capacities for agricultural soil and water management; co-design of inclusive and effective climate adaptation and mitigation bundles at the farm level; improved detection, monitoring and management of biotic threats through gender sensitive, socially inclusive technology packages; designing, developing, testing, repairing, and servicing scale-appropriate machinery; the generation, use and storage of soil health and other farming practice data that support more sustainable agriculture; and facilitated investment in proven farm technology bundles by manufacturers, distributors and small-scale farmers.

Capacity sharing in the Program builds on past and ongoing efforts and interactions initiated by EiA, PH and MFs Initiatives. The MFS Initiative has been working on a "virtual institute" to host training courses to which national universities can align and professional development courses can be based. EiA developed an e-learning hub that hosts various training materials

for self-paced learning, and its scientists have on the other hand benefited from training on social sciences by the GREAT (Gender-Responsive Researchers Equipped for Agricultural Transformation. PH developed innovations hubs and capacity building plans based on regional needs determined through consultations. Also, a partnership with The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) was developed where monthly seminars on topics around data analytics and soil health are offered.

Within the Sustainable Farming Program, the entry point of capacity sharing efforts will be demand and needs assessment of the stakeholders in target geographies, supported by the Capacity Sharing Accelerator and Scaling Program. This will be realized through development of innovative capacity sharing and training materials and activities. Building on lessons from past efforts, the Program will engage multiple partners through networks and functional stakeholder platforms for accelerated reach and adoption of solutions, co-development of higher education curricula, and delivery mechanisms and training materials on co-creation and system sciences, among other topics. Co-creation and system sciences is a new area requiring specific efforts so that educational institutions can train future and currently practicing agricultural professionals in appropriate methods.

The capacity development objectives will vary from instilling "short-term" skills or techniques that can be learned relatively quickly through short-term courses to students, topical seminars (such as adaptation of prototypes and maintenance/repairs of mechanization solution) using platforms and virtual classrooms, and longer-term engagements where "deep" capacities in critical thinking, advanced analytics and modelling are developed through secondments, internships, and training programs. The longer-term sharing of capacities entails embedding staff within Program activities to work with CGIAR and other partners through the solution development and testing process, followed by piloting and scaling. For university degree-oriented training on priority topics, the Program will designate opportunities for MSc and PhD training targeted to students from local RUFORUM universities, supported also through knowledge exchange with advanced universities, with co-supervision by Program scientists. CGIAR scientists will also work with RUFORUM universities and Technical and Vocational Education and Training Institutes to co-design upgraded training curricula.

These Capacity Sharing interventions require systematic demand assessment to identify the activities that will remain within the Sustainable Farming Program, the Centers and the Capacity Sharing Accelerator, leveraging on existing infrastructure and the need for innovative solutions. Collaborating with leading experts on resilient and sustainable farming practices, the Program will also build data assets by supporting collation and harmonization of national agronomy and soils datasets, from both new and legacy data, for driving development of agronomy solutions and policy guidance and strengthen human knowledge base, skills and capacities for the development of integrated agronomy, plant health and farming system solutions. Thus, CGIAR and its range of partners will work collaboratively to enable sharing and integration of capacities to enable partners to better participate and contribute effectively to foresight analysis and development of solutions in response to local and more site-specific challenges. In this way, the Program's capacity sharing strategy will improve skills and generate data, methods and tools for local development of better tailored sustainable farming solutions.

11. Gender and social inclusion

Agricultural institutions too often lack capacities to prioritize the design and scaling of inclusive technologies. When assessing the performance of crop and livestock innovations, gender equality and social inclusion components are often ignored due to the limited awareness and skills to conduct interdisciplinary research among researchers as well as lack of disaggregated data, tools and protocols. The Sustainable Farming Program will address gender and social

inequalities in agri-food systems by employing an inclusive and gender responsive approach throughout its AoWs.

The process of designing, deploying, and scaling agronomic, soil and plant health, and farming system solutions too often fails to incorporate the diverse perspectives and needs of women, youth, and socially excluded groups. The wide and pervasive gender gap in agricultural productivity is a major limiting factor to agricultural development (Maeda et al., 2014). Gendered (non-land) agricultural input, technology, and extension services gaps create noticeable productivity differences between women and men (Peterman et al. 2014), ranging from 8% (Slavchevska, 2015) to 28% (Oseni et al., 2015). Some studies show that the adoption of improved varieties intended to increase productivity or enhance other agronomic outcomes is gendered, with men more likely to adopt than women (e.g., Gaya et al., 2017). These constraints combine to negatively impact women's abilities to adapt to climate change (Huyer, 2016). Furthermore, there is a complete lack of understanding of age (generational) gaps in productivity (Lindsjö et al., 2020), but more broadly, the extent of youth involvement and benefits derived from sustainable agricultural intensification. In the case of youth, acceptance of innovations must consider the importance of mechanization, value addition and digital agriculture, as youth seek to disassociate with the drudgery associated with small-scale farming, are attracted to higher value and more marketable enterprises, and regard smart phones as their main access to advisory services and market intelligence.

Building on the achievements of EiA, PH and MFS Initiatives, the Sustainable Farming Program will be fully responsible for assembling interdisciplinary teams to co-design and implement gender-responsive and socially inclusive approaches to identifying bottlenecks for scaling innovations for achieving equitable impacts. The Sustainable Farming Program will collaborate with the Gender Accelerator to further generate evidence for facilitating institutional and policy change to promote gender equality and social inclusion in farming systems. The Program will engage in capacity development for conducting interdisciplinary research to identify diverse needs, constraints and impacts of sustainable farming solutions.

Towards these ends, the Program will address the following overarching research questions across its AoWs in relation to gender equality and social inclusion.

- What are gender-and social responsive innovations and innovation bundles that ensure inclusive approaches and achievements across the Sustainable Farming Program's key areas of work? This question relates to equitable and inclusive innovation development.
- What are contextually relevant approaches for the scaling of inclusive and gender-responsive Sustainable Farming innovations? This question relates to equitable and inclusive scaling of innovations.
- What are the social equity and gender-related effects within and outside the household that result when such integrated agronomic, plant health and farming system solutions get used/adopted by women, men, and youth farmers? This question relates to equitable and inclusive outcomes, impact and policy pathways.
- Which capacity development and training models most effectively increase social and biophysical science research capacities to ensure that workflows develop gender- and youth-responsive integrated agronomic, soil and plant health and farming system solutions? This question relates to the selection of capacity development approaches.

In terms of Program outputs, outcomes, and impacts related gender equity and social inclusion, the Sustainable Farming Program will generate evidence on the efficacy of co-creation methods to bundle innovations responding to farmer demands, placing emphasis upon the expressed needs and preferences of women and youth. Program activities will strengthen partner capacities and contribute to an enhanced use of co-creation and system sciences methods to develop, bundle and contextualize integrated solutions responding to the needs of women and youth. Through the Sustainable Farming Program's activities, by 2030

women, youth, and vulnerable groups will benefit from integrated agronomic, soil and plant health, and farming system innovation bundles. For the gender equity and social inclusion component to be successful, the Sustainable Farming Program needs dedicated human and financial resources that are programmed into each Key Area of Work. In addition, resources dedicated to coordinating gender equity and social inclusion activities and for enhancing synergies across the Key Areas of Work are also required.

12. Climate change

Much of the challenge before the Sustainable Farming Program is to ensure that more potent climate-resilient farming practices emerge and gain traction across the tropics. Climate change severely affects crop and livestock production, and these impacts are expected to increase into the future as the result of more frequent and intense extreme weather events, floods and prolonged droughts (FAO, 2018). Altered pest and disease pressures further exacerbate risks to farms, and increased exposure to higher temperatures reduces the capabilities and threatens the health of farm workers (Cicero et al., 2021). Climate change mainly with rising temperature and declining precipitation and other natural resources leading to desertification. Climate change also reduces the benefits from otherwise proven agricultural interventions; particularly soil conservation efforts, water-saving technologies and irrigation schemes (Lissner et al., 2024). This points toward the need for rapid adaptation of proven climate-resilient innovations by farmers and within agricultural development agendas, accompanied by anticipated mitigation co-benefits. For this reason, the Program will recommend and deliver a stream of proven climate resilient farming practices and technology bundles through AoW 1, in conjunction with the Climate Action Program.

Toward this end, the Program will develop, validate and deploy the technologies and tools that ensure integrated agronomic, plant health and integrated farming innovations that are climate responsive now and into the future. This service makes sure that the Program develops, and bundles climate responsive innovations related to soil organic carbon protection and gains, GHG containment, more responsible fertilizer management, water conservation and harvesting, and rapid response to new pest and disease outbreaks. These efforts include the use of latest data science and modeling techniques to inform the prioritization and evaluation of candidate interventions across multiple climate hazards, again performed in conjunction with the Climate Action Program. While AoW 1 specifically integrates climate adaptation and mitigation within fields and on farms, all other Program Areas of Work are tasked to incorporate climate resilience within their specialized interests, particularly through their processes of co-creation with partners and stakeholders. The tools developed in AoW 1 will help to evaluate and enhance the solutions being co-created in the other AoWs.

In this way, the Program will identify, mobilize and distribute state-of-the-art climate resilience frameworks, and screen and evaluate the effectiveness of climate adaptation by various products, practices, and technology bundles, both in terms of immediate benefits to climate-impacted farming communities, but also in terms of mitigative contributions over time. This latter element relies heavily upon the efforts of the Climate Action Program. This process of impact evaluation will be used to compare the potency of solutions with the Scaling for Impact Program to develop investment ready information and inform regional agendas. The evaluation of options will also consider other key agronomic performance indicators, such as profitability, inclusiveness, resource use efficiency, and soil health; ensuring that enhancing the adaptation and mitigation capacity of the solutions does not counteract other agronomic gains.

Planned work on determinants of adopting sustainable farming solutions for climate change adaptation and mitigation will provide new insights useful for policymakers, farmer-facing

organizations, and investors. These insights will focus on how access to and use of climate information, climate risk perception, and adaptive and mitigation capacity preferences influence the adoption of larger adaptation and mitigation strategies. Evidence synthesis will compile and deliver policy- and investment-ready information on farming system solutions under different scenarios of climate change, in conjunction with efforts by the Scaling for Impact and Policy Programs. This thrust will lead to an investment pipeline of single or integrated farming solutions, illustrating their effectiveness, mitigation co-benefits, potential limitations, and likelihood of adoption for widespread inclusion across the agricultural and environmental communities.

In support of these efforts, the Program will also implement capacity sharing activities to enhance climate awareness and promote climate resilient farming among all our public, private, and research partners. Again, this is performed in collaboration with the Climate Action and Scaling for Impact Programs and the Capacity Sharing Accelerator. Capacity sharing also builds upon the past experiences and expertise to accelerate partnerships and platforms within the Excellence in Agronomy, Plant Health and Mixed Farming Initiatives. Capacity sharing topics will include climate information services for small-scale farmers to support locally led adaptation of farming systems, evaluating and designing effective adaptive capacity of sustainable farming practices, and measuring the mitigation co-benefits of farming practices at scale. These efforts will contribute to better translation of research products into climate policies and actions as related to CGIAR's global targets by 2030.

13. Risk management

Risks will be finalized and mitigation actions will be developed as part of the risk management plan during the Inception Phase.

The Sustainable Farming Program is evolving from three Initiatives implemented between 2022 and 2024 and so does the risk management strategy.

Risk title	Risk statement including potential event, sources, and consequences on objectives
Risk 1: Uncontrolled change causing disruption	Uncontrolled changes emerging from transitioning from Initiatives to Programs can disrupt Center and partner teams' key research activities, resulting in losing progress in the Program AoWs, momentum and funding.
Risk 2: Failure to attract, and/or retain talent	Uncertainty and limited clarity of roles, responsibilities and opportunities for Center and partner staff in the Program structure can result in limited attraction and retention of key talent, weakening the Program research and scaling teams.
Risk 3: Limited inter-Program integration	Speed of change, uncertainty of financial resources and limited system approaches would result in insufficient inter-Program integration/collaboration, reducing synergies key for Sustainable Farming system integrated approaches, outputs and outcomes.
Risk 4: Limited stakeholder involvement and potential conflicts	Limited stakeholder involvement in Program planning and implementation due to speed of change, number of partners, and funding uncertainty can lead to misalignment of goals, conflicts, delays and/or non-delivery of Program outputs and outcomes.
Risk 5: Funding uncertainty limits proper planning	Funding uncertainty limits proper planning of research and scaling activities by Center and partners' teams, delaying and/or interrupting the delivery of Program outputs and outcomes.

14. Funding sources

As indicated in the 29 May version of the Portfolio Narrative, the Sustainable Farming Program will be funded through combinations of pooled and bilateral funding. Each type of funding will be governed and managed in accordance with applicable rules. The Programs management and team will drive accountability, transparency, complementarity, and synergy across all sources and types for funding.

Regarding bilateral funding, the Annex presents a table with a non-exhaustive list of projects aligned to the Sustainable Farming Program. This table includes active projects managed by the Centers participating in the Program, namely AfricaRice, Alliance (CIAT, Bioversity), CIMMYT, CIP, ICARDA, ICRISAT, ILRI, IITA, IRRI, IWMI, and the WorldVeg. The list includes a total of 143 projects, with durations between 0.5 to 9 years, from 2025 onwards. The total investment of these projects during the implementation period from 2025 onwards is USD 139M, with an average value per project of about USD 1M for the duration period. Estimations indicate that bilateral projects mapped to the Sustainable Faming Program would be bringing an annual average of USD 66M to support research activities, respond to the research questions and deliver the outputs and outcomes and respond to the demands of countries indicated in Section 3, the Program theory of change (Section 5) and AoWs (Section 6). The funders of these bilateral and W3 projects include international funding agencies, private sector and some governments from low- and middle-income countries.

Regarding pooled funding, Table 14.1 (to be added in the final version) presents the high-level breakdown per AoW considering two scenarios: (1) a baseline (combination of annual pooled funds received by EiA, MFS and PH Initiatives during 2024); and (2) a scenario considering an increase of about 10% of the budget. The Annex describes priorities for the utilization of pooled funding.

Overall, the program will seek for complementarity of pooled and bilateral funding to deliver the research results that are committed in this proposal and will adjust the annual work plans according to funding evolution. It is expected that in the future, CGIAR donors would align their funding priorities with those of the 2025-30 Portfolio, so that new bilateral or W3 projects will be designed to contribute more specifically the one or several of the Program AoW(s), and also to promote inter-Program collaboration. Since bilateral and W3 projects respond to specific demands from the call, countries, partners and/or funders, their utilization is restricted by the commitments established by the contracting Centers with limited flexibility.

The three Initiatives (EiA, PH and MFS) have been receiving an average annual pooled funding of USD 36 M since 2022. The tentative allocation of this annual funding per AoW presented in Table 14.1 (to be added in the final version) is the results of mapping the Initiative budget per Work Package (WP) to the Program AoWs. Initiative teams provided input for this budget, which was discussed by the Program writing team. The principles used for budget mapping include (i) WP budget was mapped in one or more relevant AoW(s), where key research topics initiated under EiA, PH and MFS Initiatives could continue. This allocation is based on the 80:20 principle where about 80% of work would be allocated to continue key research topics and 20% would be reallocated to new or topics that received less attention in the past. (ii) This initial budget is likely to evolve once the full prioritization and comparative analysis is completed at CGIAR and Program level, which would mean budget adjustments to be made during year one of implementation for the following years. The Annex includes a graph that explains the main connection of 2022-24 Initiatives and the Sustainable Farming Program's AoWs.

In the final version, a table will be inserted here, showing the breakdown of pooled funding by Area of Work for different budget scenarios.

Annex - Pooled funding

This section describes some principles and guidelines for using the pooled funding allocated to the Sustainable Farming Program. This Program builds on three Initiatives, namely Excellence in Agronomy (EiA), Plant Health (PH), and Mixed Farming Systems (MFS), all of those working at field, farm, and community level on complementary farming system dimensions but in some cases without having sufficient success in creating effective cooperation during Initiative implementation. Initiative teams conducted a mapping of Work Packages and activities that would deserve continuation through the Program AoWs, and also which would be de-emphasized. Figure 14.1.1 shows the main alignment of Initiatives to the Program AoWs, but some Initiatives such as MFS and PH also mapped part of their work in other relevant AoWs. The result of this analysis is presented below.

An important difference between the 2022-24 Portfolio and the 2025-30 Portfolio is that these efforts are now part of a single Program, which now aims at integrating and bundling agronomic, plant health, and farming system solutions for scalable action in response to key challenges hampering the sustainable intensification of priority farming systems. The Sustainable Farming Program aims to co-develop and scale with partners, particularly NARES, a series of socio-technical innovation bundles tailored to specific contexts. These bundles emerge from synergistic interactions, integrating the most relevant technologies, tools and services to respond to country and regional demands with pooled and bilateral/W3 funding. This approach avoids assuming that all Program or W3/bilateral project specific solutions are universally applicable or overlooking key solutions from previous interventions. Since the Sustainable Farming Program aims at integrating the work of three Initiatives and relevant W3/bilateral projects, integrative functions and research activities will receive pooled funds. These investments foster cross-AoW and Program and Accelerator integration, unlock bilateral funding opportunities, and drive large-scale impact.

The team will use pooled funding to deliver synergies and efficiencies across the Program through AoW 8 (Program efficiency and delivery), which supports common key functions that are required for all other AoWs. These functions are related to prioritization and decision-making (docking with the Scaling for Impact Program), data management and analytics (docking with the Digital Transformation Accelerator), capacity sharing (docking with the Capacity Sharing Accelerator), policy advisory services (docking with the Policy Innovations Program), and facilitating delivery and scaling partnerships (docking with the Scaling for Impact Program). These functions require long-term expertise and operations and are not only essential for the Program itself but also for associated W3/bilateral projects. Several of these functions were part of the Initiatives constituting the Sustainable Farming Program and operationalizing these across those Initiatives in a single program will create efficiencies and avail resources to invest in other activities.

There are two integrative areas of research that will receive pooled investment: AoWs 1 and 7. Within AoW 1(Climate adaptation and mitigation on farms), pooled funds will be essential for supporting the design, implementation, and scaling of farm-level practices that address climate risks. Funds will also be directed towards evaluating the adaptive and mitigative potential of climate-smart practices through data science, modelling, and the development of frontier GHG-reduction technologies. Pooled funds will support assessing return on investment, develop climate scaling pathways, and strengthen institutional capacities. The pooled funds will advance foundational research initiated by the Initiatives to deliver committed outputs.

AoW 7 (System Integration) is a pivotal research area that will use pooled funds to advance system integrative research. By developing methodological approaches that blend biophysical

and human-centered design principles, AoW 7 emphasizes gender and youth-responsive research and capacity sharing, particularly with higher-education organizations. This integrative approach aims to create stakeholder-oriented DST integrating solutions coming from other AoWs. The ultimate goal is to strengthen system approaches and foster system-oriented, sustainable farm approaches and practices through enhanced stakeholder decision-making.

Another important principle is that pooled funding will be primarily invested in supporting globally relevant AoWs and functions, and in facilitating regionally defined teams that will focus on priority challenges and topics in the region co-defined with AoWs 1,7 and 8,(see Sections 6.1, 6.7 and 6.8) research and scaling partners and through the demand signaling from the downstream Scaling for Impact Program.

Pooled funds will also be used to strengthen key research of AoWs looking into specific farm components (AoWs 2 to 6, see Sections 6.2 to 6.6). Pooled funding would perform as the "glue" to define priority research activities to be complemented by W3/bilateral projects. This will allow the prioritization of investments in expertise, skills, and assets that are required to implement a global Program effectively and efficiently at scale and in cooperation with other CGIAR Programs and Accelerators and partners which is essential for facilitating this vision. We foresee the pooled funding to be targeted towards AoWs 2 through 6.

AoW 2 (Precision Nutrient Management, see Section 6.2) is evolving from work within EiA and continues activities by multi-Center teams and external partnerships. With high relevance to the Nairobi declaration on Africa Fertilizer and Soil Health, continued investments through CGIAR pooled funding have a high likelihood of catalyzing further W3/bilateral and national investments. Continued investment will ensure (i) the momentum to improve precision nutrient management tools is sustained, e.g. through support of AgWise, by integrating key aspects such as farmer inputs and acidity management, and expansion to new countries, (ii) integration of knowledge from other AoWs such as climate adaptation is supported, (iii) partnerships created and engaged in the co-design and development of precision nutrient management solutions as part of the 2022-24 Portfolio are maintained, (iv) strengthened partnership and collaborations to grow funding for precision nutrient management at regional and national levels, and (v) new opportunities for utilizing AI, e.g. to enhance modeling integrated into decision tools to provide more-tailored recommendations.

Regarding AoW 3 (Resilient Soils), pooled funding will contribute to developing a soil health KPI framework that enables soil health monitoring to inform decision making at the farm, regional and national levels. This will be continuously updated with inclusion of biological indicators, carbon sequestration potential etc. as progress is made. The KPI framework will be a key contribution to guiding investments and efforts to improve the health and resilience of Africa's soil through the African Union 10-year Fertilizer and Soil Health plan, and to share lessons with other regions. Pooled funding will be used to establish a network of long-term monitoring sites across diverse agroecological typologies to fill knowledge gaps linking agronomic practices to potential changes in soil health over time. These data will be leveraged to co-design and scale soil health management solutions at scale. These activities will also be a critical entry point for stakeholder participation, including cross-sectoral engagement at the policy level.

The pooled funding investment in AoW 4 (Plant Health and Mycotoxin Safe Crops) will focus on addressing significant and emerging plant health threats that have documented national, regional, or global impact. This will involve supporting coordinated phytosanitary approaches and disease management networks. Specifically, the investment will include monitoring for changes in pathogen virulence, with a significant emphasis on utilizing AI and citizen science

tools for surveillance and inform decision making. The investment will also involve developing modeling, risk prediction, and DST for establishing context-appropriate Integrated Pest, Disease and Weed Management (IPDWM) strategies. Furthermore, investments will continue in gender-responsive research, generating evidence for policy design and advocacy, and scaling inclusive IPDWM for priority constraints, as well as promoting private and public sector involvement in regions affected by mycotoxin contamination to expand the previously developed Integrated Mycotoxin Management (IMM) packages. Additionally, funds will be allocated for facilitating rapid responses to PDW emergencies.

Within AoW 5 (Integrated Water Management), pooled funds will be used strategically to attract larger investments in R&D to develop and deliver solutions at scale. We will use the pooled funding to develop data driven tools and techniques needed to prioritize and evaluate water management solutions and their contributions to agronomic gains I). In co-developing scalable and socially inclusive integrated water management solutions we will use the funding to develop integrated water management solution according to contexts using the G x E x M approach, circular economy principles and alternative water resources and ensure these are socially and culturally acceptable. For Water-resilient farming systems at scale, we will use the pooled funding to co-finance collaboration with the Scaling for Impact and Capacity Sharing Programs that would focus on providing technical assistance to public and private sector partners to attract larger investments using Sustainable Farming's knowledge products.

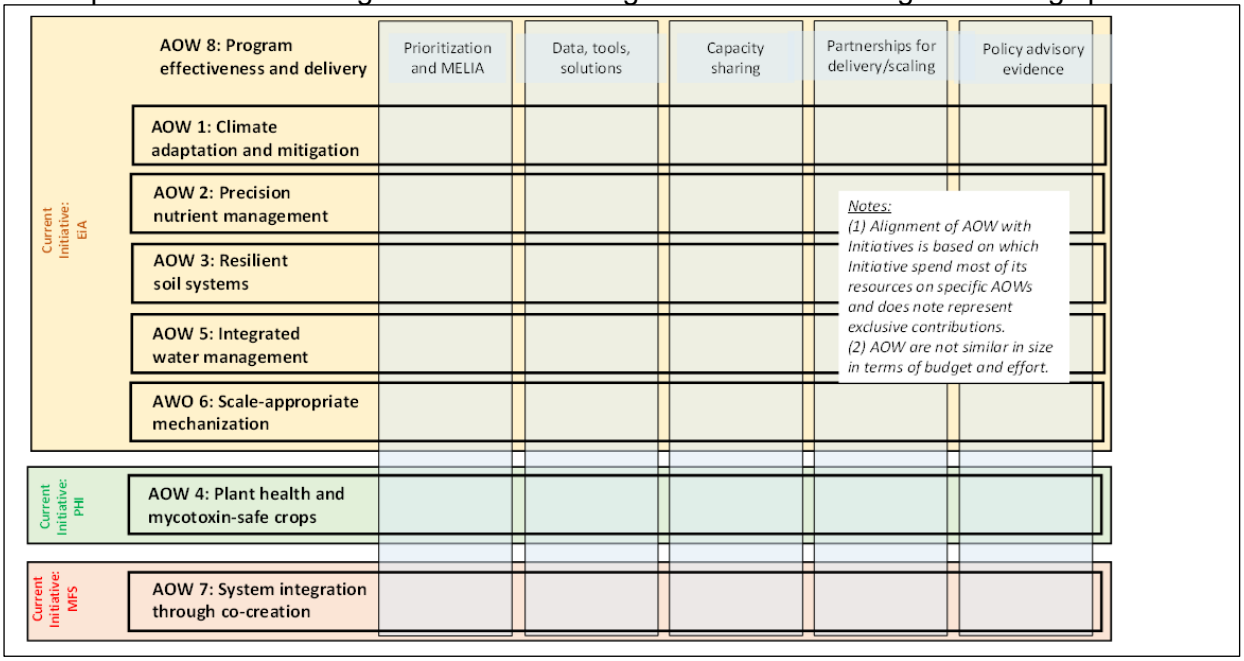

Figure 14.1.1. Main alignment of Initiatives to the Sustainable Farming AoWs. **Note**: this figure represents the main alignment of Initiatives, but PH and MFS have also mapped work in other relevant AoW. Similarly, EiA has mapped some work in AoW 7.

Within AoW 6 (Scale-appropriate Mechanization - SAM), pooled funds will be used to co-develop socially inclusive options that improve labour productivity, reduce drudgery, and enhance resource efficiency, building on current Initiatives' efforts. Resources will also support validating sustainable business models for SAM service provision, fostering entrepreneurship among local fabricators and service providers. A portion of the funds will be allocated to developing and disseminating training materials for value chain actors involved in designing, developing, repairing, and providing mechanization services. Additionally, funding will support research to generate evidence on factors influencing SAM adoption and intra-household labour dynamics for informing policies on mechanization. New strands of work in this AoW

include assessing unmanned vehicles for various farm operations and precision agriculture including seeding and the application of fertilizers and crop protection materials.

Regarding discontinuation of previously pooled-funded activities, this varies between Initiatives. As for EiA, this includes: (i) Activities that have delivery final products that are ready to be transferred to other partners as 'turnkey solutions' are being hosted on the MyEiA platform (https://my.eia.cgiar.org/login); (ii) use Cases that have delivered final decision support or other agronomic tools will receive reduced levels of investment, mainly to retain secondary support services to these scaling partnerships; and (iii) strategic R&D projects that have delivered final outputs or that have not been effective in doing so will be discontinued, including FTEs that have been covered, and partnerships with advanced research institutes be revised.

PH Initiative previous activities that will de-emphasized include those where sufficient progress already such as the completed diagnosis of key knowledge and capacity gaps, the baseline reporting on available databases and tools, the report on integration and management of data, identification of biosecurity risk to seed delivery pathways and strategies for mycotoxin sampling and testing. Sufficient progress has been made for identifying target sites for IPDWM options, improved aflatoxin bioprotectants & and associated regulations, and DST for deploying more equitable IPDM innovations.

As for MFS, activities to be discontinued are those that have been successfully completed, mainly related to stakeholder engagement, baseline and descriptive studies about the main types of mixed farming systems and their status, challenges and opportunities for sustainable intensification. The available results from these activities will support the Program activities of the Systems Integration AoW 7 but also other AoWs allowing better understanding of opportunities, challenges and trade-offs associated with bundled innovations and improve targeting and scaling. Other activities being de-emphasized from MFS Initiative are those related to purely agronomic management technologies such as crop/variety testing, crop management options and mechanization, that will be carefully embedded into other AoWs and sites.

On the other hand, freed-up pooled funding will be invested in (i) Areas of Work that have received relatively less effort in the 2024-24 Portfolio, including climate adaptation and mitigations on farms, long-term experiments, whole-farm system integration, and scale-appropriate mechanization; (ii) Broadened delivery and scaling partnerships beyond single partner Use Cases to facilitate accelerated scaling through the ASSAPs integrating the PH and MFS platforms; (iii) Global and regional functions that are required for an agile and effective farming system agronomy research and innovation program; (iv) Strategic R&D to retain a viable solution pipeline in response to challenges that matter for prioritized farming systems; (v) emerging areas of work that could receive seed money to develop sound proposals for multi-Center and large bilateral projects; and (vi) collaborative, co-financed activities with other Programs and Accelerators. The latter would mean to identify two or three key collaborative activities to be co-financed and co-implemented in common locations/countries aiming at a more integrated CGIAR response to country demands.

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