CGIAR

INITIATIVE ON
Excellence in
Agronomy

CGIAR Initiative on Excellence in Agronomy

ANNUAL TECHNICAL REPORT 2022

CGIAR Technical Reporting 2022

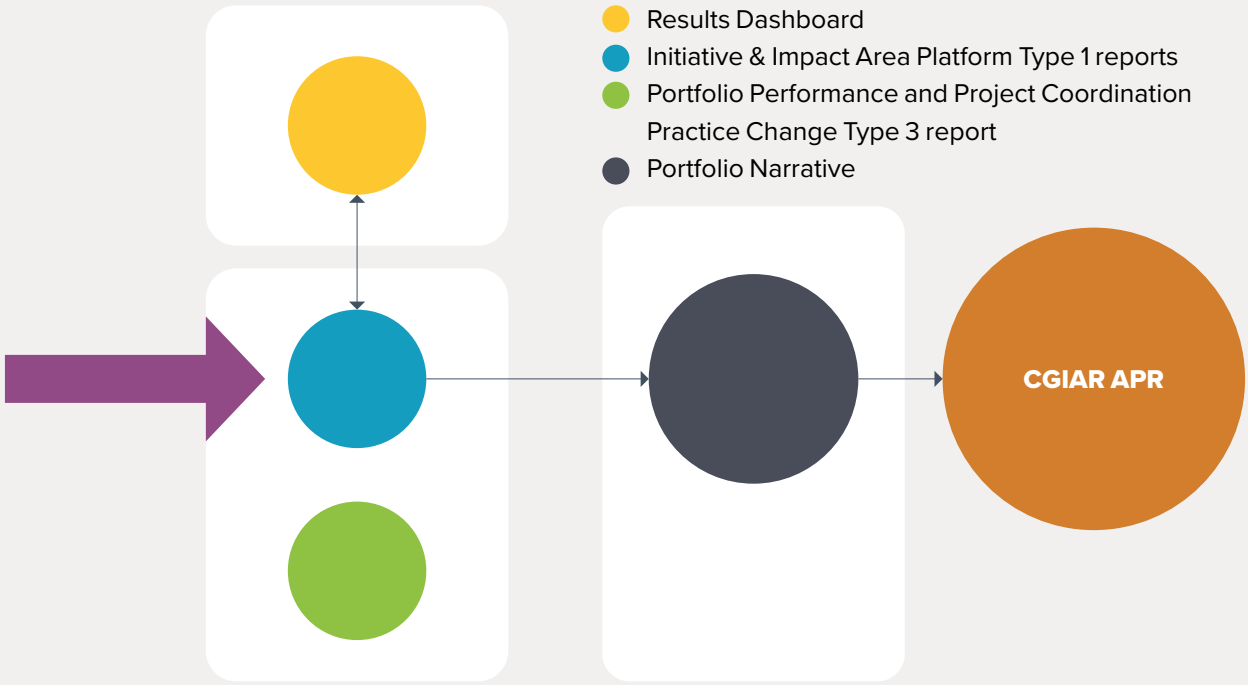
CGIAR technical Reporting has been developed in alignment with the CGIAR Technical Reporting Arrangement.

This Initiative report is a Type 1 report and constitutes part of the broader CGIAR Technical Report. Each CGIAR Initiative submits an annual Type 1 report, which provides assurance on Initiative-level progress towards end-of-Initiative outcomes.

The CGIAR Technical Report comprises:

- Type 1 Initiative and Impact Area Platform reports, with quality assured results reported by Initiatives and Platforms available on the CGIAR Results Dashboard.
- The Type 3 Portfolio Performance and Project Coordination Practice Change report, which focuses on internal practice change.
- The Portfolio Narrative, which draws on the Type 1 and Type 3 reports, and the CGIAR Results Dashboard, to provide a broader view on portfolio coherence, including results, partnerships, country and regional engagement, and synergies among the portfolio's constituent parts.

The CGIAR Technical Report constitutes a key component of the CGIAR Annual Performance Report (APR).



US$	2022	2023	2024
Proposal Budget for the first business cycle	$17,000,000	$26,882,000	$31,118,000
Budget approved for 2022	$15,450,656		

Section 1 Fact sheet

Initiative name	Excellence in Agronomy for Sustainable Intensification and Climate Change Adaptation
Initiative short name	Excellence in Agronomy (EiA)
Action Area	Resilient Agrifood Systems
Geographic scope	**Regions targeted in the proposal:** Central and West Asia and North Africa; East and Southern Africa; Latin America and the Caribbean; South Asia; Southeast Asia and the Pacific; West and Central Africa **Countries targeted in the proposal:** Bangladesh; Cambodia; Cameroon; Colombia; Côte d'Ivoire; Egypt; Ethiopia; Ghana; India; Indonesia; Kenya; Malawi; Mali; Mexico; Morocco; Mozambique; Nepal; Nigeria; Peru; Philippines; Rwanda; Senegal; Tanzania, United Republic; The Democratic Republic of the Congo; The Socialist Republic of Viet Nam; The United Arab Emirates; Uganda
Start date	Jan. 1, 2022
End date	Dec. 31, 2024
Initiative Lead	Bernard Vanlauwe – b.vanlauwe@cgiar.org
Initiative Deputy	2022: Madonna Casimero; 2023: Job Kihara
Measurable three-year End of Initiative outcomes (EOI-Os)	**EOI-O 1: Gender and youth-responsive solutions piloted** By 2024, at least 20 public and private scaling/demand partners pilot gender- and youth-responsive agronomic solutions, targeting at least one million farmers through extension, social, and/or information technology networks, and use common Monitoring Evaluation & Learning (ME&L) approaches to report on how these solutions perform against the agronomic gain KPIs.
	EOI-O 2: Use and sharing common, open and FAIR data, tools, and analytics By 2024, at least 75% of research and scaling partners use and share common, open, and FAIR data, tools, and analytics to support the co-creation of locally relevant agronomic solutions, integrating climate-smart, inclusivity, and sustainability dimensions, and assessing their performance using standardized protocols.
	EOI-O 3: Cooperate with EiA to fill key knowledge gaps By 2024, scientists from at least five non-CGIAR ARIs with complementary expertise in relevant research areas, and scientists from at least ten NARS partners cooperate with EiA to fill key knowledge gaps for delivering agronomic solutions at scale through at least ten strategic R&D projects.
	EOI-O 4: Collective decision By 2024, decisions made on key aspects of an expanding agronomy-at-scale research portfolio of EiA (e.g., stage-gating decisions in relation to Use Cases) are taken collectively by CGIAR agronomists and scaling partners based on common learning and objectively obtained information on, amongst others, prioritization and progress with the delivery of agronomic gain.

OECD DAC Climate marker adaptation score*	**Score 2: Principal:** The activity is principally about meeting any of the three CGIAR climate-related strategy objectives — namely, climate mitigation, climate adaptation, and climate policy, and would not have been undertaken without this objective.
OECD DAC Climate marker mitigation score*	**Score 1: Significant:** The activity contributes in a significant way to any of the three CGIAR climate-related strategy objectives — namely, climate mitigation, climate adaptation, and climate policy, even though it is not the principal focus of the activity.
OECD DAC Gender equity marker score*	**Score 1A: Gender accommodative/aware:** Gender equality is an objective, but not the main one. The Initiative/project includes at least two explicit gender-specific outputs, and (adequate) funding and resources are available. Data and indicators are disaggregated by gender and analyzed to explain potential gender variations and inequalities.
Website link	https://www.cgiar.org/initiative/11-excellence-in-agronomy-eia-solutions-for-agricultural-transformation/

*The Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC) markers refer to the OECD DAC Rio Markers for Climate and the gender equality policy marker. For climate adaptation and mitigation, scores are: 0 = Not targeted; 1 = Significant; and 2 = Principal.
The CGIAR GENDER Impact Platform has adapted the OECD gender marker, splitting the 1 score into 1A and 1B. For gender equality, scores are: 0 = Not targeted; 1A = Gender accommodative/aware; 1B = Gender responsive; and 2 = Principal
These scores are derived from Initiative proposals, and refer to the score given to the Initiative overall based on their proposal.

A farmer transplanting rice in her farm, in Bihar, India. Photo credit: IRRI

Section 2 Initiative progress on science and towards End of Initiative outcomes

Visit by the Alliance under the AICCRA project to monitor the setups with the Demo Plots for Curriculum Development. September, 2022
Photo credit: ©2023 Alliance of Bioversity International and CIAT/Owen Kimani

Overall summary of progress against the theory of change

The CGIAR Research Initiative on Excellence in Agronomy (EiA) aims to utilize the latest advancements in data science, geospatial analytics, remote sensing, and behavioral sciences to develop gender- and youth-responsive agronomic solutions that are widely applicable and locally relevant. EiA also emphasizes the importance of co-creation with demand partners, the scientific community, and other service providers in the development of these solutions at scale.

In 2022, EiA achieved a number of results cutting across its research and delivery objectives and contributing to seven[1] Sustainable

1 Goal 1: End poverty in all its forms everywhere.
Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
Goal 6: Ensure availability and sustainable management of water and sanitation for all.
Goal 10: Reduce inequality within and among countries.
Goal 13: Take urgent action to combat climate change and its impacts.
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
Goal 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

Felicia Sambuo, a member of womens group evaluating a technology on a demonstration site in upper West Region of Ghana. Photo credit: P. Mponela/Alliance of Bioversity International and CIAT

Development Goals (SDGs) as per the overall Initiative theory of change. These results include development of agronomic solutions, use of modern data science approaches, advancing the research pipeline, and improving efficiencies in operations and framework for measuring agronomic gains. The Initiative created outcomes across policy change, innovation use, and capacity change.

Two agronomic solutions in Ethiopia (NextGen Agroclimate_validation and Fertilizer Use at landscape scale) were piloted by 15,400 farmers (32% female) resulting in 42% uptake of the location-specific fertilizer recommendation among 11,200 smallholder farmers (https://cgspace.cgiar.org/handle/10568/126394). The NextGen agro-climate recommendation has been validated and increases wheat grain yield by up to 25%. The landscape-specific fertilizer recommendation has also been validated and increases teff and wheat grain yields by 1 ton/ha and 2.5 ton/ha respectively. With regards to policy change, the Innovation on Mechanized conservation agriculture was incorporated into the support mechanism for farmers in Morocco (Conservation Agriculture_FarmerFeedback), and has also informed country strategy (Generation Green 2030) where up to 1 million ha of cereals will be cultivated under Conservation Agriculture by 2030 (https://mel.cgiar.org/reporting/download/report_file_id/36457). This is also influencing the private sector to complement government efforts towards financial inclusion of farmers in acquiring direct seeders (https://www.fellah-trade.com/fr/actualites-maroc/article/17391,le-semis-direct-pour-une-agriculture-de-conservation).

In addition, the capacity of CGIAR and of partners from the National Agricultural Research and Extension Systems (NARES) was enhanced and used improved high-performance computation to advance data science in low bandwidth environments. Various workshops involving 140 (33% female) participants were organized using the Collaborative GARDIAN (CG) Labs across six CGIAR Centers (CIP, IITA, ILRI, the Alliance of Bioversity International and CIAT, CIMMYT, and IWMI) and NARES partners including Institut d'Economie Rurale (Mali) (IER) in Mali, Savanah Agriculture Research Institute (SARI) in Ghana, National Root Crop Research Institute (NRCRI), and Institute of Agricultural Research (IAR) in Nigeria. Private- and public-sector partners, through capacity-building support facilitated by EiA, integrated agronomic recommendations, data-gathering tools, and location-specific fertilizer recommendation in Cambodia, Ghana, and Ethiopia respectively. Some examples include Agri-Smart and Brooklyn Bridge to Cambodia (BB2C) (direct rice seeder producers) modified seeders based on agronomic recommendations and incorporated same e.g., plant spacing into their farmer refresher trainings, reaching 650 (30% female) smallholder farmers in Cambodia. The Ethiopia Agriculture Office at the district level has reached a total of 7,700 (10% female) wheat growers with the location-specific recommendation. The data-gathering tools — Agronomy Insurance Nexus Tool, Gender Exemplar Participatory Tool, and Inclusive Survey Instrument — were incorporated by Ghana Agriculture Insurance Pool (GAIP) to improve the development, delivery, and verification of bundled insurance packages for smallholder farmers.

A number of outputs were generated across the four Work Packages resulting in the outcomes above, with innovations in various stages of scaling

readiness. Capacity-development leading to over 9,879 short-term people trained, of which 33% were female, was emphasized, and publications added to the body of knowledge via pee- reviewed papers, journals, reports, briefs, and manuals.

In developing agronomic solutions through Use Cases,[2] a co-creation process (https://cgspace.cgiar.org/handle/10568/127175) has been established to identify scaling partners within specific farming systems and countries, and their agronomy knowledge and research product gaps. Eighteen agronomic solutions, including a NextGen agro-climate advisory in Ethiopia, planting date advisory in India, and conservation agriculture in Morocco, amongst others, are being developed as innovations across 18[3] countries currently, in the six CGIAR regions, to address the agronomy gaps (All use case tracker). This process also incorporates user preferences in terms of packaging of the agronomic content in formats like chatbots, interactive voice response (IVR), and unstructured supplementary service data (USSD) to support various scaling approaches either led by extension agents or directly working with farmers. Current solutions are packaged in different formats for ease of content access and use (Egypt_MVP Demo; e-agrology Demo).

EiA recognizes the importance of modern data science, analytics approaches, and infrastructure to drive the development of agronomic solutions and more. These solutions rely on actionable, open, and FAIR (findable, accessible, interoperable, and reusable) data, which necessitates agreements on data assembly, tools, standardization, and their governance. A key EiA result in 2022 was moving towards creating minimum data requirements for data collection, and coalescing agreement on these. The minimum dataset created includes variables that are tied to standards and protocols (where relevant) and is organized by four key stages in agronomy-at-scale research: on-station trials, field validation trials for agronomic solutions, solution piloting, and solution scaling. These sets of minimum data are being added to DataScribe v.1.0 as common global blocks for survey standardization and to inform decisions about the performance of agronomic solutions at various stages. To ensure born-FAIR data is collected, historical data is effectively utilized and, to facilitate data-driven decisions, the Initiative has developed and employed tools such as DataScribe, AgroFIMS, and FAIRscribe for survey development and data assembly. A modular decision-support framework (AgWise), consisting of sequential crop-modeling and machine learning, has been developed. This framework makes use of public data on weather and soils, and a variety of agronomic trial data to generate agronomic recommendations that can increase yields and profit for farmers. This framework is currently being used to support EiA Use Cases but is also generalizable to any use case and agronomy recommendation needs of external partners (e.g., NARES and other partners) (https://github.com/AgWISE-EiA). The Initiative established three support groups on data management, analytics and modeling, and field-validation of recommendations/solutions to activate technical capabilities across Work Packages. The groups have supported 10 agronomic solutions in achieving minimum viable product (MVPs[4]) stage related to fertilizer, planting date, and variety recommendations.

To address key knowledge gaps and facilitate innovation in agronomy research, a set of six internal strategic research and development (R&D) projects have started, focusing on: climate change, soil health, agronomic fortification, mechanization, yield at scale, and behavioral change. A number of knowledge products (journal papers, reports, and others) were developed, referring to agronomic biofortification of zinc in rice, predicting soil fertility properties, the experimentation of mechanized

2 See Glossary for definition.
3 Cambodia; Cameroon; Colombia; Côte d'Ivoire; Egypt; Ethiopia; Ghana; India; Malawi; Mexico; Morocco; Mozambique; Nigeria; Peru; Rwanda; The Democratic Republic of the Congo; The Socialist Republic of Viet Nam; Zambia.
4 See Glossary for detailed definition.

weeders in Mexico and Madagascar, climate-smart advisories, decision-support for irrigation timing in potatoes, and climate change adaptation in lowland rice. The Climate Prioritization Tool (CAPTain) aims at identifying climate adaptation solutions and practices based on prevailing climate hazards through participatory consultation with stakeholders. This tool has been developed to address climate-adaptation related challenges within the Use Cases and was piloted in South Asia.

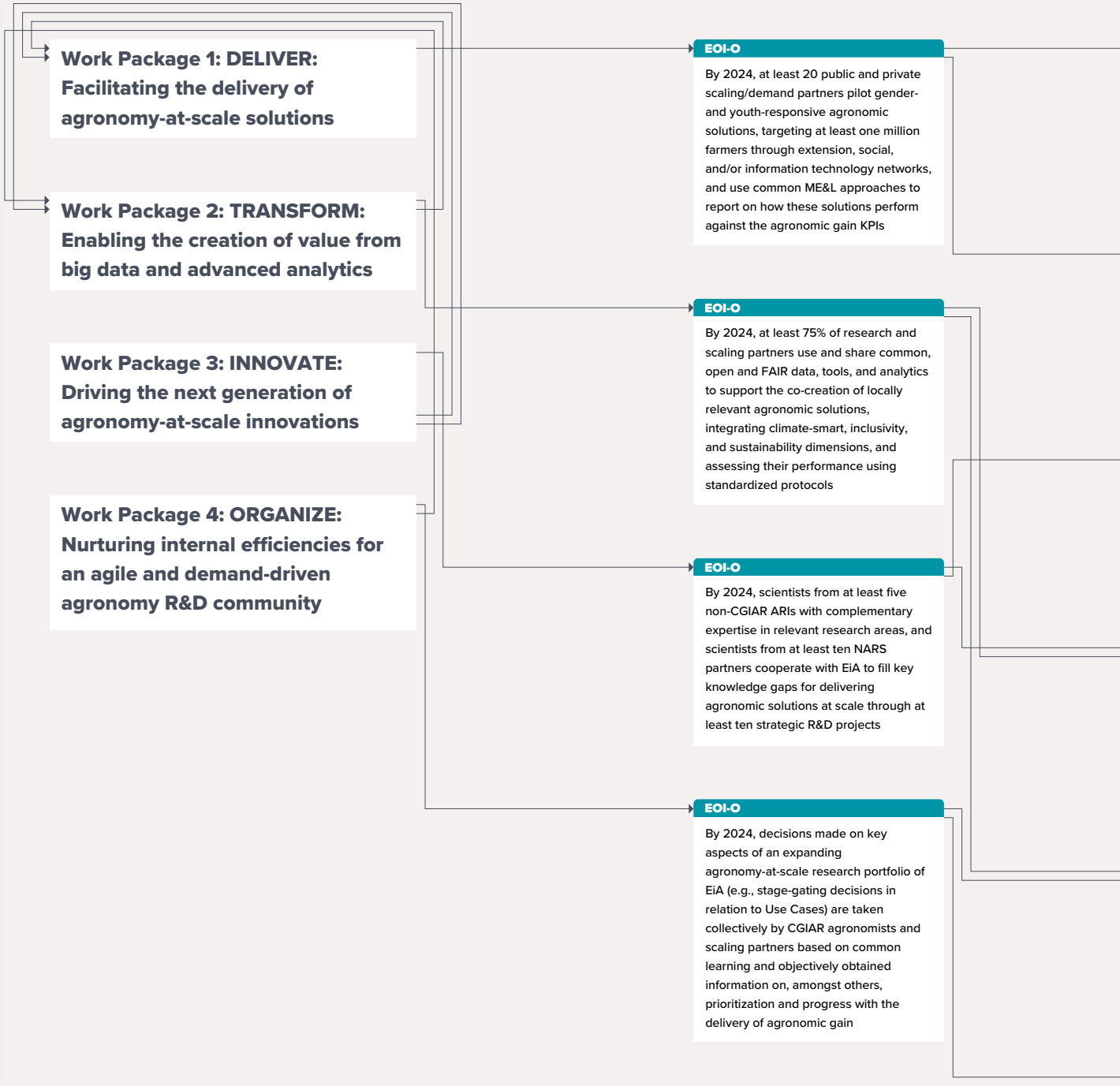
For improved targeting, an integrated survey tool that will generate data across all Use Cases on current farmer practices, climate, farmer segmentation, gender and youth, and yield gap decomposition has been developed using DataScribe for standardization and compliance. Various Standard Operating Procedures (SOPs) to support implementation of the integrated survey tools have also been developed to be applied in 2023. To set priorities, map appropriate demands, and assess agronomic gains of advisories, progress was made towards the development and implementation of guidelines for assessing agronomic gain across geographies, farming systems, and R&D stages (Guidelines_Agronomic gain assessment). The current key performance indicators for assessing the gains cover land productivity and its stability, resource use efficiency, and soil health. In addition, a meta-analysis was performed to quantify genetic gain — yield increase through use of new variety and calculated by yield difference between new variety and variety popularly grown in the target site — and agronomic gain in sub-Saharan Africa across 12 countries, using 208 paired observations from 40 studies (https://cgspace.cgiar.org/handle/10568/125682).

After designing, validating, and piloting agronomic solutions, it has become evident that the demand-driven approach used by EiA effectively targets critical agronomic gaps of scaling partners and end-users. However, lessons learned from this approach, which focuses on a single demand partner, may restrict the scaling of agronomic solutions, thereby limiting its benefits to a broader audience. Consequently, the Initiative recommends the implementation of an agronomy scaling and acceleration platforms approach, where a single use case can serve multiple scaling partners within key geographies and/or cropping systems.

In addition, it has become evident that capacity-building is required on computer literacy and data management before a greater percentage of research and scaling partners can use and share open and FAIR data, tools, and analytics.

Initiative-level theory of change diagram

This is a simple, linear, and static representation of a complex, non-linear, and dynamic reality. Feedback loops and connections between this Initiative and other Initiatives' theories of change are excluded for clarity.



EOI — End of Initiative outcome

AA — Action Area

IA — Impact Area

SDG — Sustainable Development Goal

- Nutrition, Health, and Food Security
- Poverty Reduction, Livelihoods, and Jobs
- Gender Equality, Youth, and Social Inclusion
- Climate Adaptation and Mitigation
- Environmental Health and Biodiversity

Teams from CGIAR's three Action Areas — System Transformation, Resilient Agrifood Systems and Genetic Innovation — worked to develop an improved set of Action Area outcomes in October 2022. Since this was near the end of the reporting cycle for 2022, it was decided not to update the theories of change based on these new Action Area outcomes.
The exception to this is Genetic Innovation — for this Action Area, as the new outcomes had already been widely discussed among the relevant Initiatives, and with its advisory group of funders and other stakeholders, the decision was made to update their outcomes in time for the 2022 reporting cycle.

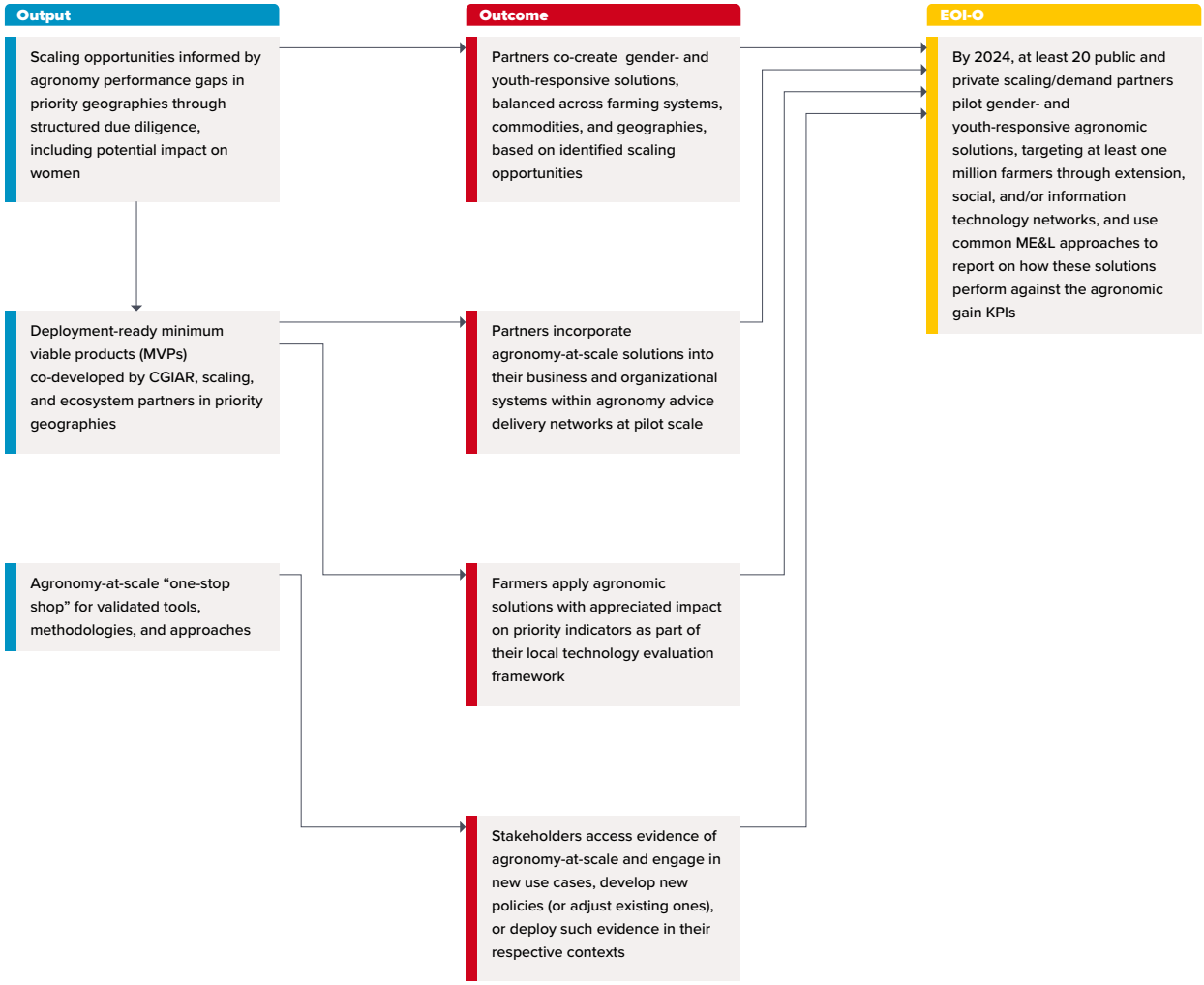
Progress by End of Initiative outcome

EOI-O 1	A portfolio of 18 active Use Cases has provided a global network of partners from across both private and public sectors, co-creating agronomy solutions with CGIAR scientists. Through interventions from specialized groups on gender and youth inclusion, this portfolio has been able to begin the process of incorporating gender-transformative approaches. Given the locations and value chains where the Use Cases are active, as these solutions move to piloting and a scaling, the potential for reaching one million farmers, demonstrating tangible agronomic gain, remains within reach.
EOI-O 2	Through tool development and improvement backed by training and demonstrations of the value proposition, at least three research and/or scaling partners began working with EiA's FAIR data-collection tools to enable the development of a pool of standardized data that can support locally relevant agronomic solutions (through alignment with other EiA activities around decision support).
EOI-O 3	The first set of six R&D internal projects is operational with the first knowledge gaps already addressed and the seven communities of practice that will be important to build the R&D pipeline active. Therefore, progress in 2022 has ensured that INNOVATE is on track to achieve the EOI outcome.
EOI-O 4	In 2022, the ORGANIZE Work Package has laid down the foundation for expanding the agronomy-at-scale research portfolio through: i) the development of tools and approaches to support the creation of well-grounded agronomy solutions and prioritization based on ex-ante analytics at different scales; ii) the formulation of agronomic gain assessment framework, guidelines, and SOPs for agronomic gain key performance indicator measurement (e.g., yield of various crops at plot and field level); and iii) development of sound monitoring, evaluation, learning and impact assessment framework, strategies, and data collection tools.

Farmers evaluate response of rice agronomic recommendation, Nigeria. Photo credit: S. Sallau/IITA

Section 3 Work Package-specific progress

Work Package 1:
DELIVER: Facilitating the delivery of agronomy-at-scale solutions

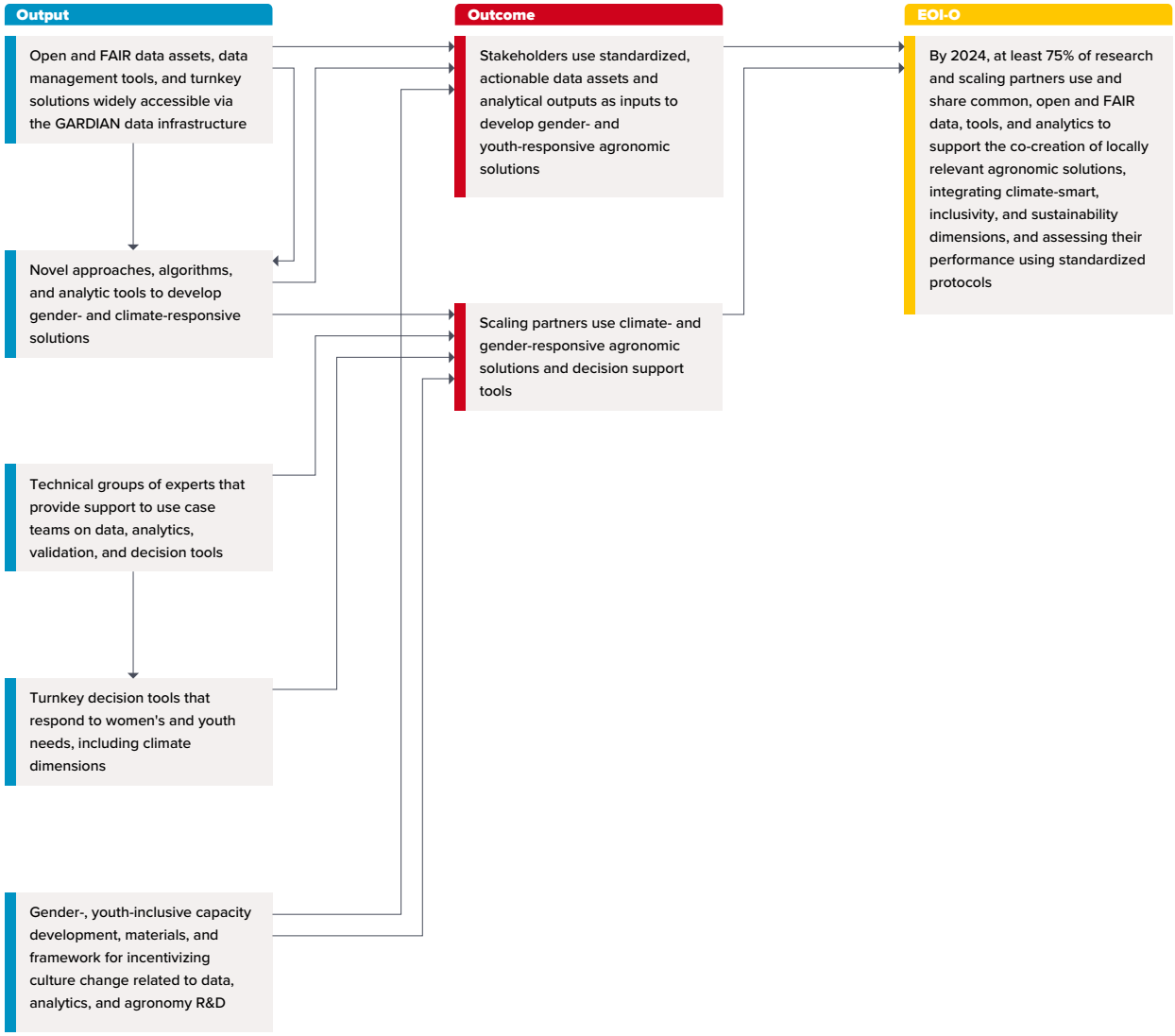


Work Package 1 progress against the theory of change

Delivering on the agenda of demand-driven agronomy solutions at scale (EOI outcome) has required that we implement a credible process for developing a pipeline of potential Use Cases (output 1.1/cluster of activities [CoA] 1.1) through a comprehensive co-creation process. Through this process, a new cohort of Use Cases was enrolled onto the Initiative, with a set of partners from the private and public sector, and CGIAR and non-governmental organizations (NGO) partners.

Several learnings have been generated in each of the Use Cases (output 1.2/CoA 1.2) about partnership formation, dealing with issues of co-investment in innovation development, data sharing, ensuring user-centered design of MVPs, and anticipating how scaling ecosystems around the MVP are likely to evolve. As a result, a new CoA (CoA 1.4) has been initiated to focus on the creation of agronomy scaling and acceleration platforms, at a regional level, focused on locally relevant farming systems across all the six global regions of the Initiative. Furthermore, the scaling readiness support function has also been expanded to a broader scaling support function (CoA 1.5), to support use case teams to incorporate best practices on building scaling-ready MVPs within the Use Cases. The one-stop-shop for agronomy solutions (OSSAS) platform (output 1.3/CoA 1.3), which hosts both internally (Initiative) facing portals and externally facing content and services, has been inaugurated and continues to be improved as new components are added. Currently, this platform hosts the use case enrolment portal, the events portal, and a demo version of an online learning platform and the impact platform. These Use Cases have assembled several innovations such as: (i) EiA-Use-Case-Morocco, and (ii) AKILIMO Potato Rwanda_SNS. (ii) (Tailored Fertilizer_Potato) and (iii) (Stepwiseinvestment approach_Cocoa). Existing Use Cases from the EiA incubation phase, including (i) Planting Date_Advisories and (ii) NextGen Agroclimate tool, are also advancing through their final stages of development (piloting and scaling).

Work Package 2:
TRANSFORM: Enabling the creation of value from big data and advanced analytics

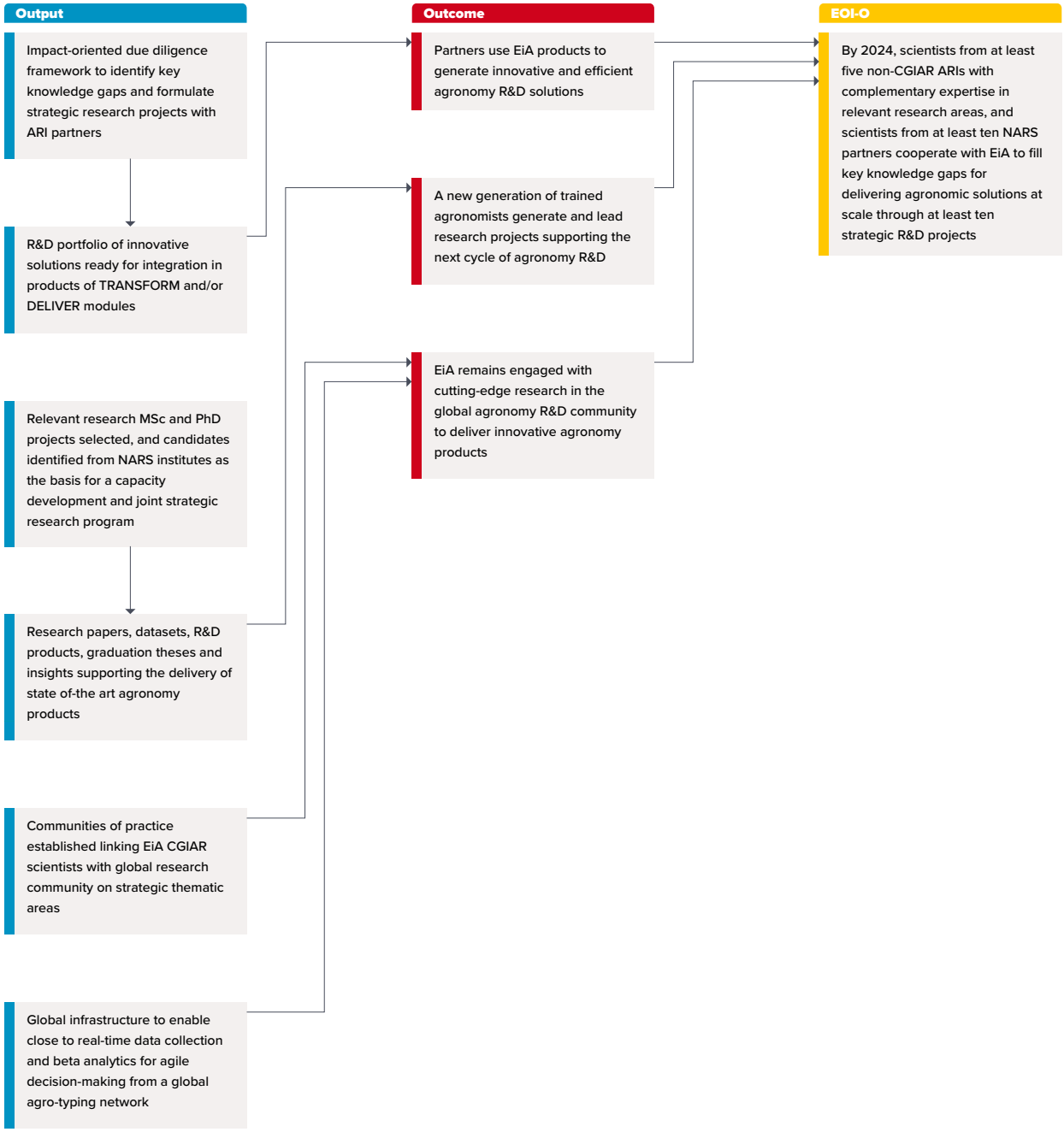


Work Package 2 progress against the theory of change

EiA's agrifood transformation goals rely heavily on actionable data. Output 2.1/CoA 2.1 deals with collecting and managing data related to agronomic outcomes to be open and FAIR. Highlights include: agreement on required data for key activities, aligned data dictionaries and standards, improved tools to collect born-FAIR data (DataScribe, AgroFIMS), and render historical data FAIR (FAIRscribe, Carob). Output 2.2/CoA 2.2 includes a proof-of-concept data pool (https://datapool.scio.services/#/) to aggregate and retrieve standardized data, including gender-disaggregated data, for machine learning, crop and empirical modeling, and other analytics. Another key result improved analytical collaboration via the DIAR Labs platform, allowing computation in low-bandwidth situations. This platform was instrumental in six data science workshops (EiA and other projects/Initiatives).

Output 2.3/CoA 2.3 enabled technical capabilities across Work Packages through three use case support groups on: (i) data management, (ii) analytics and modelling, and (iii) field-validation of recommendations/solutions. Support group highlights include a data catalog on CGIAR Labs used across Use Cases, a weather service intercomparison study, and shared sampling framework algorithms for Use Cases. The groups supported over 10 Use Cases to realize MVPs on fertilizer, planting date, and variety recommendations. A key output 2.4/CoA 2.4 result was a decision-support framework (AgWise) for NARES and other partners to make data-driven decisions. In addition, a planting date analytical methodology developed for South Asia was successfully adapted for Rwanda. A proof-of-concept dashboard to monitor EiA's data collection was also developed and tested (https://github.com/EiA2030/dc_dashboard/tree/release/development). Output 2.5/CoA 2.5 refers to improved skills and best practices, including those on data management and analytics, through capacity development. Activities in 2022 focused on enabling NARES and use case partners to deliver open and FAIR data and use new technologies and computational capabilities to harness machine learning and other data science tools to transform agrifood systems. Computational and agronomy data management capacity was enhanced for at least 160 NARES participants and use case partners through 8 workshops.

Work Package 3:
INNOVATE: Driving the next generation of agronomy-at-scale innovations

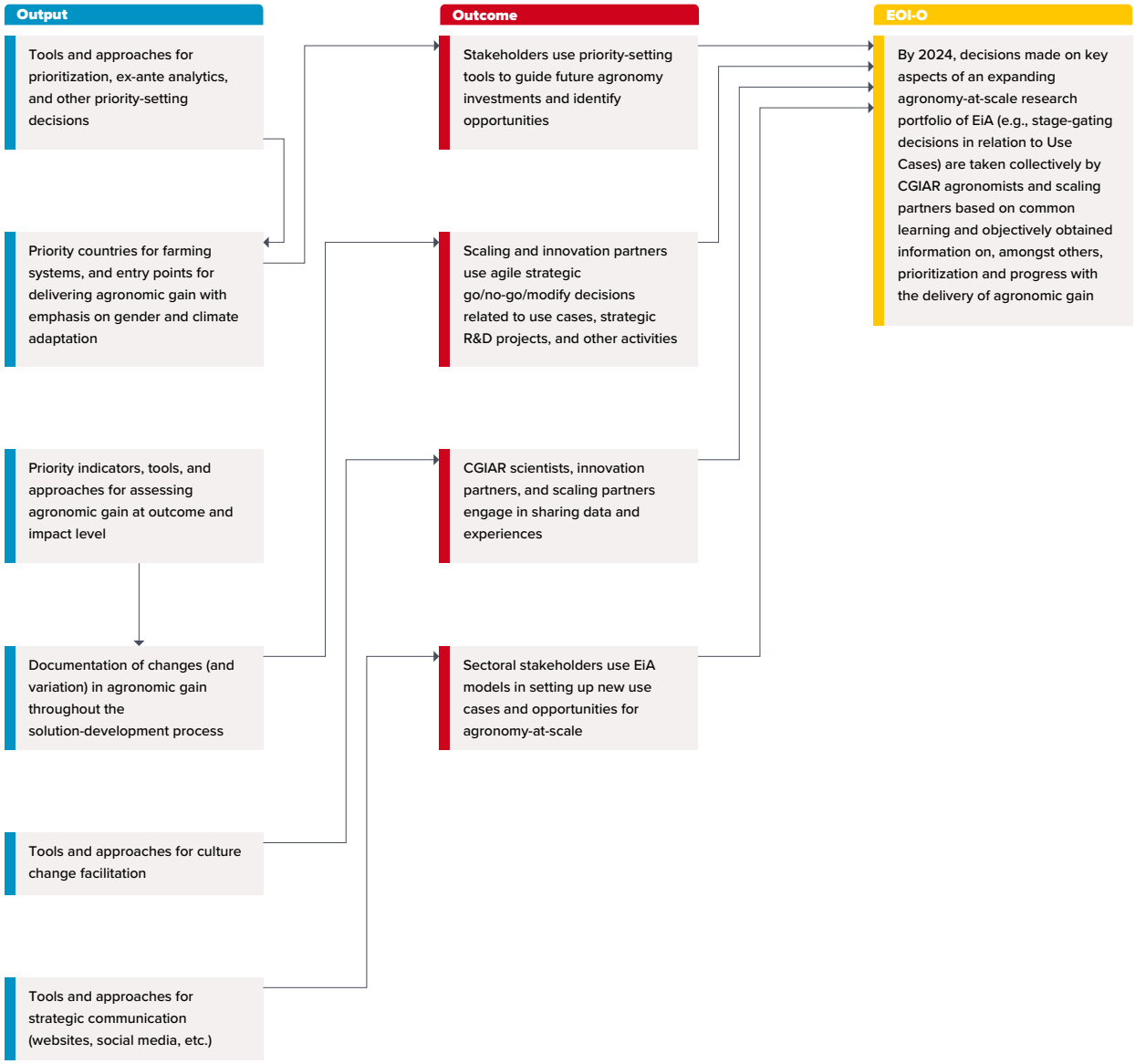


Work Package 3 progress against the theory of change

The first set of six internal R&D projects is operational, focusing on climate change, soil health, agronomic fortification, scale appropriate mechanization, yield at scale, and behavioral change. These resulted in two publications, on agronomic biofortification of zinc in rice (https://hdl.handle.net/10568/126613) and predicting soil fertility properties (https://hdl.handle.net/10568/127428). The Climate Change R&D project produced a first version of the Climate Prioritization Tool (CAPTain) and piloted it in South Asia (output 2), preparing for it to be tested by region partners in 2023 (outcome 1). The Mechanization R&D project set up experiments in Mexico and supported the final assembly of data, analysis and publication of results from several years of research on weeding practices and services in Madagascar. The Behavioral Change R&D project prepared survey tools to investigate fertilizer advisory and the trade-offs in the scaling pathway.

Seven communities of practice are operational, in addition to the R&D project topics, two communities focus on gender and agronomy, and farming systems (output 5). The mechanization community defined their scope, common understanding, and potential mechanization entry points for Use Cases in a 17-participant workshop in October 2022 (Mechanization WorkshopReport_2022). Collaboration in the climate adaptation community of practice resulted in the finalization of the analysis and publication of three knowledge products about climate-smart advisories, decision support for irrigation timing in potatoes (https://hdl.handle.net/10568/125659) and climate change adaptation in lowland rice. The farming systems community contributed to the development of the SOP for farmer segmentation and recruited a PhD student for 2023. Additionally, INNOVATE supported the publication of four research papers that will support the delivery of state-of-the-art agronomy products (output 4), related to crop response to fertilizer and site-specific nutrient management.

Work Package 4:
ORGANIZE: Nurturing internal efficiencies for an agile and demand-driven agronomy R&D community



Work Package 4 progress against the theory of change

The ORGANIZE Work Package is advancing towards achieving its EOI outcome through the outputs achieved in 2022. Widely applicable, transferable, and replicable tools to ground the Use Cases were developed, such as the integrated survey tool and toolkit with the SOPs for farmer segmentation, gender and youth responsiveness assessment, and sampling strategy (output 4.1). Implementation of the prioritization framework resulted in the identification of 23 priority countries and 16 farming systems which are now used in the on-boarding for new Use Cases in DELIVER (output 4.2). The assessment of agronomic gain key performance indicators will be facilitated with the guidelines and SOPs developed for rice, cassava, teff, barley, maize, sorghum, wheat, and for field and harvest area measurement (output 4.3). Examples of SOPs include: (i) maize SOP; (ii) cassava SOP; and (iii) wheat SOP. Implementation of monitoring, evaluation, learning and impact assessment (MELIA) is advanced with the development of the MELIA framework, studies design, and strategy and data collection methodologies (output 4.4) (MELIA design plan). Knowledge products were developed to communicate to stakeholders about EiA and what it does to improve agronomic gain for smallholder farmers through the delivery of agronomy solutions at scale. Various printed and online communication materials were published including the EiA Initiative inception to communicate to stakeholders about EiA and what it does (output 4.6). EiA released the strategic document brief *Agronomic adaptive strategies to strengthen smallholder farmers' resilience to climate change* and hosted a roundtable discussion on climate change and its effects, and the need for response and adoption of processes to co-develop agronomy solutions and strategies at scale that enhance smallholder farmer adaptive capacity and resilience at COP27 in Egypt (https://cgspace.cgiar.org/handle/10568/125495) EiA also launched its events website as a convening platform for different conversations in agronomy (https://events.scalingagronomy.org/events).

Hayde Campos, a potato farmer harvesting in a field where data were collected in the e-Agrology data management system. La Libertad, Peru Photo credit: CIP

Work Package progress rating

WORK PACKAGE	TRAFFIC LIGHT / RATIONALE	
1		The DELIVER Work Package is on track, given the fact that all clusters of activities/outputs have made progress towards the anticipated targets, and have generated considerable evidence towards fulfilling the theory of change. Learnings from the use case implementation has generated learnings leading to the creation of two new clusters of activities focused on scaling platforms and structured scaling support.
2		2022 progress of the TRANSFORM Work Package largely aligns with the Plan of Results and Budget and Work Package theory of change. There was a delay in implementing a fourth support group on interfaces for solutions (under Output 2.3/CoA 2.3). However, this group was not required in 2022 as solutions were still being developed and field-validated or piloted. The delay did not therefore jeopardize the success of the Work Package, and this group will be set up in 2023.
3		The six R&D projects and seven communities of practice are operating as planned together with Advanced Research Institutes (ARIs) and National Agriculture Research Systems (NARS) to fill key knowledge gaps for delivering agronomic solutions at scale. Some activities about the agro-typing network, students and renewing the R&D pipeline have been rescheduled for 2023 due to administrative difficulties.
4		Annual progress largely aligns with the Plan of Results and Budget and the Work Package theory of change. The ORGANIZE Work Package is well on track to achieving the outcomes at EOI. All tools and approaches required to ground the Use Cases, measure agronomic gain key performance indicators and to implement MELIA were completed. Slight delays in implementing the integrated survey with the Use Cases were observed because of the unforeseen length of time required to integrate the questions for current practices, farmer segmentation, gender and youth, and yield decomposition into one integrated survey tool.

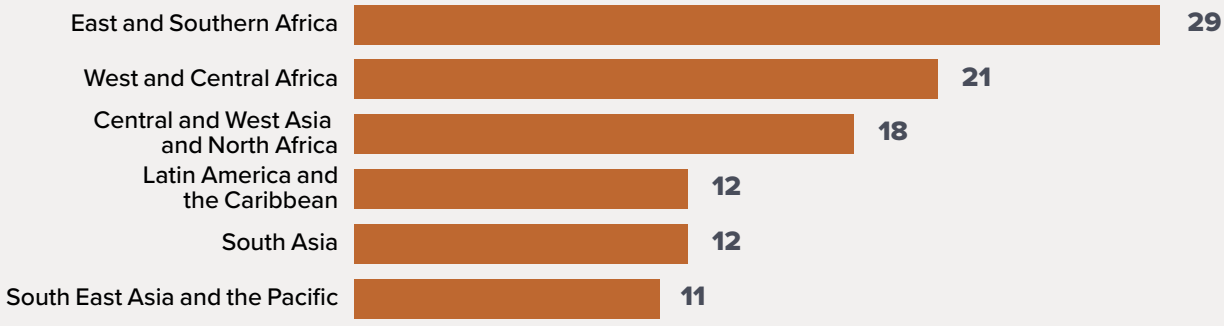
KEY		
On track		• Annual progress largely aligns with Plan of Results and Budget and Work Package theory of change • Can include small deviations/issues/ delays/risks that do not jeopardise success of Work Package
Delayed		• Annual progress slightly falls behind Plan of Results and Budget and Work Package theory of change in key areas • Deviations/issues/delays/risks could jeopardise success of Work Package if not managed appropriately
Off track		• Annual progress clearly falls behind Plan of Results and Budget and Work Package theory of change in most/all areas • Deviations/issues/delays/risks do jeopardise success of Work Package

Section 4 Initiative key results

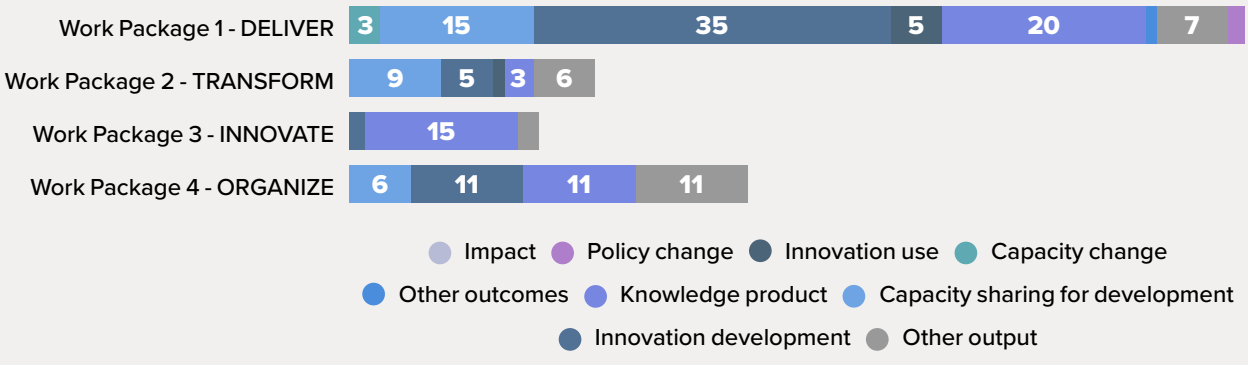
This section provides an overview of the 2022 results reported by Excellence in Agronomy. These results align with the CGIAR Results Framework and Excellence in Agronomy's theory of change. Further information on these results is available through the CGIAR Results Dashboard.

Results by country

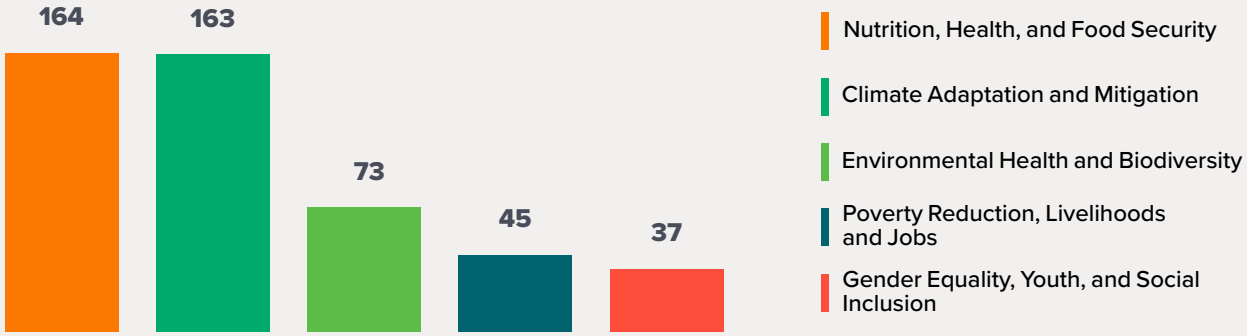
Results by region



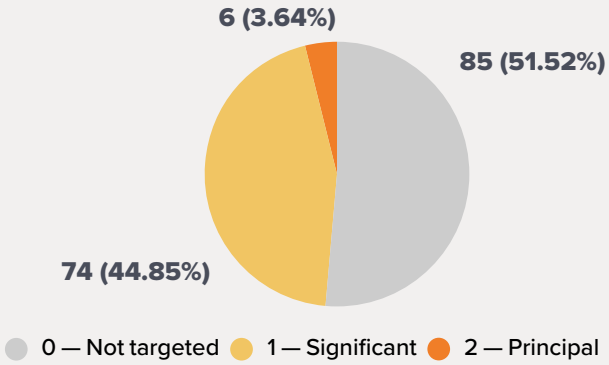
Results by Work Package



Impact Area contributions



Results by gender tag

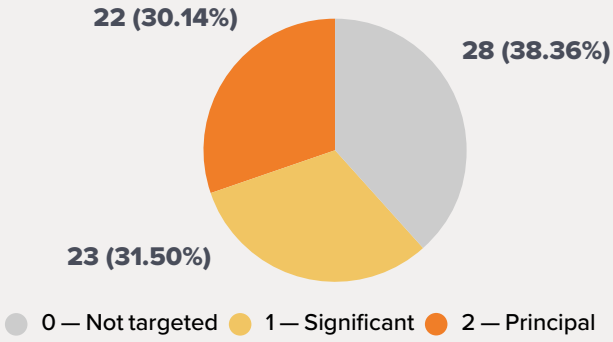


0 = Not targeted: The activity/result does not target gender equality.

1 = Significant: The activity/result contributes in significant ways to gender equality, even though it is not the principal focus of the activity.

2 = Principal: Gender equality is the main objective of the activity/result and is fundamental in its design and expected results.

Results by climate change tag

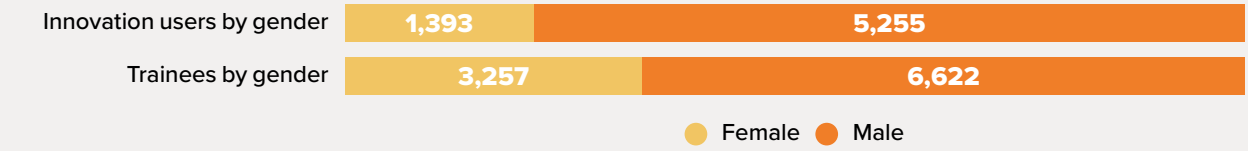


0 = Not targeted: The activity does not target climate mitigation, adaptation, and climate policy goals of the CGIAR as put forward in its strategy.

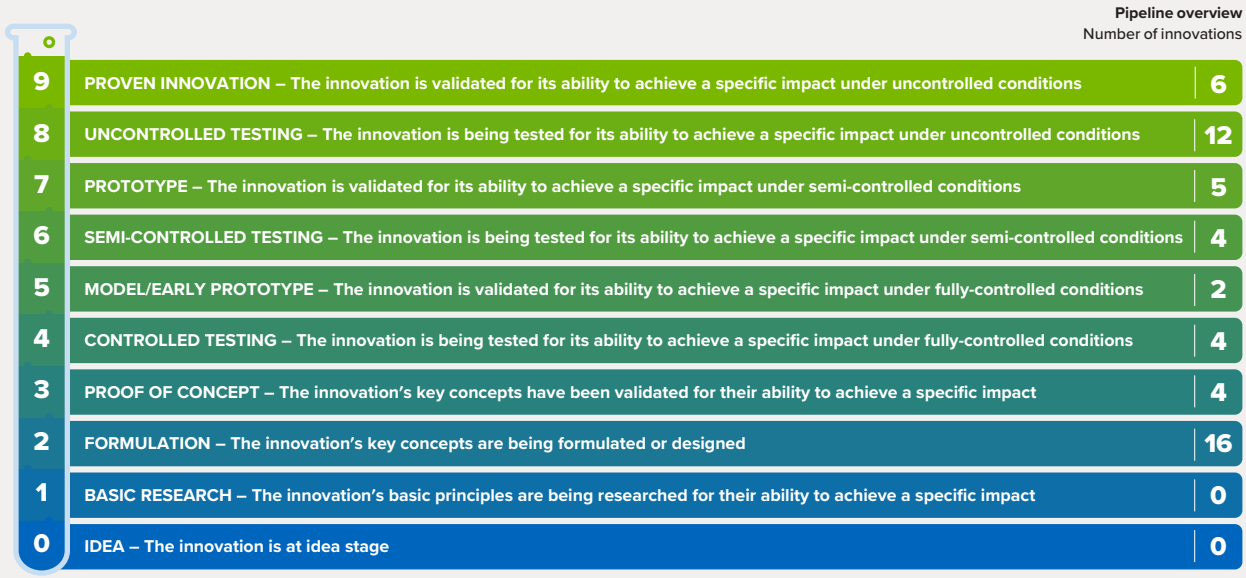
1 = Significant: The activity contributes in significant ways to either one of the three CGIAR climate-related strategy objectives — namely, climate mitigation, climate adaptation, and climate policy, even though it is not the principal focus of the activity.

2 = Principal: The activity is principally about meeting either one of the three CGIAR climate-related strategy objectives — namely, climate mitigation, climate adaptation, and climate policy, and would not have been undertaken without these objectives.

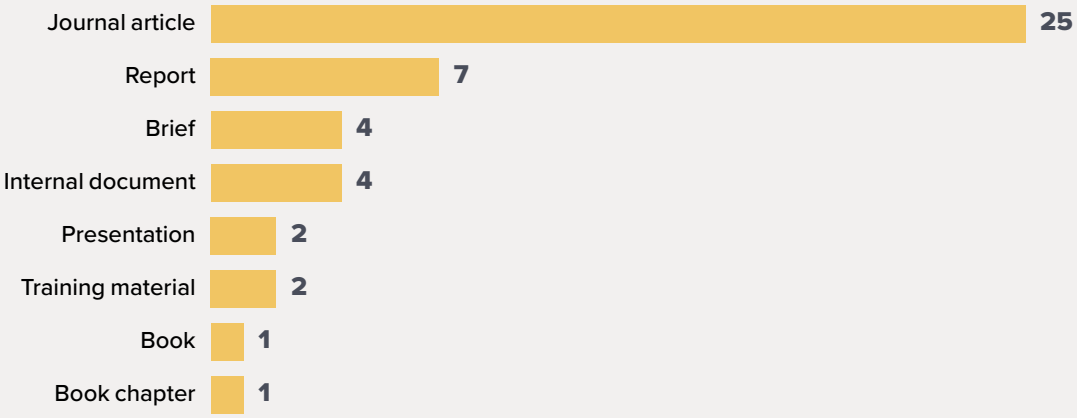
Innovation users and trainees by gender



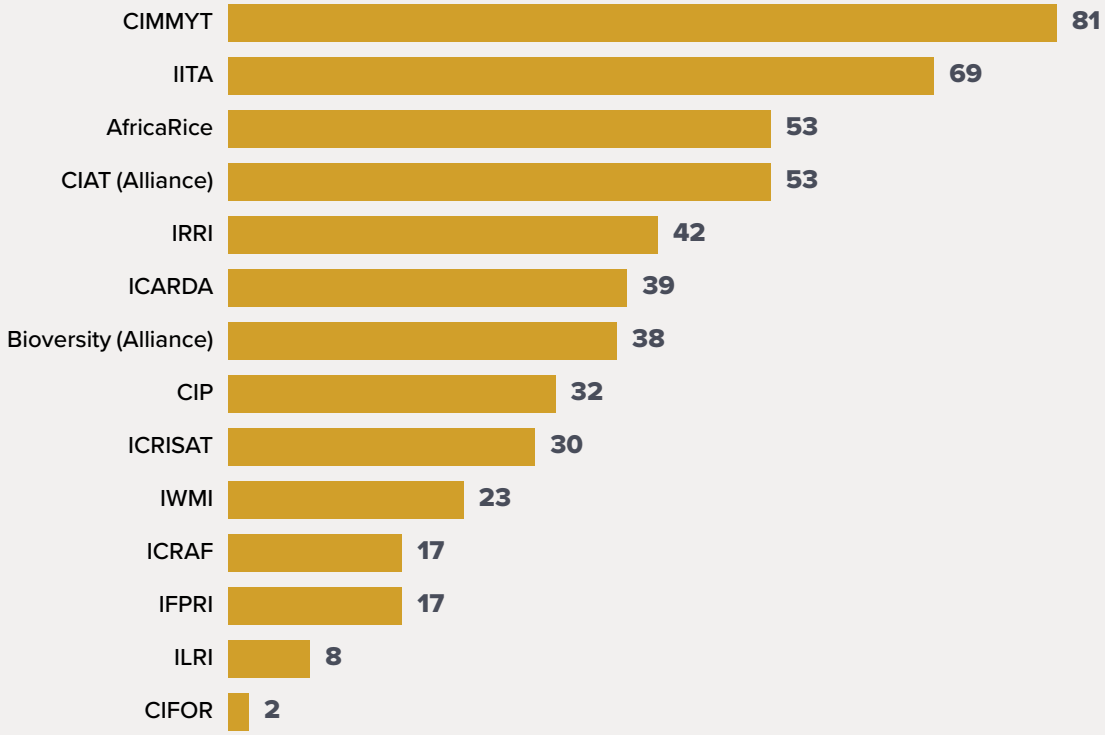
Innovation by readiness level



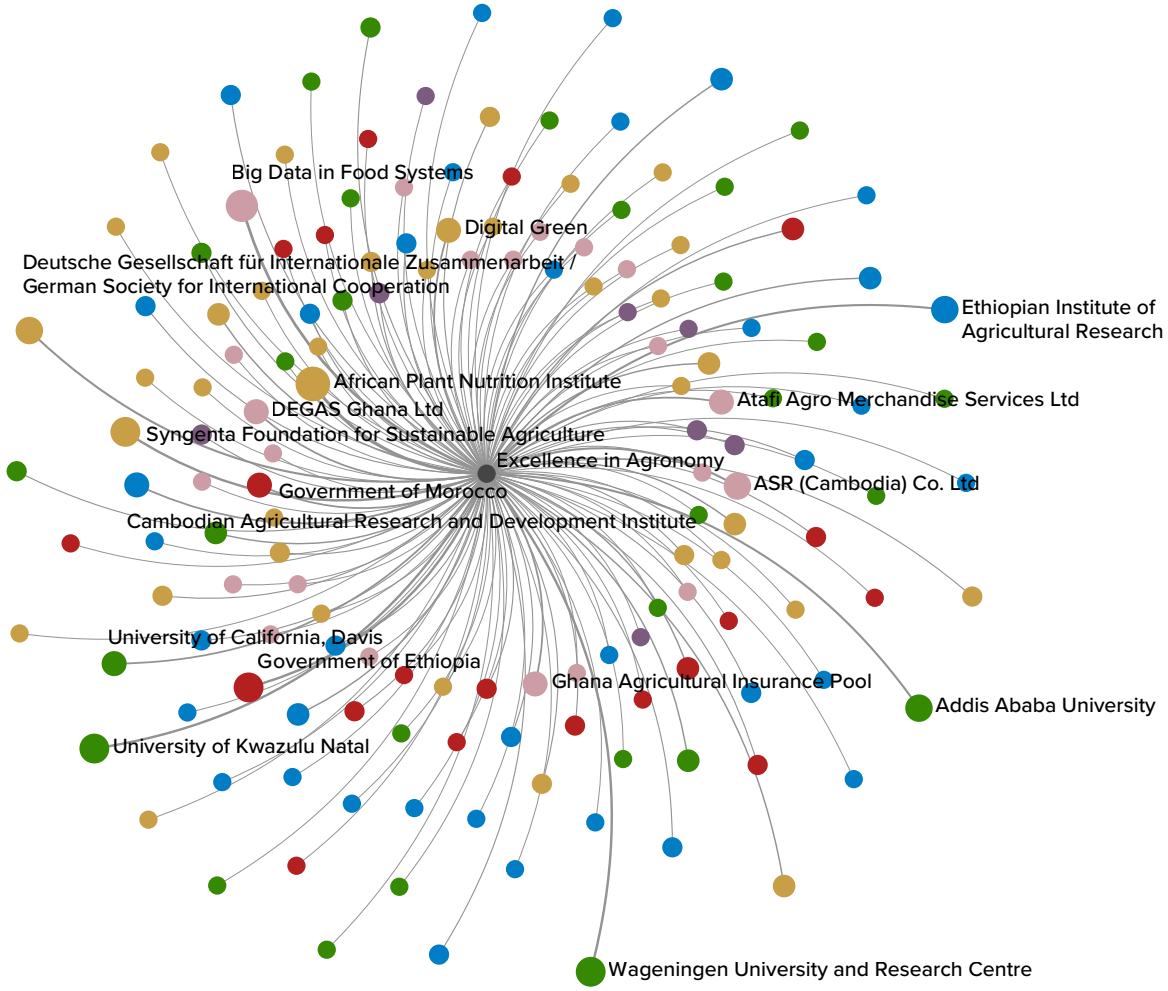
Knowledge products by type



Contributing CGIAR Centers



Section 5 Impact pathway integration – External partners



Partners typology	# of partners	% of partners
Research organizations and universities (NARS)	37	24.2%
Research O&U (National) (Universities)	29	19.0%
Private company (other than financial)	22	14.4%
Government (National)	20	13.1%
NGO International (General)	8	5.2%
All Other Categories	37	24.2%

Top five institution types

All other categories · Government (National) · NGO International (General) · Not applicable · Private company (other than financial) · Research O&U National (NARS) · Research O&U National (Universities)

Note: CGIAR Centres are excluded from the analysis. Partners and edges are sized by the number of results. Labels are shown for the partners involved in the most results.

Partnerships and Excellence in Agronomy's impact pathways

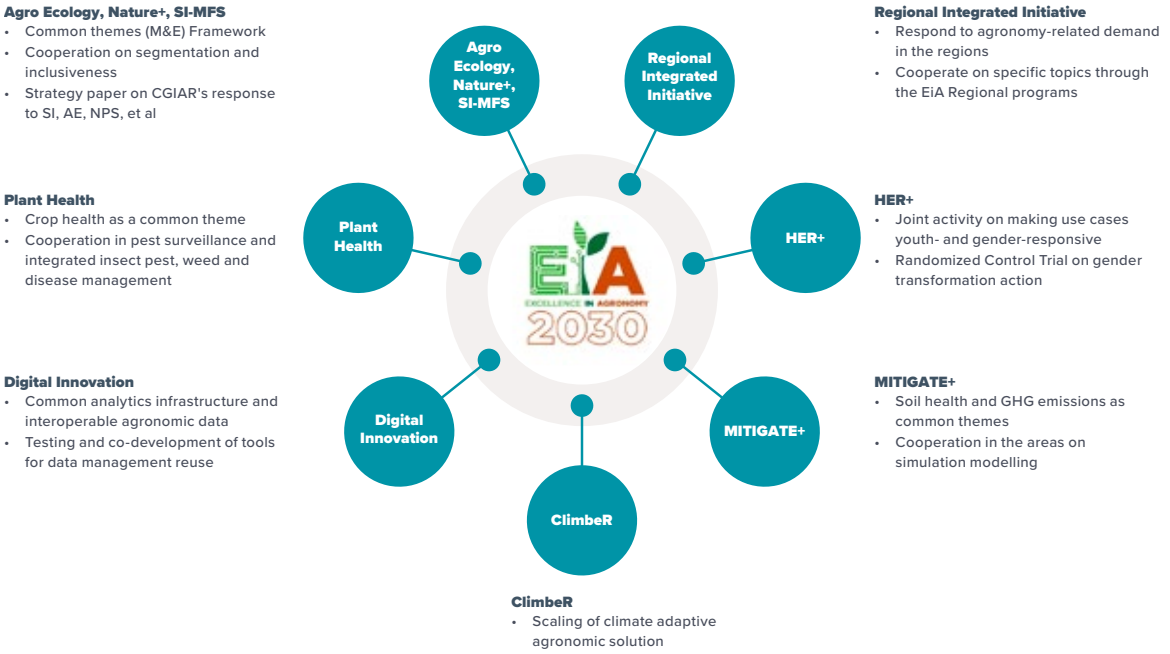
Excellence in Agronomy (EiA) collaborated with 148 partners (as shown in the above table per partner category) in generating its 2022 results. These partners include the NARS, ARIs, universities, private companies, governments, and international NGOs. Partners were engaged based on their demand for agronomic solutions and based on their expertise in areas such as data infrastructure, analytics and advanced research. A stakeholder workshop was organized to launch EiA and to refine collaborative plans with partners in the West and Central Africa region and roadmaps developed to support the engagement and planning with the partners.

These partners are best placed to influence end users in the uptake of the solutions due to their experience in scaling through networks of farmers and other value chain actors. Though six partners are shown in the graph as having contributed to more results in 2022 (based on size of node), all results were achieved through multiple partnership arrangements as shown by the various results nodes and linkages between results in the graph.

With regards to roles, NARS, governments, and private companies have demanded and contributed to the development and scaling of agronomic solutions (innovations) and other results, ensuring institutionalization and integration of recommendations into national extension systems and country policies (e.g., led and participated in 13 trainings, testing and piloting of agronomic solutions.) Other private companies and universities also contributed to the development and scaling of agronomic solutions and data-to-analytics infrastructure. For instance, Big Data in Food Systems (SCiO) provided innovative artificial intelligence (AI)-enabled services as well as technical expertise in data analytics and infrastructure, and the Ethiopian NARES partner coalition also promoted open and FAIR data for rapid data-driven insights in Ethiopia to support the development of the agronomic solution on location-specific fertilizer recommendation.

Research institutes (both national and international), including Wageningen University & Research (Netherlands) and the University of Kwazulu-Natal (South Africa), contributed in generating a number of results including the development of agronomy ontology (https://www.ebi.ac.uk/ols/ontologies/agro), and the development of a logic framework to integrate mechanization into Excellence in Agronomy.

Section 6 Impact pathway integration – CGIAR portfolio linkages



Portfolio linkages and Excellence in Agronomy's impact pathways

Excellence in Agronomy (EiA) forged strategic alliances and collaboration with other CGIAR global Initiatives in achieving the 2022 results and contributed to the EOI outcomes, Action Area outcomes and Impact Area goals. The Initiative, through its collaboration with global Initiatives and regional integrated Initiatives (RIIs), contributed to 48 results in addition to its 2022 primary results.

The DELIVER Work Package, through its Use Cases, worked with four CGIAR global Initiatives — **Nature Positive Solutions** (NPS), **Mixed Farming Systems** (MFS), **Plant Health**, and **Livestock and Climate** (LC) — and with five RIIs, including **Asian Mega Deltas**, **Diversification in ESA**, **From Fragility to Resilience in CWANA**, **WCA Food Systems Transformation**, and **AgriLAC Resiliente**, to respond to agronomy-related demands in the regions. It also partnered with **Plant Health** on pest surveillance and insect pest and disease management as required by Use Cases. The TRANSFORM Work Package collaborated with the **Digital Innovation** Initiative to test and co-develop common analytics infrastructure, generate interoperable data using EiA mediated tools, and jointly developed tools for responsible data management and reuse, to enable use of sensitive data without compromising privacy and ethics considerations and/or regulations. EiA collaborated with Gender Equality in the development of integrated survey tools to ensure Use Cases are gender- and youth-responsive and will jointly support implementation of gender-transformative approaches as part of selected use case scaling strategy.

Collaboration between EiA and non-pooled projects, including Cereal System Initiative for South Asia (CSISA), Sustainable Soybean Production in Northern Ghana (SSPING) and the African Cassava Agronomy Initiative (ACAI), facilitated the development of MVPs through adaptation of decision-support frameworks, partnership formation and strategies, tools and approaches. Discussions are ongoing with Low-Emission Food Systems on soil health and greenhouse gas emissions and to cooperate in simulation modeling, and with Nature Positive Solutions, MFS, and **Agroecology** to develop common monitoring and evaluation framework and cooperate on farmer segmentation and inclusiveness.

Section 7 Adaptive management

RECOMMENDATION	SUPPORTING RATIONALE
Adjust the theory of change for DELIVER and ORGANIZE Work Packages to include two outputs, 1.4 and 4.8, and modify the Initiative Results Framework based on learnings	The use case model, which focuses on a specific demand partner and geographic area, is limited compared to partnership platforms organized around a specific farming system or geography. These platforms result in more partners engaged in developing and scaling agronomic solutions and facilitate interactions between partners. A new cluster of activity (CoA 1.4) will be added to DELIVER to host EiA platforms (agronomy scaling and acceleration platforms) that assemble partners interested in specific farming systems or geographies. In addition, ex-ante assessment is part of CoA 4.1 under ORGANIZE, but a new CoA is needed to broaden ex-ante assessment to include other demands in the agronomy space, such as advice on areas where intensification is needed or in relation to fertilizer or lime deployment strategies (EiA Work Package and Activity Cluster), (Results Framework).
Discuss with Center/Alliance teams to increase full-time equivalent (FTE) allocation to EiA deliverables (e.g., to at least 75%) to make sure that there is sufficient dedication to enable delivery of the commitments.	Many EiA colleagues have 50% or less of FTE dedicated to EiA. In practice, this means that such colleagues have multiple responsibilities, often overcommitting their time to a series of different engagements (Window 3/bilateral projects or Initiatives). Formalizing with Center/Alliance Teams to allocate FTEs that allow for proper delivery of quality results, aiming at having 75% of time dedication, would facilitate the delivery of outputs and outcomes. This issue is best addressed considering across Initiatives and through alignment of Window 3/bilateral projects to those Initiatives.
Coordinate interactions between EiA and other Initiatives (e.g., Genetic Innovations) that are critical towards the delivery of EiA results.	Discussions between EiA and other relevant Initiatives were on an ad-hoc basis, limited coordination was a logical consequence of an inception year where EiA prioritized setting up its own teams and activities. However, better coordination would be needed in selecting and interacting with Initiatives, adding value to the Initiatives' deliverables.

Section 8 Key result story

Farmer Field Day held at Mariira, to demonstrate the different Climate Smart Technologies used in farming. December 22nd, 2022. Murang'a county, Kenya. ©2023 Alliance of Bioversity International and CIAT/ Photo credit: Owen Kimani

Smallholder farmers in Ethiopia utilizing NextGen agro-climate advisory increased wheat yield by 25% and earned an additional US$600/ha/season

A NextGen agro-climate advisory in Ethiopia increased wheat grain yield of smallholder farmers by up to 25% with an average additional partial profitability of US$600 per ha per season when compared to a blanket recommendation. The advisory has been developed by integrating over 25,000 crop responses to fertilizer application datasets with spatial co-variants using machine learning algorithms. The advisory and the partnership model between Excellence in Agronomy, GIZ, Digital Green, and national institutes has attracted significant interest to scale.

Wheat is grown by about 4.8 million farmers and is the second most important grain food staple in Ethiopia, after maize. Despite its importance, Ethiopian wheat farmers only achieve between 35 and 45 % of a farm's attainable yield, with most producing an average of 2.5 t/ha, compared to a potential of around 6–7 t/ha. This is because of climate and input use constraints (lack of access to context and site-specific agro-advisory); poor soil fertility; and rainfall variability. The objective is to address the yield gap by developing a context- and site-specific agro-advisory decision-support tool and making it available to smallholder farmers.

Using the use case model, EiA engaged Digital Green to establish a collaboration opportunity to deliver agronomy at scale. This collaboration has been the result of demand for site-specific fertilizer advisory content, which is climate- and context-specific, and the Ethiopian Government's needs for the wheat production areas in the Ethiopian Highlands.

An integrated location-specific and season-smart DST/advisory has been co-developed and co-piloted in Ethiopia. The advisory is developed by integrating crop responses to fertilizer data with co-variants. This advisory considers "next-season"

climate information when developing recommendations, making it season-smart. Further, integration is made with the Ethiopian Digital Agroclimate advisory Platform (EDACaP) to generate information about planting timelines. The DST is also integrated with the Quantitative Evaluation of the Fertility of Tropical Soils (QUEFTS), which predicts water-limited yield and indigenous soil fertility supply. Effort is underway to integrate the DST with DSSAT and APSIM models to simulate the roles of good agronomic practices.

- An innovative partnership among national institutes, EiA, GIZ, and Digital Green has been built to facilitate co-creation, and to generate agro-advisory content and use agile dissemination channels to reach extension workers and farmers and collect feedback. This collaboration resulted in the co-development of tailored, location-specific and climate-informed DST to: (i) guide planners, extension workers, and farmers on appropriate planting timelines, and the amount and types of fertilizers required; (ii) promote and co-implement the advisory service; and (iii) build national capacity.
- The DST has been validated in the Amhara, Oromia and Southern Nation Nationalities and People (SNNP) regions of Ethiopia, with 300 farmer participants during the 2021–2022 season. The DST has demonstrated a higher wheat grain yield of up to 25%, reaffirmed by farmers and extension workers who took part in field days. Noting the successes, the DST is being piloted across five districts within three regions in Ethiopia. Despite the huge cost of fertilizer during the summer of 2022, over 3,500 farmers have implemented the DST, out of the over 10,000 farmers reached, with high performance levels already being recorded.
- Across all testing locations, partial profit per hectare per season increased by 24% (US$580) and 16% (US$412), respectively, when location-specific fertilizer rates were compared to local and national blanket recommendations. An average monetary gain of about US$2.3 billion per season can be achieved when a location-specific fertilizer rate of about 5.3 t/ha is applied to a wheat production area of about 1.75 million ha.
- Results also showed notable advantages in terms of agronomic, nutrient, and water use efficiencies.
- Chief Executive Officers (CEOs) of the Crop Development and Agricultural Extension at the Ministry of Agriculture who visited some of the sites in November 2022 witnessed the performance of the DST and have committed to support streamlining the tool as an extension package after further piloting.
- The EiA–GIZ–Digital Green partnership has been recognized and the CEO of the Agricultural Extension has selected the DST (and its partnership framework) to be implemented in specified districts during the 2023 season.

“Even if you force me to stop using the new location-specific recommendation, I will apply it at night.”

Mr Abate Ajajew, farmer from Lemo District of Shurmu Dacho Kebele

References

1 *Abera, W, et al. 2022. NextGen Agroadvisory (modules).* DST _Review _Alliance

2 *Liben, FM, et al. 2022. Developing and piloting location-specific fertilizer recommendation for Wheat in Ethiopia.* Piloting Location specific Report

3 *Abera, W, Ebrahim, M, and Liben, FM. 2022. Piloting site and context specific Agro-advisory to transform wheat production in Ethiopia.* Piloting site and context specific Agro-advisory to transform wheat production in Ethiopia | Alliance Bioversity International - CIAT (alliancebioversityciat.org).

4 *Abera, W, et al. 2022. A data-mining approach for developing site-specific fertilizer response functions across the wheat-growing environments in Ethiopia. Experimental Agriculture. DOI:* 10.1017/S0014479722000047

5 *Tamene, L, et al. (eds). 2017. A review of soil fertility management and crop response to fertilizer application in Ethiopia: Towards development of a site- and context-specific fertilizer recommendation. CIAT publication No. 443. International Center for Tropical Agriculture (CIAT), Addis Ababa, Ethiopia. 86p.*

Annex 1: Supporting documents

Excellence in Agronomy 2022 list of results

Glossary

LINKS TO IMPACT AREAS

Primary Impact Area: Climate Adaptation and Mitigation

Other relevant Impact Area(s): Nutrition, Health and Food Security

GEOGRAPHIC SCOPE

Region: Eastern Africa

Country: Ethiopia

KEY CONTRIBUTORS

Contributing Initiative(s): Excellence in Agronomy

Contributing Center(s): Alliance of Bioversity International and CIAT — CIAT Regional Hub, CIMMYT. Primary: Alliance of Bioversity International and CIAT — Headquarters (Bioversity International)

Contributing external partner(s) (full names):

- **ARARI:** Amhara Regional Agricultural Research Institute
- **DIGITAL GREEN:** Digital Green
- **EIAR:** Ethiopian Institute of Agricultural Research
- **GE:** Government of Ethiopia
- **GIZ:** Deutsche Gesellschaft für Internationale Zusammenarbeit/German Society for International Cooperation
- **AAU:** Addis Ababa University
- **SSA:** Scuola Superiore Sant'Anna

LINK TO CGIAR RESEARCH PROGRAMS

https://alliancebioversityciat.org/stories/ethiopian-farmers-location-specific-fertilizer-makes-difference

COVER PHOTO: A researcher capturing real time data for developing digital cassava agronomy solutions, Rwanda.
Photo credit: IITA

We would like to thank all funders who supported this research through their contributions to the CGIAR Trust Fund.