



INITIATIVE ON
Digital Innovation



CGIAR Initiative on Digital Innovation

ANNUAL TECHNICAL REPORT 2022



CGIAR Technical Reporting 2022

CGIAR Technical Reporting has been developed in alignment with the [CGIAR Technical Reporting Arrangement](#).

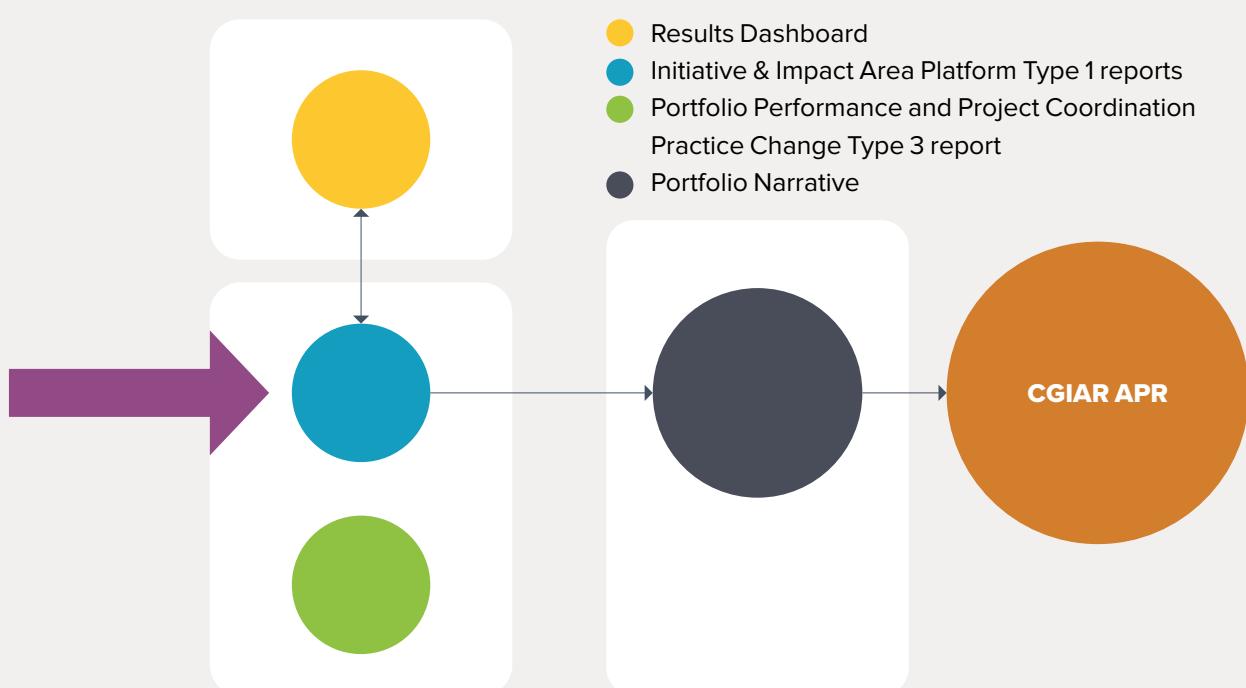
This Initiative report is a Type 1 report and constitutes part of the broader CGIAR Technical Report. Each CGIAR Initiative submits an annual Type 1 report, which provides assurance on Initiative-level progress towards End of Initiative outcomes.

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 from initial submission	\$9,000,000	\$10,010,000	\$8,990,000
Approved 2022 Budget	\$4,817,591		

2022 Disbursement Target based on Approved FinPlan

Section 1 Fact sheet

Initiative name		Digital Innovation
Action Area		Systems Transformation
Geographic scope		Countries targeted in the proposal: Bangladesh, Botswana, Egypt, Ghana, Guatemala, India, Indonesia, Kenya, Malawi, Mexico, Mozambique, Nepal, Rwanda, South Africa, Zimbabwe Countries with results reported in 2022: Bangladesh, Botswana, Egypt, Ethiopia, Guatemala, India, Indonesia, Kenya, Mexico, Mozambique, Rwanda, South Africa, Zimbabwe
Start date		April 1, 2022
End date		March 31, 2025
Initiative Lead		Jawoo Koo – j.koo@cgiar.org
Initiative Deputy		Andrea Gardeazabal – a.gardeazabal@cgiar.org
Measurable three-year End of Initiative outcomes (EOI-Os)		EOI-O 1: Strengthened digital ecosystems Local digital agrifood ecosystems are strengthened through the Initiative-facilitated open collaborative environment that leads to more than five impact-driven use cases that promote inclusive and sustainable impacts. EOI-O 2: Gender-responsive services More than three partners revise strategies and business plans to provide gender-responsive and inclusive digital agrifood advisory services that contribute to bridging the digital divide. EOI-O 3: Improved digital skills At least 1,000 people (40% women) improve digital skills to access digital agrifood advisory services that support productive, profitable, and climate-resilient farming and manage climate and market risks. EOI-O 4: Equitable resource allocations At least two natural resource management organizations improve technical capacities to monitor food, land, and water systems in real time, assess climate risks, and inform stakeholders to equitably allocate water resources. EOI-O 5: Strengthened information systems More than five information systems are strengthened by incorporating the Initiative-contributed high-frequency agrifood system monitoring data and analytics to manage climate and market risks. EOI-O 6: Strengthened organizational capabilities At least six partner organizations boost digital capabilities to utilize real-time data and analytics, analyze underutilized data assets, and generate timely and actionable insights for extension, sustainable development, and accelerated impacts.

OECD DAC Climate marker adaptation 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 Climate marker mitigation score*	Score 0: Not targeted: The activity does not target the climate mitigation, adaptation, and climate policy objectives of CGIAR as put forward in its strategy.
OECD DAC Gender equity marker score*	Score 1B: Gender-responsive: On top of the minimum requirements for 1A, the Initiative/project includes at least one explicit gender equality outcome, and the Initiative/project team has resident gender expertise or capacity. The Initiative/project includes gender equality indicators and monitors the participation of and differential benefits for diverse men and women.
Website link	https://www.cgiar.org/initiative/digital-innovation

*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.

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



Overall summary of progress against the theory of change

While global warming, epidemics, and wars pose multiple threats to our food systems, there are unprecedented opportunities for technological solutions to contribute to an accelerated, sustainable, and inclusive transformation of food, land, and water systems. Digital tools have demonstrated their potential to provide agrifood systems with timely insights and services that can improve productivity and profitability, increase resilience to climate shocks, and promote environmental sustainability. However, there are concerns around the digital divide, inadequate information systems, and limited capabilities in low- and middle-income countries to fully benefit from these innovative digital solutions.

Researchers at IWMI and the University of Mpumalanga collecting 3D hydrology data in South Africa.
Photo credit: Jawoo Koo (IFPRI)

Our theory of change (TOC) is designed to address these system-level challenges by generating research-based evidence and innovative digital solutions for making informed decisions at three levels — policymakers and investors, digital innovators and service providers, and users of data and digital solutions — across food, land, and water systems in focus geographies. We have developed five Work Packages that work together to address our research questions in a complementary way.

During the first nine months of the Initiative in 2022, we achieved 67 results, which include 38 knowledge products, 15 innovation developments, 5 capacity-strengthening outcomes, 2 policy changes, and 2 innovation uses. These results

showcase the diversity of our digital innovation work across food, land, and water systems, including impact assessment studies to provide evidence, advanced analytics using artificial intelligence (AI) to support decision-makers, and case studies that promote the innovative use of real-time data and digital solutions for managing climate and market risks. This section provides updates on our research progress toward achieving the End of Initiative (EOI) outcomes for each Challenge Area.

Challenge area 1: The digital divide

The potential of digital technologies is clear, yet their reach is not universal. The Global South — and especially women and rural areas — is underserved by digital technologies and infrastructure. *In what ways can policymakers, investors, and innovators effectively address the digital divide in food, land, and water systems?*

In 2022, we initiated a series of digital impact assessment studies in Kenya and India to fill the critical knowledge and evidence gap identified regarding inequalities within digital ecosystems. Data collection in Kenya has been completed and is scheduled for analysis in 2023, while the study in India is set to launch in early 2023. These studies will help guide policies and strategies for reducing the digital divide.

Through consultations with digital ecosystem stakeholders from both public and private sectors in Kenya and India, we have identified essential **services** and **actions** to accelerate inclusive digitalization in agrifood systems. These include applying human-centered design principles, developing common digital taxonomies, implementing a unique identifier system for agrifood system actors and their assets, and establishing data-sharing policies. In addition, we have received complementary resources to organize two global ICT for Agriculture conventions in 2023–2024. These conventions will bring together public–private digital innovators and research and science experts to share knowledge,

demonstrate impacts, and showcase the values of private–public partnerships.

We anticipate that our research and partnership activities will promote innovation-enabling partnerships, policies, and investments that foster digital inclusion, ultimately leading to increased job opportunities.

Challenge area 2: Inadequate information

Access to timely, reliable, and actionable information is a major challenge faced by decision-makers in the Global South. Information systems often lack integration with pertinent analytics, resulting in limited utilization of data and knowledge for decision-making and impact. *How can information systems improve their services and products to be more timely, accurate, actionable, and inclusive?*

To address this challenge, we are developing **digital twins of agrifood systems** in target regions to improve their information services and products. The digital twin approach involves creating a virtual replica of a physical agrifood system using real-time data and simulation models, an area in which CGIAR has extensive expertise, to test what-if scenarios and facilitate informed decision-making. As an initial step, we launched a series of real-time monitoring pilot programs across food, land, and water systems in 2022. These pilots utilized **satellite remote sensing**, **seasonal forecasts**, **internet-connected sensors**, and **citizen science initiatives** for collecting groundtruth data. Additionally, we began developing integrated modeling frameworks in Southern Africa to simulate crop production and natural resource management scenarios. Soon, we will integrate the system-level monitoring data into these modeling frameworks and use them to develop a series of digital twin case studies.

Through the digital twin approach, we aim to provide decision-makers with more accurate, timely, actionable, and inclusive information, thereby enabling them to make informed decisions and positively impact people's livelihoods.

Sita Kumari (right), farmer, uses mobile phone apps to enhance her yields and get access to market and labor.
Photo credit: C. De Bode (CGIAR)

Challenge area 3: Limited capabilities

Digital literacy and skill levels across the Global South remain low, particularly for the most food-insecure communities, such as rural women and youth. *What capacity-building strategies can be used to enhance the digital skills and capabilities of service providers and users in food, water, and land systems?*

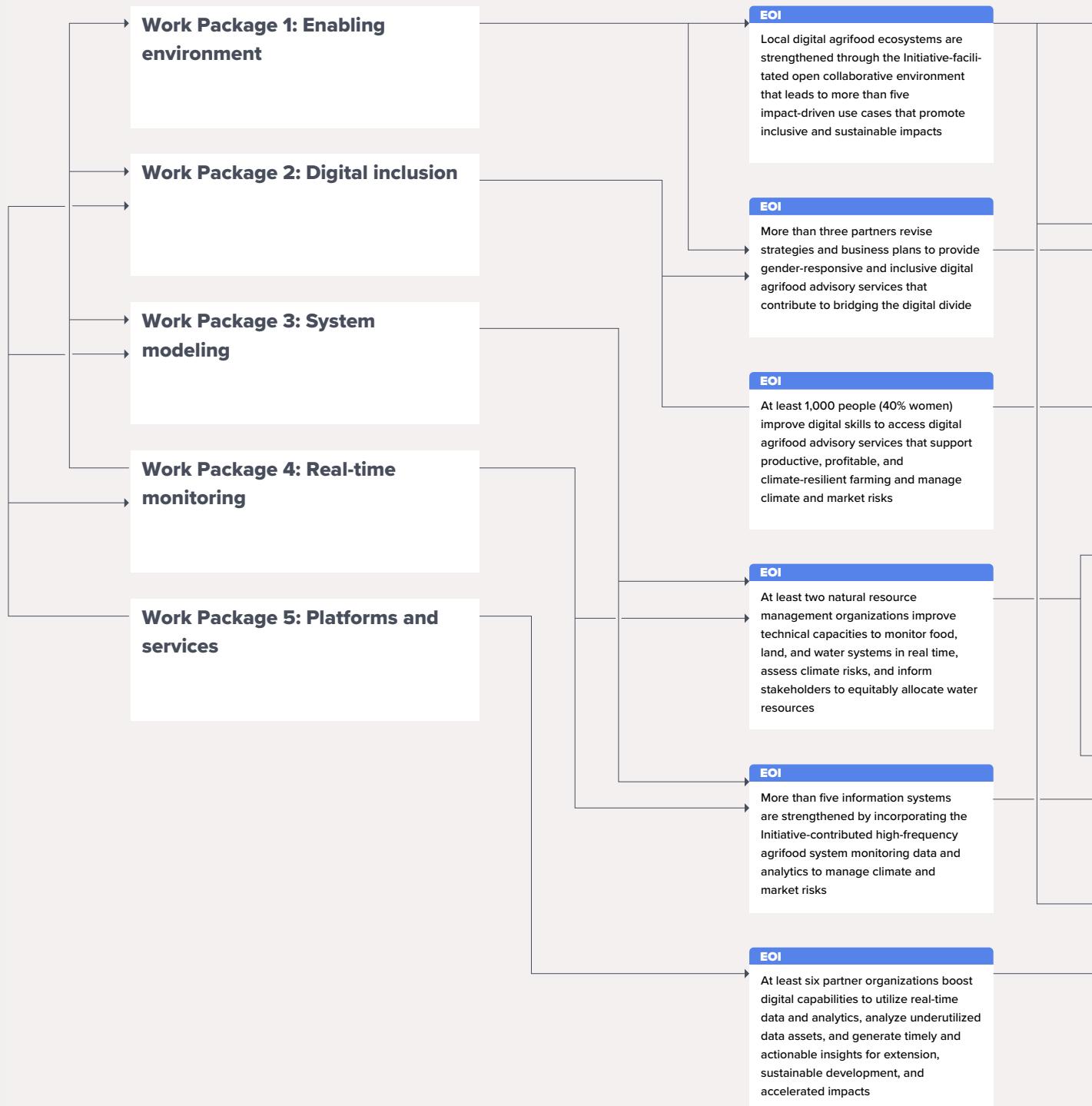
Based on consultations with digital development practitioners and service providers, we hypothesized that the most effective approach to addressing limited capabilities in the Global South should target both digital service providers and end users simultaneously. Digital extension and service providers can offer more gender-responsive and inclusive content and channels to increase engagement with diverse user groups and benefit those who need the services most. Meanwhile, end users' digital equity can be improved through targeted investments by stakeholders in capacity-strengthening, access to technologies, and resources, leading to reduced poverty.

To better understand the current state of digital capabilities in rural communities, we launched two types of digital ecosystem assessments in 2022. We conducted household surveys across two states in India and one state in Kenya to assess digital literacy and skill levels at the end-user level. Additionally, we initiated digital ecosystem assessment studies in Guatemala, India, and Kenya to understand the capabilities and gaps in agrifood system service providers. These assessments will be completed in early 2023, and their results will be used to test the effectiveness of various gender and inclusion strategies in achieving associated outcomes.



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.



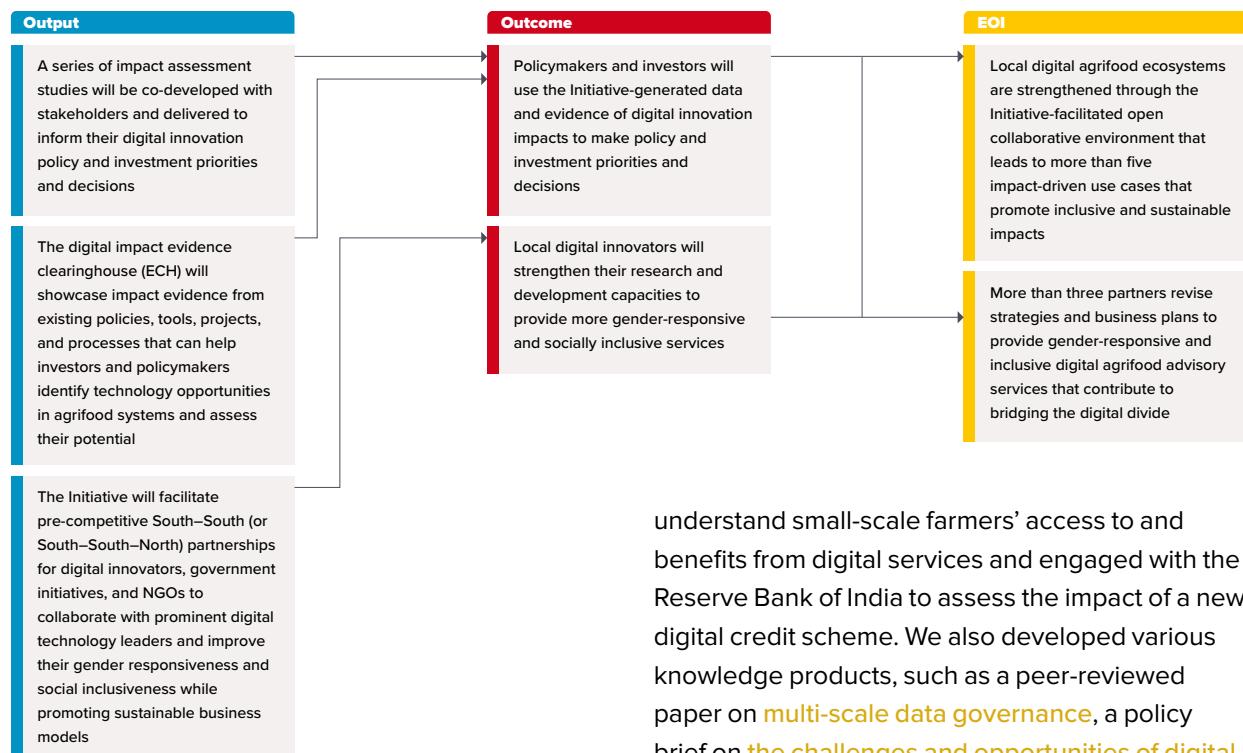
Progress by End of Initiative outcome

EOI-O 1: Strengthened digital ecosystems	We aimed to develop more than five impact-driven open collaboration partnerships to strengthen local digital ecosystems across our focus geographies. We are making progress toward this objective, having formed four strategic partnerships with key stakeholder organizations within the first year. We have also successfully secured a grant to organize two global ICT for Agriculture events in 2023–2024. Building on the success of the Big Data in Agriculture conventions and the Inspire Challenges by CGIAR Platform for Big Data in Agriculture , we will leverage the ICT for Agriculture conferences as a platform for sharing knowledge, fostering collaboration, and advocating for digital equity.
EOI-O 2: Gender-responsive services	We aimed to engage with more than three organizational partners to revise their strategies and business plans to provide gender-responsive and inclusive digital agrifood advisory services. We are progressing toward this goal through our planned joint research with two private sector partners in India. The upcoming digital inclusivity toolbox and the human-centered design clinics programs will play a critical role in accomplishing this outcome.
EOI-O 3: Improved digital skills	We aimed to enhance the digital skill levels of at least 1,000 individuals (40% women) to facilitate their access to digital agrifood advisory services. By continuing our engagement with the digital ecosystem assessment participants in Guatemala, Kenya, and India, we are on track to achieve this goal. The forthcoming innovation of the digital inclusivity toolbox will enable us to measure the level of digital skill improvements over time.
EOI-O 4: Equitable resource allocations	We aimed to engage with at least two natural resource management organizations and improve their technical capacities to monitor food, land, and water systems in real time, assess climate risks, and inform stakeholders to equitably allocate water resources. We are on track to achieve this goal by co-designing and developing digital twin case studies in Southern Africa with two water resource management authorities. Our work focuses on responding to their innovation demands in the management of environmental flows, water quality, and drought risks within their respective river basins.

EOI-O 5: Strengthened information systems	<p>We aimed to strengthen more than five information systems by incorporating high-frequency agrifood systems monitoring data and analytics for managing climate and market risks into the digital twin case studies. We are advancing toward this goal, with five digital twin case studies in Guatemala, Kenya, and the Limpopo River Basin. In 2022, we began developing innovative pilots to address real-time monitoring data gaps in soil management, food production, consumption, climate adaptation, and agro-meteorology. We have established a technical partnership with a global modeling program, World Modelers, to assist in making data and modeling tools accessible to decision-makers.</p>
EOI-O 6: Strengthened organizational capabilities	<p>We aimed to improve the digital capabilities of at least six partner organizations to utilize real-time data and analytics more effectively. We are on track to achieve (and potentially exceed) this goal. We have identified nine potential partners across all of our focus geographies and engaged with them to assess their organizational capabilities and their scope to strengthen these. Additionally, we launched a series of “train-the-trainers” workshops in 2022 on the use of drones, data collection tools, and digital agriculture applications overall, to enhance technical capacity at a local level.</p>

Section 3 Work Package-specific progress

Work Package 1: Enabling environment



Work Package 1 progress against the theory of change

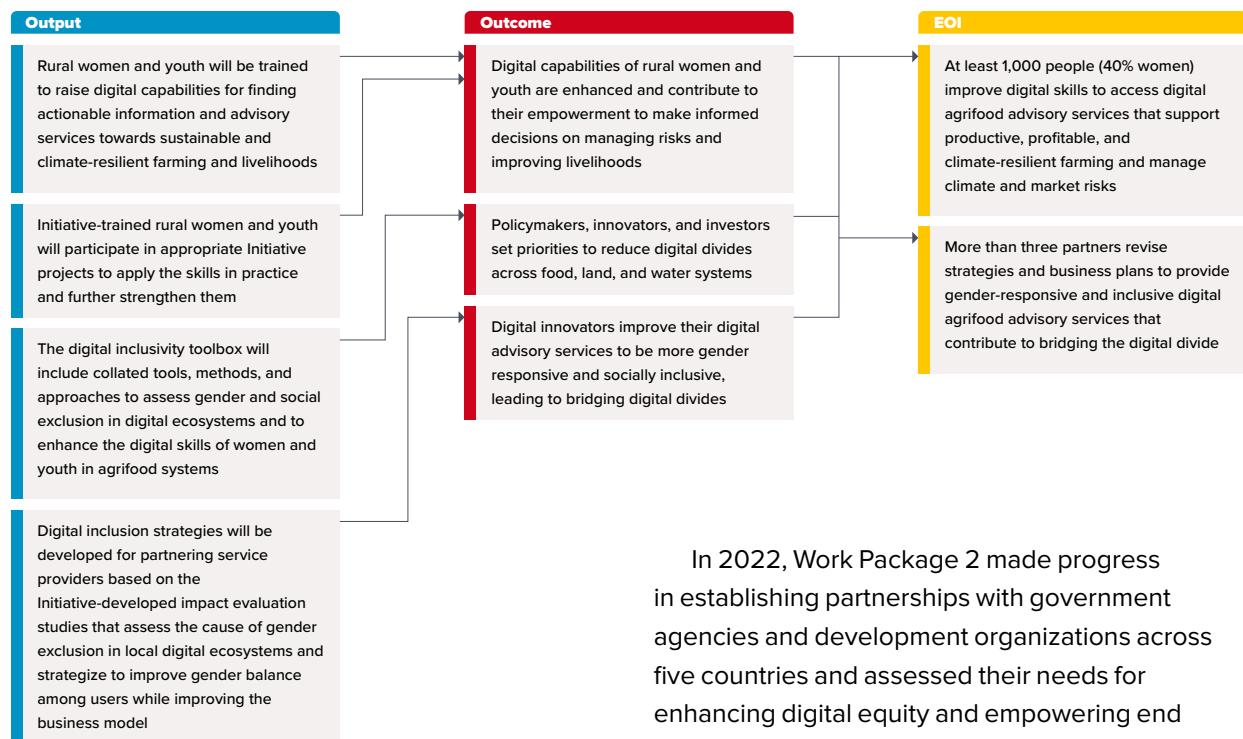
Work Package 1 addresses the digital divide challenge, guided by the research question, “In what ways can policymakers and investors effectively address the digital divide in food, land, and water systems?” Specifically, this Work Package aims to achieve two outcomes, “data-driven policy and investment decisions” and “collaborative partnerships,” to strengthen the enabling environment in local digital ecosystems. In 2022, Work Package 1 made progress toward its three major areas.

First, Work Package 1 focused on generating key evidence regarding the impact of digital solutions. We conducted data collection in Kenya to

understand small-scale farmers’ access to and benefits from digital services and engaged with the Reserve Bank of India to assess the impact of a new digital credit scheme. We also developed various knowledge products, such as a peer-reviewed paper on [multi-scale data governance](#), a policy brief on [the challenges and opportunities of digital agriculture](#), and a report on [digital agriculture case studies in India](#). Second, Work Package 1 initiated a process to further enhance CGIAR Platform for Big Data in Agriculture’s [Evidence Clearinghouse](#), which aggregated evidence on the impact of digital solutions toward the United Nations Sustainable Development Goals, with a new collection of over 100 evidence records. Third, to understand the enabling environment for collaborative partnerships, this Work Package conducted a series of rapid [digital ecosystem assessments](#) with local digital innovators and government agencies to characterize their needs and map incentives for collaborations.

The Work Package 1 activities and results aimed at enhancing comprehension of digital innovation systems’ dynamics and fostering more inclusive and responsible digital innovation. We assess that the Work Package 1 TOC assumptions hold.

Work Package 2: Digital inclusion



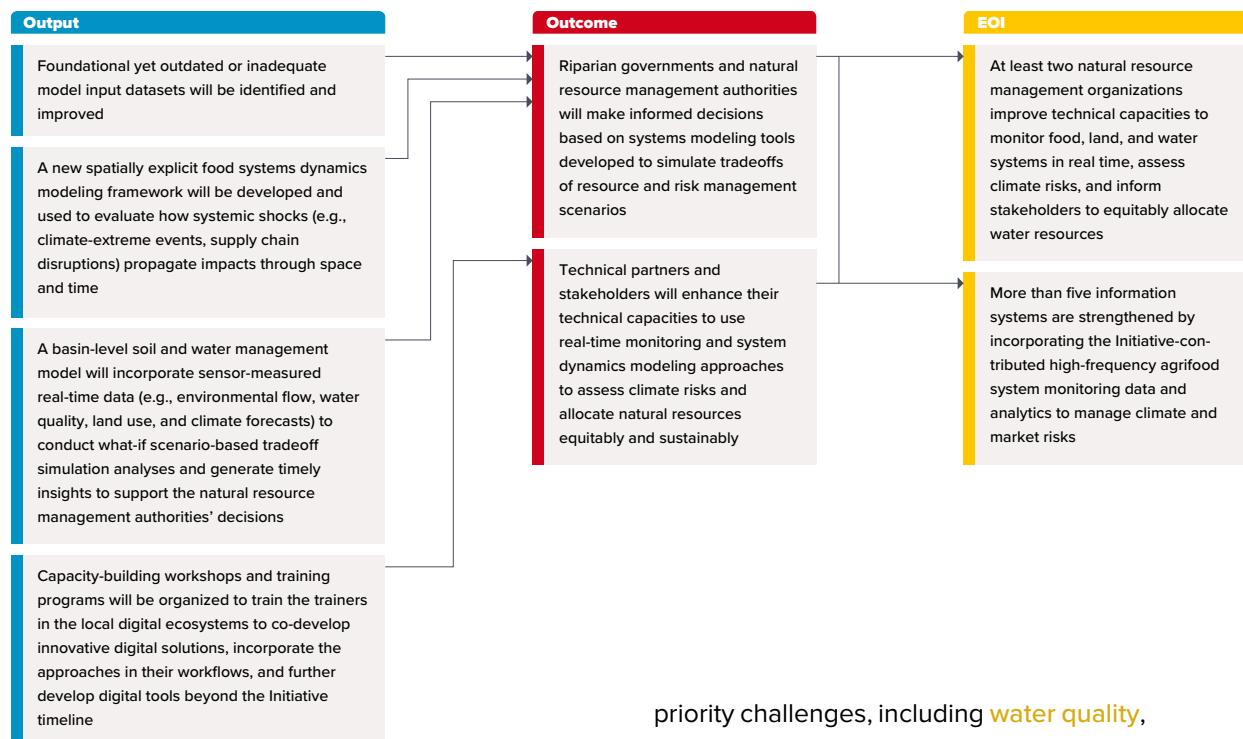
Work Package 2 progress against the theory of change

Work Package 2 addresses the challenges in the digital divide and limited capabilities, guided by two research questions: “In what ways can policymakers and investors effectively address the digital divide in food, land, and water systems?” and “What capacity-building strategies can CGIAR, National Agricultural Research and Extension Systems (NARES), and partners use to enhance the digital skills and capabilities of women and youth and empower them in food, water, and land systems?” This Work Package aims to achieve two outcomes, “policy and investments for digital inclusion” and “digitally empowered women and youth,” to improve digital equity.

In 2022, Work Package 2 made progress in establishing partnerships with government agencies and development organizations across five countries and assessed their needs for enhancing digital equity and empowering end users, especially rural women and youth. To improve the gender responsiveness of digital services, the Work Package initiated the development of a [rapid inclusivity assessment toolkit](#) and the provision of human-centered design clinics. WP2 “trained the female trainers” to enhance women’s [digital skills](#) and [improve champion farmers risk management](#). Work Package 2 demonstrated how the digital gender divide negatively impacts women farmers’ income due to [asymmetries in the access to market price information](#). Work toward the outcome on policy and investments for digital inclusion will begin in early 2023, and efforts will continue to develop a digital inclusivity toolbox for more gender-responsive and socially inclusive digital services.

Collectively, Work Package 2 made progress in establishing partnerships, assessing baselines, and developing components of flagship outputs for gender-responsive and inclusive digital innovation outcomes. Based on this progress, we assess that the Work Package 2 TOC assumptions hold.

Work Package 3: System modeling



Work Package 3 progress against the theory of change

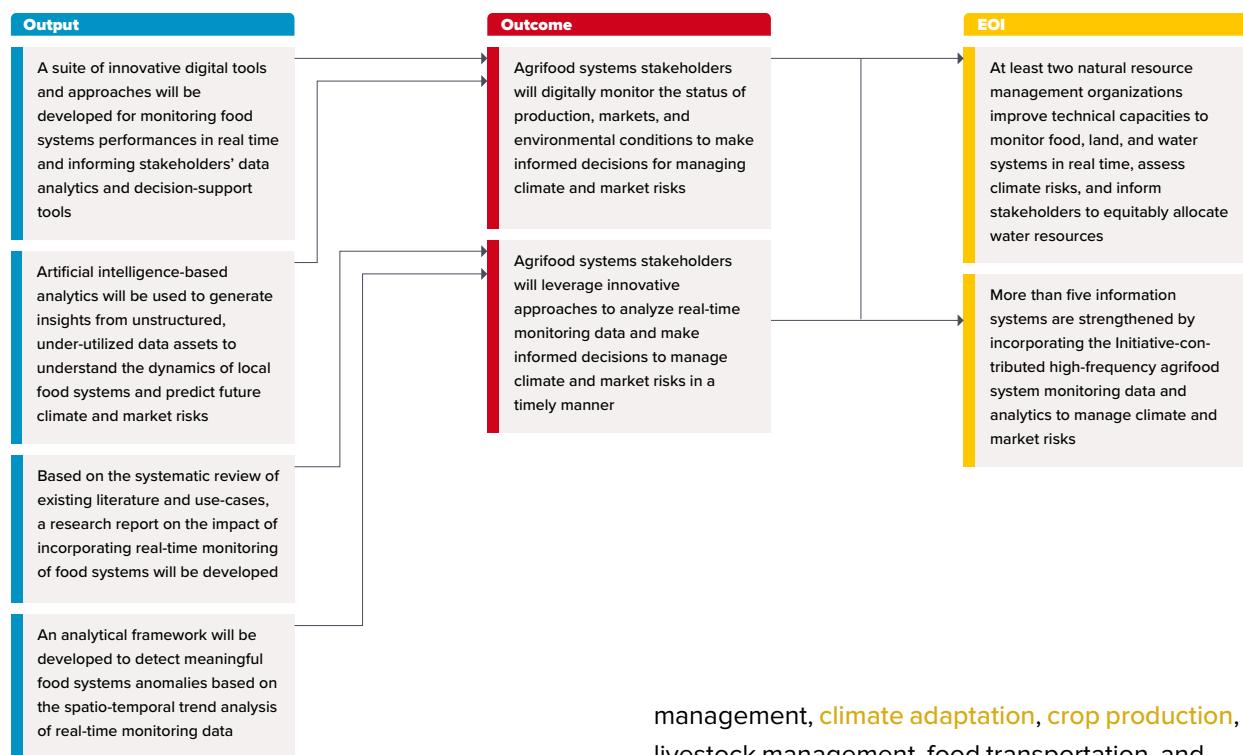
Work Package 3 addresses the inadequate information challenge, guided by the research question “How can information systems improve their services and products to be more timely, accurate, actionable, and inclusive?” Specifically, this Work Package aims to address the challenge by achieving two outcomes, “sustainably managed food, land, and water resources” and “stakeholders’ use of systems modeling approaches,” to support data-driven decision-making.

In 2022, Work Package 3 activities targeted the Limpopo and Inkomati River Basins in Southern Africa and focused on developing the key data and analytical components of the basin-level digital twins. Work Package 3 prioritized the development of digital twins that could address stakeholders’

priority challenges, including **water quality**, **drought**, and environmental flow management in the respective basins. Results include cutting-edge real-time natural resource monitoring tools for sustainable water resource management, such as **drones**, **satellites**, **ground-penetrating radars**, **unmanned surface vehicles**, and **3D modeling of river sections with stream-flow hydraulics**. Additionally, Work Package 3 collaborated with citizen science programs to address groundtruthing data gaps while strengthening local digital innovation capacities with **AI-assisted automations** in **biomonitoring of water quality**. In December 2022, the Limpopo Watercourse Commission developed its four-year “Integrated Transboundary River Basin Management” work plan, which included specific activities informed by Work Package 3’s ongoing work on the monitoring of environmental flows.

Overall, the demand-driven nature of WP3 activities addresses specific technical and capacity challenges presented by natural resource management authorities. We assess that the Work Package 3 TOC assumptions remain valid.

Work Package 4: Real-time monitoring



Work Package 4 progress against the theory of change

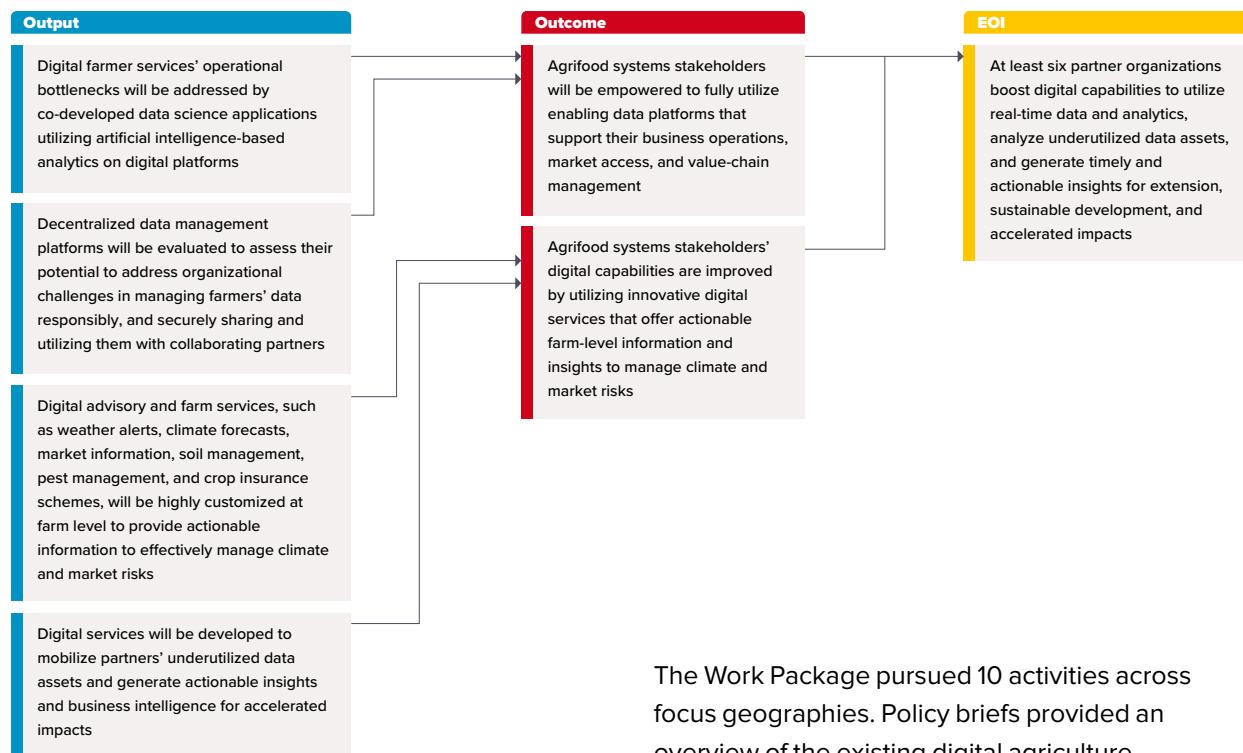
Work Package 4 addresses the inadequate information challenge, guided by the research question “How can information systems improve their services and products to be more timely, accurate, actionable, and inclusive?” Specifically, this Work Package aims to address the challenge by achieving two outcomes, “improved food systems monitoring capabilities” and “timely managed climate and market risks,” using real-time monitoring data to support data-driven decision-making.

In 2022, Work Package 4 focused on developing innovations that can generate timely, actionable insights from improved real-time monitoring data for effectively managing shocks across agrifood systems. These innovations span soil and water

management, **climate adaptation**, **crop production**, livestock management, food transportation, and **food consumption and diet quality**. A total of seven real-time monitoring activities were launched in 2022, with four more planned for 2023. Advanced analytics using machine learning models were employed in most of these activities to analyze real-time data at high frequency. Key results from 2022 include publications on monitoring **diet quality**, **climate adaptations**, and **rice production**. Notably, Work Package 4 scaled CGIAR’s high-frequency agrifood monitoring innovations, initiated under the CGIAR Research Programs, for partners to **track nutrition security in Guatemala** and promote maize farmers’ adoption of sustainable agriculture practices in Mexico.

Work Package 4’s real-time monitoring data and tools will collectively form the basis of digital twin case studies, where the physical state of the target agrifood system is digitally monitored and systematically modeled to support data-driven, timely risk management. We assess that the Work Package 4 TOC assumptions remain valid.

Work Package 5: Platforms and services



Work Package 5 progress against the theory of change

Work Package 5 addresses the limited capabilities challenge, guided by the research question “What capacity-building strategies can be used to enhance the digital skills and capabilities of service providers and users in food, water, and land systems?” Specifically, Work Package 5 aims to achieve two interrelated outcomes: stakeholders’ utilization of “enabling data platforms” and “innovative digital services.”

In 2022, Work Package 5 generated policy briefs, technical papers about existing innovations, capacity development through [in-person training](#), a [diploma course](#), and [webinars](#), as well as letters of intent for establishing collaborative [partnerships](#). These results serve as building blocks that contribute to the achievement of Work Package 5 outcomes.

The Work Package pursued 10 activities across focus geographies. Policy briefs provided an overview of the existing digital agriculture ecosystem and the enabling environment in [India](#), showcasing how different [platforms and services](#) support extension advisory services. Technical reviews and reports produced insights on how improvements and use cases could be further developed to enhance the use and functionalities of selected platforms and [underutilized data](#), including over 100,000 research outputs from CGIAR.

A set of capacity development efforts were introduced to stakeholders and target users across geographies to familiarize them with available, accessible, and transformative digital technologies, such as [drone technologies](#) and [open-source tools](#). These capacity development efforts were designed and implemented to be gender-inclusive, ensuring that over one-third of participants were [women](#).

Through these activities, multiple partnerships and collaborations were established among institutions and other initiatives with complementary capabilities and similar interests. We assess that the Work Package 5 TOC assumptions remain valid.

Work Package progress rating

WORK PACKAGE	TRAFFIC LIGHT / RATIONALE
1	 <ul style="list-style-type: none"> The annual progress of digital impact assessment studies experienced minor delays in 2022, primarily due to procedural setbacks in obtaining permits for household surveys in Kenya and establishing institutional non-disclosure agreements in India.
2	 <ul style="list-style-type: none"> Although most tasks proceeded as scheduled, we encountered delays in acquiring additional expertise and managing the subsequent onboarding processes. Having overcome these obstacles, we anticipate a stronger start and increased momentum in 2023.
3	 <ul style="list-style-type: none"> All systems modeling activities are progressing as planned. A series of progress update reports have been completed on time. Presentations and demonstrations of progress will be made to stakeholders in focus geographies in Q1 2023.
4	 <ul style="list-style-type: none"> All real-time food systems monitoring activities are progressing as planned, drawing on CGIAR's expertise in decision-support systems and scaling for impact. In 2023, project outputs will be integrated into digital twin case studies.
5	 <ul style="list-style-type: none"> All activities related to enabling platforms and services are advancing as planned. Over 20 results have been produced, including policy briefs, technical reports, and capacity-building activities. In 2023, these achievements will contribute to the Initiative flagships across Work Packages.

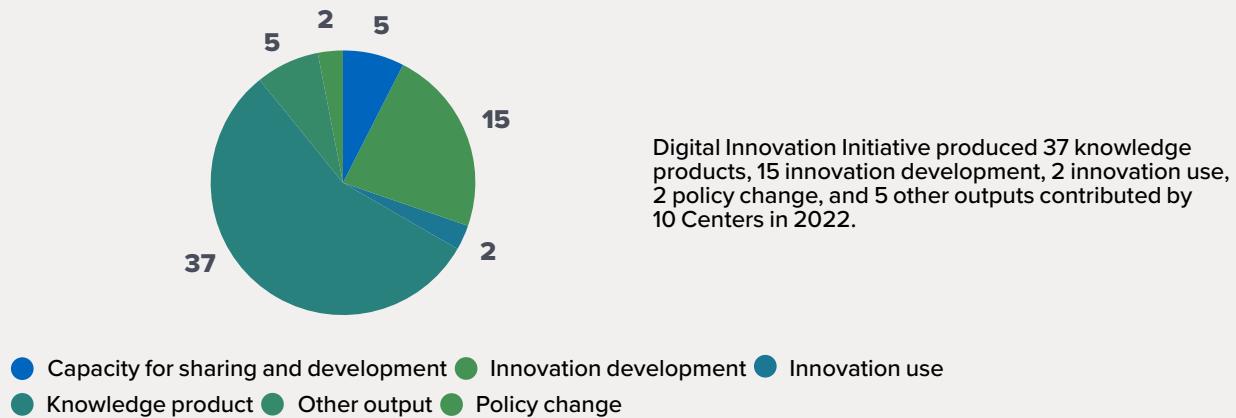
KEY

On track	 <ul style="list-style-type: none"> 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	 <ul style="list-style-type: none"> 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	 <ul style="list-style-type: none"> 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

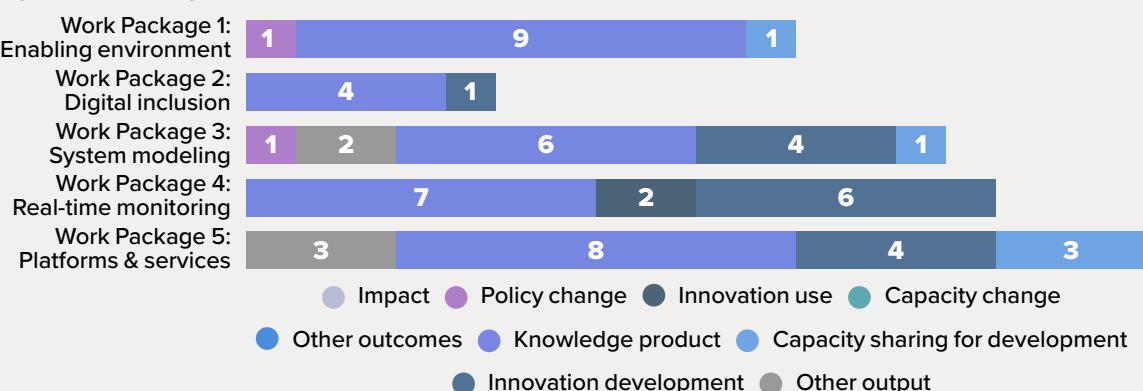
Section 4 Initiative key results

This section provides an overview of 2022 results reported by Digital Innovation. These results align with the CGIAR Results Framework and Digital Innovation's theory of change. Further information on these results is available through the [CGIAR Results Dashboard](#).

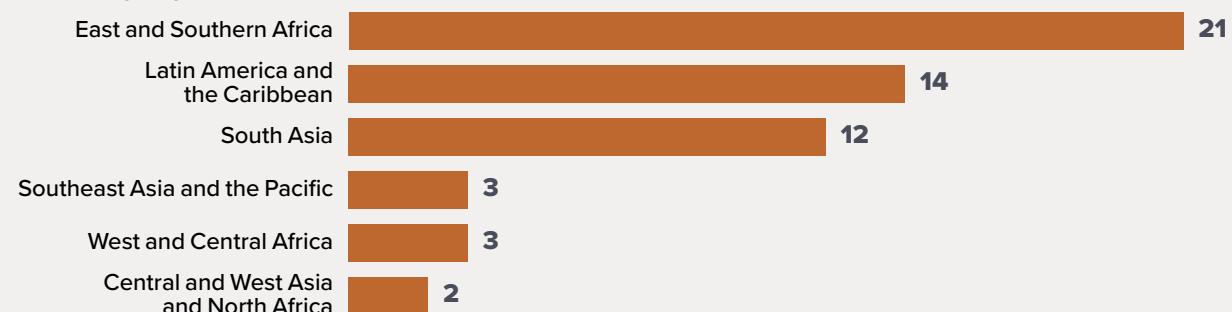
Overview



Results by Work Package

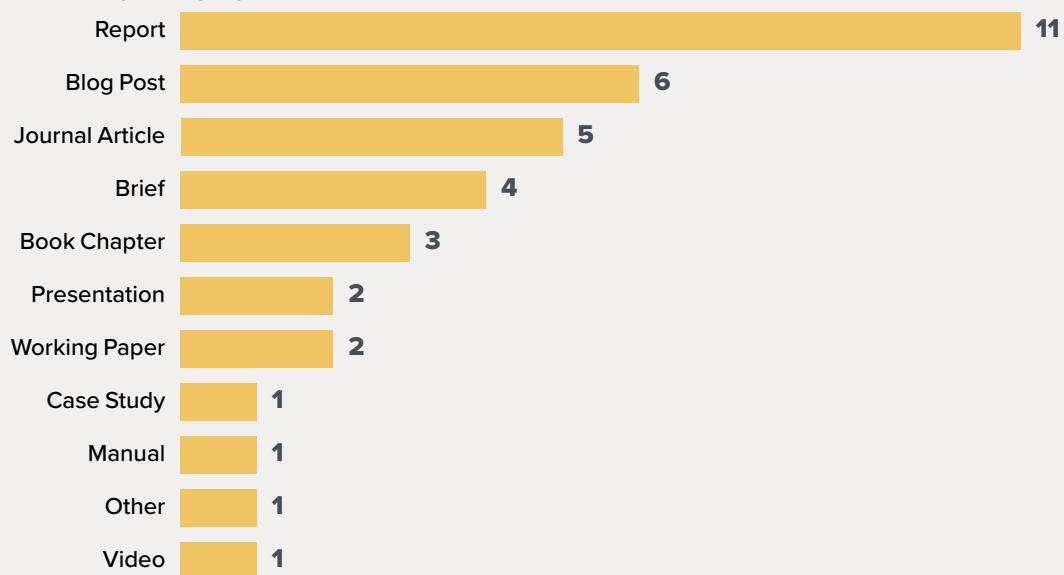


Results by region



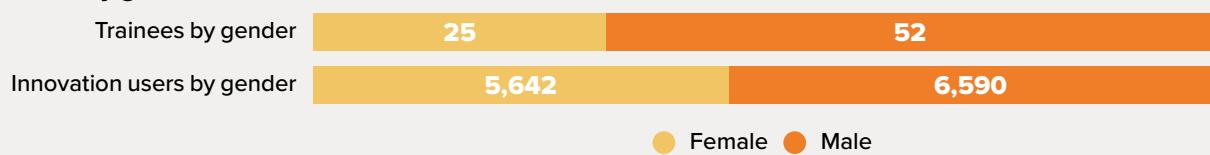
East and Southern Africa (Ethiopia, Kenya, and the Limpopo and Inkomati River Basins in Southern Africa) covered the most number of results, followed by Latin America and the Caribbean (Guatemala), South Asia (India and Bangladesh), Southeast Asia (Indonesia), West and Central Africa (Rwanda), and Central and West Asia and North Africa (Egypt).

Knowledge products by category



Knowledge products included 11 reports, 5 journal articles, 4 briefs, 3 book chapters, and 2 working papers

Trainees by gender



Short-term trainings conducted by six Centers strengthened the technical capacity of 77 people from 20 organizations including government agencies, non-governmental organizations, and academic institutions. Total number of innovation users through the Initiative partners (Kellogg and Nestle) and collaborating Initiatives (AgriLAC Resiliente and Diversification for Resilient Agrifood Systems in East and Southern Africa) have reached over 5,000 women and 6,000 men.

Section 5 Impact pathway integration – External partners



Partnerships and Digital Innovation's impact pathways

The Initiative collaborates with 70 external partners whose expertise and missions align with our TOC. We selected our partners based on their potential contributions toward the EOI outcomes and their alignment with our expertise and values.

We identified our primary demand partners during the proposal development stage, including the Limpopo Watercourse Commission (LIMCOM). We collaborate with LIMCOM to strengthen their technical capacity in the equitable management of natural resources using real-time monitoring and decision-support tools, an area in which CGIAR has extensive expertise. Our partnership also builds on LIMCOM's previous engagement with CGIAR to develop environmental flows in the basin.

Our demand partners also serve as our innovation and scaling partners. We partnered with Farm Radio International to enhance their capacity to engage with rural populations using automated audio analysis tools. This partnership contributes to our outcomes of reducing the digital divide in rural

Women agriculture professionals learning digital data collection and modelling skills in Bali, Indonesia.
Photo credit: Celina Agaton

communities and enhancing rural digital capabilities at scale. We also established partnerships with NARES agencies in Guatemala, Rwanda, Ethiopia, and India to help build their digital capabilities while sharing groundtruthing data to improve the utility and value of our research.

When selecting private sector partners, we prioritized organizations with complementary technical expertise and the synergistic potential to generate global public goods. For instance, we partnered with [Bluenumber](#), a company specializing in digital identities, to pilot a decentralized data management system that allows Mexican farmers to track their data usage. This partnership also offers Bluenumber an opportunity to apply their technology in agrifood systems in the Global South. We also collaborated with [Impact Observatory](#), a satellite-based mapping company, around their open-access global land cover maps, which were independently evaluated as the most accurate by a peer-reviewed journal article.

Section 6 Impact pathway integration – CGIAR portfolio linkages



Portfolio linkages and Digital Innovation's impact pathways

We have a unique strategic partnership with the Digital & Data unit of the [CGIAR System Management Office](#). This collaboration allows us to leverage the expertise and resources of both parties to drive digital innovation in research and digital transformation across the entire CGIAR system, based on the [recommendations](#) made by the [CGIAR Independent Advisory and Evaluation Service](#). Digital & Data leads the design and development of e-infrastructure, analytics platforms, and data management standards to drive CGIAR's institutional digital transformation, while we, Digital Innovation, focus on generating research-based impact evidence, innovations, and case studies toward timely decision-making across food, land, and water systems. Together, we aim to deliver on the goal of "Making the digital revolution central to the way CGIAR works," as called for in the [CGIAR 2030 Research and Innovation Strategy](#).

We jointly engaged with 18 Initiatives to identify opportunities for coordinating their digitally enabled research activities and synergizing their efforts.

Researchers from IFPRI, CIMMYT, the Alliance of Bioversity International and CIAT, and IITA participating in the drone training in Tanzania. Photo credit: Tanzania FlyingLabs

Most of these engagements began during the Initiative design stage in 2021, and these continued in 2022 with more targeted approaches. For instance, while Digital & Data is leading the engagement with the Market Intelligence Initiative to support the development of the Market Intelligence Dashboard using a human-centered design approach, engagements with Regional Integrated Initiatives (RIIs) such as AgriLAC Resiliente, Diversification in East and Southern Africa, and Transforming Agrifood Systems in South Asia have been led by Digital Innovation to coordinate on digital impact assessments and digital twin case studies with closely aligned TOC in the shared focus geographies.

Additionally, in collaboration with the Excellence in Agronomy Initiative, we have jointly initiated the development of an AI-and large language model-based agricultural knowledge search and summarization tool. This tool aims to facilitate digital extension services' utilization of over 100,000 research outputs in [CGSpace](#) and [GARDIAN](#).

Section 7 Adaptive management

RECOMMENDATION	SUPPORTING RATIONALE
Integrate real-time data into unified modeling frameworks to create digital twin case studies in focus geographies.	A stronger connection between Work Package 3 (Modeling) and Work Package 4 (Monitoring) will be essential for delivering effective and practical digital twin case studies and achieving outcomes.
Demonstrating the impact of data-driven decisions in equitable partnerships with NARES agencies.	In 2022, our results showcased the potential of diverse pilots for creating positive outcomes. To further contribute to the transformation of agrifood systems, we should aim to work at scale, gathering solid evidence to demonstrate the utility and impact of these approaches at local levels.
Collaborate with digital farmer services in India to develop joint studies evaluating gender strategies' efficacy, aiming to digitally empower women for positive outcomes.	During our 2022 stakeholder interactions, we observed a general agreement on the existence of a gender digital divide in India. However, digital farmer service providers, particularly in the private sector, lack motivation to tackle this issue unless it is proven profitable. We will research to design the win-win benefits of digital gender and inclusion strategies.
Conduct research exploring methods for responsible AI-based analytics to generate scientifically robust and actionable insights.	We have created promising pilots showcasing the potential of AI to tackle data and decision-making challenges. It is crucial to clarify the role of AI, convey its limitations, and present roadmaps to enhance its scientific accuracy, transparency, and reproducibility.
Narrow the geographical focus to Guatemala, Kenya, India, and the Limpopo River Basin.	As we collaborated more closely with other Initiatives and partners, our activities extended to over 15 countries. Going forward, we will prioritize working in four key locations where we have established equitable partnerships with key local stakeholders, in collaboration with RIs.
Organize the Initiative's activities around flagships ¹ , without being constrained by organizational structures.	While we have made efforts to enhance coordination and communication throughout the Initiative, our activities have been primarily organized within individual Work Packages. Moving forward, we will encourage the Initiative team members to better coordinate activities around three flagship outputs: the digital knowledge hub, digital twins, and the digital inclusivity toolbox.
Leverage the ICT for Agriculture conferences to engage with digital innovators and foster impact-driven South–South collaborations that bolster local digital innovation ecosystems.	The United States Agency for International Development has granted us the opportunity to organize the ICT for Agriculture conferences in 2023–2024, bringing together digital innovators, researchers, and practitioners from around the world to exchange knowledge and explore collaboration possibilities. This effort will contribute to achieving multiple EOI outcomes.

¹ Annex 1: [Digital Innovation Flagships](#)

Section 8 Key result story



Artificial Intelligence enables extension services reaching 12 million farmers in sub-Saharan Africa to respond to farmers' voices

Radio is ubiquitous in the Global South, and it is a vital source of timely agronomic information for farmers in rural Africa, where one extension worker covers more than 4,000 farmers. **Farm Radio International (FRI)** supports over 700 radio shows in 40 countries across sub-Saharan Africa to broadcast discussion between experts, including CGIAR scientists, on locally relevant issues. FRI also receives voicemails so that it can provide locally relevant information. To overcome the challenge of listening and analyzing the overwhelming volume of voicemails, FRI has partnered with CGIAR to develop an AI-based solution to automatically extract insights from over 12 million listeners. This is contributing to reducing the digital divide in rural Africa.

A woman in Sikilo village with her radio. In Senegal, climate forecasts and farming advisories are now available to more than 7 million rural people, via community radio stations.

Photo credit: V. Meadu (CCAFS)

Agronomic extension can be much more effective when it makes use of farmers' knowledge and takes account of their needs and perspectives. Farmers themselves have a lot to say, and listening to them could enable much more effective extension. To this end, FRI has developed the Uliza system, which allows over 12 million listeners to call a number advertised during a show, which is then returned free of charge, allowing them to answer multiple-choice questions and leave a voice response to an open-ended question. The result is a huge repository of farmers' knowledge and perspectives, disaggregated by age, gender, and country. Through one radio program, "On Air Dialogues," for example, FRI received more than 12,000 responses, and 30% of calls were made by women. In their own words, farmers answered open questions such as "If you had the power to change

things, what would you do to make a better life for farming families?" The project demonstrated that farmers have a lot to say, but analyzing and transcribing the large volume of calls has proved to be a challenge. About 90% of farmers' responses were not analyzed and utilized in a timely manner.

To address this challenge, FRI has teamed up with the CGIAR Digital Innovation Initiative to create

an automated solution that can rapidly analyze the content of voice messages and respond to farmers' queries on air without the need for FRI staff to listen to each message individually. In 2022, using a human-centered design approach, the Initiative team identified FRI's requirements and developed an initial prototype solution using a sample of audio data.

“ CGIAR’s innovative AI-based solution will empower Farm Radio to include millions of farmers in the conversation. By hearing each farmer’s voice, we can gain a deeper understanding of their perspectives and priorities. This valuable insight will lay the foundation for future projects with Farm Radio, ultimately enhancing our impact.”

— Karen Hampson, Senior Manager (Program Development), Farm Radio International

The new solution, [published as a Technical Report](#), combines machine learning approaches in transfer learning, unsupervised learning, and corpus linguistics. The audio analytics approach typically relies on machine learning models trained using large databases of speech that have been manually analyzed and labeled. These databases do not exist for the majority of the 2,000 languages spoken in Africa, and the models would also struggle with local dialects, vocabulary, and speech patterns. The transfer learning method has addressed this data issue by first training a machine learning model based on a well-known language and then fine-tuning for local languages with a small amount of labeled data in the target language, resulting in an effective speech recognition tool. When applied to the FRI audio archive, the new prototype model, based on the fine-tuned XLR-S speech recognition model, outperformed other

open-source speech recognition tools in both Swahili and Hausa.

Moving forward, the team will work on improving the transcription accuracy of the local languages by further fine-tuning the model with the full FRI audio archive. In 2023, the team aims to apply the solution to FRI's new project, [On-Air for Gender-Inclusive Nature-based Solutions](#), which addresses climate change and biodiversity loss issues through targeted radio programs broadcast from 220 stations across 38 sub-Saharan African countries. The Initiative will provide on-site capacity-building exercises for radio show hosts to familiarize them with the new solution. In 2024, the team plans to conduct a field study focused on evaluating the combined impact of radio shows and the automated tools on listeners' food security, gender equality, and livelihood outcomes.

LINKS TO IMPACT AREAS	GEOGRAPHIC SCOPE
<p>Primary Impact Area: Poverty Reduction, Livelihoods, and Jobs</p>  <p>Other relevant Impact Area(s): Nutrition, Health, and Food Security; Gender Equality, Youth, and Social Inclusion; Climate Adaptation and Mitigation; Environmental Health and Biodiversity</p>     <p>Which collective global targets for the relevant Impact Area(s) from the CGIAR 2030 Research and Innovation Strategy does the key result contribute to?</p> <ul style="list-style-type: none"> • End hunger for all and enable affordable healthy diets for the 3 billion people who do not currently have access to safe and nutritious food. • Lift at least 500 million people living in rural areas above the extreme poverty line of US\$1.90 per day (2011 PPP). • Close the gender gap in rights to economic resources, access to ownership of, and control over land and natural resources, for over 500 million women who work in food, land, and water systems. • Equip 500 million small-scale producers to be more resilient to climate shocks, with climate adaptation solutions available through national innovation systems. • Stay within planetary and regional environmental boundaries: consumptive water use in food production of less than 2,500 km³ per year (with a focus on the most stressed basins), zero net deforestation, nitrogen application of 90 Tg per year (with a redistribution toward low-input farming systems) and increased use efficiency, and phosphorus application of 10 Tg per year. 	<p>Region(s): Sub-Saharan Africa Country/ies: Kenya, Nigeria, Tanzania, Uganda</p> <p>Contributing Initiative(s): Digital Innovation Contributing Center(s): CIMMYT (Primary), IFPRI Contributing external partner(s):</p> <ul style="list-style-type: none"> • University of Nottingham; Farm Radio International <p>CGIAR Platform for Big Data in Agriculture</p>
References	References
	<ol style="list-style-type: none"> 1. Jones-Garcia, Eliot. 2022. <i>Speech recognition, machine translation, and corpus analysis for identifying farmer demands and targeting digital extension</i>. CGIAR Technical Report International Maize and Wheat Improvement Center (CIMMYT). https://hdl.handle.net/10568/127005 2. Jones-Garcia, E., G. Kruseman, and B. Brown. 2021. <i>Emotion classification and sentiment analysis for sustainable agricultural development: exploring available tools for analyzing African farmer interviews</i>. CIMMYT Integrated Development Program Discussion Paper. https://hdl.handle.net/10883/21789 <p>COVER PHOTO: A field technician uses Rice Crop Manager, a software developed by IRRI, to get real-time recommendations on his plot. Photo credit: I. Serrano/IRRI</p>



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