CGIAR

INITIATIVE ON
Digital Innovation

A workshop in Bali, Indonesia focused on enabling people from local communities, especially women, to use digital tools and techniques.

Credit: Open Knowledge Kit (OK Kit)

CGIAR Research Initiative on
Digital Innovation

Annual Technical Report 2024

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The Artificial Intelligence (AI) software ChatGPT was used to support the editing of parts of this report, specifically to improve clarity, grammar, and style. ChatGPT was not used to generate the content of the report. All edits made with AI assistance were reviewed and validated by the authors to ensure accuracy, coherence, and alignment with the original intent.

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CGIAR Technical Reporting 2024

CGIAR Technical Reporting has been developed in alignment with CGIAR's Technical Reporting Arrangement. This annual report ("Type 1" Report) constitutes part of the broader CGIAR Technical Report. Each CGIAR Research Initiative/Impact Platform/Science Group Project (SGP) submits an annual "Type 1" Report, which provides assurance on progress towards end of Initiative/Impact Platform/SGP outcomes.

As 2024 marks the final year of this CGIAR Portfolio and the 2022-24 business cycle, this Type 1 Report takes a dual approach to its analysis and reporting. Alongside highlighting key achievements for 2024, the report also provides a cumulative overview of the 2022-24 business cycle, where relevant. This perspective captures the evolution of efforts over the three-year period. By presenting both annual and multi-year insights, the report underscores the cumulative impact of CGIAR's work and sets the stage for the transition to the 2025-30 Portfolio.

The 2024 CGIAR Technical Report comprises:

- **Type 1 Initiative, Impact Platform, and SGP Reports:** These annual reports present progress towards end of Initiative/Impact Platform/SGP outcomes and provide quality-assured results accessible via the CGIAR Results Dashboard.
- **Type 3 CGIAR Portfolio Practice Change Report:** This report provides insights into CGIAR's progress in Performance Management and Project Coordination.
- **Portfolio Narrative:** Drawing on the Type 1 and Type 3 reports, as well as data from the CGIAR Results Dashboard, the Portfolio Narrative synthesizes insights to provide an overall view of Portfolio coherence. It highlights synergies, partnerships, country and regional engagement, and collective progress.
- **Type 2 CGIAR Contributions to Impact in Agrifood Systems: evidence and learnings from 2022 to 2024:** This report offers a high-level summary of CGIAR's contributions to its impact targets and Science Group outcomes, aligned with the Sustainable Development Goals (SDGs), for the three-year business cycle.

The Portfolio Narrative informs the 2024 CGIAR Annual Report – a comprehensive summary of the organization's collective achievements, impacts, and strategic outlook.

Elements of the Type 2 report are integrated into the CGIAR Flagship Report, released in April 2025 at CGIAR Science Week. The Flagship Report synthesizes CGIAR research in an accessible format designed specifically to provide policy- and decision-makers at national, regional, and global levels with the evidence they require to formulate, develop, and negotiate evidence-based policies and investments.

The diagram below illustrates these relationships.

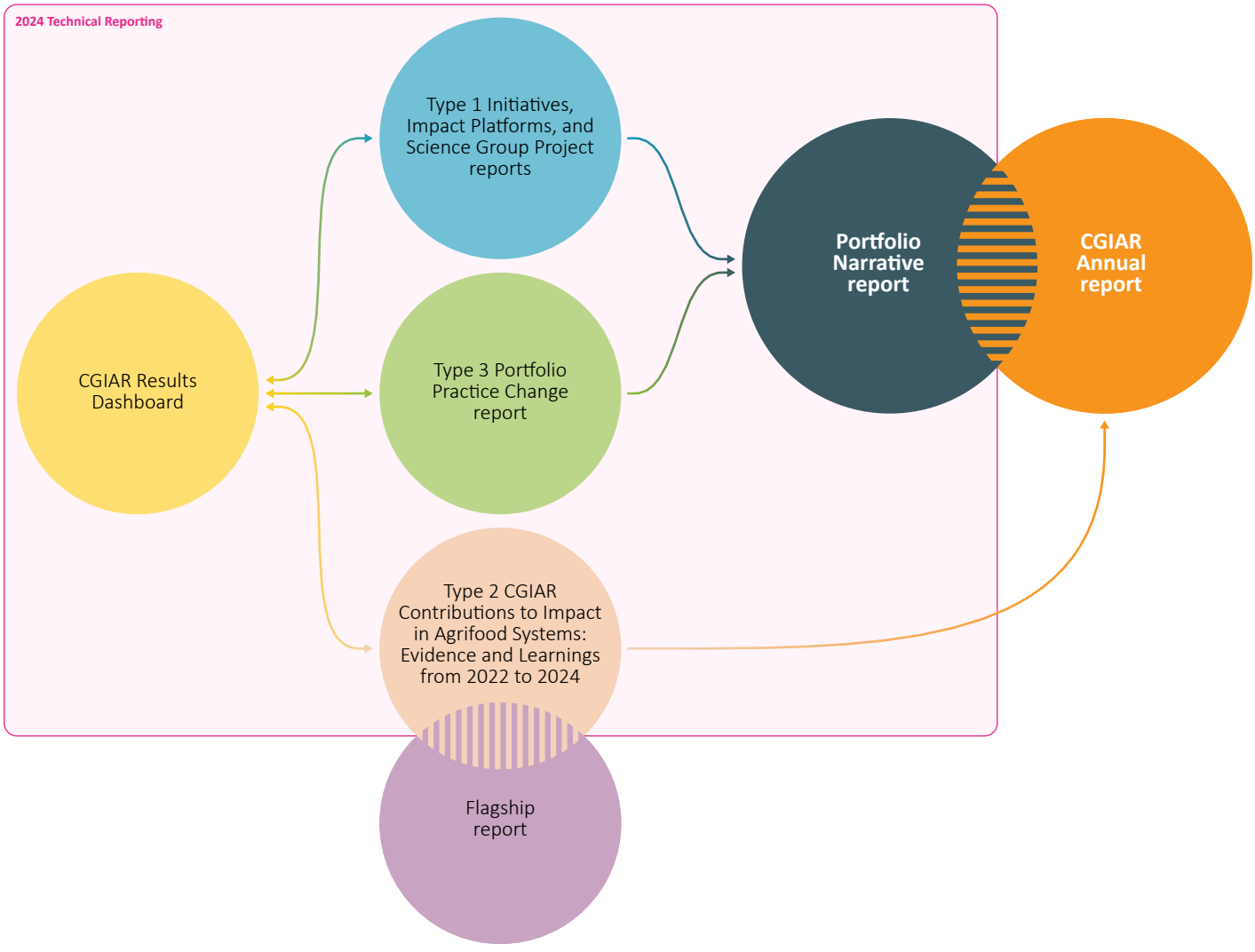


Figure 1. CGIAR's 2024 Technical Reporting components and their integration with other CGIAR reporting products.

Section 1: **Fact sheet, executive summary and budget**

Initiative name	Digital Innovation and Transformation
Initiative short name	Digital Innovation
Initiative Lead	Jawoo Koo- j.koo@cgiar.org
Initiative Co-lead	Andrea Gardeazabal- a.gardeazabal@cgiar.org
Science Group	Systems Transformation
Start – end date	01 April 2022 – 31 December 2024
Geographic scope	**Countries** Bangladesh · Botswana · Egypt · Ghana · Guatemala · India · Indonesia · Kenya · Malawi · Mexico · Mozambique · Nepal · Rwanda · South Africa · Zimbabwe
OECD DAC Climate marker adaptation score[1]	**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[1]	**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[2]	**Score 1B: Gender responsive** On the 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 indicators and monitors participation and differential benefits of diverse men and women.
Website link	https://www.cgiar.org/initiative/digital-innovation/

[1] 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.
[2] 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.

EXECUTIVE SUMMARY

The CGIAR Research Initiative on Digital Innovation was established in 2022 with the goal of generating research-based evidence and innovative digital solutions with the potential to accelerate transformation toward sustainable and inclusive agrifood systems.

After three years, the Initiative has outperformed across all planned outcomes, and in the process demonstrated how CGIAR can support stakeholders to overcome challenges that prevent the digital transformation of food, land, and water systems from being realized in the global South.

Challenge area 1: Weak information systems mean that available information is inadequate or does not reach those who need it most.

In Southern Africa, the Initiative demonstrated how a "Digital Twin" of a regional-scale ecosystem can be created with stakeholders to address weak information systems. In Odisha Sate, India, agricultural advisory services were expanded to 6,000 farmers. In Kenya, livestock market intelligence services were expanded to 4,000 pastoralists. In Rwanda and Guatemala, a crowdsourced approach to create real-time data on diet quality was applied, filling data gaps for decision-makers at a fraction of the cost of other approaches. In Mozambique, the Initiative worked with the government to create an alternative source of agricultural production statistics using satellite imagery.

Challenge area 2: The digital divide means that digital technologies and infrastructure do not meet people's needs, especially women and rural populations.

Through an Inspire Challenge program, the Initiative worked with five organizations to increase women's use of digital agricultural services, showing how a human-centered-design approach can be used to ***overcome the digital divide***. A new tool was created for agricultural service providers to improve the inclusivity of their digital services, while artificial intelligence (AI) was used to support Farm Radio International to automatically translate, transcribe, and analyze phone calls from farmers speaking Swahili and Luganda.

Challenge area 3: Digital literacy and skill levels across the global South remain low, particularly for marginalized and food-insecure individuals and groups such as women.

The Initiative created digital tools, participatory platforms, and partnerships to address low levels of digital literacy and skills. Hosting two annual ICTforAg conferences and establishing the ICTforAg Learning Network meant that 800 stakeholders were engaged by the Initiative. Fully digital agricultural plots and ranches were established in Guatemala and Kenya to accelerate the development of digital capacities and locally adapted innovations. AI applications to lower the bar to access technologies were also explored, such as in the Water CoPilot interface to the Digital Twin in the Limpopo River Basin and in a data collection app for citizen scientists with automatic machine-learning verification of records.

These examples are among at least 20 use cases generated by the Initiative, along with 60 new innovations, 236 knowledge products, and 95 other outputs, resulting in 28 cases of innovation adoption, 16 cases of policy change, and 14 other outcomes. The Initiative provided direct training to 2,533 people (31 percent women when reported) in formats from diploma courses for agricultural professionals to WhatsApp-based courses aimed at farmers, as well as 45 cases of capacity sharing.

Working with 250 partners in 47 countries (see Section 5 on Partnerships for details), the Initiative showed the importance of strategic partnerships across public, private, research, and international sectors. Public-sector collaborations facilitated an enabling environment for digital technologies while private-sector partnerships helped bridge research innovations with market-driven solutions. Research institutions ensured scientific rigor, and international organizations fostered knowledge exchange and funding. NGOs contributed to inclusivity and social impact, particularly in gender-inclusive services and digital literacy. This multi-sectoral approach enabled the successful deployment of digital innovations, strengthened research capacities, and scaled impactful solutions, laying the foundation for sustainable transformation in agriculture and food systems.

	2022	2023	**2024**
PROPOSAL BUDGET	$9.00M	$10.00M	**$9.00M**
APPROVED BUDGET [1]	$4.82M	$4.94M [2]	**$4.65M** [2]

[1] The approved budget amounts correspond to the figures available for public access through the Financing Plan dashboard.
[2] These amounts include carry-over and commitments.

Trainees at a workshop in Bihar, India explore Agrotutor: an AI-powered digital tool designed to improve the livelihoods of smallholder farmers in the Global South. Credit: CIMMYT

Section 2: **Progress towards End of Initiative 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.

CHALLENGE STATEMENT

Our food system is unsustainable: in 2020, 720–811 million people faced hunger, yet one-third of food produced was wasted. Digital technologies have transformative potential to shift food, land, and water systems toward climate resilience and sustainability, but significant challenges persist.

1. Digital divide: Access to digital technologies is uneven, particularly in the Global South, where rural areas and women are underserved. More than 600 million people live outside of mobile network coverage, with 67 percent in sub-Saharan Africa. Only 13 percent of small-scale farmers in sub-Saharan Africa have accessed digital services, and women across low- and middle-income countries are 15 percent less likely to use mobile internet than men. Infrastructure gaps exacerbate this divide, with rural deployment costs up to five times higher than in urban areas, generating far less revenue. Policymakers and investors often lack alignment to address these disparities.
2. Inadequate information: Real-time monitoring of food, land, and water systems is increasingly feasible, yet decision-makers lack timely, reliable, and actionable data. Weak information systems perpetuate inefficiency, poverty, and economic stagnation. More than 300 million small-scale producers lack access to digital climate advisory services, hindering their ability to adopt improved technologies and manage risks. Fragmented data systems and inadequate coordination among public, private, and civil society actors limit evidence-based policy responses to challenges such as price shocks, pests, and climate risks.
3. Limited digital capabilities: Technological investments must be matched with efforts to build digital literacy and skills, especially among marginalized groups such as women. Social norms often limit women's access to technology, and digital literacy remains low in the Global South. Promising digital tools exist, but further research, codesign, and capacity strengthening are needed to deliver tailored, actionable insights for stakeholders managing food, land, and water systems.

Addressing these challenges is critical to realizing the full potential of digital solutions for sustainable and equitable food systems.

RESEARCH QUESTIONS

1. Digital Divide
   - What are the impacts of investments in digital infrastructure on inclusion, poverty reduction, food security, and jobs?
   - How can public-private partnerships drive sustainable and impactful digital innovation in rural areas?
   - What strategies can increase women's participation in digital ecosystems and address barriers to their access to digital advisory services?
2. Inadequate Information
   - How can real-time data and advanced analytics improve decision-making for disaster preparedness, market resilience, and sustainable agrifood systems?
   - What digital technologies can deliver locally relevant, actionable, and timely information to enhance agricultural productivity and sustainability?
   - How can high-frequency agrifood system monitoring data support resilience to climate and market shocks?
3. Limited Digital Capabilities
   - How can digital literacy and capacity-building initiatives empower marginalized groups, especially women and rural communities?
   - How can data platforms and digital services be sustainably maintained and improved to support timely and inclusive decision-making?
   - How can digital advisory services be tailored to be more localized, actionable, and inclusive for effective climate risk management?

SPHERE OF **CONTROL**

WORK PACKAGES

WORK PACKAGE 1
Enabling Environment.

WORK PACKAGE 2
Digital Inclusion.

WORK PACKAGE 3
System Modeling.

WORK PACKAGE 4
Real-time Monitoring.

WORK PACKAGE 5
Platforms & Services.

SPHERE OF **INFLUENCE**

End-of-Initiative Outcomes

End-of-Initiative Outcome 1
Strengthened digital ecosystems.

End-of-Initiative Outcome 2
Gender-responsive services.

End-of-Initiative Outcome 3
Improved digital skills.

End-of-Initiative Outcome 4
Equitable resource allocations.

End-of-Initiative Outcome 5
Strengthened information systems.

End-of-Initiative Outcome 6
Strengthened organizational capabilities.

Action Area Outcomes

Systems Transformation

1 · National and local multi-stakeholder platforms are strengthened to become more effective and sustainable, addressing development trade-offs and generating strategies for effective food, land, and water systems transformation.

2 · Research institutions, government analytical units, and scaling partners in the Global South have improved knowledge, skills, access to data, capacity to develop tools, innovations, and undertake research to support transformation of food, land and water systems contributing to livelihood, inclusion, nutrition, environmental and climate objectives.

3 · Global and regional institutions, such as funding agencies, international organizations, and coordinating bodies use CGIAR research evidence in the development of strategies, policies, and investments to drive sustainable transformation of food, land, and water systems contributing to livelihood, inclusion, nutrition, environmental and climate resilience objectives.

4 · CGIAR-NARS-SME networks use market segments, target product profiles to orient variety development and deployment towards those that provide larger scale benefits across the 5 Impact Areas.

5 · Implementation partners (e.g. NARES, NGOs, private companies) actively support dissemination, uptake, and implementation of CGIAR innovations.

SPHERE OF **INTEREST**

Impact Areas

Nutrition, Health & Food Security

- End hunger for all and enable affordable health diets for the 3 billion people who do not currently have access to safe and nutritious food.

Poverty Reduction, Livelihoods & Jobs

- Reduce by at least half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.
- Lift at least 500 million people living in rural areas above the extreme poverty line of US $1.90 per day (2011 PPP).

Gender Equality, Youth & Social Inclusion

- Offer rewardable opportunities to 267 million young people who are not in employment, education, or training.
- Close the gender gap in rights to economic resources on, access to ownership of, and control over land and natural resources, for more than 500 million women who work in food, land, and water systems.

Climate Adaptation & Mitigation

- Implement all National adaptation Plans (NAP) and Nationally Determined Contributions (NDC) to the Paris Agreement.
- Equip 500 million small-scale producers to be more resilient to climate shocks, with climate adaptation solutions available through national innovation systems.

Environmental Health & Biodiversity

- Stay within planetary and regional environmental boundaries: consumptive water use in food production of less than 2500 km3 per year (with a focus on the most stressed basins), zero net deforestation, nitrogen application of 90 Tg per year (with redistribution towards low-input farming systems) and increased use efficiency, and phosphorus application of 10 Tg per year.

GroundTruth staff Nkosingithandile Sithole, Ayanda Lephane and Nick Pattinson (l-r) field test the MiniSASS citizen science smartphone app. Credit: GroundTruth

Summary of progress against the theory of change

Over the past three years, CGIAR's Initiative on Digital Innovation gathered substantial evidence demonstrating both the potential and the risks of using digital technologies to transform food, land, and water systems. Since 2022, we systematically assessed how digital solutions could address structural challenges, such as inadequate information systems, persistent digital divides, and limited digital literacy, particularly in low- and middle-income countries. Through diverse use cases, this work provided insights into what worked, what did not, and what required further refinement to ensure effective and equitable digital transformation.

Research and implementation efforts focused on five key outcomes: strengthening ecosystems, improving digital skills, enabling equitable resource allocation, promoting gender-responsive services, and developing robust information systems. Across these areas, substantial evidence from multiple digital tools and platforms documented successes and limitations that provided critical lessons for scaling digital solutions in agrifood systems.

Strengthening digital ecosystems was a central objective. ICT for Agriculture (ICTforAg) conferences played a pivotal role by convening farmers, researchers, policymakers, technology developers, and private-sector actors to exchange knowledge and forge partnerships. Evidence from ICTforAg events in Kenya, Mexico, and India confirmed their effectiveness in breaking silos and fostering interdisciplinary collaboration. Participants reported increased organizational visibility, expanded networks, and enhanced opportunities for cross-border learning. Kuza Biashara, an enterprise engaging over 1 million farmers and 5,000 agricultural entrepreneurs across 6 countries, experienced a surge in website traffic and inquiries after participating in ICTforAg conferences, signaling heightened interest in digital agricultural solutions. However, tracking direct implementation of ideas presented at these conferences proved challenging, though follow-ups indicated that participants adapted insights gained to refine their projects and strategic plans.

Improving digital literacy was another priority. The Digital Agriculture Diploma Program, developed in collaboration with AgriLAC Resiliente, trained 52 professionals from government institutions, academia, and cooperatives in the Central American Dry Corridor. Assessments showed that 59 percent of participants rated their digital skills as medium and 41 percent as high after the program, compared to only 13 percent before. This Initiative led to the creation of the Digital Agriculture Living Lab in Chiquimula, Guatemala, where professionals applied digital tools such as in-situ sensors, soil moisture monitoring systems, and weather stations to support precision agriculture.

Additionally, the ICTforAg Learning Network played a crucial role in bridging digital literacy gaps. Launched in early 2024, the network engaged 795 registered users, including researchers, agribusiness professionals, and extension workers, in structured discussions, mentorship, and skill-building exercises. The platform featured an Innovation Showcase with 72 digital solutions, a Virtual Collaborative Space supporting 11 active partnerships, and a Mentors Connect program with 30 experts. AgroTutor Academy provided digital literacy training via online courses and WhatsApp-based learning modules, attracting an average of 21 daily visitors and increasing engagement with AI-driven advisory tools. Challenges included inconsistent mentor-mentee interactions and the need for more region-specific content tailored to diverse farming systems.

The assessment of digital innovations for equitable resource allocation provided critical insights. A major breakthrough came with the development of Digital Twins, which provided real-time monitoring and modeling capabilities for food, land, and water management. The Digital Twin for the Limpopo River Basin aggregated data from 1,408 hydrological channels, 305 discharge stations, and 303 rainfall stations across Mozambique, Botswana, South Africa, and Zimbabwe. The platform's AI-driven WaterCopilot enabled stakeholders to make informed water management decisions. Evidence confirmed that these models enhanced decision-making by integrating diverse datasets, yet challenges remained in ensuring equitable data access across countries with various technical capacities and regulatory landscapes. Improved data-sharing frameworks and cross-border governance mechanisms were identified as key areas for further work.

Beyond Digital Twins, AI-powered solutions played an increasing role in agricultural advisory services. Automatic Speech Recognition (ASR) technology demonstrated potential for bridging literacy

gaps by enabling voice-to-text transcriptions for farmers using mobile devices. The Initiative played a key role in supporting the development of Longa, an end-to-end ASR tool designed for Bantu languages, in collaboration with Farm Radio International (FRI). This tool transcribed and translated voice messages in Swahili and Luganda, allowing farmers to engage with radio advisory programs more effectively. The Initiative facilitated technical development, fine-tuning models for low-resource languages and improving transcription accuracy by 10 percent in Luganda speech recognition. As a result, FRI secured additional funding from external sources to scale Longa's deployment across several African countries. By incorporating multiple African languages and dialects, the ASR system enabled two-way communication, allowing smallholder farmers to receive and provide feedback on agronomic recommendations. The success of this collaboration underscored the importance of AI-driven tools tailored to the linguistic and digital realities of smallholder communities, ensuring equitable access to information.

Gender inclusion was another focal research objective, with a particular emphasis on ensuring digital solutions addressed systemic inequalities. The Inspire Challenge program successfully expanded gender-responsive advisory services, reaching 61,728 women and 105,230 youth through four service providers. The Challenge winners — WomBees, Innovakit, Climate-Smart Coffee, and Agroconsultas — implemented strategies to increase women's participation in agrifood systems. WomBees trained 383 women beekeepers and developed the BEEKIND app, delivering training in vernacular languages and facilitating access to loans. Innovakit enrolled 271 women in digital financial literacy programs and secured over 300 million pesos in financing for women-led agribusinesses. Agroconsultas increased the number of female users submitting queries on its advisory platform from 41 to 89 within a year.

The Multidimensional Digital Inclusiveness Index (MDII) addressed structural challenges limiting gender equity in digital agriculture. The MDII assessed inclusiveness in digital innovations, identifying gaps in accessibility, stakeholder relationships, and social impacts. While gender-responsive digital solutions expanded market access and improved advisory services, barriers such as digital illiteracy, device affordability, and socio-cultural norms continued to restrict women's participation. In Bangladesh, only 2.3 per cent of surveyed women had received training in internet-based applications, compared to 15.4 percent of men. Moreover, 79.1 percent of women lacked access to smartphones, relying instead on friends and family for digital information. These findings underscored the necessity of holistic interventions that combine digital inclusion strategies with broader social policies to dismantle systemic inequalities.

Further research examined the role of robust information systems in improving decision-making. Digital platforms such as MiniSASS, Enviro-Champs, Meghdoot, KAZNET, and e-Agrology demonstrated how advanced data collection and analytics enhanced efficiency, transparency, and accessibility. MiniSASS, an AI-powered water quality monitoring tool, saw user engagement grow from 55 submissions in 2023 to 547 in 2024. Meghdoot, which provided crop-specific weather advisories, expanded its reach to 313,288 registered farmers across 650 agricultural districts in India. AI-driven analytics significantly improved advisory services on these platforms. Meanwhile, e-Agrology standardized agronomic data collection and published ten years of agronomic data, providing a replicable model for cross-border data harmonization. However, challenges persisted in ensuring data interoperability, managing privacy concerns, and securing long-term funding for digital information systems.

A student at University Center East (CUNORI) in Guatemala demonstrates the digitized irrigation system they designed as part of the Digital Agricultural Plot project with CIAT.

Credit: CIAT.

These findings reinforce the necessity of continuing to gather evidence and using IT to iteratively design, deploy, and scale digital solutions for food, land, and water system transformation. Digital innovations must be rigorously tested across diverse contexts, with lessons continuously integrated into future developments. Investing in research, multi-stakeholder collaboration, and policy alignment will be critical to ensuring that digital tools effectively address systemic challenges while minimizing risks. Only by maintaining a cycle of evidence-based adaptation and scaling can digital transformation contribute meaningfully to more resilient and inclusive agrifood systems.

Progress against End of Initiative Outcomes

This infographic provides a concise summary of the Initiative's progress toward achieving its Theory of Change End-of-Initiative outcomes for the 2022-2024 period. By drawing on reported results, it offers a comprehensive synthesis of progress made against the established outcome targets, highlighting the Initiative's overall impact and key achievements at the conclusion of this three-year cycle.

EOIO 1

Strengthened digital ecosystems

More than five impact-driven open collaboration partnerships.

EOIO 2

Gender-responsive services

More than three organizational partners to revise their strategies and business plans to provide gender-responsive and inclusive digital agrifood advisory services.

EOIO 3

Improved digital skills

Enhance the digital skill levels of at least 1,000 individuals (40 percent women) to facilitate their access to digital agrifood advisory services.

EOIO 4

Equitable resource allocations

Engage with at least two natural resource management organizations and improve their technical capacities to monitor food-land-water systems in real-time, assess climate risks, and inform stakeholders to equitably allocate water resources.

EOIO 5

Strengthened information systems

More than five information systems are strengthened by incorporating the Initiative-contributed high-frequency agri-food system monitoring data and analytics to manage climate and market risks.

EOIO 6

Strengthened organizational capabilities

Improve the digital capabilities of at least six partner organizations to utilize real-time data and analytics more effectively.

19 partnerships enhanced data-driven decisionmaking, inclusivity and climate resilience in global digital ecosystems.

Goal: More than five impact-driven use cases that promote inclusive and sustainable impacts are developed.

Progress: 19 partnerships enhanced data-driven decision-making, inclusivity, and climate resilience in global digital ecosystems.

6 digital service providers increased use of their services by women through Human Centered Design. The MDII assessment was used by to boost inclusivity by 3 organizations.

Goal: More than 3 organizational partners to revise their strategies and business plans to provide gender-responsive and inclusive digital agrifood advisory services.

Progress: 6 digital service providers increased use of their services by women through human-centered design. The MDII assessment was used to boost inclusivity by 3 organizations.

1732 women registered with agrifood advisory services as a result of the Inspire Challenge. ISAT expanded climate-smart advisories to 6,000 farmers (22% women) in Odisha.

Goal: Enhance the digital skill levels of at least 1,000 individuals (40 percent women) to facilitate their access to digital agrifood advisory services.

Progress: 1,732 women registered with agrifood advisory services as a result of the Inspire Challenge program. ISAT expanded climate-smart advisories to 6,000 farmers (22 percent women) in Odisha, India.

2 NRM organizations in the Limpopo River Basin and the Inkomati-Usuthu catchment adopted real-time monitoring tools.

Goal: Engage with at least 2 natural resource management organizations and improve their technical capacities to monitor food-land-water systems in real-time, assess climate risks, and inform stakeholders how to equitably allocate water resources.

Progress: 2 NRM organizations in the Limpopo River Basin and the Inkomati-Usuthu catchment adopted real-time monitoring tools.

8 information systems adopted high-frequency monitoring tools for natural resource management, climate-smart agriculture, dietary and food market intelligence.

Goal: >5 information systems incorporate high-frequency agri-food system monitoring data and analytics to manage climate and market risks.

Progress: 8 information systems in adopted high-frequency monitoring tools for natural resource management, climate-smart agriculture, dietary and food market intelligence.

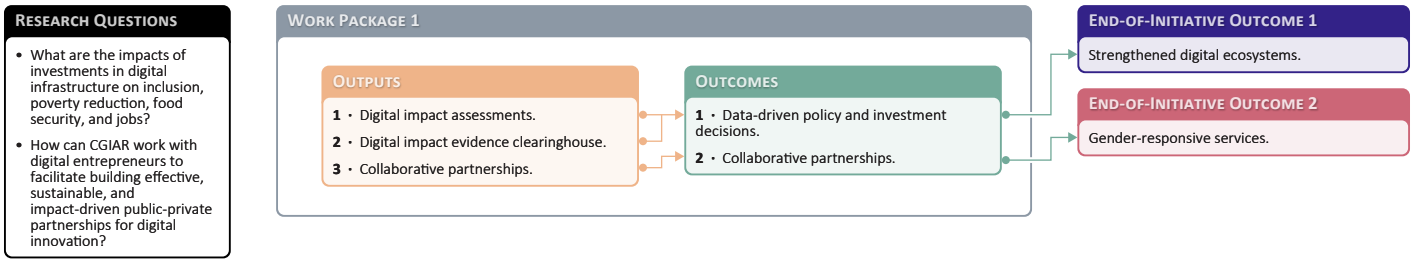
13 partner organizations strengthened their ability to use real-time data and analytics through working with the Initiative, adopting tools, changing strategies and forming partnerships.

Goal: Improve the digital capabilities of at least 6 partner organizations to utilize real-time data and analytics more effectively.

Progress: 13 partner organizations strengthened their ability to use real-time data and analytics through working with the Initiative, adopting tools, changing strategies, and forming partnerships.

Section 3: **Work Package progress**

WP1: Enabling environment

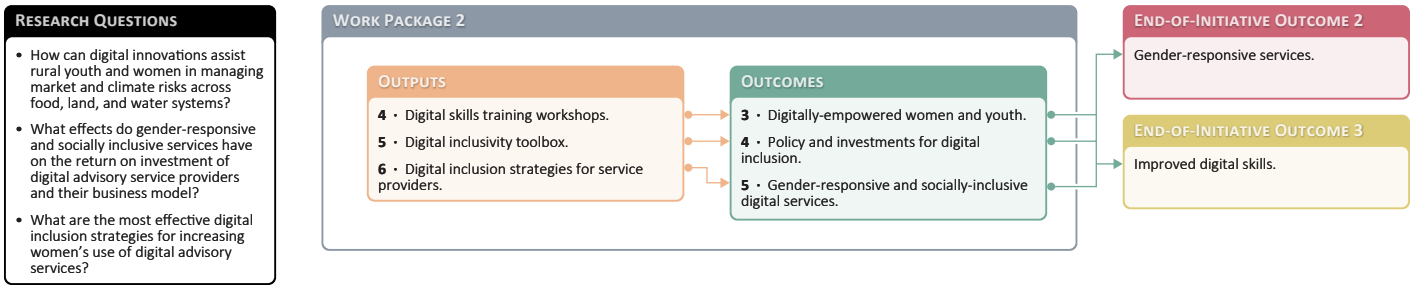


Work Package 1 progress against the theory of change

The Initiative contributed to evidence-based decision-making by leveraging digital tools, participatory platforms, and partnerships that enhanced agricultural policies and investments. In Mexico, the Agri-Innovation Roundtable facilitated collaboration between research institutions, agribusinesses, and financial enablers, leading to the development of pilot solutions such as the integration of digital innovations with conservation techniques in maize production. This effort generated empirical evidence on water savings, productivity, and watershed health, informing scalable investment strategies in sustainable farming. In Mozambique, the Statistics from Space project introduced next-generation agricultural production monitoring through satellite remote sensing and AI-augmented analytics. This initiative, supported the Government of Mozambique, contributed to improving the accuracy of national crop yield predictions, influencing agricultural policies and food security planning. Similarly, the Digital Twin for the Limpopo River Basin demonstrated the potential of AI-powered virtual models to optimize water resource management by integrating hydrological and climate data across multiple countries. This provided policymakers with real-time insights for resource allocation, flood prevention, and drought mitigation strategies, illustrating how digital solutions can support cross-border policy frameworks. The IFAD AgroWeb3 mission in Kenya secured high-level government support and showcased an innovative business model connecting smallholder farmers to agri-tech and food-tech markets. This collaboration, involving CIMMYT and private-sector partner IDENTI, leveraged blockchain technology to strengthen market integration for small-scale producers, demonstrating the potential of decentralized digital systems in improving transparency and access to agricultural markets. Collaborative partnerships played a central role in scaling digital innovations and ensuring their alignment with the needs of diverse stakeholders. Both the ICTforAg conferences and the ICTforAg Learning Network established a space for knowledge exchange, engaging nearly 800 stakeholders from the public and private sectors to share best practices, co-create digital solutions, and strengthen digital capacity. Additionally, the CultivateNext partnership, developed with TechnoServe and Seedstars, provided funding and technical assistance to agrifood technology startups, prioritizing sustainability and gender inclusion. The Initiative also contributed to the LATAM Digital Agriculture Week 2024, co-organized with the Inter-American Institute for Cooperation on Agriculture, the Economic Commission for Latin America and the Caribbean, the Development Bank of Latin America, and Bayer, to foster dialogue among governments, financial institutions, and technology developers to advance digital agriculture across Latin America. The partnership with India's Government of Maharashtra on digital needs and gaps in Farmer Producer Organizations further illustrated how CGIAR research and engagement informed digital strategies for agricultural transformation at the policy level.

Public-private partnerships proved essential for scaling digital innovation, requiring structured collaboration, sustained investment, and policy alignment. We learned the need for co-developed digital solutions that balance evidence-based research with market and policy demands. Strengthening these partnerships through co-financing, shared governance, and data-sharing frameworks will be critical to ensuring digital agriculture remains inclusive, scalable, and impactful.

WP2: Digital inclusion



Work Package 2 progress against the theory of change

The Initiative significantly advanced digital literacy and skills among rural women and youth by engaging 2,732 individuals. Through Inspire Challenge, LetsEndorse's WomBees initiative in India trained over 1,000 rural women beekeepers via mobile app, equipping them with science-based honey production practices and digital training modules for income generation. In Colombia, Innovakit piloted a Digital Influencer program, supporting 500 women farmers with microlearning courses, in-person training, and microloans, securing 300 million COP (USD 72,000) in financing. In Argentina, Agroconsultas expanded its digital advisory platform, adding 30 women experts and facilitating 232 new women registrations. In South Africa, the Enviro-Champs program trained 1,000 youth in climate and environmental monitoring, strengthening their data collection and water management skills.

The Initiative also influenced eight policies, strategies, and investments to advance digital inclusion. In Kenya, Sprout developed a gender-responsive insurance strategy, ensuring inclusive climate-resilience solutions for women farmers. In Colombia, Innovakit's WhatsApp-based Digital Influencer initiative promoted financial inclusion for rural women. Agroconsultas in Argentina expanded its platform to include gender-disaggregated analytics and enhance women's participation in agribusiness. At a global policy level, the Breakthrough Agenda AI Dialogue at ICTforAg 2024 shaped responsible AI adoption in agriculture. The Virtual Irrigation Academy in South Africa and Malawi applied the MDII to assess and improve accessibility for smallholder farmers. Additionally, FRI's Longa AI speech recognition tool secured investment, further expanding rural farmers' engagement in local languages.

Lastly, the Initiative exceeded expectations in strengthening the digital capabilities of 10 partner organizations across multiple regions. Farm Radio International (FRI) developed Longa, improving engagement with smallholder farmers. Farmerline in Ghana used MDII to refine business-to-farmer services, expanding training for marginalized farmers. In Indonesia, BSIP utilized MDII results in enhancing Layanan Konsultasi Padi to address digital literacy gaps, ensuring better accessibility for rice farmers. The Philippines Department of Agriculture applied human-centered design principles to improve the Rice Crop Manager Advisory Service and incorporated georeferencing into the Registry System for Basic Sectors in Agriculture for improved farm mapping. Meanwhile, in South Africa, DUCT's MiniSASS system advanced AI-driven water quality monitoring and UNICEF YOMA's Enviro-Champs program integrated Open Data Kit (ODK) for citizen science-based environmental monitoring. The Limpopo Watercourse Commission (LIMCOM) implemented a digital monitoring system for drought forecasting and water quality, while the Indian Meteorological Department (IMD) adopted a CGIAR-developed data dashboard, and the Uttar Pradesh Government co-developed an Agri Data Stack to improve digital agricultural data interoperability.

WP3: Systems modeling

Research Questions

- How can natural resource management organizations monitor and model dynamics in food, land, and water systems to inform risk management decisions?
- How can real-time data and advanced analytics assist in better preparation for and defense against natural disasters such as floods and droughts across food, land, and water systems?
- How can digital innovations help water management authorities monitor agricultural water use and quality issues in real time?

Work Package 3

Outputs

7 · Improved foundational model input datasets.

8 · Spatial analysis framework for simulating food systems dynamics.

9 · Digital twins of river flows and water quality dynamics.

10 · Capacity-building workshops are organized to train the trainers.

Outcomes

6 · Sustainably managed food, land, and water system resources.

7 · Stakeholders' use of systems modeling approaches.

End-of-Initiative Outcome 4

Equitable resource 1 allocations.

End-of-Initiative Outcome 5

Strengthened information systems.

Work Package 3 progress against the theory of change

Over the past two years, the Initiative has significantly advanced water resource management in the Limpopo River Basin through the development and handover of a Digital Twin, which is a virtual representation of the basin's hydrological system. This project, led by the International Water Management Institute (IWMI) in collaboration with the Limpopo Watercourse Commission (LIMCOM), aims to enhance decision-making and promote sustainable water use across the basin, which spans Botswana, Mozambique, South Africa, and Zimbabwe.

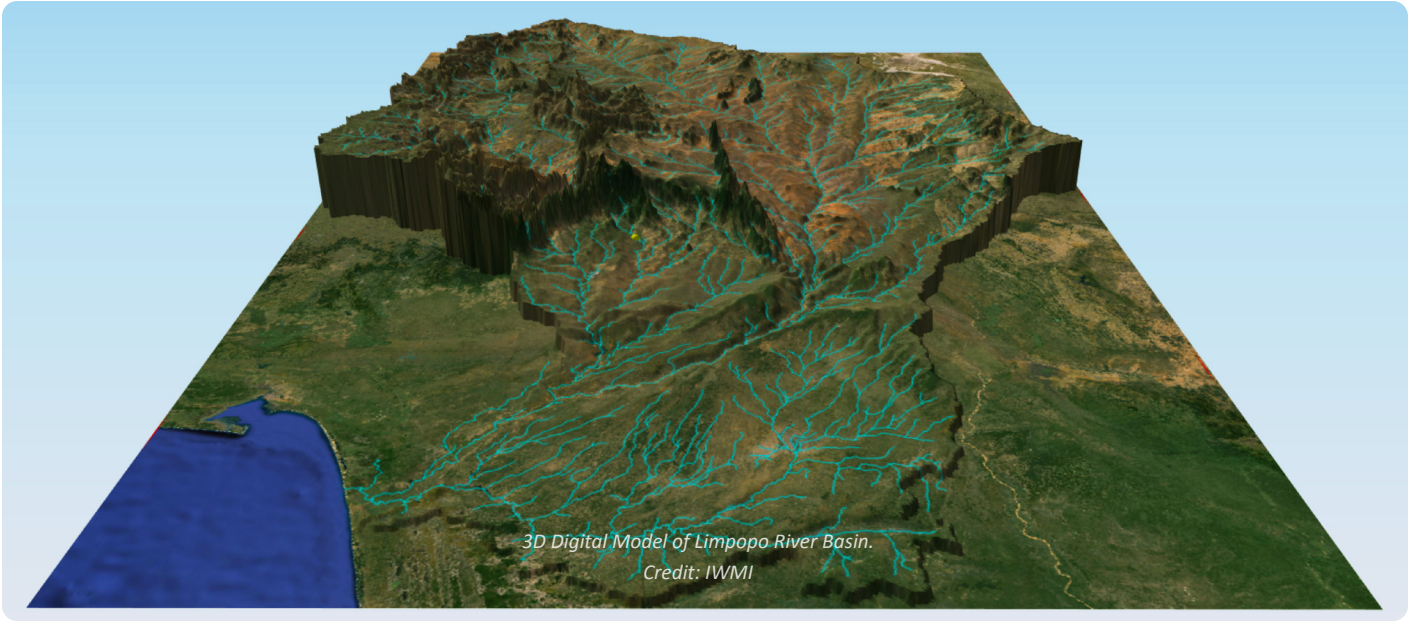
To create the Digital Twin, the Initiative brought together partners to create and integrate the diverse streams of data required by such a system, in close collaboration with end users at LIMCOM. A co-design ideation workshop and prototype demonstrations were conducted to foster engagement, with the result that LIMCOM adopted the Digital Twin as a key component of its strategy for integrated river basin management. LIMCOM officials presented the collaboration to a group of African ministers at the 10th World Water Forum in Bali.

In October 2024, the prototype Digital Twin was formally handed over to LIMCOM, which will integrate the tool with its information management system while continuing to close data gaps and build functionality. The prototype integrates high-resolution 3D topographical maps with near-real-time historical and forecasted data. This system includes hydrological models that monitor river discharge, rainfall, water quality, and ecosystem health, providing stakeholders with detailed insights into water availability and risks.

Additionally, a partnership with Microsoft Research led to the creation of Water CoPilot, an AI-based interface that permits users to make queries and generate reports that include maps and graphics, allowing them to easily make use of the powerful data and modeling contained in the system.

Many innovations were developed to generate the data required for a Digital Twin in a developing world context. One of these, the MiniSASS app, is a smartphone application allowing citizen scientists to collect data on water quality that is automatically verified by a machine learning algorithm. This has generated interest from UN Water, as it has the potential to address concerns with the reliability of citizen science data even as it fills vital data gaps for monitoring progress on the Sustainable Development Goals relating to water issues. A partnership with UNICEF-Yoma allows young people to train as citizen scientists in exchange for incentives such as a blockchain-verified digital curriculum vitae.

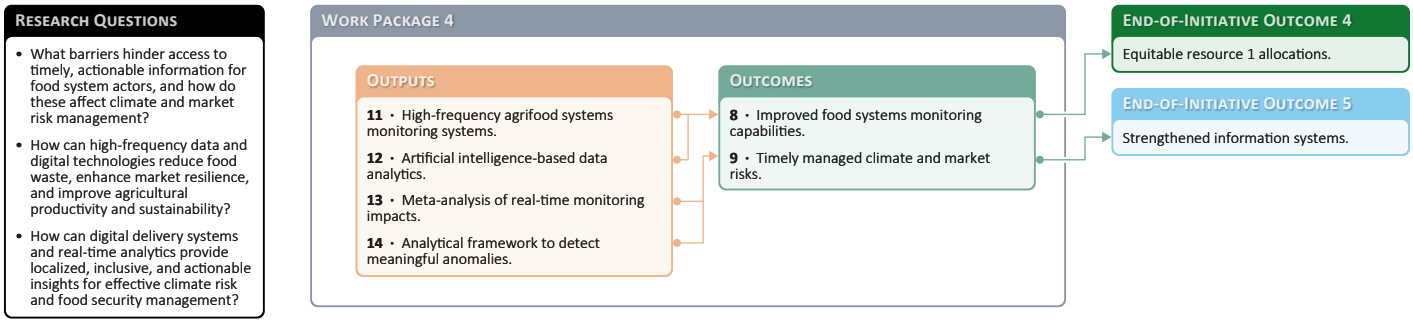
Limpopo River Basin Digital Twin Components and Features
The Limpopo River Basin Digital Twin is a virtual representation of the Limpopo River Basin, updated with real-time data and utilizing simulation, machine learning, and reasoning to aid decision-making. Its components are designed to provide comprehensive insights into water resources, with the following detailed features.



3D Digital Model of Limpopo River Basin.
Credit: IWMI

COMPONENT	DESCRIPTION	DETAILS/STATISTICS
Digital Twin Portal	Central hub for accessing and interacting with the Digital Twin model	Includes hydrological modeling, 1,408 channels covering 400,000 km², 305 discharge stations, 303 rainfall stations, 3 types of seasonal climate forecasts, 20-year historical database
Visualization Application	Interactive tool for visualizing datasets through graphics and maps	Facilitates exploration of spatial and temporal trends in water resources
River Discharge & Environmental Flow (e-flow) Charts	Specialized charts displaying natural and present-day river discharge and environmental flows	Enables analysis of water distribution for river ecosystems and beneficiaries
Reservoir Volume Monitoring	Machine learning-based tool for near-real-time insights into water storage	Daily updates on 1,424 waterbodies and 96 dams
Reservoir Forecasting	Predictive tool using experimental machine learning for future reservoir levels	Currently available for Middelburg Dam and Loskop Dam, aids in planning for water shortages/surpluses
Environmental Framework Assessment (EFA) Tool	User-friendly tool to test river management scenarios and assess social/environmental risks	Allows users to generate and test environmental flow scenarios in the Limpopo River Basin
FISHTRAC	Real-time fish tracking solution with sensors for river health and water quality data	Trigger alerts in Digital Twin for environmental problems, particularly water pollution
Drone Solutions	High-resolution Lidar, multi-spectral imaging, and submergible drones for river mapping	Used for environmental flow (e-flow) assessments
Virtual Reality Tour	Immersive VR experience at Balule site on Olifants River	Allows exploration and spatial understanding of key water resources
AI-based Virtual Assistant	Co-designed with Microsoft Research under Farm Vibes, powered by GPT-4, natural language interface	Enhances accessibility, helps draft reports, plots maps, explores scenarios (still in testing phase)
Open Data Cube (ODC)	Robust open-source software package supporting the digital twin by providing access to satellite and geospatial data for analysis	Built on Digital Earth Africa best practices, cloud-based AWS architecture, adheres to FAIR data principles, incorporates seven products
Drought Monitoring	Monitoring Tool for monthly analysis of drought conditions	Uses Standardized Precipitation Index (SPI) for rainfall deficiency and Vegetation Condition Index (VCI) for vegetation health to aid decision-making
Irrigated Mapping Areas	Irrigated Mapping Tool using machine learning to identify and map irrigated areas in the Limpopo River Basin	Analyzes satellite imagery to differentiate irrigated and non-irrigated land, enhances land-use classification, supports sustainable agricultural planning
MiniSASS	Citizen science biomonitoring tool for assessing river health and water quality through macroinvertebrate sampling	Uses a mobile and wep app with machine learning for real-time macroinvertebrate identification, has collected over 1,200 water quality measurements using custom data collection apps in KwaZulu-Natal, South Africa, supported by GroundTruth and CGIAR Digital Innovation
Enviro-Champs	Community-driven citizen science initiative empowering youth to monitor water quality and environmental health	Approximately 1,000 citizen scientists in KwaZulu-Natal, collected water quality measurements using custom apps like MiniSASS and EnviroChamp app, partnered with YOMA-UNICEF for training and blockchain-based digital CVs, supported by GroundTruth, DUC, CGIAR Digital Innovation, and uMngeni-uThukela Water

WP4: Real-time monitoring



Work Package 4 progress against the theory of change

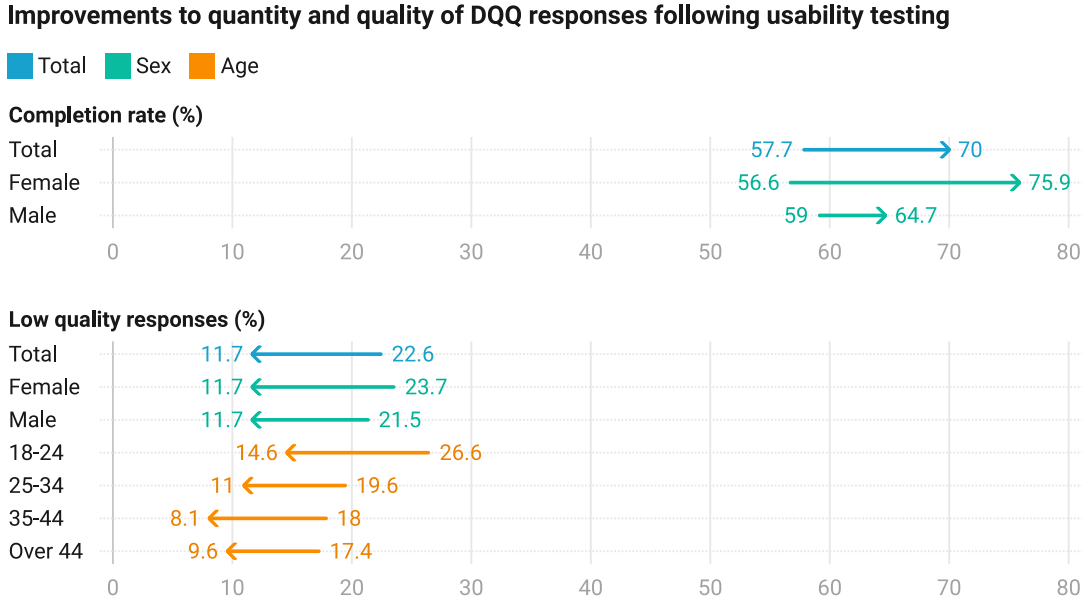
Between 2022 and 2024, WP4 made substantial progress in strengthening information systems and integrating digital technologies to address agrifood system challenges. A key milestone was the establishment of high-frequency monitoring systems, such as the Diet Quality Questionnaire (DQQ) in Guatemala and Rwanda. The DQQ, implemented via Interactive Voice Response and WhatsApp, provided critical data to stakeholders for decision-making and improved food security. In Guatemala, local organizations ensured regional adoption, while in Rwanda, similar systems mapped food flows, aiding market infrastructure planning and transport modeling.

The Agricultural Digital Plot in Guatemala emerged as a standout achievement, functioning as an innovation hub for site-specific agronomy. Equipped with agro-climatic sensors and weather stations, the plot validated data collection technologies for localized use, informing climate adaptation and agricultural practices. It also facilitated capacity building through diploma programs, which trained professionals and educators in digital agriculture, with regional scalability in mind. This model offered a scalable platform for testing technologies in resource-constrained environments, generating actionable insights for localized challenges and climate adaptation.

In India, real-time crop monitoring in Uttar Pradesh utilized Sentinel-2 satellite data to map cropping patterns, supporting enhanced planning. Similarly, in Senegal's River Valley, satellite remote sensing and machine learning assessed irrigation investments' impacts on rice cultivation. The Remote Sensing-based Information and Insurance for Crops in Emerging Economies (RIICE) initiative was expanded to Côte d'Ivoire, leveraging satellite tools like MAPscape-RICE for rice production monitoring and yield prediction addressing misclassification challenges through local experiments and crop modeling.

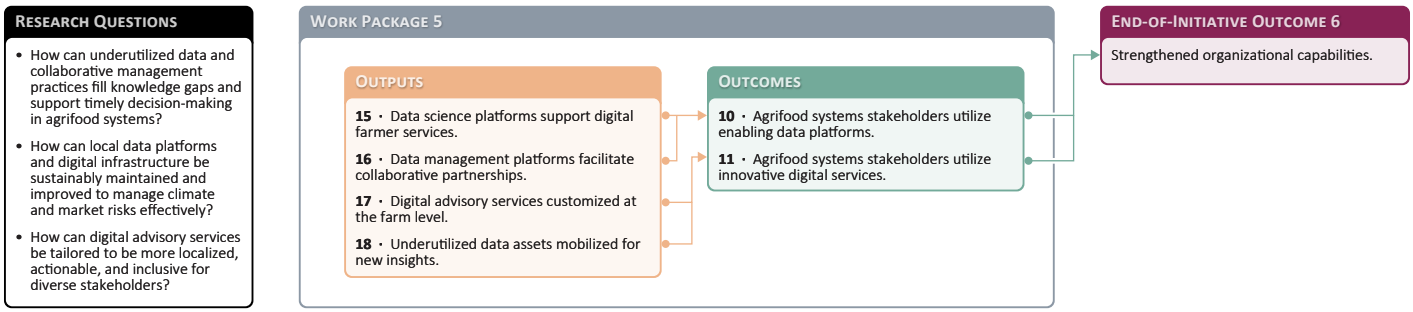
Human-centered design improvements to the DQQ system addressed usability, trust, and connectivity challenges. In Rwanda, usability testing of the DQQ based on the country's Unstructured Supplementary Service Data revealed design flaws that, once addressed, increased survey completion rates from 58 to 70 percent, significantly boosted female participation, and improved data quality while reducing costs.

WP4 achieved strong progress in aligning activities with Initiative outcomes, including strengthened information systems and enhanced digital capabilities among stakeholders. More than five information systems were strengthened. These activities contributed to CGIAR's Impact Areas of Nutrition and Food Security, Climate Adaptation, and Resilient Agrifood Systems and addressed diverse challenges across regions.



Pre-usability testing (arrow start) to post-usability testing (arrow end).

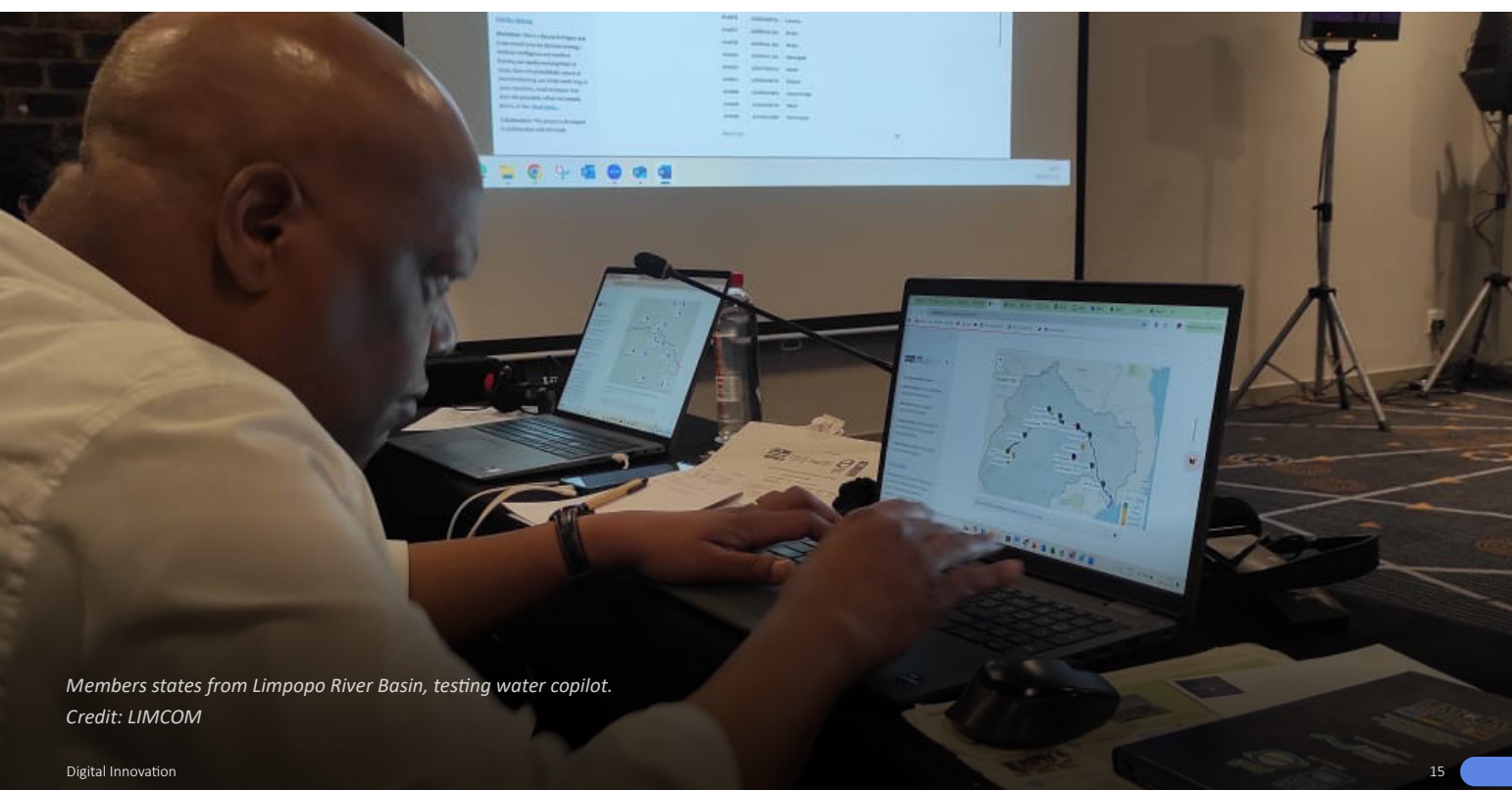
WP5: Platforms and services



Work Package 5 progress against the theory of change

From 2022 to 2024, the Initiative significantly advanced responsible data management and digital service adoption across key sectors, improving decision-making, sustainability, and resource efficiency. In India, Bayer Crop Sciences scaled up site-specific nutrient management by integrating the Rice Crop Manager (RCM) API into its FarmRise platform, benefiting rice farmers. The India Meteorological Department (IMD) implemented the Meghdoot Dashboard, enhancing its Agro-meteorological Advisory Service (AAS). In South Africa, the Inkomati-Usuthu Catchment Management Agency integrated FishTrac, strengthening water quality monitoring, while the LIMCOM became the first African River Basin Organization to implement a Digital Twin system for transboundary water management. In Kenya, AgroWeb3 & CIMMYT showcased blockchain-based solutions to connect smallholder farmers with markets, and in Mexico, Kellogg used e-Agrology to promote sustainable maize farming. Additionally, FRI in Africa developed Longa, an AI-powered speech recognition tool, to analyze farmer queries, while Farmerline in Ghana and the Virtual Irrigation Academy leveraged MDII to refine digital services for smallholder farmers.

The Initiative also strengthened the digital capabilities of 10 partner organizations, equipping them with tools to enhance climate resilience, market access, and agricultural productivity. In Kenya, the Kenya Integrated Agricultural Management Information System incorporated KAZNET, providing livestock market intelligence to over 4,000 pastoralists. In Mexico, PepsiCo & Grupo Trimex used e-Agrology to track sustainable maize farming, reducing carbon dioxide emissions and production costs. In Guatemala, CUNORI University formally adopted digital agriculture training, enhancing technical capacity in the Corredor Seco region. In India, ISAT Climate Information Services provided weather insights to over 6,000 farmers and the Indian Council for Agricultural Research collaborated with IRRI to scale up RCM, improving nutrient management. The Philippines Department of Agriculture incorporated georeferencing into the Registry System for Basic Sectors in Agriculture for better farm mapping, while LIMCOM in Southern Africa continued its Digital Twin adoption for real-time water resource management. These advancements underscored Digital Innovation's pivotal role in fostering sustainable, data-driven solutions that enhance agricultural and environmental resilience globally.



Members states from Limpopo River Basin, testing water copilot.
Credit: LIMCOM

Work Package progress rating summary

WORK PACKAGE	PROGRESS RATING & RATIONALE
1	On track Digital Innovation has driven digital transformation in agrifood systems by shaping policies, regulatory frameworks, investments, and education. It supported strategy development, enabled early warning systems, and fostered public-private innovation. Major partners adopted digital tools for sustainability and inclusion. With widespread uptake across sectors and regions, we overachieved this target.
2	On track Digital Innovation advanced digital inclusion by empowering rural women and youth through training, financial access, and inclusive technologies. It enabled over 1,500 women to diversify incomes and influenced gender-responsive strategies and policies globally. Tools such as the MDII and AI platforms improved services for marginalized farmers. With broad institutional adoption and impact, we overachieved this target.
3	On track Digital Innovation advanced sustainable natural resource management by shaping strategies, driving ecosystem monitoring, and promoting climate-smart agriculture. It enabled digital adoption by public agencies and agrifood companies and trained 292 professionals in real-time monitoring and modeling across regions. These efforts strengthened global capacity for data-driven sustainability and contributed to our overachieving this target.
4	On track Digital Innovation strengthened partner capacities by enabling real-time data use in agriculture, climate, and resource management. Companies and institutions across Latin America, Africa, and Asia adopted tools for sustainable farming, water monitoring, and nutrition tracking. From AI-powered advisories to Internet of Things learning platforms, these innovations improved decision-making. With broad uptake and measurable impact, we have overachieved this target.
5	On track Digital Innovation advanced responsible data practices and digital platform adoption, enabling smarter decisions in agriculture, climate, and resource management. From AI tools and blockchain in Africa and Asia to climate monitoring and sustainable farming platforms in Latin America, partners improved service delivery, transparency, and sustainability. With widespread institutional integration, we overachieved this target.

Definitions

On track

- 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 jeopardize success of Work Package.

Delayed

- Progress slightly falls behind Plan of Results and Budget and Work Package theory of change in key areas.
- Deviations/issues/delays/risks could jeopardize success of Work Package if not managed appropriately.

Off track

- Progress clearly falls behind Plan of Results and Budget and Work Package theory of change in most/all areas.
- Deviations/issues/delays/risks do jeopardize success of Work Package.

Citizen scientists in South Africa test water quality using the MiniSASS assessment technique.
Credit: Groundtruth

Section 4: **Quantitative overview of key results**

This section provides an overview of results reported and contributed to, by the CGIAR Initiative on Digital Innovation from 2022 to 2024. 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.

The data used to create the graphics in this section were sourced from the CGIAR Results Dashboard on 04 April 2025. These results are accurate as of this date and may differ from information in previous Technical Reports. Such differences may be due to data updates throughout the reporting year, revisions to previously reported results, or updates to the theory of change.

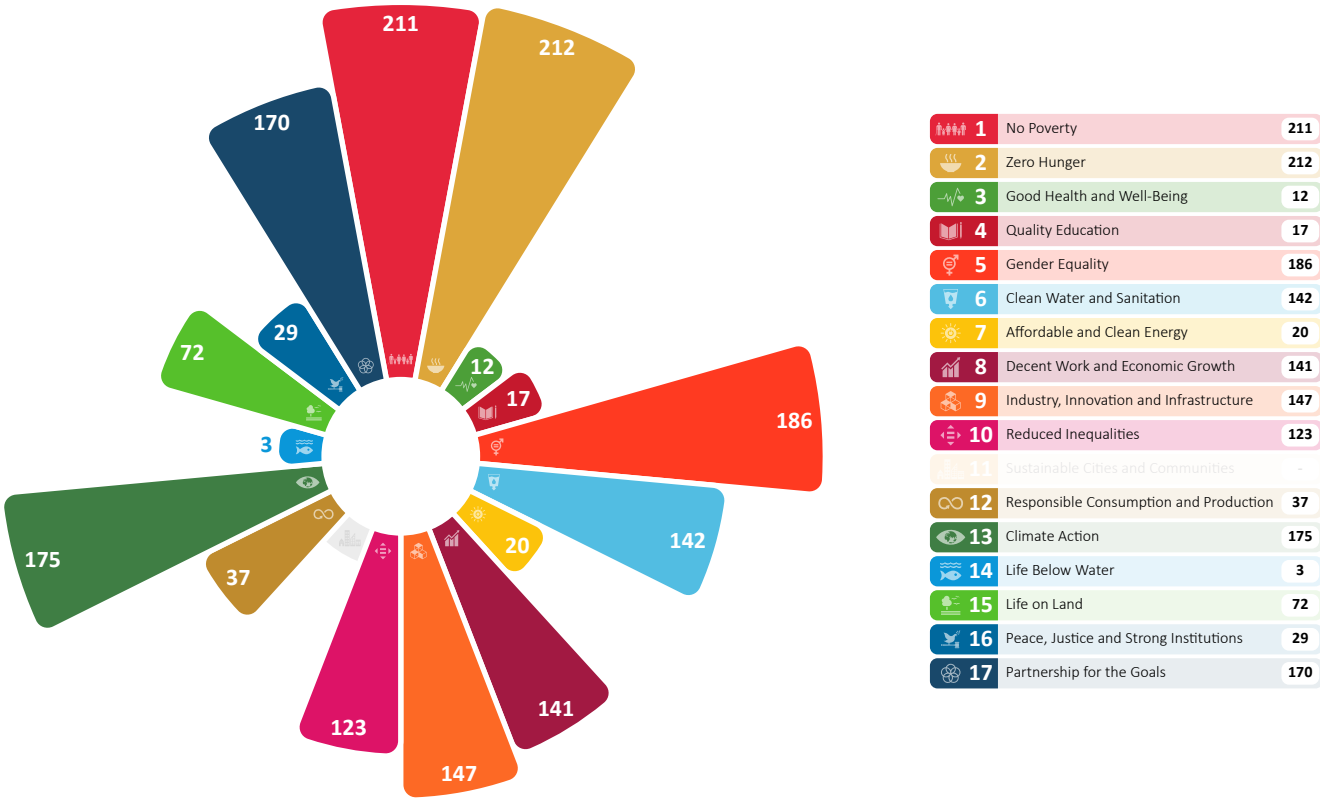
Overview of results by category

Outputs

Outcomes

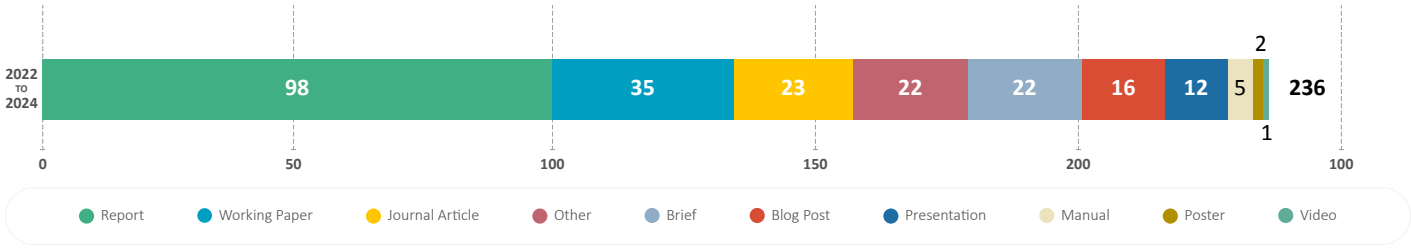
Digital Innovation produced 497 results: 236 knowledge products, 61 innovation development results, 45 capacity sharing for development results, and 95 other outputs from 2022 to 2024. It also produced 29 innovation results, 16 policy change results, and 14 other outcomes in the same period.

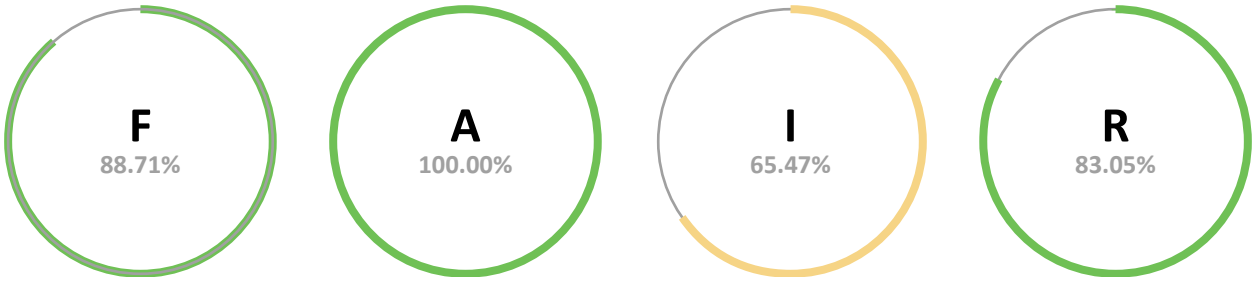
Contributions to the UN Sustainable Development Goals



Of the 17 UN Sustainable Development Goals (SDGs), from 2022 to 2024 Digital Innovation contributed to 16, mostly geared to Goals 1 (no poverty), 2 (zero hunger), 5 (gender equality), 6 (clean water and sanitation), 8 (decent work and economic growth), 9 (industry, innovation, and infrastructure), 10 (reducing inequalities), 13 (climate action), and 17 (partnerships for the goals).

Knowledge products by type and their FAIR scores

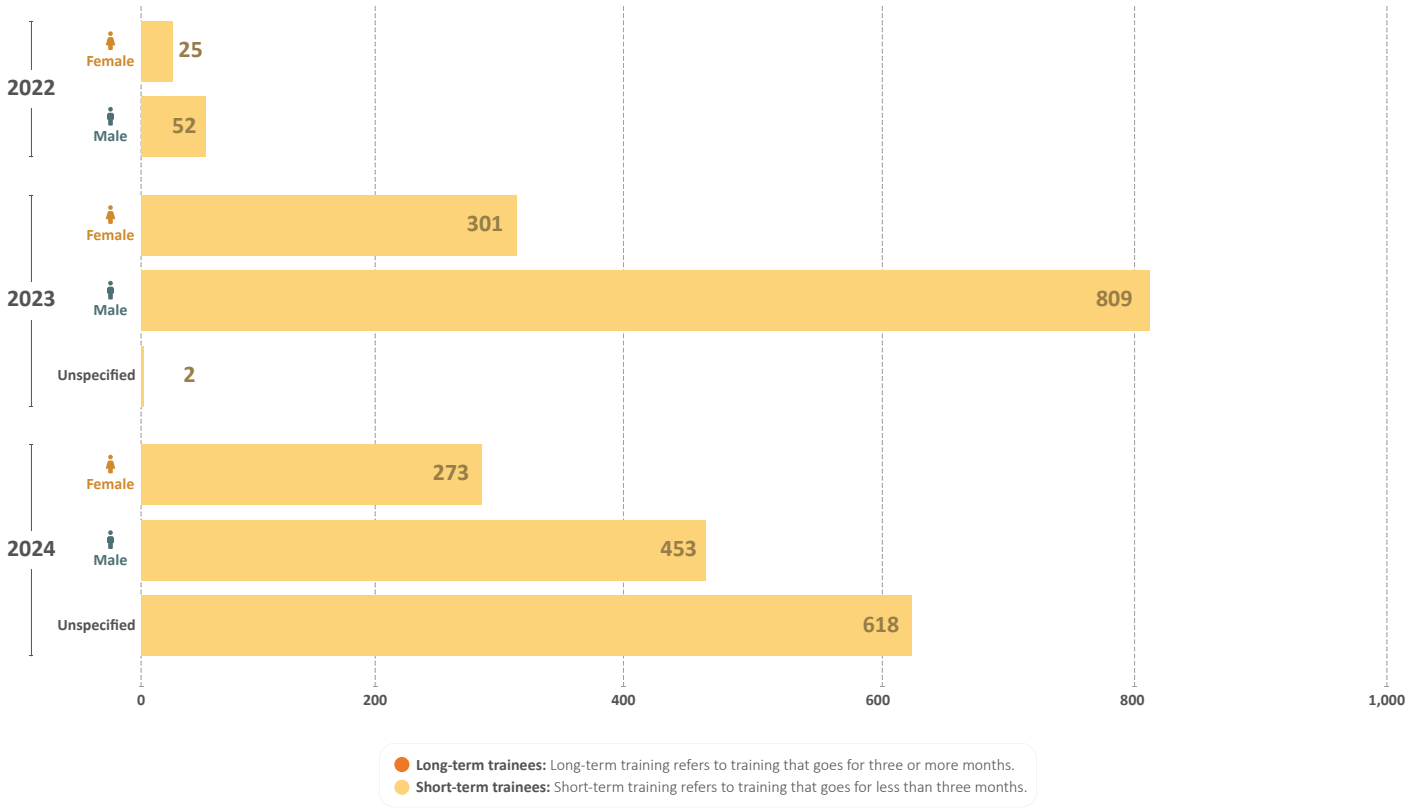




FAIR scores refer to a set of principles that support the reusability of digital assets. FAIR (findability, accessibility, interoperability, and reusability) scores are calculated based on the presence or absence of metadata in the CGSpace repository. CGIAR Open and FAIR Data Assets Policy

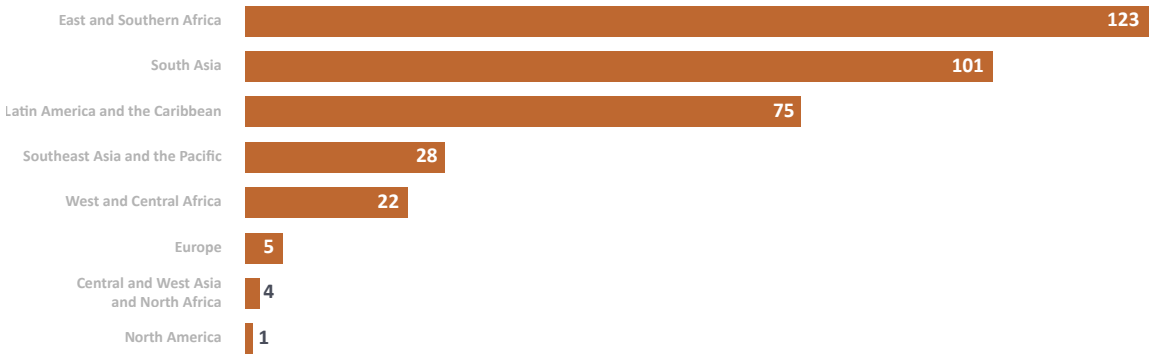
The majority of knowledge products produced, such as reports, working papers, and journal articles, were open access and relatively easy to search — with 89 percent findable.

Number of individuals trained by Digital Innovation



The number of cumulative short-term trainees recorded was almost 2,000 from 2022–2024. The majority of the trainees were from national research organizations and universities, national agricultural research systems, national governments, and private companies.

Distribution of results by region

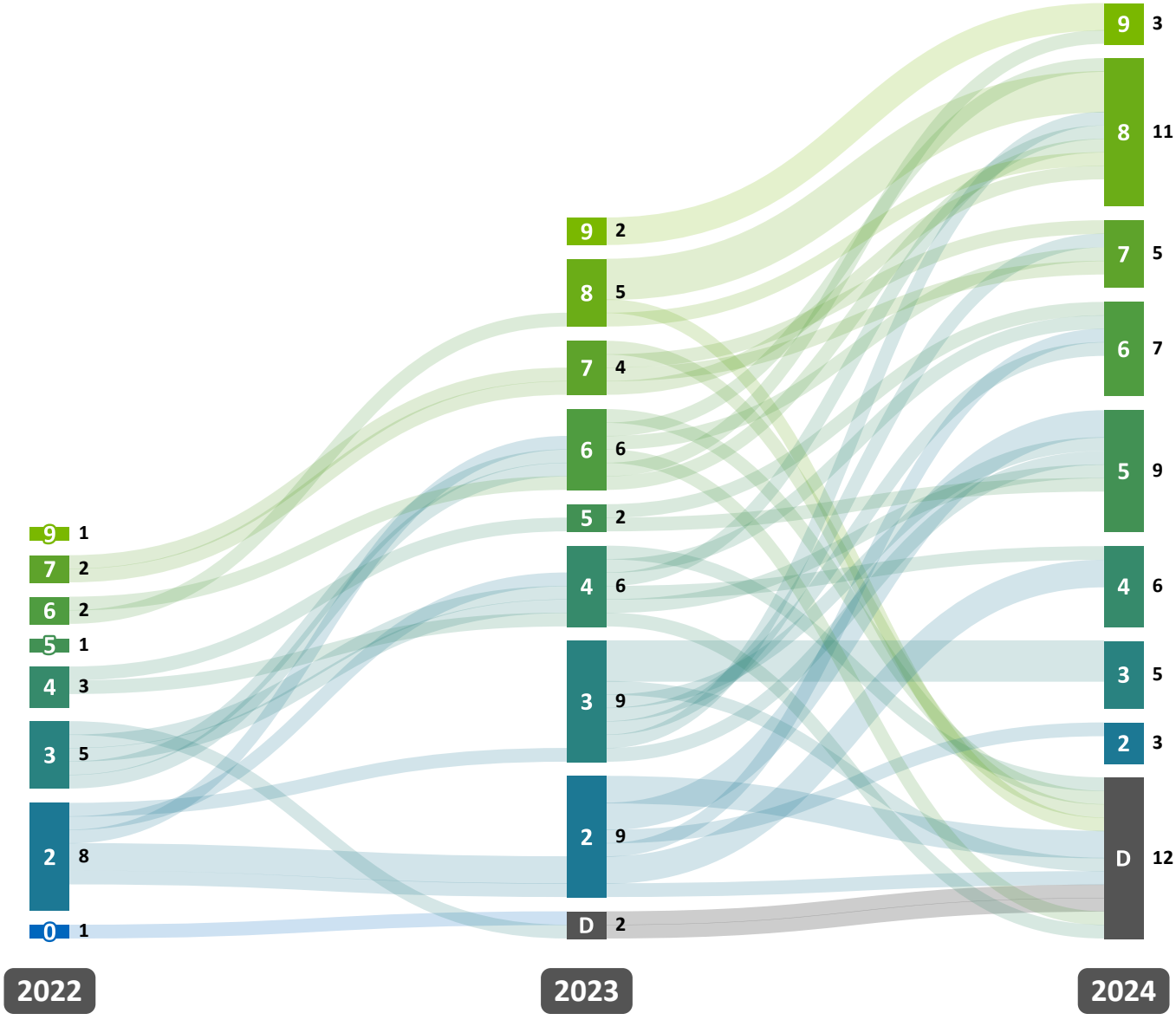


Most of the research activities implemented and outputs produced by Digital Innovation focused on East and Southern Africa, South Asia, and Latin America over the 2022–2024 period. Furthermore, results from other regions such as Southeast Asia and West and Central Africa increased through joint implementation and resource sharing with bilateral projects.

Number of innovations and their readiness levels

		Pipeline overview # of innovations
9	**Proven Innovation** The innovation is validated for its ability to achieve a specific impact under uncontrolled conditions	3
8	**Uncontrolled Testing** The innovation is being tested for its ability to achieve a specific impact under uncontrolled conditions	12
7	**Prototype** The innovation is validated for its ability to achieve a specific impact under semi-controlled conditions	6
6	**Semi-Controlled Testing** The innovation is being tested for its ability to achieve a specific impact under semi-controlled conditions	9
5	**Model/Early Prototype** The innovation is validated for its ability to achieve a specific impact under fully-controlled conditions	9
4	**Controlled Testing** The innovation is being tested for its ability to achieve a specific impact under fully-controlled conditions	8
3	**Proof of Concept** The innovation's key concepts have been validated for their ability to achieve a specific impact	7
2	**Formulation** The innovation's key concepts are being formulated or designed	6
1	**Basic Research** The innovation's basic principles are being researched for their ability to achieve a specific impact	0
0	**Idea** The innovation is at idea stage	1

Innovation Readiness trend (2022-2024)

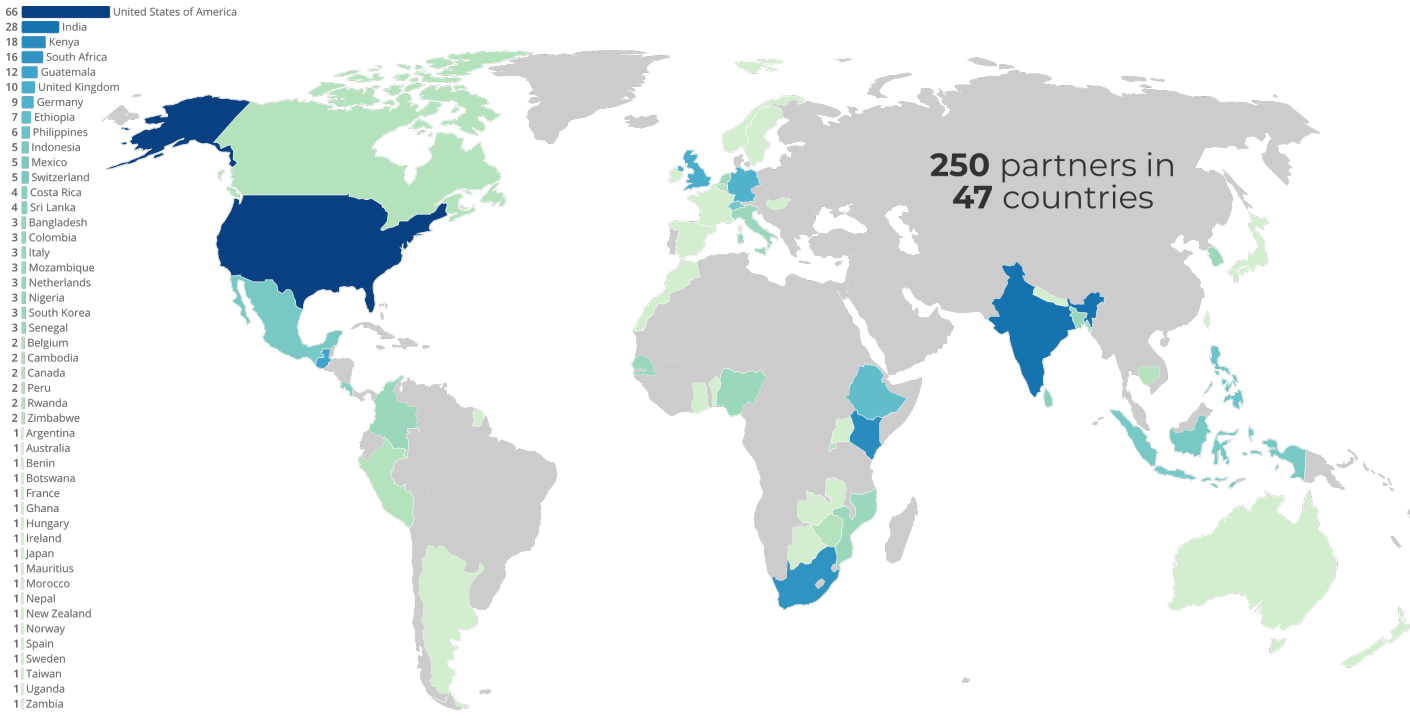


9 Proven Innovation · 8 Uncontrolled Testing · 7 Prototype · 6 Semi-Controlled Testing · 5 Model/Early Prototype · 4 Controlled Testing · 3 Proof of Concept · 2 Formulation · 1 Basic Research · 0 Idea · D Discontinued

Digital Innovation reported 60 innovations from 2022 to 2024, of which 3 were already at the "proven" stage. Most innovation users were from governments, research organizations and universities, and other organizations.

Modeling water flows in the Limpopo River Basin using drone technology.
Credit: GroundTruth

Section 5: **Partnerships**



Partnerships and Digital Innovation's impact pathways

Over the past three years, strategic partnerships have played a pivotal role in achieving the outcomes of our Initiative by leveraging expertise, resources, and networks across public, private, research, and international sectors. These collaborations enabled the successful deployment of digital innovations, strengthened research capacities, and facilitated the scaling of impactful solutions in agriculture and food systems.

Public-sector partnerships, including engagements with government agencies and ministries, provided essential policy support and facilitated regulatory alignment for digital innovations. By collaborating with national and regional government entities, such as the ministries of agriculture in Kenya, Nigeria, and Rwanda; the Mexican Secretariat of Agriculture and Rural Development; and the local government of Maharashtra, India, the Initiative ensured that emerging technologies were integrated into policy frameworks, increasing their adoption at scale. This was evident in projects such as the implementation of remote-sensing applications for rice production, where government agencies played a crucial role in validating methodologies and ensuring alignment with national agricultural strategies.

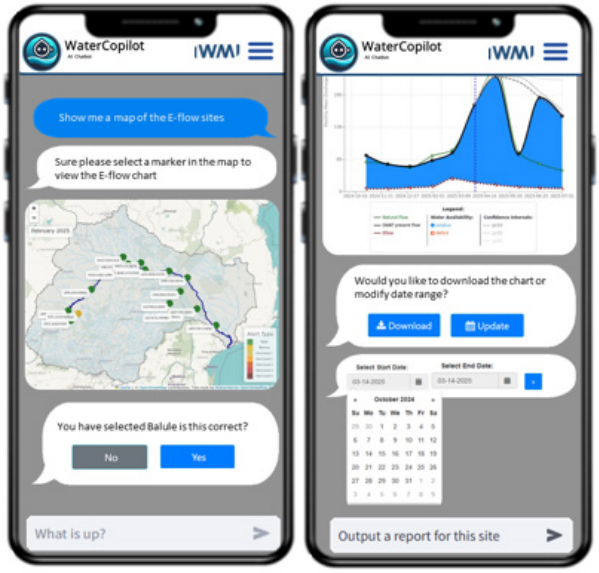
Private-sector engagement was instrumental in bridging gaps between research-driven innovations and market-driven solutions. Partnerships with agribusinesses, industry stakeholders, and technology firms, including Yara International, Bayer Crop Science, Bimbo, Syngenta, Microsoft, IBM, and Corteva Agriscience, enabled the co-development of digital tools, ensuring their usability and scalability. For instance, collaborations with the agricultural industry facilitated the application of the PROBFLO framework for real-time decision-making, demonstrating the potential of AI-driven analytics in enhancing supply chain efficiency. These engagements also fostered investments in technological infrastructure, accelerating the deployment of precision agriculture solutions and expanding access to advanced analytics for smallholder farmers.

Research institutions and universities contributed significantly to the scientific rigor and innovation embedded within the Initiative's projects. By working closely with academic partners such as the University of Nairobi, University of São Paulo, Wageningen University, University Center East of the University of San Carlos in Guatemala (CUNORI), and Texas A&M University, the Initiative ensured that methodologies were robust, data-driven, and aligned with global research standards. This was exemplified in the ECOSat project, which assessed the feasibility of satellite-based carbon offset estimations. Research partnerships ensured that the modeling approaches used in the project were scientifically validated, enhancing credibility and adoption by stakeholders.

The role of international organizations, such as the Bill & Melinda Gates Foundation, German Agency for International Cooperation, Inter-American Development Bank, International Fund for Agricultural Development, UN Food and Agriculture Organization (FAO), United States Agency for International Development, and World Bank, was central in fostering knowledge exchange, capacity building, and access to global funding mechanisms. These collaborations allowed for the cross-pollination of best practices across regions and facilitated access to financial resources essential for scaling digital innovations. The ICTforAg Conferences and Learning Network exemplified this dynamic, providing a platform for multi-stakeholder dialogue and shared learning, ultimately enhancing the impact of digital transformation efforts in smallholder farming systems.

NGO partnerships and civil society engagements contributed to the inclusivity and social impact of the Initiative's interventions. By working with non-profit organizations such as AGRA (formerly the Alliance for a Green Revolution in Africa; now Sustainably Growing Africa's Food Systems), the Agribusiness Market Ecosystem Alliance, Digital Green, and the Syngenta Foundation, the Initiative ensured that digital solutions were co-designed with end-users and addressed their specific needs and constraints. This was particularly relevant in projects focused on digital literacy, gender-inclusive services, and access to agricultural advisory services, where NGOs played a vital role in capacity building and outreach efforts.

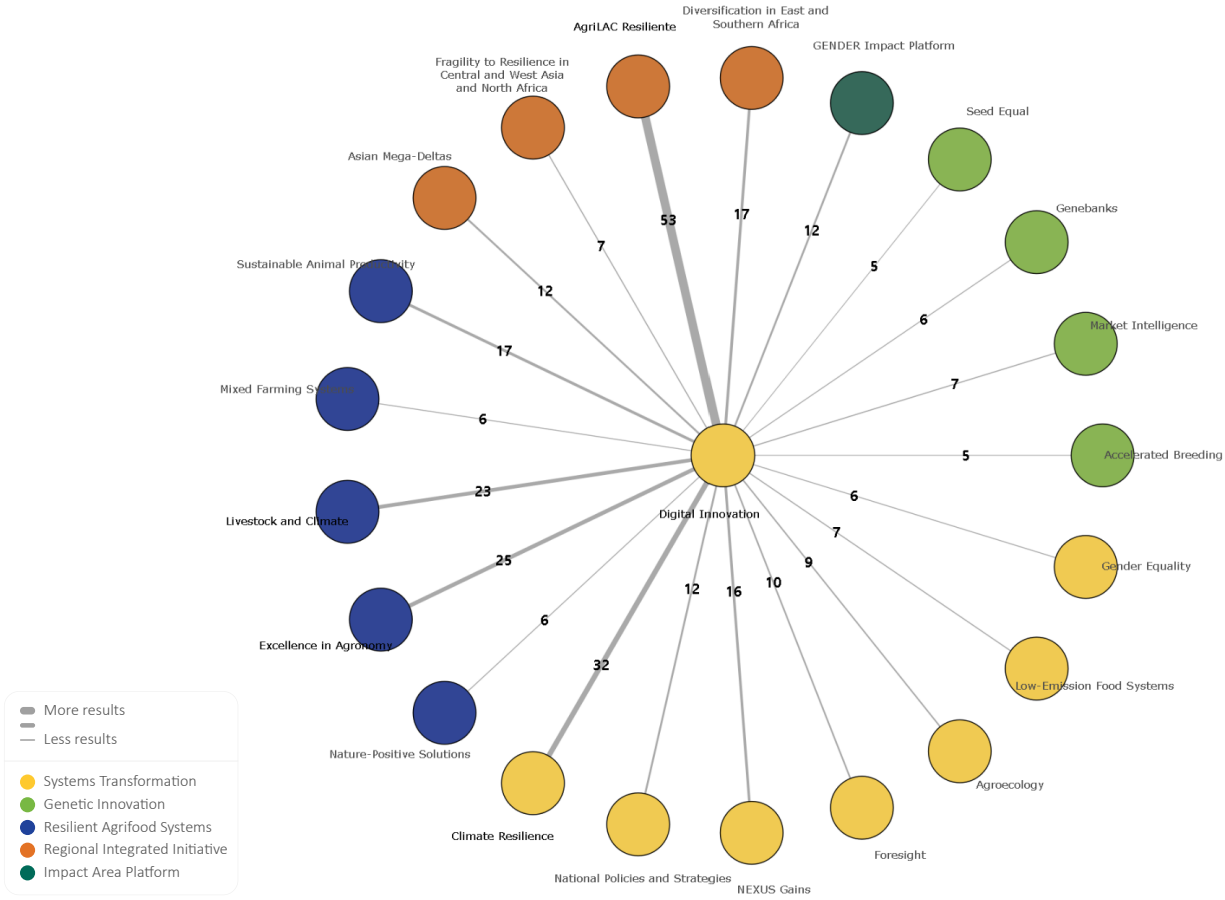
Across these partnership modalities, the Initiative demonstrated that a collaborative, multisectoral approach is essential for driving systemic change in the agricultural sector. The convergence of public policy support, private-sector innovation, scientific research, and international collaboration created an enabling environment for digital transformation. By leveraging the strengths of each partner type, the Initiative not only achieved its intended outcomes but also laid the groundwork for sustainable, long-term impact in agrifood systems.



IWMI's WaterCopilot, AI agents translating trusted scientific evidence into actionable insights, we aim to accelerate decision-making and drive impactful solutions for sustainable water management.

Farmers in Odisha, India can now access tailored advice on sowing, planting, pest control and harvesting through the iSAT climate agro-advisory service. Credit: ICRISAT

Digital Innovation's internal network of collaborations



This diagram presents the internal collaborations of the Digital Innovation initiative with other CGIAR Initiatives, Impact Area Platforms, and Science Group Projects. Connections are sized according to the number of shared reported results, highlighting the depth of collaboration across the CGIAR Portfolio. A results threshold filter is applied (set to a minimum of five results) to focus the view on the most significant collaborations. Thicker lines represent stronger collaborative links based on a higher number of shared results.

Portfolio linkages and Digital Innovation's impact pathways

Out of 483 results reported by Digital Innovation, 69 results (14 percent) had contributions made with other Initiatives within the Portfolio. The top contributing Initiatives were Resilient Agrifood Innovation Systems in Latin America and the Caribbean (AgriLAC Resiliente, 25 results), Building Systemic Resilience Against Climate Variability and Extremes (Climate Resilience, 10 results), and Excellence in Agronomy for Sustainable Intensification and Climate Change Adaptation (Excellence in Agronomy, 10 results).

- AgriLAC Resiliente contributed to a gender-focused report in Guatemala, which identified barriers to digital inclusion and recommended user-centered strategies, and to development of e-Agrology, a high-frequency monitoring system that improved sustainability metrics for over 250,000 farmers. Additionally, AgriLAC Resiliente contributed to CGIAR's presence at Digital Agriculture Solutions Forum 2023, which was organized by FAO and the International Telecommunication Union and advocated for inclusive digital climate solutions,
- Climate Resilience contributed to advancing real-time, remote-sensing-based monitoring of rice production systems across Africa and Latin America. It supported the adaptation and scale-up of the RIICE platform in Senegal and Kenya to generate geolocated, seasonal data on rice area, yield, planting dates, and climate-driven losses. These platforms enable governments and partners to design targeted interventions, improve food security policies, and support the development of insurance and microfinance products for farmers. In Guatemala, Climate Resilience helped establish the Digital Agricultural Plot at CUNORI University, integrating Internet of Things and sensor-based technologies to improve resilience and agricultural practices in the dry corridor.
- Excellence in Agronomy contributed to advancing the systematic integration of human-centered design (HCD) in CGIAR's digital innovation processes. It launched Uxtools4ag, an online platform offering practical guidance on user research for inclusive digital development and organized immersive HCD training workshops to build capacity among digital innovators. Excellence in Agronomy also co-produced a gender-focused report with FUTOP, a Guatemalan development consultancy, that identified barriers to digital inclusion and recommended user-centered strategies.

Digital Innovation contributed to 82 results produced by 18 other Initiatives within the CGIAR Portfolio. The top Initiatives included AgriLAC Resiliente (23 results), Livestock and Climate (10), and Diversification in East and Southern Africa (10).

- Digital Innovation supported AgriLAC Resiliente by strengthening digital tools, data systems, and capacities to enhance climate resilience and inclusive agricultural development in Central America. The Initiative's contributions included deployment of e-Agrology for high-frequency agronomic data collection and digitalization of monitoring systems. It also improved climate data services, supported local agroclimatic committees, and conducted applied research using machine learning to guide agronomic decisions.
- Digital Innovation contributed to the Livestock and Climate Initiative by supporting the development and integration of KAZNET, a digital crowdsourcing platform that enables real-time monitoring of livestock markets, rangeland conditions, and household resilience indicators in Kenya and Ethiopia. This platform, which is integrated into national systems such as the Kenya Agricultural Observatory Platform, empowers pastoralists and policymakers with geo-referenced, citizen-contributed data. It enhances decision-making and early warning through AI, remote sensing, and user-friendly dashboards. These tools improve access to climate and market intelligence, support index-based livestock insurance, and strengthen resilience against drought and climate shocks in arid and semi-arid regions.
- Digital Innovation contributed to the Diversification in East and Southern Africa Initiative by supporting the development and application of tools and strategies to scale agricultural innovations more effectively. It promoted the use of Picture-Based Insurance for accessible, low-cost crop insurance and advanced the Scaling Readiness Framework to guide innovation planning, partnership building, and impact tracking. Digital Innovation also facilitated the use of immersive Virtual Field Trips and contributed to the establishment of the Scaling Hub in Eastern and Southern Africa.

Through a collaboration with UNICEF-Yoma, youth in southern Africa can access training in digital citizen science skills that is recorded in a blockchain-based CV. Credit: Groundtruth

Section 7: **Key result story**

An AI assistant to preserve vital natural resources

A "digital twin" of the Limpopo River Basin will help preserve freshwater resources for 18 million people in Southern Africa.

Sergio Sitoe, LIMCOM Executive Secretary, discussing the importance of co-designing the Limpopo Basin Digital Twin at the 10th World Water Forum.
Credit: LIMCOM

Primary Impact Area

Other relevant Impact Areas targeted

Contributing Initiative

Digital Innovation

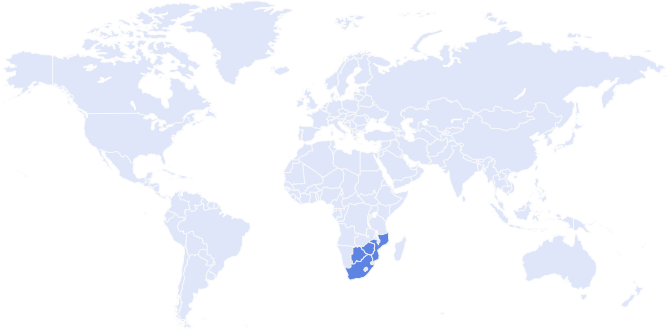
Contributing Centers

IFPRI · IWMI · Alliance of Bioversity-CIAT

Contributing external partners

Amazon Web Services · GroundTruth · United Nations Children's Fund (UNICEF) · Limpopo Watercourse Commission (LIMCOM) · United States International University–Africa (USIU Africa) · University of Kwazulu Natal (UKZN) · South African National Biodiversity Institute (SANBI) · Water Research Commission (WRC) · United Nations Development Programme (UNDP) · Global Water Partnership (GWP) · Digital Earth Africa · African Women in Agricultural Research and Development (AWARD) · World Economic Forum (WEF) · Microsoft · University of Mpumalanga (UMP) · Charles Sturt University (CSU) · The King's University (TKU)

Geographic scope



Countries: Botswana · Mozambique · South Africa · Zimbabwe

The Limpopo River Basin traverses South Africa, Botswana, Zimbabwe and Mozambique. Authorities in these four countries must work together to protect this ecosystem from overuse, pollution, drought, and flooding. They can now easily act on complex real-time data and forecasting across all 400,000 km2 of the Basin thanks to a complete virtual model of the river system. The model provides an interface combining monitoring, scenario prediction, 3D modelling, mapping, and an AI chatbot to simplify decision-making.

A water manager in the Limpopo River Basin opens their web browser to type a question: "What is the status of the rivers in the Basin?" In short order, the answer comes back in the form of a map of the rivers in the Basin annotated with the current alert status for each in shades of green, yellow, and red. "Would you like to analyze the alert for another date?", asks the AI assistant.

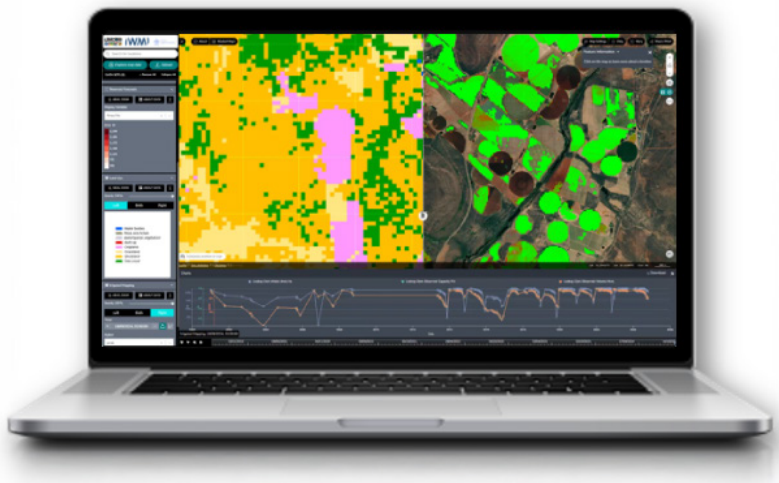
Managing precious freshwater resources across the Limpopo River Basin, home to 18 million people in Southern Africa, comes with unique challenges. Through the Limpopo Watercourse Commission (LIMCOM), agencies in the four countries through which the rivers flow collaborate to take data-driven decisions when faced with challenges such as water overuse, pollution, frequent floods, and pervasive droughts. As climate change puts further pressure on water resources, places like the Limpopo River Basin demonstrate how humanity must adapt.

The Digital Twin for the Limpopo River Basin brings a radically innovative approach to meeting this challenge. It provides real-time virtual representation of the ecological and human systems in the river basin, allowing ecosystem managers to understand the impact of their decisions with little additional training.

While Digital Twins are often used to manage industrial processes, this is the first time one has been used to manage water resources in a developing-world setting, which put researchers in a race to find, adapt, or invent the solutions needed to build the model.

The core of the Digital Twin consists of a hydrological model of the river system that integrates near real-time, historical, and forecasted data on aspects such as water discharge, rainfall, water quality, and human water use and provides detailed insights into water availability and risks. It includes real-time and forecasted hydrological data on 1,408 river channels covering an area of 400,000 km2, data from 303 rainfall stations and 305 water discharge monitoring stations, and daily water availability updates on 1,424 waterbodies and 96 dams.

The Digital Twin project, led by the International Water Management Institute (IWMI) as part of the CGIAR Initiative on Digital Innovation, brought together these data from various national and international partners in a cloud computing platform.



Different resolutions, different details: The digital twin would offer more precise agriculture water management scientific products layers compared to the more generalized view at lower resolutions.

With research partners such GroundTruth and Rivers of Life, the project filled data gaps from innovative sources such as sensors pulled by drones to map under river surfaces or even attached to fish. A team of 1,000 citizen scientists collected 1,200 AI-verified water quality measurements using a smartphone app developed by the project.

To put these complex data in the hands of any user, the Digital Twin interface adopts 3D monitoring, virtual reality, and a new AI-based user interface — Water CoPilot, created in partnership with Microsoft Research — that can draft reports, plot maps, and explore various scenarios in response to written queries.

Through Digital Twin, users working for LIMCOM and other water management bodies can now easily test multiple river management scenarios and assess the social and environmental risks of their decisions.

In 2024, the prototype Digital Twin was formally handed over to LIMCOM, which enthusiastically participated in its design and testing and promoted the collaboration that produced it in events such as the 10th World Water Forum, in Bali. Now part of LIMCOM's strategic planning, the Digital Twin is set to change the paradigm of natural resource management in the Limpopo Basin and beyond.

"The development of the Digital Twin prototype for the Limpopo Basin, which runs alongside LIMCOM's own management information systems, is a big leap forward for the Basin and the region, as it allows innovative management of river basin resources by testing and using new, cutting-edge, technologies."

Eddie Riddell, Regional Coordinator, LIMCOM UNDP-GEF7 project

2022 key result story

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

2023 key result story

AI to unlock the citizen science revolution

CGIAR

INITIATIVE ON

Digital Innovation

Drone technology training.
Credit: IFPRI / Jawoo Koo