



INITIATIVE ON
Digital Innovation

Outcome Case Study Report (2022-2024)

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Abstract

The CGIAR Digital Innovation Initiative (2022–2024) is a transformative effort to leverage digital technologies in addressing critical challenges in global agrifood systems. By emphasizing inclusivity, sustainability, and scalability, the Initiative has made significant strides across five key outcomes: strengthened ecosystems, improved digital skills, equitable resource allocation, gender-responsive services, and robust information systems.

This report synthesizes evidence from case studies, documentation reviews, and stakeholder interviews, showcasing innovations such as Digital Twins, AI-powered advisory platforms, and gender-inclusive digital services.

Findings demonstrate substantial impacts, such as empowering women and youth through gender-inclusive digital services, improving digital literacy, and enabling equitable resource management in climate-vulnerable regions through advanced tools. However, embedding digital innovations effectively and efficiently in land, water, and food systems remains a complex and context-specific challenge.

The results highlight the need for ongoing research, testing, and validation to address the particularities of agri-food systems, such as data integration, socio-cultural barriers, and stakeholder diversity.

Recommendations emphasize building on existing successes, expanding digital ecosystems, and fostering partnerships to secure long-term impact and sustainability.

Digital Innovation Initiative:
Outcome Case Study Report
(2022-2024)

Andrea Gardeazabal and Ellestina Jumbo. CGIAR Digital Innovation Initiative Working Paper. December 2024

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Introduction

The CGIAR Digital Innovation Initiative, launched in 2022, aims to transform global agrifood systems through digital solutions. By addressing systemic issues such as inadequate information systems, a persistent digital divide, and insufficient digital literacy—particularly in low- and middle-income countries—it seeks to foster sustainable and inclusive development across food, land, and water systems. Leveraging cutting-edge technologies and cross-sectoral collaborations, this effort tackles structural inequities that hinder progress.

With a focus on digital inclusion, capacity building, and equitable resource access, the Initiative employed diverse methodologies tailored to regional and stakeholder needs. These include the development of Digital Twins for real-time resource management, gender-responsive advisory platforms, and capacity-building programs for underserved populations. Such interventions were designed not only to address immediate challenges but also to establish long-term sustainability by empowering stakeholders and strengthening resilience in food, land and water systems.

Collaboration was central to this strategy. Governments, non-governmental organizations, private sector actors, and local communities worked together to bridge gaps and create synergies essential for scaling solutions and ensuring their relevance across diverse contexts.

The evidence presented in this Case Study Report demonstrates the transformative potential of digital technologies in food, land and water systems.

Achievements include the creation of enabling environments for digital ecosystems through global and local partnerships, enhanced gender inclusion in digital agrifood services, capacity-building programs that have improved digital literacy, the development of robust information systems, such as Digital Twins, which support real-time decision-making and resource management, and contributions to equitable resource allocation through advanced tools and participatory approaches. However, challenges remain, particularly in addressing systemic inequities, ensuring sustainable funding, and scaling innovations effectively across diverse contexts.

Recommendations emphasize the importance of strengthening collaborative frameworks to build multistakeholder alliances that enhance resource sharing, technology adoption, and policy alignment. There is a need to invest in training programs and infrastructure to bridge gaps in digital literacy and access. Targeted interventions should be developed to empower women and marginalized groups, ensuring equitable access to digital solutions. Efforts should focus on replicating successful models, such as Digital Twins, across regions with similar challenges. Additionally, promoting the collection and use of high-frequency, standardized data can improve decision-making and innovation scalability.

Methodology

This Outcome Case Study Report (2022–2024) was designed to present evidence of how the initiative achieved its End of Initiative Outcomes (EOIOs) through a detailed case study approach. This method enabled a nuanced exploration of specific interventions and their contributions to the initiative's goals. The selection of case studies focused on showcasing diverse examples of digital innovations and their impact, emphasizing geographic variety, stakeholder involvement, and the application of cutting-edge technologies like Digital Twins and gender-inclusive platforms.

Semi-structured interviews were conducted, offering qualitative data from three key groups: CGIAR teams managing the interventions, end-users such as farmers and extension workers, and other stakeholders like government agencies, research organizations, and private sector actors.

Data from both document reviews and interviews were analyzed to identify patterns, draw connections, and assess progress. Quantitative data, including adoption rates and engagement metrics, were summarized to provide additional insights. A comparative analysis across cases helped identify best practices and contextual factors that influenced the success of specific interventions. Triangulation was employed to ensure the validity of the findings, cross-referencing data from multiple sources to confirm evidence and address inconsistencies. To link findings to the initiative's objectives, each case study was mapped to the relevant EOIOs, illustrating specific contributions and challenges. This process highlighted direct and indirect impacts while identifying barriers and opportunities for scaling and sustainability.



Participants at the Nairobi in-person ICTforAg 2024 conference, one of five simultaneous event locations along with the Virtual Day.

Credit: X / @skanikasinh

End of Initiative Outcome (EOIO) 1

Strengthened ecosystems

Information and communication technologies (ICT) have become increasingly important instruments for improving agricultural operations. ICT for Agriculture (ICTforAg) conferences provide opportunities for knowledge sharing,

innovation exchange, and networking among stakeholders such as farmers, researchers, government agencies, and technology developers.

Strengthening ecosystems is essential for fostering sustainable agricultural innovation and addressing systemic challenges in the agri-food sector. Ecosystems, composed of interconnected actors such as farmers, researchers, policymakers, technology developers, and private sector stakeholders, serve as the foundation for collaboration, knowledge exchange, and co-creation of solutions. A robust ecosystem enables the efficient flow of information, resources, and technologies, enhancing the capacity of all stakeholders to respond to emerging agricultural challenges, including food security, climate change, and market accessibility.

ICTforAg conferences were meant to play a pivotal role in this context by creating platforms where these diverse actors could converge to share knowledge, showcase innovations, and establish partnerships. Such interactions are critical for strengthening ecosystems as they break silos, promote interdisciplinary collaboration, and foster trust among stakeholders.



Robust ecosystems also mean building resilience against global and local agricultural challenges, enabling adaptive strategies that benefit smallholder farmers and other vulnerable groups. By aligning policies, technologies, and practices through shared understanding, strengthened ecosystems contribute to long-term sustainability and equitable outcomes across the agricultural value chain.

This section presents findings relating to ICTforAg conferences held across the global south, focusing on their objectives, outcomes and recommendations.

Evidence

ICTforAg conferences and events provide a platform or opportunity for different stakeholders to interact and share ideas. According to a speaker at an ICTforAg event in Kenya, these events are critical in building collaborations that help to understand the tech ecosystem in Kenya. While it is difficult to track how many connections they made during the events, constant communication via emails by the new networks created shows that these events help build networks and collaborations between attendees, speakers and even co-organizers/sponsors.

Networks built have impacted positively on visibility of different organizations in the ICTforAg sector.

A speaker at the ICTforAg events in India stated that networking in an in-person cannot be compared to a virtual event as it gives all those in attendance the chance to have fruitful discussions without limitations. He, however, noted that these events are short meaning most sessions must be rushed due to time constraints. Finally, it was noted that tracking networks built through the events was difficult because for bigger organizations such as Kuza Biashara who interact with more than 1 million farmers and 5,000 agriprenuers across six countries, it is difficult to track who utilizes tools availed on their websites and other platforms

Research Implementation

While there were many insightful presentations at ICTforAg, participants in the study stated that they had not tracked implementation of their ideas by the attendees of the events. However, follow-ups via email depicted that attendees had learnt some ideas that would hopefully uptake them and implement them in their activities or projects. This does not mean that none of the research ideas presented were implemented.

A female participant in Kenya stated that while there were many research ideas presented, some insightful ideas helped her organization in developing a roadmap. This was a water management system tool that was presented at an ICTforAg event in Kenya.

A speaker in the ICTforAg in events stated that though the organization he represented was not a research institute, they built agriculture technologies through research. Attending these events meant that it would increase visibility of the technologies they built. As an enabler to their business, having successful and impactful technologies means than more and more stakeholders including research organizations, agriprenuers and even farmers visit their website. While this cannot be quantified as increase in uptake of the new technologies but rise in number of visitors to the websites means that people are interested in the ideas that the company presented.

Benefits to the Speakers and Co-organizers/sponsors

ICTforAg has had impact on speakers who actively participate and present their work in the events. A participant in India states that participating in these events has helped them to understand better what areas of collaboration government agencies can leverage on by working with private sector players and other non- governmental players. The participant who works for the government further elaborates that collaborations are critical to build capacity of government agencies to better deliver services to its citizens. The ICTforAg events are therefore an important opportunity for the government to present its work and learn from other participants. A speaker at the ICTforAg event in Kenya stated that, while a lot of the innovations revolve around development of apps, she learnt that there are efforts to build capacity of farmers to better understand how the apps work. The end user in most of these apps is the farmer and many tech companies are working in making sure that farmers are better placed to understand how the apps and different technologies work.

Influence of ICTforAg on the Policy Discourse

There was a consensus among the participants in the study that ICT has a huge influence on the policy conversation in Kenya and India. Using evidence-based findings, it has become easy to bring together policy makers on the table to help in integrating and influencing change, especially for government ministries. Policy implementation is seamless when there is ICTforAg from the government. The private sector and other stakeholders in the ICTforAg space play a vital role in moving the conversation into policy formulation and implementation through engagements with government departments and ministries. One critical aspect is digitally empowering extension workers (both private and public) as they have direct interaction with farmers. This way they are better placed to influence uptake of products and services by farmers. In addition, technology has a lot of advantages that can help revolutionize agriculture. The developers therefore have a lot of work to do to convince policymakers at the government ministries to leverage on this to influence policy change that will help transform the agriculture sector.

On the conversation of whether ICTforAg had directly influenced policy change, most of the interviewees explained that they have not yet seen the policy changes, but the conversations have got policymakers thinking about how best to use technology to transform the sector. Government policymakers are now holding meetings with research organizations and tech companies to better understand how different technologies work and how they can be integrated into government policies for implementation. For example, in India, the Carbon markets are still being understood and will take time before this can be taken up into the policy frameworks by the government.

Significant Outcomes from ICTforAg Conferences

ICTforAg conferences have helped participants to build networks of like-minded people which most hope will help build collaborations and

ICTforAg 2024 attendance, locations, sessions and speakers

Attendance - 2128 total



partnerships in implementing different projects. KUZA Biashara has been working with research organizations, government agripreneurs and farmers. These events play an important role in reaching a wider audience which hopefully will lead to more uptake and utilization of different tools and technology presented at the events. In addition, the conferences presented an opportunity for the participants to learn about the innovations that are in the market and how they influence different aspects of agriculture such as financial, access to markets, weather etc. Learning what is available creates an opportunity for collaboration with like-minded tech companies and other organizations. A participant in Kenya stated that through the conferences, she was able to build partnerships in implementing projects with CGIAR and USAID. Most significant to the participants is the feedback from those who attended the conferences. The feedback has helped in improving technologies to ensure maximum benefits to end users and policy makers.

ICTforAg Learning Network

Some participants in the study have heard about the Learning Network but have not participated yet in it. However, they believe virtual engagements are important following conclusion of ICTforAg events. For continuity they suggest that the Learning Network to be active because brilliant ideas discussed at the events may never be implemented if virtual engagements and interactions do not occur frequently. Those who have not interacted with the Learning Network have engaged with other online platforms such as workshops organized by CGIAR. They are, however, interested in joining the Learning Network as an extension to the ICTforAg conferences that they have attended. A participant in India stated that while the Learning Network is active days after the conferences, the engagement starts to decline over time. He recommended events like hackathons and incubation facilities for startups, that ensure tech companies or participants continue to be actively engaged and have prizes to be won as an incentive.

More topics for discussion

1. From research to policy implementation
2. Impact of technologies along the value chains
3. Correct usage of upcoming technologies
4. Policy conversation around soil carbon issue
5. Use of new technologies to measure soil carbons stocks
6. Data availability to the private sector
7. Access to more markets
8. Getting more financing to the sector
9. Climate and sustainability/ climate smart agriculture
10. Policy on intermediaries as farmers to markets
11. Policies around digital technologies in agriculture

In conclusion, all the participants were open to being part of the friendly critic group for constructive and well-intended feedback on how to improve ICTforAg events and the virtual engagement platforms.

Recommendations

The ICTforAg conferences contributed positively to strengthening ecosystems by fostering collaborations and building networks that enhance the interconnectedness and capacity of stakeholders within the land, water and food sector. By bringing together diverse actors, these conferences encourage the co-creation of solutions, the sharing of best practices, and the development of innovative tools and technologies tailored to local needs.

However, the impact of ICTforAg conferences on ecosystem strengthening is not without its challenges. The limited duration and concurrent sessions often hinder deeper engagement and sustained collaboration. Additionally, while networks formed during these events enhance visibility and potential partnerships, the lack of mechanisms to track

and measure the long-term impact of these collaborations can weaken their contribution to ecosystem resilience. Furthermore, the reliance on virtual engagement, though efficient, may not fully capture the depth of interaction required to foster trust and meaningful exchanges, especially for stakeholders in regions with limited digital infrastructure.

The following concrete recommendations were given by participants of the study.

1. There were many very interesting sessions but since they were held on- currently, in-person participants were unable to switch between rooms. However, those attending virtually had the liberty to switch between rooms. It was therefore recommended that organizers should find a way of making sure that the conferences can be longer to make it easy for attendees to attend as many sessions as possible. Co-currency of events meant participants could not interact with presenters and participants from other regions for example India. Record the sessions so that participants unable to join or attend all the sessions can listen and watch the recordings after the event
2. Reduce the presentations and have longer sessions for speakers to fully interact with the participants. The Q&A sessions are very important, but they were not fully fruitful or utilized due to time constraints as there were many presentations. Just like first recommendation, the participant recommended more days for the conferences to ensure participants sufficiently engage with the speakers
3. In contrast to the first two recommendations, a participant of this study suggested reduction of conferences days because it called for commitment for one to attend the conference for two or three days. She suggested a day is sufficient and many participants would just commit to a day of attending the conference



Mitch McTough (IWMI) showcases the use of virtual field trips in water4ag projects in challenging contexts, at the Nairobi 2024 ICTforAg conference.

Credit: X / @MMCTOUGH



ICTforAg 2024 NextGen Ambassadors



An ICTforAg Learning Network Mentor Speed Dating Event

4. It is important to do follow-ups after the conference to ensure that the things discussed and recommended do not die down after the conference. So many good ideas and suggestions come up in these events and it is critical that the conversations continue via virtual engagements
5. Give room for cross-border learning. ICTforAg events happen in different countries, and this presents an opportunity to share ideas between different countries.
6. All the participants have, in one way, or another, used virtual engagement frequently. Owing to the nature of work and inter-country collaborations, virtual engagements have become a mode of communication to ease travelling for such engagements. Due to time and financial constraints, most organizers decide to have virtual engagements with a few in-person meetings that take time to organize. From the findings, all the participants hold several virtual meetings weekly. However, due to the nature of work where meetings are held virtually and in-person, it becomes difficult to attend all virtual meetings

Overall, ICTforAg conferences are valuable platforms for strengthening ecosystems by creating opportunities for dialogue and innovation. To maximize their positive impact, addressing the barriers to deeper engagement, long-term tracking, and equitable participation is crucial.



EoIO 2

Gender-responsive services

A farmer in Guatemala answers questions on her information needs as a part of the human-centered design process applied by the Initiative.

Credit: Anna Muller (Alliance of Bioversity International and CIAT)

The Digital Innovation Initiative sought to improve the gender-responsiveness of more than three organizational partners to revise their strategies and business plans to provide gender-responsive services. A gender-responsive approach in innovation and technology seeks to incorporate the unique needs and roles of all genders in order to achieve equitable benefits of both genders equally. This entails drawing attention to the specific needs and experiences of both women and men at every stage of the innovation process while addressing specific challenges such but not limited to access to resources, equal pay, safe work environment and education. Examples of gender-responsive technologies include apps that aim to empower women through access to information. By addressing issues like funding gaps, political will, and research in gender dimensions, a gender-responsive approach helps create a more inclusive and sustainable future, allowing all people to benefit from technological progress.

One way that this was envisioned to be achieved was through the Inspire Challenge. The Inspire challenge was introduced at the ICTforAg 2023 as a Pay-for-Results initiative aimed at enhancing women's participation in digital agri-food advisory services. Launched by CGIAR, the main aim of the program was to promote gender inclusion in the agricultural technology sector.

The challenge had two primary objectives:

1. To incentivize organizations to improve gender balance in their digital agri-food programs.
2. To share insights on applying the Pay-for-Results model to tackle complex ICT challenges.

Following an online application process that drew 334 organizational applicants, five winners were selected from 80 submissions. These winners/ challengers were chosen based on three key criteria: readiness, innovation, and verifiability. The selected challengers received technical support, funding, and resources, and upon meeting the gender inclusion goals, they were eligible for additional prize money in 2024.

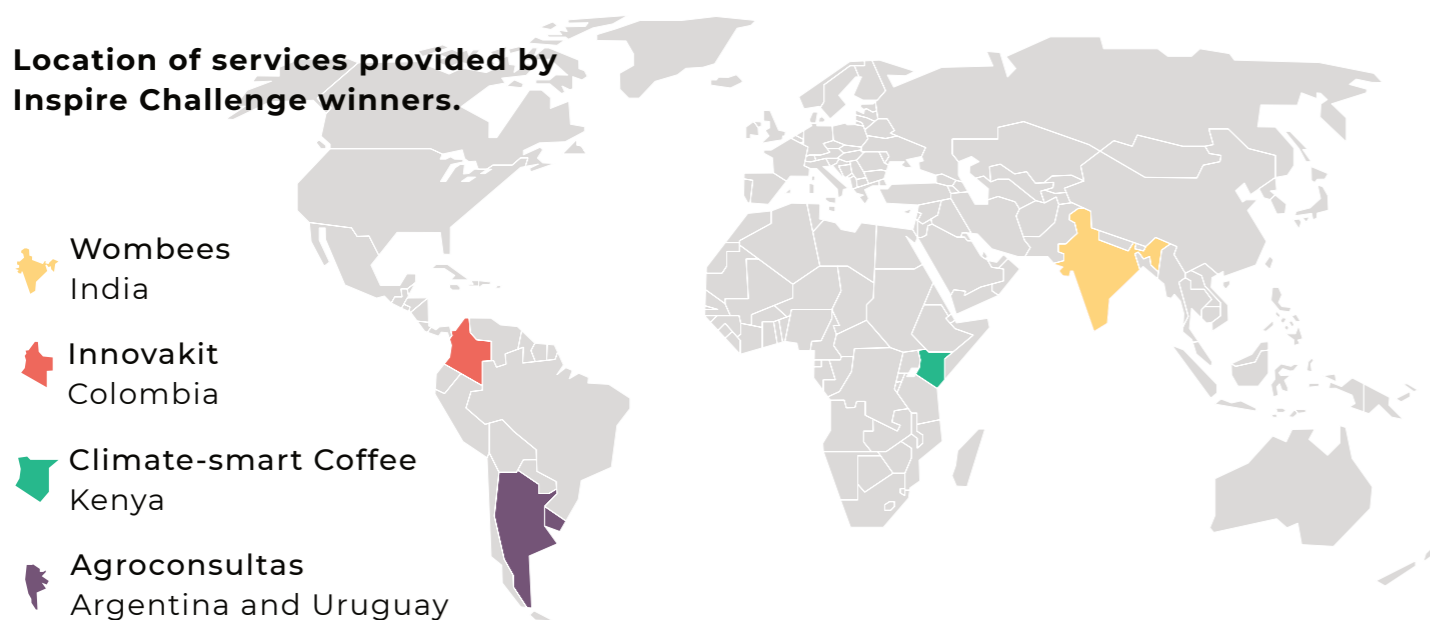
Through the Inspire Challenge winners' inclusion in the program, a total of approximately 61,728 women were reached across the four service providers, alongside 105,230 youth. Service provided across the winners were diverse but one main strategy used to integrate gender-responsive services was through intentional empowerment initiatives.

For example, WomBees intensified their efforts to empower women by prioritizing their needs and perspectives. This was done by inclusion of champion beekeepers during the training

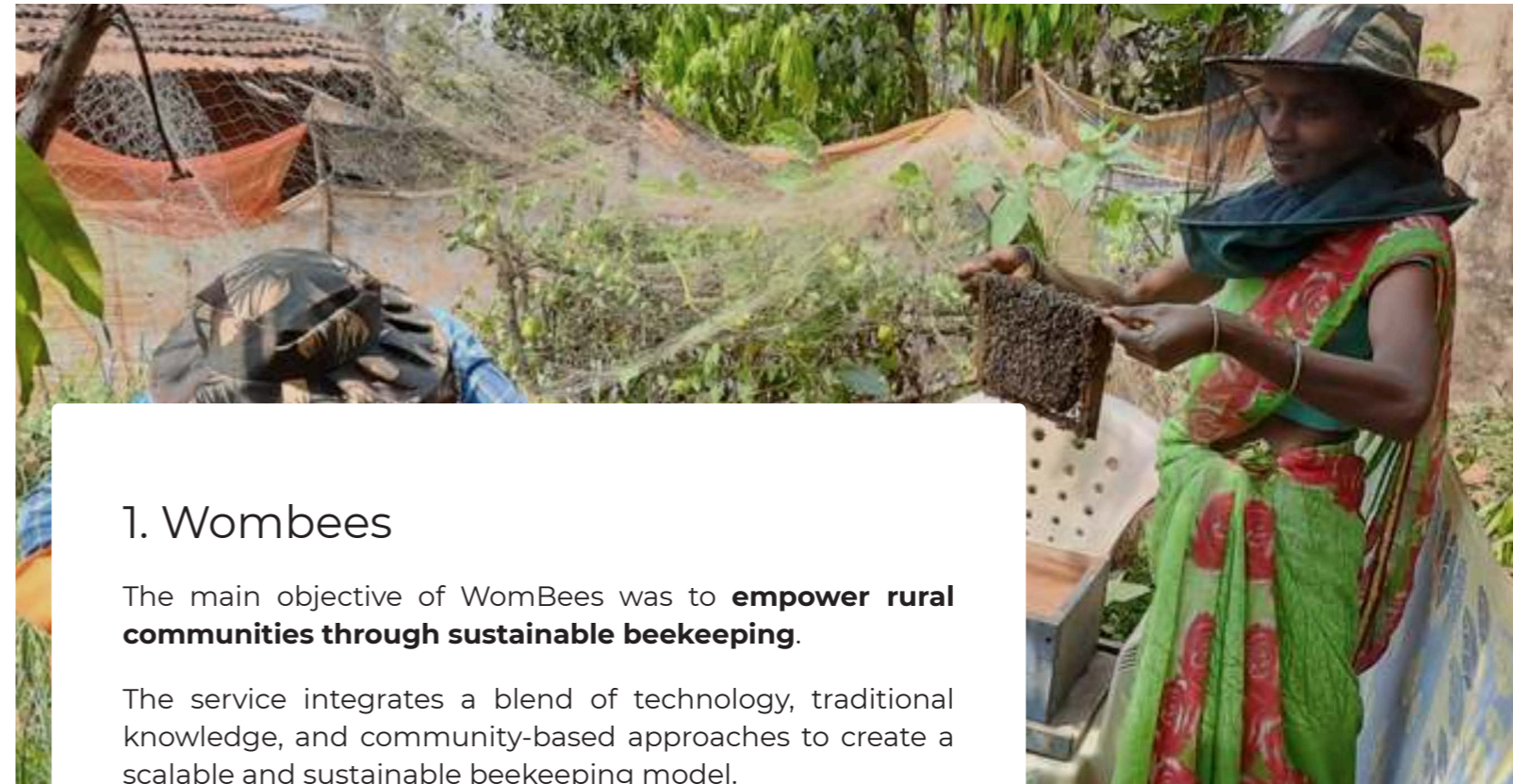
periods. This enabled them to place a stronger emphasis on women's involvement in beekeeping. A similar approach was taken by Agro-consultas, where they tailored their trainings according to the requests of Argentina's Rural Women's Network. Where previously, the design and execution of initiatives lacked a gender perspective, currently these missing concepts are in full adoption. One notable way this has been achieved is by implementing preferential access options for women to their site content as well as the inclusion of female experts in the panel of specialists who answer users' technical questions.

Another important milestone is the recognition that technology plays an integral role in ensuring gender inclusivity and digital inclusion. In particular, Climate-Smart Coffee and Innovakit report using platforms such as WhatsApp not only for communication but also for virtual digital delivery of resources and trainings. The role of Artificial Intelligence should also be highlighted here, specifically the use of Chatbots that were used to engage more closely with women. Today, approximately 3 billion people use WhatsApp globally according to Statista. There is clear undebated evidence that digital tools have become an essential strategy for digital inclusion especially in this post-pandemic era. They especially prove to be beneficial in the context of community engagement initiatives.

Location of services provided by Inspire Challenge winners.



Evidence: How did the services achieve gender responsiveness?

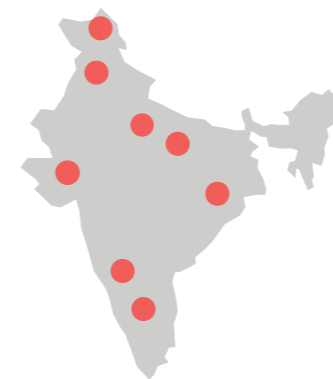


1. Wombees

The main objective of WomBees was to **empower rural communities through sustainable beekeeping.**

The service integrates a blend of technology, traditional knowledge, and community-based approaches to create a scalable and sustainable beekeeping model.

Site: Various across India



Achievements:

- A total of **383 women were trained** from a baseline of zero and this was achieved by incorporating a more gender-focused lens. This number not only reflects those who showed up but those who were also able to complete the training program willingly.
- Women's access to technology was enhanced by the development of the BEEKIND App** which provided access of trainings in vernacular languages as well as aiding with ongoing beekeeping practices.
- Access to loans in their names meant that **more women were enabled to take up scientific beekeeping** which in turn increased their financial independence and in turn boosting their confidence.



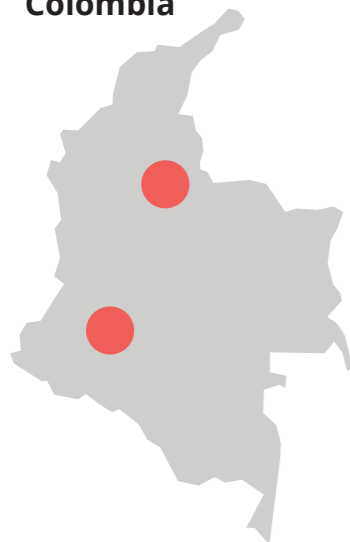
Evidence: How did the services achieve gender responsiveness?



2. Innovakit

The main objective of Innovakit was to **promote the digital and financial inclusion of women farmers in the coffee sector**. They mainly used WhatsApp as a knowledge transfer digital platform that provides services to farmers, their communities, and the environment in general.

Site: Huila and Santander, Colombia



Achievements:

- i. In total, **271 women participated in the interaction group**, presenting an increase in women's engagement from a baseline of zero. The digital influencers in each area monitored the activities generated by the participants of the program on a weekly basis.
- ii. Enrolment in a **WhatsApp financial health course reached 155 women** who upon completion received a certificate of attendance. Time to completion of the course was duly recorded, providing insights to their educational dedication.
- iii. **Innovakit has supported over 500 women**, achieving access to financing exceeding 300 million pesos, with a compliance rate of 100%. This methodology implemented through WhatsApp proved to be an effective and accessible system for participants in rural areas.

“ We designed mechanisms to create a community, knowledge capsules for management via WhatsApp and a WhatsApp course for financial health.

Hugo Lopez (Innovakit)



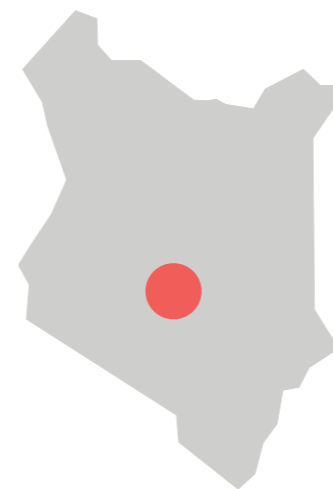
Evidence: How did the services achieve gender responsiveness?



3. Climate-smart coffee

The main objective of Climate-Smart Coffee was to **capture the channel, language and media mediums that best enhance climate resilience**. The service is an insurance technology for farmers with the aim of protecting them against extreme weather events and aid them in building climate resilience.

Site: Mount Kenya region, Kenya



Achievements:

- i. **The increase in the women farmers enrolled in Climate-Smart Coffee.** The goal was to enrol 30% of women farmers from a group of 1000, of which 48% was achieved in the end.
- ii. A total of **269 farmers were engaged with giving feedback, 81% of whom were women**. Engagement in the program included the use of WhatsApp for calls, group chats as well as feedback with Chatbots.

“ During the Inspire Challenge, Climate Smart Coffee uncovered a higher-than-expected smartphone penetration rate for women coffee farmers, and with support from our team leader at the Inspire Challenge, we launched a WhatsApp Chatbot for farmers. This has not only led to more insights on our early warning mobile advisory service for coffee farmers, but it has also inspired us to explore incorporating AI to have deeper conversations with coffee farmers, particularly women, where little known understanding exists.

Ashley King-Bischof (Climate-Smart Coffee)



Evidence: How did the services achieve gender responsiveness?

Altos de Chipión, Córdoba, Argentina

Insumos y servicios > Insumos > Semillas y plantines > Trigo

Buenas.. fecha optima de DM CATALPA para noreste de Córdoba.altos de Chipion



Servicio Técnico Don Mario

4. Agroconsultas

The main objective of Agroconsultas was to **increase the engagement of women on their digital platform.**

The platform is a digital technical assistance space where users have access to different agricultural information.

partir del 25/5 al 20/6 con

Site: Argentina



Achievements:

- i. An increase in **the number of questions asked by women increased from 41 to 89** on the platform. This was mainly driven by adjustment in communication style on social media, updated graphic materials and mailing campaigns.
- ii. **29 new female experts joined the team** from different fields and covering different topics on the platform, increasing female representation.
- iii. **The number of new registered female users increased by 20%**, from 194 in 2023 to 232 in 2024. This was driven mainly by targeted campaigns in the first four months of the implementation of the service. New unique site visits were also recorded.



Learnings

While there are significant and notable achievements in gender inclusion efforts, social-cultural barriers remain a top limitation for most contexts. In India, one of the main barriers highlighted was the sociocultural contention that needed to be considered when implementing the training program. As a solution, the men of the family were invited to the trainings, which in turn increased the turn-up of the training programs. However, this sometimes also meant that women's participation in discussions was diminished. Another example is of Central Kenya, where women are not registered as often as men are in coffee farming, despite working on the farms with similar frequency. Land access which is culturally given to men also create a barrier for women to engage¹ even when they have a smartphone and are approached for in person trainings.

Another important aspect to note when it comes to gender responsiveness in a digital framework is that it is complex to persuade users to try unknown digital services. Due to differences in literacy levels and learning rates across the different services, there is need to understand the different needs that should be considered. One way that Agroconsultas tackled this was the identification effective actions, such as social media campaigns targeted at women and direct messages within their platform. This allowed them to capture the interest of new users and promote the use of Agroconsultas services.

¹ www.weeffect.org/stories/the-future-of-coffee-is-female/

Recommendations

Continued learning on gender responsiveness is crucial to understand how different settings can best be approached. Access to smartphones has surely shifted the way that digital innovation can be targeted and utilised especially in rural areas. More work needs to be directed towards designing tools and resources that are contextualised for gender inclusiveness. This includes collaboration with different agencies, experts and even local authorities in understanding how best this goal can be tackled in the most effective way. The Inspire challenge demonstrated a significant example of how women engagement and inclusivity can be achieved across various programs. Despite challenges that come with gender responsiveness, there are important learning approaches which can be horizontally adopted.



CUNORI student Alejandro Rodas demonstrates the app-controlled irrigation system he developed

EoIO 3

Improved digital skills of users

Several factors such as climate change, degradation of natural resources and decreased agricultural productivity are some of the main culprits in transforming agrifood systems in Latin America and the Caribbean. As such, the need for digital innovations that can transform not only the agrifood systems

but also community livelihoods are of vital importance. With this consideration in mind, CGIAR Research Initiatives on Digital Innovation and AgriLAC Resiliente collaborated with different stakeholders to provide tools and techniques on digital agriculture to professionals in the Central American Dry Corridor in 2022. Termed the Digital Agriculture Diploma Program, a total of 26 agricultural professionals were initially brought from different sectors such as government institutions, academia, international organizations as well as local cooperatives. Over time, additional graduates (9 from Innovative Extension Services in 2023 and 17 CUNORI faculty members from Digital Tools for Research in 2024) were also trained for this course. The course offered an intensive digital skill and knowledge transfer in agriculture with the aim of equipping them with the tools to address challenges such as climate change, resource degradation and food security in their communities. With contributions from institutions such as MAGA, WFP, and IICA-CRIA, these cohorts represent an excellent example of the potential of digital skills to drive meaningful change in the Central American Dry Corridor and beyond.

One of the main success outcomes of the digital course was the establishment of the **Digital Agriculture Living Lab in Chiquimula**, Guatemala which supports testing innovative tools on ground. The lab hosts several innovative digital tools such as in-situ sensors, soil moisture monitoring systems and weather stations. These tools enable the real-time data collection for evidence-based decision-making. The lab has been established with the anticipation of address critical issues like water retention during droughts and precision agriculture. The pathways are a potential for improving productivity and food security in regions that are most vulnerable to climate variability. Apart from local impact, the course has provided a scalable blueprint for integrating digital technologies into agriculture globally. The methodologies and learnings from this initiative highlight how empowering professionals with targeted digital skills can lead to the adoption of innovative, data-driven practices. Moreover, the growing need for the inclusive nature of the digital programs encourages women's participation in agricultural innovation as seen in the digital course.

Evidence: How did the Digital Agriculture Diploma Programs improve the digital skills of users?

Participants in the Digital Agriculture Diploma Program found several aspects of the course beneficial and impactful, particularly the use of Google Earth Engine and AquaCrop. To understand the impact of the digital diploma course, information from 32 participants were analysed from an online feedback survey. Of the respondents, 22 were males and 10 were females, representing 69% and 31% respectively. Of the respondents, 94% are currently employed in different sectors and the remaining 6% are currently unemployed. When asked to evaluate their digital skills before and after the course, 59% of participants rated their skills as medium and 41% as high after the course. This contrasts

with the pre-course responses, where approximately 38% rated their skills as low and 50% as medium. Only 13 % rated their skills high before the course (see Figure 1). Of those reporting high skills after the course, 67% were male and 33% were females (see full information in Figure 2). When asked which topics they found their jobs, the use of technology in agriculture was highly ranked alongside the use of drones. It was noted that the use of drones in precision agriculture and the application of digital tools like mobile applications and GIS were essential for improving productivity and decision making in agriculture. Tools such as Google Earth and Aquacrop were noted to be particularly useful in application to their area of work. Additionally, the programs focus on data manipulation, historical environmental data and the use of R for modelling crop water requirements were valued for their applicability in research and project development. Other aspects that were highlighted were the integration of new software applications for pest identification and human-centered technological solutions. Many emphasized that the program's comprehensive approach to integrating technology with agriculture inspired innovative project ideas, particularly those aimed at enhancing crop yields and optimizing farming practices. On average the respondents found no income change due to the course, but some have noted that the course helped them to get new jobs or promotions.

Overall, the participants rated the course 4.5 on a scale of 1 to 5 when asked about the general course perception. The course provided valuable knowledge on how to apply satellite information, Internet of Things (IoT), and other innovative technologies in agriculture, ultimately helping to improve efficiency, reduce costs, and increase sustainability in agricultural practices. While both males and females are on average applying the skills from the course in their current jobs, when asked how confident they were in using the new skills, generally the males were more confident than females.

Figure 1. Subjective perception of the digital diploma course by gender

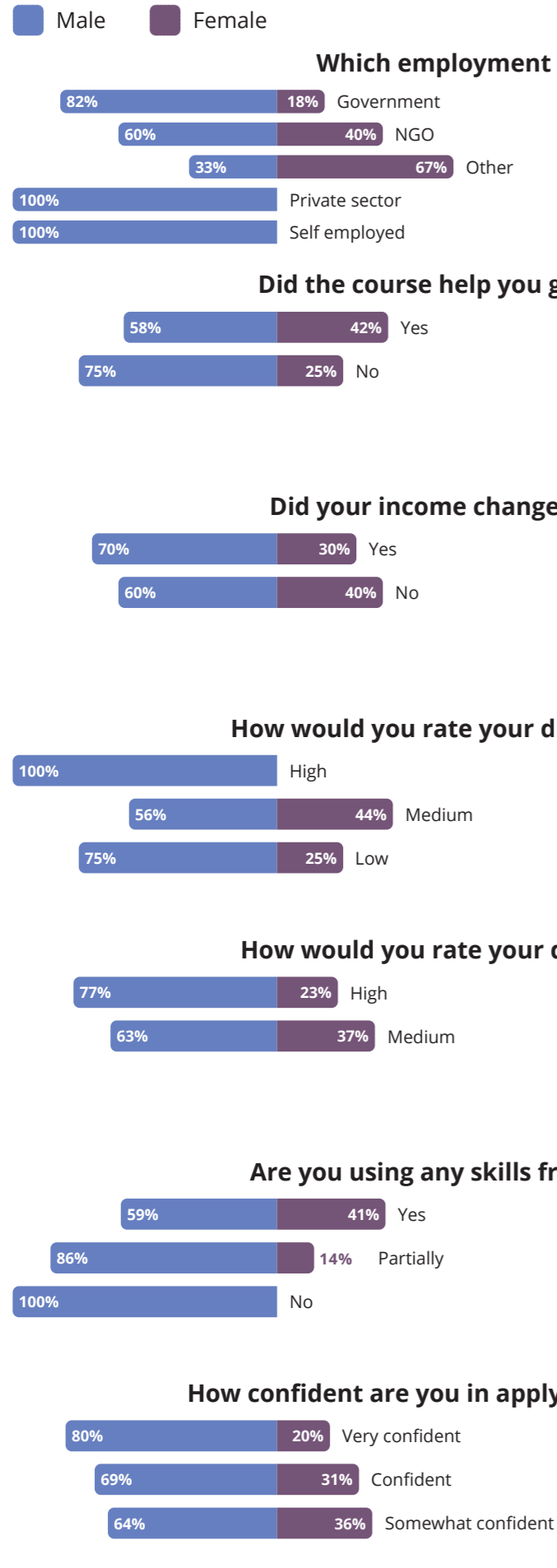
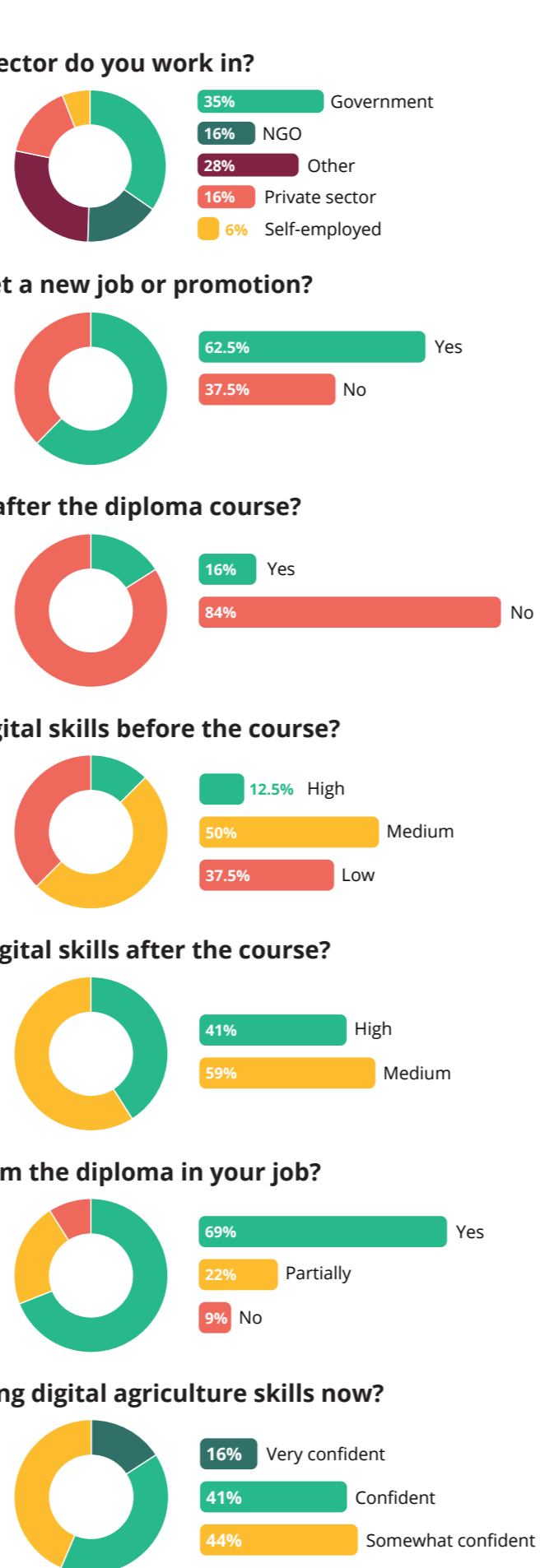


Figure 2. Subjective feedback on the impact of the Digital course



Learnings

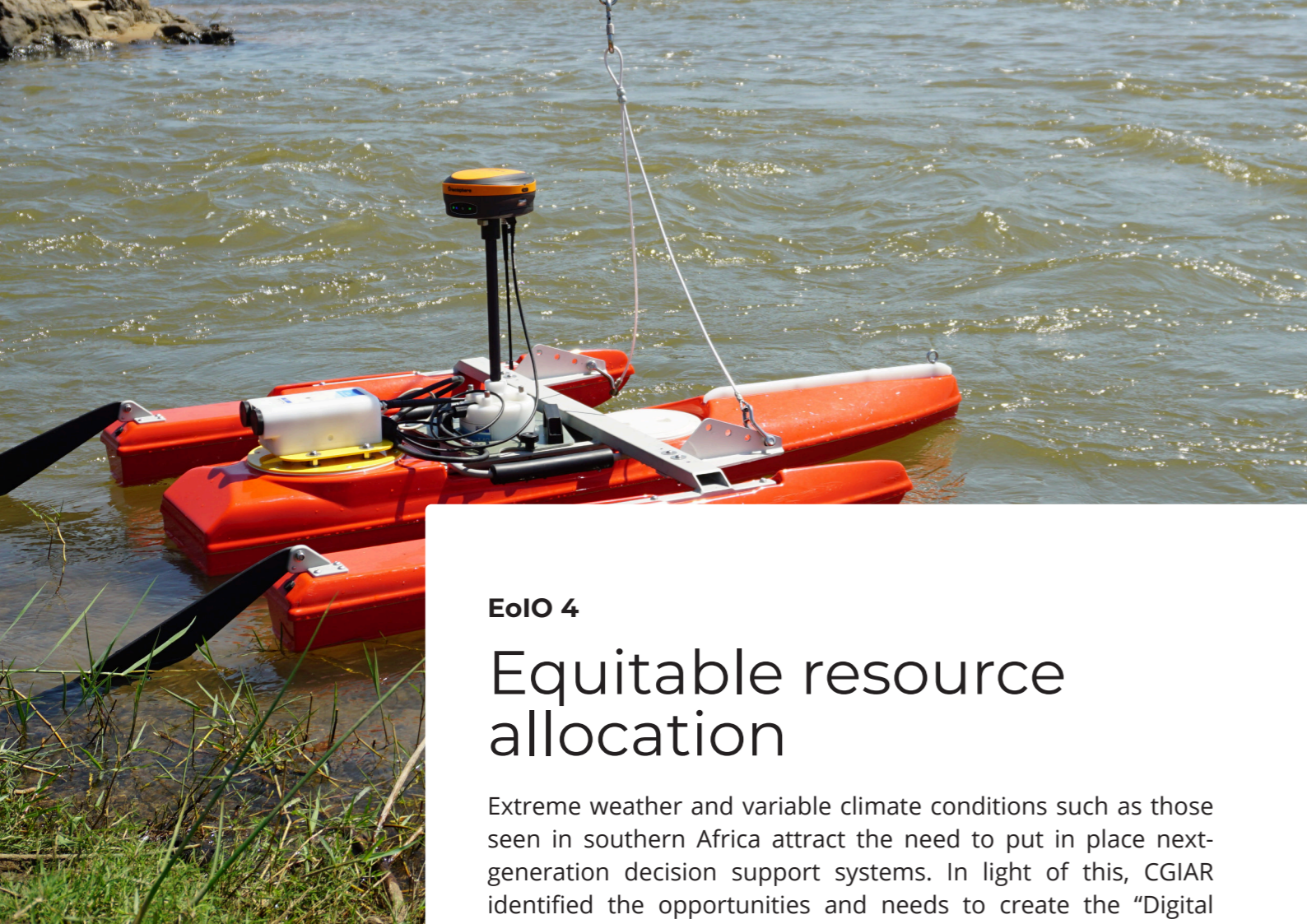
Participants expressed interest in a range of topics for a future edition of the course, particularly around data analysis and the use of drones for precision agriculture. The practical aspect of the course, particularly in areas like drone usage, sensor management, and remote sensing for precision agriculture was highly commended. They highlighted the need for deeper training in data analysis tools such as RStudio, Big Data, and AI for predictive modelling, along with practical field projects to apply these technologies. Emerging topics like Internet of Things (IoT) in agriculture, smart irrigation technologies, and regenerative agriculture also garnered attention, reflecting a desire to enhance sustainability and productivity. Additionally, participants emphasized the importance of dedicating more time to previously introduced topics, ensuring thorough understanding and practical implementation of digital platforms and tools in real-world agricultural contexts.

Some challenges and limitations encountered during the course were also noted, particularly around the program structure and resource limitations. One of the main limitations encountered during the course was around time constraints. Majority of the participants noted that the programs duration was insufficient for deep learning and for application of the content. Balancing the program's time demands with existing work responsibilities also posed as a significant challenge for some participants. Some also noted that the course covered too many topics superficially, suggesting that fewer topics with more depth which could improve the experience. Another area to adjust for future editions of the course was around resources which were seen as insufficient. Specifically access to necessary equipment, tools and stable internet connections which was a huge hinderance for participation and learning. These issues point to opportunities for refining the program structure, improving resource availability, and addressing administrative concerns.

Recommendations

The digital course offered advanced tools to address current climate change problems. Structured towards working professionals, the course has demonstrated great achievement in incorporating new skills for old problems.

Moreover, the Digital Plot established as a result of the course showcases an innovative space integrating advanced technologies for learning, exploration, and technology validation in the agri-food sector. By working in partnership with academic institutions, government agencies, and international organizations, the program proves the potential of digital agriculture to transform livelihoods and strengthen resilience across regions affected by similar environmental and socioeconomic challenges. For future version of this courses, the suggestions highlighted above demand for more applied learning and emerging technologies in digital agriculture.



EoIO 4

Equitable resource allocation

Extreme weather and variable climate conditions such as those seen in southern Africa attract the need to put in place next-generation decision support systems. In light of this, CGIAR identified the opportunities and needs to create the “Digital Twin²”, building upon an existing and no longer functioning natural resource management system in the Limpopo River basin. The Digital Twin was developed as part of the Limpopo Information System (LIMIS) with the main aim of establishing a real-time, data-driven integrated monitoring and modelling system. Digital Twin is a virtual representation of these aspects, with the ability to connect real-time measurements to simulations as well as decision support tools. Such systems are increasingly used in the management of water basins globally.

Upon its establishment, the Digital Twin will be used to answer two research questions:

1. How can food-water-land system dynamics be monitored and modelled to inform natural resource management organizations in making sustainable and inclusive decisions?
2. How can real-time data and advanced analytics assist in better preparation for and defence against natural disasters such as floods and droughts across food-water-land systems?

The end user of the Digital Twin is the Limpopo Watercourse Commission (LIMCOM³) who are currently in the process of adopting the system with capacity building sessions planned in the coming months.

An unmanned surface vehicle used to create high-resolution scans below river surfaces, one of several innovations developed for the Digital Twin project.

Credit: Jawoo Koo (IFPRI)

² iwmi.cgiar.org/blogs/can-digital-twins-help-river-basin-management-in-developing-countries/

³ limpopocommission.org/

Information systems have for the longest time been identified as a key to effective water management. What differentiates this system from all other systems however is that this is the first time environmental flows has been operationalized with forecast capabilities. The system creates automated alerts that warn water managers about the status of the river. It is also embedded with Artificial Intelligent (AI) virtual assistant with GPT 4.0 that practitioners can ask questions to and receive a report.

Currently the basin encompasses four countries; Mozambique, Botswana, South Africa and Zimbabwe where such information will be utilised. LIMCOM has already adopted the Digital Twin as part of its strategy in a project entitled “Integrated Transboundary River Basin Management for the Sustainable Development of the Limpopo River Basin” project (LIMCOM-UNDP/GEF)⁴. The project aims to uplift the living standard of the basin’s

population and conserve its resources and ecosystem services through various community level interventions. Besides using the Digital Twin for water resources, there is interest to investigate broader planning purposes such as landscape scenario and grazing regimes. These could help aid inform on strategies to offset pressure on water resources. Moreover, the replicability of the Digital Twin can be easily achieved and deployed to support other river basins. Following the presentation of the Digital Twin at the 25th World Water Forum in Bali, there is interest in adopting this tool across both Africa and Asia.

⁴ limpopocommission.org/wp-content/uploads/2023/11/Integrated-Transboundary-River-Basin-Management-for-the-Sustainable-Development-of-the-Limpopo-River-Basin.pdf



Sérgio Siteo, LIMCOM Executive Secretary, at 10th World Water Forum in Bali discussing the importance of co-design at the 10th World Water Forum in Bali.

Credit: LIMCOM

Evidence: How is the Digital Twin supporting equitable natural resources allocation?

The Digital Twin portal includes a suite of tools and applications designed to support data-driven water management which has fostered collaboration with different stakeholders. As it stands, data required by the Digital Twin for its functionality can already be accessed through other data providers. Such data includes river hydrology, rainfall, flood warning and irrigation mapping. The collective integration of this data in the Digital Twin is a step towards evidence-based decision making and real-time support. Moreover, the system enables the potential of citizen scientists through digital and traditional means. Currently, the system has incorporated an AI WaterCopilot, which is an effective tool not just for interrogating data and for data-driven decision making, but it also serves as a tool for empowering local communities as it gives them meaningful access to otherwise complex information. Apart from the Digital Twin itself, other deliverables have been delivered to LIMCOM including technical applications, documentation and communication materials. While its functionality is multifaceted, the priority of the tool will be in analyzing water availability and biodiversity health of rivers along the Limpopo basin.

Currently, the Digital Twin for the Limpopo River Basin offers advanced tools for real-time water management and decision-making. Its core SWAT hydrological model provides near real-time data and three-month seasonal forecasts supported by a robust database of 1,408 channels covering 400,000 km². This information is currently available for seasonal forecasting, including 305 discharge stations, and 303 rainfall stations. Complementary tools include reservoir volume monitoring

which currently provides daily updates for 1,424 waterbodies. Future applications of the tools are aimed at expanding these capabilities by integrating drone-based environmental flow assessments, enhancing citizen science contributions through platforms like YOMA-UNICEF, and scaling the technology to other basins globally. These innovations promise to break down the divide between complex data models and practical user-friendly management of water resources, making water management more responsive and inclusive.

Learnings

Development of the Digital twin did not come without challenges, and these should be clearly noted for adoptability. One notable constraint for this initiative is the lack of data that a Digital Twin requires for example to have in place sensors throughout the basin. Considering that there are large differences in the number of sensors in the Limpopo River Basin across different countries, this poses a technical challenge. Nevertheless, data fed from both citizen science as well as satellite imagery can be used to fill this gap. However, this requires solving the disconnect with citizens to ensure a smooth feedback loop. Furthermore, the delivery of such a tool requires a multistakeholder approach with technical partners including government, universities and international organizations. To ensure technical sustainability, solutions beyond the project-based lens should be carefully analyzed. Data sharing protocols and data sharing agreements from different countries should also be well specified within such frameworks. This is due to the difference in regulations around data access and

“ The development of the digital twin prototype for the Limpopo Basin, running alongside LIMCOM’s own management information systems provides a big leap forward for the basin and the region, to allow innovative management of river basin resources, testing and making use of new technologies at the cutting edge

Eddie Riddell

Regional Coordinator, LIMCOM UNDP-GEF7 project

accessibility which may require attention towards federated access. This process can be smoothed by collaborating with technological partners who have a track record of facilitating such processes.

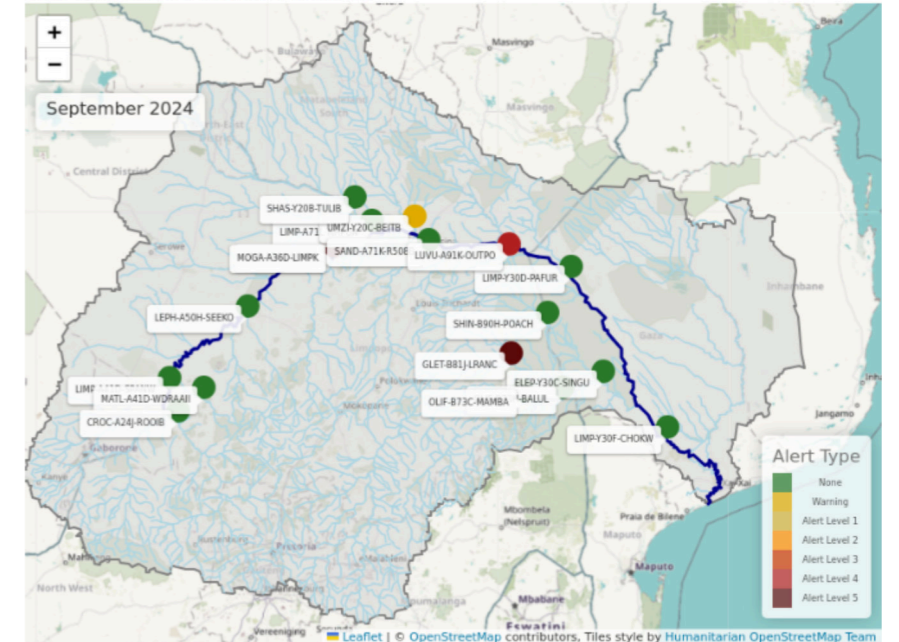
Recommendations

The Limpopo River basin Digital Twin represents an approach that is both transformative and innovative in solving issues around water management.

The integration of AI-driven support, citizen science and earth observation offer a powerful tool for evidence-based and sustainable decisions. What should be highlighted is the ability of the system to translate complex data into actionable insights, making it a paradigm shift in resource management and offering a user-friendly model for advancing equitable resource allocation. For the future, it is foreseen that enhancing the livelihoods of communities reliant on the basin's resources will be achieved by this innovation. The challenges that arise with its use require careful attention which needs to be solved within a multistakeholder platform. The potential of the system has already drawn attention for replicability in other regions, rendering the Digital Twin as an innovative model for advancing water security and sustainable development.

- **Healthy Rivers:** Most of the rivers were classified as "Healthy," meaning they are flowing well and maintaining ecological balance.
- **Warning:** The Luvuvhu River below the Outpost Private Lodge in Kruger National Park is almost reaching E-flows.
- **Critical Alerts:** Shashe River upstream of the confluence with Limpopo River and Letaba River upstream of Little Letaba River in Kruger National Park faced a Level 5 Ecosystem threat, meaning immediate action is required to add water and maintain E-flows.

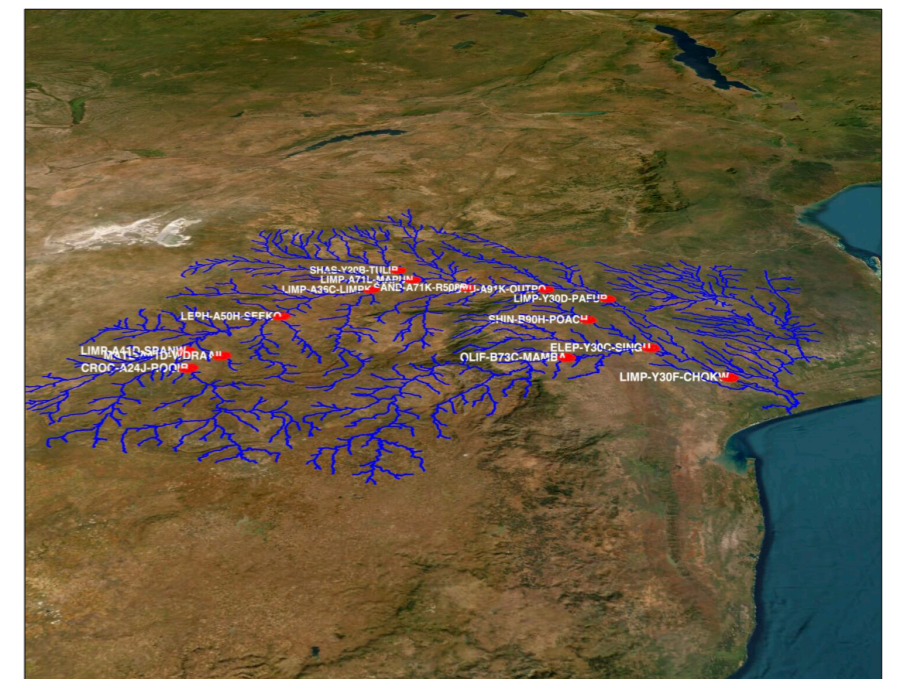
Visual representation of the alerts for last month:



Would you like to analyze the alert for another date? If so, please provide the specific date (in YYYY-MM-DD)

Yes, Could you tell me more about the rivers with Critical Alerts?

Screenshot of the GPT AI-based Water CoPilot interface



3D representation of data on the Limpopo River Basin accessible through the Digital Twin portal



EoIO 5

Strengthened information systems

To achieve the full capacity of digital technologies specifically in shifting food-land-water systems, adequate information is required. Digital technologies allow for real-time monitoring of these systems at a lower cost and

higher accuracy than ever before. In lieu of this, CGIAR's multidisciplinary experts were identified to help address and strengthen information systems. It is well noted that weak information systems not only waste budgets but slow the flow of information that can be used to alleviate poverty. Moreover, outdated knowledge is difficult to apply in practice and require better and up to date information. The services identified were MiniSASS, Enviro-Champs, Meghdoot, KAZNET and e- Agrology.

- i. The mini stream assessment scoring system (MiniSAAS) is an AI-powered app that captures how human activity affect rivers.
- ii. The Enviro-Champs tackles issues of sanitation by training community members to monitor and report sewage leaks.
- iii. Meghdoot is a mobile app that provides location and crop specific weather information across India.
- iv. KAZNET is a digital platform for monitoring market behaviour, food security and rangeland conditions in extensive livestock systems informing early and anticipatory action.
- v. e-Agrology is a platform that enables sharing of data which has received consent from the farmers.

Citizen scientists use miniSASS to collect water quality data

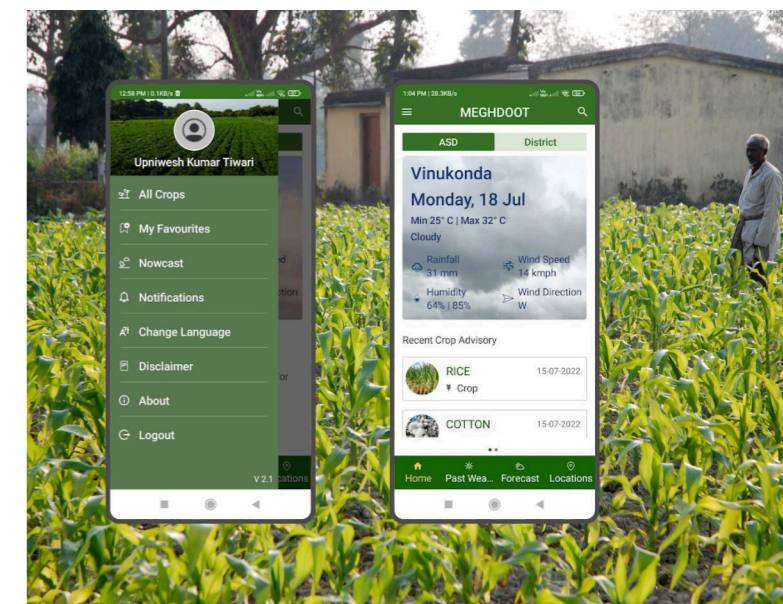
Credit: Nicholas Pattinson (GroundTruth)

The impact across the different services is diverse but great emphasis can be placed on how widespread they are becoming. Currently, MiniSAAS has 547 submissions in 2024, compared to just 55 in 2023, indicating a significant increment in people engaging with the platform. Moreover, the YOMA MiniSAAS course has had 932 people enrolling in the course with 584 successfully completing it. This service has been adopted all over the world and has been adopted in the UN space. For Enviro-Champs, there are currently approximately 1000 registered with the service. One notable aspect to highlight is how the Enviro-Champs saved lives in the 2023 Durban Floods via the early warning systems. Both MiniSAAS and Enviro-Champs have also been instrumental for youth employment as users are paid per delivery of a survey.

With a similar impact, KAZNET has had significant improvement in dryland monitoring in Kenya and Ethiopia with market prices being the most requested information. Such information has been critical for public institutions such National Drought Management Authority seeking to use such granular household data and international organisations such as Catholic Relief Services, using the information to address emergency support.

On the other hand, Meghdoot has been instrumental for farmers in India seeking crop specific weather forecast. This has enabled farmers to make informed decisions about planting, irrigation, and pest control, an ability needed in the face of climate change. While the tool was already in use, the Digital Innovation increased the number of languages on the platform and created a platform to understand user metrics. Currently, the Indian Meteorological Department (IMD) in collaboration with ILRI have tested the use of AI, ML and LLMs to generate crop advisory services, currently piloted in 4 districts in India.

Lastly, e-Agrology has been working as a system of standardizing data collection across different actors. Recently, they have published 10 years of agronomic data online which has adopted this standardized strategy. This initiative was aimed at digitizing data collection efforts across stakeholder collecting the same outcomes. Currently the platform is set to be adopted in countries such as Colombia, Honduras and Guatemala.



Screenshots of the Meghdoot app

Image sources: Meghdoot / CIMMYT

Evidence: How are each of the services contributing to strengthened information systems?

What are each of those services contributing to increase frequency and quality of data?

	MiniSAAS	Enviro-Champs	KAZNET	Meghdoot	e-Agrology
Data frequency	Data is collected intermittently, depending on participant availability. School children or individual citizen scientists can collect samples weekly or monthly, though no strict rules exist.	Frequency depends on environmental issues like sewer leaks or pollution incidents. Reports are event-driven, but guidelines may limit redundant reporting (e.g., reporting the same issue only weekly).	Data is collected weekly in rangelands, markets and at the household level. The market data includes livestock prices, body condition of animals, volumes, prices of essential commodities.	Twice a week (Tuesday and Friday), observed weather, forecasts, and agro advisories are updated for 650 agricultural districts in India.	High frequency data collection is collected daily by technicians across Mexico, Colombia, Guatemala, Honduras, India, and some African countries.
Accuracy	Uses AI and a mobile app to identify river invertebrates, cross-verifying user inputs with machine learning predictions. AI accuracy improves through training on 20,000+ photos of insects.	Ensures accuracy through photographic evidence with geotags and timestamps. Data is verified manually by a project team member, though plans for automated AI verification are in development.	Ensures data quality through community-based collection and verification. Data is geo-tagged to prevent data manipulation. AI and machine learning are being integrated for automated checks, especially for rangeland and livestock body condition data.	Works alongside specialized experts and piloting the use of AI and machine learning to generate accurate crop-specific advisories, reducing manual intervention in the process.	Data is cleaned using Python and R scripts through an Extract, Transform and Load (ETL) process. The system uses dashboards to present cleaned and analysed data.
Coverage	Operates globally, accessible wherever participants with smartphones and training are present. It has been adopted as a citizen science tool for SDG 6.3.2 monitoring.	Primarily active in South Africa, expanding to Mozambique, Botswana, and other countries in the Limpopo Basin through partnerships like the Enable Project	Initially started with 8 markets in Marsabit County, Kenya, and expanded to 70+ markets across Kenya and Ethiopia.	Covers 650 agricultural districts in India, with data for all 717 districts available. Plans for expansion into Mali, Senegal, and Zambia are underway.	Data is collected across multiple countries, including Mexico, Colombia, Guatemala, Honduras, India, and African nations.
Reliability	High reliability due to AI-supported identification and global accessibility. Data quality improves through continuous AI updates and participant training	Reliability stems from geotagged photographic evidence and community involvement. While manual verification has limitations, integration with AI will address gaps in reliability.	Community engagement and participatory methods ensure localized and contextually relevant data. AI integration for validation and frequent collection improve reliability.	Provides accurate weather and crop advisories through automated dashboards and weekly updates to improve precision and usability for farmers.	Ensured by trained technicians collecting data in the field, though there is no automated reliability system at the moment.
Granularity	Produces detailed water health reports based on invertebrate diversity, offering granular insights into river health at specific sampling sites.	Provides localized, issue-specific data (e.g., sewer leaks, pollution incidents) with precise geographic and temporal details.	Provides highly detailed household-level data on nutrition and consumption patterns, as well as market-level data like livestock prices, body condition and volumes.	District-level agro-advisories tailored to specific crops, weather conditions, and livestock practices, enabling localized decision-making for farmers.	Household level, with detailed data on farmers, plots, agronomic cycles, and inputs at a granular level.

How can their outputs be related to the strengthening of information systems?

	MiniSAAS	Enviro-Champs	KAZNET	Meghdoot	e-Agrology
Usability	Uses a straightforward methodology, supported by a mobile app and training videos. Citizen scientists collect river health data with the help of AI for species identification. The data is uploaded to a central platform.	Simple for users to monitor environmental issues like sewer leaks and pollution. Training is provided to a lead citizen in each village, who then trains a team. Community-friendly and accessible	Designed for ease of use by community members with basic training. Includes a dissemination component where collected data is translated into usable formats for community groups.	Farmer-friendly with intuitive features like offline functionality and availability in 15+ languages. A dashboard enables government agencies to track usage and queries.	Provides dashboards for stakeholders; data is shared through secure accounts and user-friendly visualizations like Agro Tutor.
Accessibility	Accessible globally and integrated with the UNICEF YOMA platform, enabling users to participate and earn rewards. It supports multilingual access and is open to anyone with basic training.	Geared towards local communities, primarily in South Africa but expanding to other regions (e.g., Mozambique and Botswana). Data collectors are paid through YOMA's blockchain-based system, redeemable for airtime and other necessities.	Information is shared back with the community through designated groups, ensuring even those without smartphones can access it. Besides promoting social learning, it supports participatory methods to engage underserved areas like drylands.	Supports 15+ Indian languages and English, improving accessibility for diverse user groups. Expanded to offline functionality for areas with limited connectivity.	Currently limited to internal stakeholders or through partnerships with governments or donors. Includes multilingual capabilities (English, French, and Hindi).
Interoperability	Fully integrated with Google Maps and YOMA, allowing visualization and global participation. Uses AI for invertebrate identification, enhancing the quality and usability of data	Utilizes digital technologies like geotagging and blockchain for validation and payment. While it does not yet integrate with larger systems like the "digital twin," plans are underway for expansion and integration into broader platforms	Data is used by various institutions, including humanitarian organizations and government agencies (e.g., Kenya's National Drought Management Authority and Kenya Agriculture and Livestock Research Institute). Integrations with AI and data hubs enhance its utility.	Works directly with IMD and integrates datasets from multiple divisions into a unified platform. Collaborations with global stakeholders are being explored for adoption.	The Application programme interface (API) enables connection with other systems and facilitate data sharing; integrates with dashboards and visualization tools.
Impact metrics	Has contributed to SDG indicator 6.3.2 (ambient water quality) monitoring. Over 600 samples submitted last year, providing robust data for water quality assessments	Significant local impact, with over 1,000 active participants addressing environmental issues. Collaboration with NGOs and water authorities has strengthened accountability and infrastructure maintenance	The service reaches over 700 households across the two countries and 500+ community groups. Widely recognized for its high-frequency data collection, especially in dryland areas. Data is used by organizations like the Catholic Relief Services to inform emergency responses and policy decisions.	Dashboard reports 313,288 registered farmers and 66,249 farmers at the block level. Over 500,000 users benefit from weather and agro advisories for informed decision-making.	Over 8,000 products generated from the system, with detailed data supporting projects across different countries and sectors.
Feedback mechanisms	Training certification and rewards. AI performance is monitored and updated based on real-world usage	Includes periodic feedback loops between citizen scientists and local authorities. Photographic evidence with geotags ensures data reliability	Data usage trends and community feedback are analyzed through interactions with contributors through WhatsApp groups End-line surveys are conducted to evaluate the usability of information and address gaps.	Feedback tools within the app capture farmer input. Analytics dashboards provide insights into usage patterns, helping refine services and tailor crop-specific advisories.	Data collection tools include interfaces for technicians and mechanisms for integrating end-user feedback into system improvements.

Learnings

One major learning across the services is the understanding that it is not possible for scalability to materialize without partnership, however this does not come without some challenges. For projects such as enviro-Champs where funding relies on other partners, sustainability of the tools face

considerable risks. Not only funding, but the perspectives of people working on the services vary and may pose some setbacks for future adaptation. These aspects need to be clearly addressed, and solutions identified along the service delivery process. Another major learning outcome is the need to involve more female data collectors especially for citizen science services. This is due to the different needs across the gender spectrum that may lead to some critical information being overlooked if the gaps are not addressed. Moreover, community driven services such as KAZNET and Enviro-Champs require rigorous processes of identifying and training individuals. For such services, there is a high likelihood that retention is subject to incentives available in the environment of the service. Clear motivation should be addressed to ensure long-term sustainability without creating dependence.

Recommendations

The integration of digital technologies across services like MiniSAAS, Enviro-Champs, Meghdoot, KAZNET and e-Agrology highlights the transformative potential of strengthened information systems. These tools have demonstrated their ability to provide real-time, granular, and actionable data, empowering communities and stakeholders to address critical challenges in water, sanitation, agriculture, and climate resilience. However, scalability and sustainability remain key hurdles, underscoring the need for domestication, strong partnerships, consistent funding, and inclusive approaches. There is need to ensure that these systems are embedded into the operational frameworks of institutions willing to adopt and integrate these technologies into their existing systems. This is one way that sustainability will be ensured especially when institutions are willing to pay for the operations and maintenance costs of such platforms. Moreover, efforts to involve diverse participants, including women, and to overcome technological and infrastructural barriers, will be crucial for long-term success. By ensuring domestication, fostering collaboration, leveraging AI and machine learning, and prioritizing community engagement, these services have set a foundation for global impact.



Drone training
Credit: Jawoo Koo (IFPRI)

EoIO 6

Strengthened organizations

The role of organisational interconnectivity is critical for enhancement of decision-making processes in agri-food systems. This is especially true in the context where managing climate risk and promoting sustainable development is involved. By recognising the limited digital capabilities for partner organisations, CGIAR sought to boost at least 6 agri-food research-for-development organisations in order to enable them to better incorporate high-frequency data and underutilised datasets into their decision-making processes. The Initiative aimed at fostering capabilities of organizations in order to enhance their ability to analyse complex data in real-time, leading to more informed, timely, and effective decisions. The end results is particularly important for adapting to the challenges posed by climate change, where the ability to monitor, model, and predict shifts in food-water-land systems will be essential. Specifically, work package 5 was aimed at building practitioners' digital capabilities for informed decision-making.

These efforts towards strengthened organization have had substantial improvements in the ability of organizations to utilize digital tools for real-time decision-making. From international organizations such as WFP and UNICEF to government entities such as India meteorological Department (IMD), organizations have been able to better integrate high-frequency data into their decision-making processes. Moreover, this has enabled quicker responses to climate challenges and more sustainable practices in food production, water management, and land use. Additionally, the enhanced ability to analyze underutilized

datasets has increased the value of existing data assets such as e- Agrology which has recently uploaded 10 years' worth of agronomy data online. These processes have made organizations more agile in decision-making and more capable of responding to emerging threats and opportunities in the agrifood sector.

Learnings

Building digital capacity is increasingly becoming a cornerstone of sustainable development, particularly in strengthening organizational capabilities. Such efforts stem from the need to strengthen ongoing training programs, user-friendly digital tools, and solutions that are tailored to local contexts to ensure effective adoption such as those within the Digital Twin. Moreover, the Digital Initiative have promoted gender inclusivity by actively involving women in capacity-building initiatives.

These inclusive approaches have not only enhanced the quality of targeted projects but has also supported more resilient and adaptive approaches that respond effectively to climate risks and socio-economic challenges. By acknowledging the still persistence gaps in gender- responsive approaches, the efforts from the Inspire Challenge have built a new network of evidence of the inclusion of the gender lens in agricultural development.

Furthermore, the sustainability of these initiatives hinges on robust partnerships. Collaboration with organizations, governments, and stakeholders ensures consistent support, and ensured access to funding, and resource sharing such as those seen with YOMA-UNICEF with MiniSASS and Enviro-Champs. These collaborations have the potential to create a foundation for long-term impact by providing the essential building blocks for sustainability and tools to ensure longevity beyond project closure. Such partnerships play a pivotal role in embedding digital innovation into institutional practices, fostering a culture of continuous learning, and building a resilient future for agri-food systems worldwide.

Recommendations

The strengthening of organizational capabilities has been instrumental in enabling agrifood research-for-development. The need for organizations to incorporate high-frequency data and underutilized datasets into their decision-making processes is increasingly becoming a key element for achieving developmental goals at both regional and country level. These improvements in digital capacity are critical for addressing climate change and promoting sustainable development within agrifood systems. A key factor in sustainability is the domestication of tools like E-Agrology—embedding them into institutional systems to ensure long-term relevance and funding for operations and maintenance. By focusing on building practitioners' digital capabilities, CGIAR has helped organizations enhance their ability to make more informed, timely, and effective decisions, ultimately contributing to more resilient and sustainable food systems. The initiative has demonstrated the importance of continuous capacity building, gender inclusivity, and strong partnerships in achieving long-term impact in the digital transformation of agrifood systems.

Evidence: How were organizations strengthened?

Improved decision-making

Initiatives like Kaznet in Kenya and Ethiopia, which empowers local governments and NGOs to monitor climatic shocks in real-time. By integrating high-frequency data, such as livestock prices, the tool facilitated early responses to climate impacts and better decision-making.

The Digital Twin concept, a virtual representation of real-world systems, has emerged as a transformative tool for strengthening organizations in the agri-food sector. It enables organizations to make more

informed and efficient decisions for sustainable development.

Increased institutional capacity

Through targeted capacity-building programs, partner organizations were able to better understand and leverage digital technologies. These efforts empowered them to incorporate more precise, timely, and granular data into their workflows, significantly improving decision-making. Through platforms like MiniSASS and Enviro-Champs, CGIAR boosted digital literacy, helping local communities and youth to manage water resources.

Inclusive approaches

The Inspire Challenge was an initiative aimed at addressing the digital divide by promoting inclusive approaches in the development and implementation of digital solutions for the agri-food sector. The challenge specifically focuses on creating opportunities for women to participate in and benefit from innovations that help manage climate risks and enhance food security.

Collaboration and networking

With initiatives such as eAgrology, the platform has standardized agronomic data collection across countries, strengthening the digital capabilities of agri-food organizations in Colombia, Honduras, and Guatemala. This collaboration allowed for more efficient crop management and policy development for partner stakeholders.

The Diploma Course in Digital Agriculture, developed in collaboration with CUNORI, is an example of a transformative initiative aimed at strengthening organizational and individual capacities in the agri-food sector. This strategic partnership with CUNORI expands the reach of digital agriculture training in Central America, builds practitioner expertise, and enhances institutional capabilities and development efforts.

Conclusion

The achievements of the Digital Innovation Initiative demonstrate its pivotal role in advancing sustainable, inclusive, and technology-driven solutions within food, land and water systems. Significant accomplishments, such as the development of Digital Twins for water management in the Limpopo Basin, gender-responsive services like WomBees and Innovakit, and the e-Agrology platform's data standardization efforts, underscore the potential for digital innovation to transform the sector. Yet, these cases also reveal the complexities of embedding such innovations in land, water, and food systems. For example, the Limpopo Digital Twin required extensive stakeholder collaboration and overcame challenges in data standardization and integration across countries with differing technical and regulatory landscapes. Similarly, Innovakit demonstrated the potential of using WhatsApp for gender-responsive digital inclusion but highlighted sociocultural barriers affecting women's participation in rural areas.

Research, testing, and validation are essential to address these challenges. Agri-food systems are characterized by unique conditions, including fragmented data sources, resource constraints, and diverse stakeholder priorities. Testing scalable models for tools like Digital Twins in other basins or exploring how gender-inclusive platforms can adapt to varying cultural contexts requires iterative learning and adaptation. Additionally, the integration of high-frequency data into decision-making frameworks, as seen with e-Agrology, must be refined to ensure reliability and accessibility across regions.

Looking forward, the next phase of digital innovation activities within CGIAR should prioritize adaptive research to explore how digital technologies can effectively respond to the complex interdependencies of land, water, and food systems. Partnerships with academic institutions, local governments, and private sector actors will be critical for testing and

validating these solutions. Scaling successful approaches will require enhanced investment in user-centered design, robust monitoring and evaluation frameworks, and innovative financing mechanisms. Emphasizing participatory approaches will ensure that digital tools meet the specific needs of end users, particularly smallholder farmers, women, and youth.

To sustain momentum, CGIAR must embrace a dual focus on systemic integration and local adaptability. By investing in research, iterative refinement, and collaborative innovation, the initiative can catalyze the transformation of global agri-food systems. Disseminating lessons learned and creating frameworks for cross-sectoral learning will position CGIAR as a global leader in shaping the future of sustainable, inclusive, and resilient agricultural systems through digital innovation.