CGIAR

INITIATIVE ON
Breeding Resources

Trainees in a rice field for phenotyping data collection.
Credit: IITA, Ibadan Nigeria

CGIAR Research Initiative on
Breeding Resources

Annual Technical Report 2024

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Disclaimers

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Boundaries used in the maps do not imply the expression of any opinion whatsoever on the part of CGIAR concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Borders are approximate and cover some areas for which there may not yet be full agreement.

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.

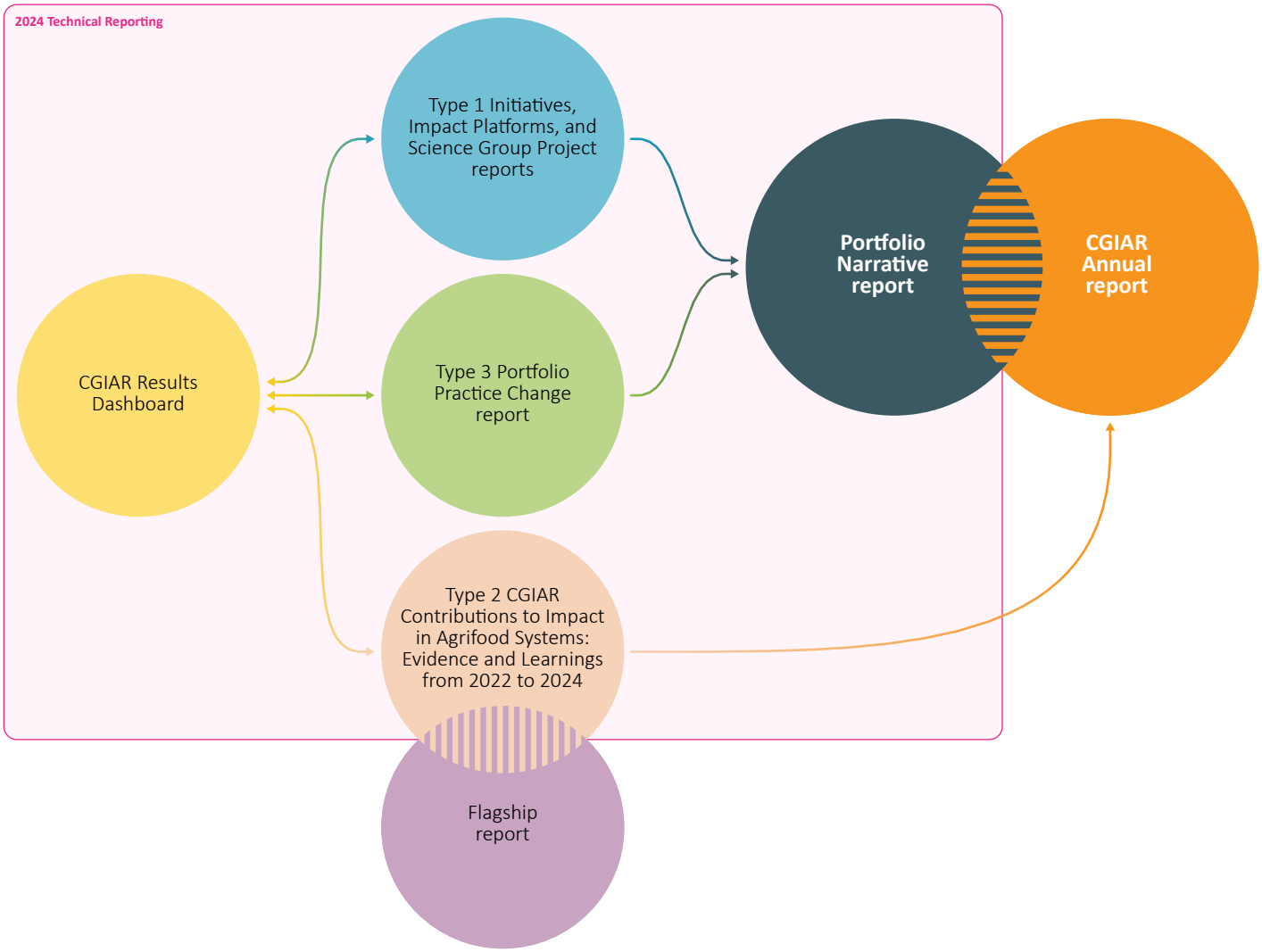


Figure 1. CGIAR's 2024 Technical Reporting components and their integration with other CGIAR reporting products.

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

Initiative name	Breeding Resources
Initiative short name	Breeding Resources
Initiative Lead	Sharifah Syedalwee (s.syedalwee@cgiar.org)
Initiative Co-lead	Eng Hwa Ng (N.Enghwa@cgiar.org)
Science Group	Genetic Innovation
Start – end date	01 January 2022 – 31 December 2024
Geographic scope	**Regions** Central and West Asia and North Africa · East and Southern Africa · Latin America and the Caribbean · South Asia · Southeast Asia and the Pacific · West and Central Africa **Countries** Afghanistan · Algeria · Angola · Argentina · Azerbaijan · Bangladesh · Benin · Bolivia (Plurinational State of) · Brazil · Burkina Faso · Burundi · Cambodia · Cameroon · Central African Republic · Chad · Chile · China · Colombia · Congo · Costa Rica · Côte d'Ivoire · Cuba · Dominican Republic · Ecuador · Egypt · El Salvador · Eritrea · Ethiopia · Gambia · Ghana · Guatemala · Guinea; Guinea-Bissau · Guyana · Haiti · Honduras · India · Indonesia · Iran (Islamic Republic of) · Iraq · Jordan · Kazakhstan · Kenya · Kyrgyzstan · Lao People's Democratic Republic · Lebanon · Liberia · Libya · Madagascar · Malawi · Mali · Mauritania · Mexico · Morocco · Mozambique · Myanmar · Nepal · Nicaragua · Niger · Nigeria · Pakistan · Panama · Paraguay · Peru · Philippines · Rwanda · Saudi Arabia · Senegal · Sierra Leone · Somalia · South Africa · South Sudan · State of Palestine · Syrian Arab Republic · Tajikistan · Tanzania, United Republic · Thailand · The Democratic Republic of the Congo · The Republic of the Sudan · The Socialist Republic of Viet Nam · Togo · Tunisia · Türkiye · Uganda · Uruguay · Uzbekistan · Venezuela (Bolivarian Republic of) · Yemen · Zambia · 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 0: Not targeted** The Initiative/project has not been found to target gender equality. However, as a minimum requirement for all Initiatives/projects, (1) a gender analysis was conducted, (2) its findings should be used to ensure at minimum that the Initiative activities/interventions do no harm and do not reinforce gender inequalities, and (3) data that are collected are gender disaggregated..
Website link	https://www.cgiar.org/initiative/breeding-resources/

[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

Over the past three years, the CGIAR Research Initiative on Breeding Resources institutionalized shared services for breeders and researchers. Breeding Resources served as a global provider of high-quality breeding solutions for CGIAR breeding programs, National Agricultural Research and Extension Systems (NARES), subregional organizations (SROs), and other key partners. Breeding Resources operated through a skilled, dynamic, and engaged team providing global shared services that include genotyping and breeding operational support, digital solutions housing the Enterprise Breeding System (EBS), and breeding analytics tools, including Bioflow, CGIAR's Breeding Analytics Pipeline. All services and support were foundationally supported through a business process management (BPM) system to ensure service compliance with global and sustainable standards, while maintaining efficiency and effectiveness. Breeding Resources maintained a global presence, with the mission of collaborating with all CGIAR Centers to strengthen breeding operations worldwide. Expanded services focused on enhanced offerings and broader reach, while fostering partnerships with the private sector.

Since 2022, Breeding Resources expanded and institutionalized a suite of shared global breeding and research laboratory services, including low- and mid-density genotyping, biochemical quality and nutritional testing, fast and low-cost genome sequencing, and trialing and nursery support, such as agronomic practices and engineering capacity (Work Packages 2 and 5). As of 2025, teams from all CGIAR Centers and several national partner institutes regularly utilized these services, helping bridge regional gaps and enabling breeders to accelerate the development of improved, climate-resilient varieties. Through the CGIAR Service Request Portal, all services and support are accessible to any user. The CGIAR Service Request Portal is a dynamic platform that enhances user engagement and ensures instant access to new data and resources. For example, newly added molecular markers are immediately made available to the entire network.

Standard Operating Procedures (SOPs) are also accessible through the CGIAR Service Request Portal, providing a centralized repository for protocols across different crops and pipelines. These SOPs are flexible enough to accommodate diverse needs across Centers and crops. They drive operational standards for many processes used by breeding operations teams across several Centers. Together with the Operations Assessment Tool, they represent a major step forward in monitoring and managing the operational quality of CGIAR's crop breeding.

Over the past three years, significant progress was achieved in the development of the EBS. Designed to serve crop breeding programs across the globe, EBS is open source and addresses the unique challenges faced by resource-poor farmers by enabling crop breeders to make data-driven decisions. EBS empowers breeders by simplifying data management, harmonizing data collection, improving data quality, and accelerating the development of better-performing crop varieties. EBS has been increasingly adopted by breeding programs, becoming an indispensable tool in breeding operations. EBS training programs enabled broad adoption across Centers and research partner institutes. The tool seamlessly connects with other solutions such as Bioflow, CGAR's Breeding Analytics Pipeline, thus streamlining workflows. Collaboration with the Global Shared Services (GSS) team ensured integration with services in the CGIAR Service Request Portal, consolidating CGIAR's digital ecosystem for breeders. The system's capacity to function offline has addressed connectivity challenges, enabling broader adoption, even in remote locations. EBS has become a cornerstone of CGIAR breeding programs, fostering collaboration, improving data management, and enabling faster delivery of improved crop varieties to meet global agricultural challenges.

To support the adoption of new technologies and implement processes related to adoption, a modern learning management system (LMS) was designed and launched in 2024. Breeding Resources' LMS aimed to make training scalable, efficient, and accessible. Partnerships with leading agricultural universities have ensured training content remains cutting-edge, while collaborations with industry leaders add practical, real-world insights.

In 2024, Breeding Resources and the CGIAR Research Initiative on Accelerated Breeding collaborated to develop an advanced breeding analytics pipeline to support crop breeders, as well as a suite of related services. This solution, called Bioflow, automates complex calculations, freeing up valuable time and allowing breeders to focus on making informed decisions that drive better outcomes.

The services and solutions developed by Breeding Resources are seamlessly interconnected, each one reinforcing and enhancing the others in a continuous cycle. This integration ensures that breeding and research data, along with their outcomes, remain harmonized, refined, and readily accessible to CGIAR and its partners. This report highlights how Breeding Resources institutionalized these services over the past three years and describes the impact of these services on CGIAR and partners' breeding efforts.

	2022	2023	**2024**
PROPOSAL BUDGET	$18.65M	$21.50M	**$21.86M**
APPROVED BUDGET [1]	$6.96M	$2.78M [2]	**$5.41M** [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.

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

- Urgent action is needed to address the global challenges of poverty, nutrition, hunger, environmental degradation, and climate change. Improved crop varieties are a proven way to significantly impact these issues, with a broad reach that is less constrained by the spatial limits of extension networks. Across the CGIAR–National Agricultural Research Services (NARS) network, the independent operation of breeding programs has given autonomy to regions but has meant that innovations are not shared to their full potential. Effective development and deployment of advanced varieties requires a coordinated effort across CGIAR and NARS.
- The Breeding Resources Initiative (BRI) will use institutional innovation to form a collaborative, performance-oriented network that strategically uses modernized breeding to deliver greater impacts more efficiently. BRI will scale innovations that include new ideas, products, services, and solutions for modernized breeding, with activities that support the innovation system to mainstream adoption of tools, technologies, and shared services (TTSS) and maximize TTSS benefits. BRI will establish shared services aligned with global standards of best practice while negotiating cheaper access to external vendors and service providers. TTSS functional teams will work with NARS to refine TTSS for local contexts.
- A common data-sharing system underpinned by standardization and data governance, as well as local software support, will bring data together from across the CGIAR–NARS network to create larger, more powerful datasets. Data visualization tools will facilitate live use of data for time-sensitive breeding decisions. Change management support from BRI will advance the breeding culture toward multidisciplinary teams of internal and external experts, with mainstreamed TTSS through managed networks. The capacity of NARS will be raised to make all breeding programs effective within the network. BRI will cultivate an innovation ecosystem through partnerships with research institutions, experts, and private companies to ensure ongoing technology prospecting and innovation in breeding.

RESEARCH QUESTIONS

- What are the opportunities and constraints to developing shared services into a full-cost recovery model?
- What are the top priorities (TTSS with maximized impact) for breeding modernization across the CGIAR–NARS network and for each region?
- How can existing capacity and resources be more cost competitive and effective?
- What TTSS adaptations are needed to mainstream NARS' use of TTSS?
- How can commercially available TTSS be made more cheaply?
- To what extent will standardized operations improve the performance of the CGIAR–NARS breeding network?
- To what extent can increased transparency on impact area contributions from breeding motivate improved performance on impacts?
- What data management strategy is needed for data capture and analytics to transform breeding?
- How can improved data management be readily implemented and mainstreamed by the CGIAR–NARS breeding network?
- What capacity or resources are needed to increase breeding program readiness to adopt TTSS and mainstream it within the CGIAR–NARS breeding network?

SPHERE OF **CONTROL**

Work Packages

Work Package 1

Strategic modernisation.

Work Package 2

Cost-effective shared services.

Work Package 3

Performance management of consistent, connected operations.

Work Package 4

Smarter use of more data.

Work Package 5

Innovation development and research exchange (Idare).

Wheat agriculture harvesting agribusiness concept. Blue sky and clouds. Ears of wheat on the field a during afternoon. Wide shot.
Credit: artifex.orlova/Shutterstock

SPHERE OF **INFLUENCE**

End-of-Initiative Outcomes

End-of-Initiative Outcome 1

1 ▶ 3 ▶ 5 ▶ CGIAR-National Agricultural Research and Extensions Systems Breeding pipelines oriented towards specific market segments, enabling greater focus on farmers' needs, drivers of adoption, and impact.

End-of-Initiative Outcome 2

4 ▶ CGIAR breeding portfolio ensures gender inclusiveness and increases gender intentionality through the candidate varieties that are being developed.

End-of-Initiative Outcome 3

1 ▶ 2 ▶ 5 ▶ Breeding pipelines have increased the rate of genetic gain, providing seed systems actors with farmer-preferred candidate varieties with step change in performance under farmers' conditions.

Action Area Outcomes

Genetic Innovation

2 ▶ 3 ▶ **1** · National and private seed company breeding programs accelerate the development of varieties that provide larger scale benefits across the 5 Impact Areas.

1 ▶ **2** · 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.

SPHERE OF **INTEREST**

Impact Areas

Nutrition, Health & Food Security

1 ▶ · 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

1 ▶ 2 ▶ · 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

1 ▶ 2 ▶ · 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

1 ▶ 2 ▶ · 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

1 ▶ 2 ▶ · 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.

Lab technician inspecting plants in a tissue culture facility.

Summary of progress against the theory of change

Improved crop varieties can have a significant impact on the global challenges of poverty, malnutrition, and hunger, as well as helping prepare agriculture for changing climates and empowering women. The efficient and successful development of high-impact varieties requires advanced technologies to guide crosses and plant selection, manage and analyze large volumes of data, and finetune breeding operations to control environmental effects. The Breeding Resources Initiative ensured the tools and technologies required for successful breeding of impactful varieties are available across CGIAR and NARES breeding networks. The Initiative's mission focused on ensuring seamless access for these networks to modern breeding practices, advanced technologies, and robust analytics through institutionalized services. These aims were accomplished by leveraging technology to enhance decision-making, eliminating duplication and optimizing resources for maximum impact, promoting seamless collaboration and information sharing across units and networks, and delivering greater agricultural innovation and efficiency globally. The Initiative functioned as a global provider of high-quality breeding solutions for CGIAR breeding programs, NARES, SROs, and other key partners. Breeding Resources operated through a skilled, dynamic, and engaged team structured into four specialized units: (1) Global Shared Services; (2) Digital Solutions; (3) Breeding Analytics; and (4) Business Process Management. Between 2022 and 2024, Breeding Resources services continuously expanded, focusing on enhanced offerings and broader reach, while fostering partnerships with the private sector and organizations such as HarvestPlus, Corteva, and others. Several hubs supported by the Initiative were established in key Centers, including IRRI, ICRISAT, and AfricaRice, unlocking new services and expanding global capacity.

Breeding Resources designed, coordinated, and delivered crop-agnostic services, reducing duplication of infrastructure and personnel investments across CGIAR Centers and national partner institutes. These shared services and technologies, delivered by Breeding Resources' GSS unit, include:

- Laboratory services: DNA analysis, sequencing, and nutrient content testing
- Breeding operational support: technical backstopping support in multiple disciplines (engineering, agronomy, irrigation, etc.)
- Data science and analytics: decision-support tools and data-driven insights
- Data management: systems to streamline data handling and usage

For technologies to succeed, staff training and the implementation of new workflows are critical, especially given the fast-paced nature of breeding cycles. As such, Breeding Resources also focused on empowering staff and supporting breeding modernization through:

- Service request platform and information dashboards: facilitating access to service and relevant information
- Centrally coordinated training: developing and sourcing expert-led materials and curricula
- Coaching on continuous improvement: providing tools, techniques, and mindsets to drive change
- Process management support: applying formal methodologies to optimize workflows
- Quality management systems: implementing standards to enhance breeding operations

These people-focused activities aimed to build capacity, trust, empowerment, and institutional knowledge in local contexts, fostering sustainable, modernized breeding operations for CGIAR and its partners. Institutionalizing the foundational elements of Breeding Resources is essential to ensure their availability in the long term and beyond crop breeding.

As of 2025, teams from all CGIAR Centers and several national partner institutes regularly utilize these services, helping bridge regional gaps and enabling breeders to accelerate the development of improved, climate-resilient varieties. For laboratory services, the increased number of samples processed from year to year highlights the expanding reliance on these tools. Without these services, breeders would face considerable challenges in achieving the same level of progress, underscoring their role in modernizing CGIAR breeding efforts. Through coordinated services, Breeding Resources has reduced costs and increased efficiency. The trialing and nursery team supported an estimated US$ 20 million worth of projects, further demonstrating the financial impact of these services.

Over the past three years, significant progress was achieved in the development of the EBS. Designed to serve crop breeding programs in Africa, Asia, and Latin America, EBS is open source and enables breeders to make data-driven decisions. The tool empowers breeders by simplifying data management, improving data quality, and accelerating the development of better-performing crop varieties. Within Breeding Resources, a team of information technologists and data management specialists employed design-thinking techniques and collaborated closely with breeders to ensure EBS met their needs. This resulted in a system that seamlessly connects, merges, and builds upon existing breeding software and data solutions, offering a centralized and powerful tool for breeding programs.

The EBS team has continued to work on integrating additional tools to further enhance its capabilities and expand its impact. EBS seamlessly connects with tools such as Bioflow, CGIAR's Breeding Analytics Pipeline, thus streamlining workflows. Collaboration with the GSS team ensured integration with services in the CGIAR Service Request Portal, consolidating CGIAR's digital ecosystem for breeders. The system's capacity to function even under very slow internet connections associated with its offline data collection feature helped address connectivity challenges, enabling broader adoption, even in remote locations. As more data are added to EBS, its utility will increase, creating a virtuous cycle where improved data access fosters enhanced collaboration and productivity. Users have reported high satisfaction with the system, reflecting its reliability and effectiveness in everyday operations. EBS has become a cornerstone of CGIAR breeding programs, fostering collaboration, improving data management, and enabling faster delivery of improved crop varieties to meet global agricultural challenges.

The Initiative's BPM system serves to connect all the services and support. Under the BPM framework, SOPs have been developed and, as of 2025, are driving the operational standards of several CGIAR and partner breeding teams. Development and implementation of these standards was jointly achieved with GSS through regular operational assessments to support improvement, an effort that was core to the quality management system developed for CGIAR by Breeding Resources. Accessible through the CGIAR Service Request Portal, the SOPs provide a centralized repository of breeding and research protocols across different crops and pipelines.

To support the adoption of new technologies, the team designed and implemented comprehensive training programs, both in person and virtually. A modern LMS (all courses) was introduced to make training scalable, efficient and accessible. The LMS serves as a centralized platform for training delivery that supports multiple learning formats, tracks progress, and provides analytics to continually enhance the learning experience. Accessible anytime and anywhere, the LMS offers a flexible and engaging experience catered to the diverse needs of its learners. Training programs delivered through the LMS are designed to improve individual and organizational performance, leading to increased productivity, enhanced job satisfaction, and a more skilled and competent workforce.

Breeding Resources also actively fostered a culture of continuous improvement by adopting the LEAN principle to streamline processes and ensure that customer needs were met effectively. To further support LEAN leaders in various CGIAR Centers, BRI developed a series of targeted training resources, including short videos covering key aspects of leadership within a LEAN framework. Accessible through the LMS, these resources are designed for individual learning or team-based discussions.

In collaboration with the Accelerated Breeding Initiative, Breeding Resources developed an advanced breeding analytics pipeline to support crop breeders, as well as a suite of related services. Bioflow, CGIAR's Breeding Analytics Pipeline, automates complex calculations, freeing up valuable time and allowing breeders to focus on making informed decisions that drive better outcomes. In parallel, the Breeding Analytics team is dedicated to advancing the field of biometrical genetics for CGIAR and national partners through a comprehensive suite of associated services and tools. Launched in 2024, Bioflow enables users to access methods for understanding or using evolutionary forces (mutation, gene flow, migration, and selection) such as automatic state-of-the-art genetic evaluation (selection force) in decision-making. The tool automates many routine workflows, making breeding more efficient, saving time, and supporting better decision-making. In many cases, tasks that once took hours or days to complete manually can now be completed in just 5 to 10 minutes.

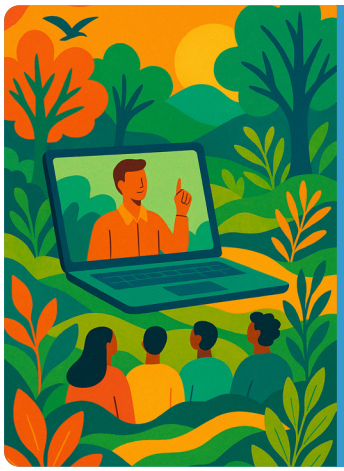
Designed to be database agnostic, Bioflow can retrieve data from the available phenotypic-pedigree databases (EBS, BMS, BreedBase), genotypic databases (GIGWA), and environmental databases (NASAPOWER) to carry out analytic procedures. It is an intuitive interface designed for breeders and partners, particularly those who lack coding skills but need to calculate breeding values and develop predictive models.

For programs with limited biometric or quantitative genetics support, especially NARES, this analytical platform has potential to alleviate longstanding challenges with data analysis. Bioflow also helps to standardize key performance indicators across CGIAR-NARES breeding networks, ensuring consistent, valuable reports for stakeholders, such as those required by the Accelerated Breeding Initiative and others.

Members of the CGIAR-NARES network can access the Breeding Analytics Pipeline through the CGIAR Service Request Portal, with free access to cloud computing included for these users. Training support for CGIAR and NARES partners is available through the same portal, where users can request a demo and learn how to use the tool. Those outside the network can still access the demo server, which offers the same capabilities, except for cloud storage.

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

CGIAR and NARES breeding teams have up-to-date knowledge and capacities to design and operate shared services, facilities, and operations.

EOIO 2

CGIAR and NARES breeding teams use shared services, facilities, and operations that have been improved for greater throughput, accuracy, and safety, at lower unit costs.

EOIO 3

CGIAR and NARES breeding teams use state-of-the-art data management systems.

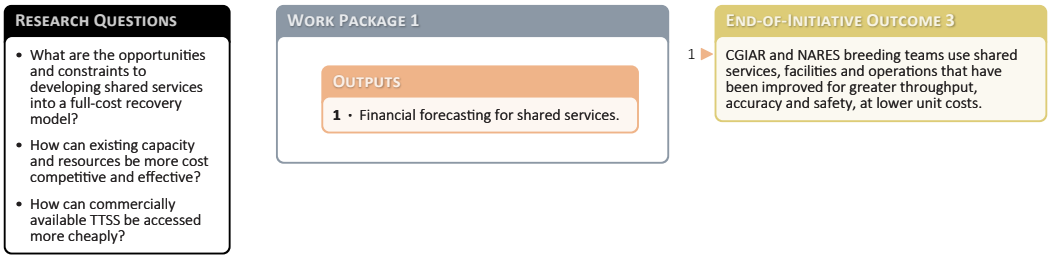
A modern LMS was introduced to make training scalable, efficient, and accessible. Partnerships with leading agricultural universities ensure training content remains cutting-edge, while collaborations with industry leaders add practical, real-world insights. The LMS serves as a centralized platform for training that supports multiple learning formats, is accessible anytime and anywhere, and tracks progress and provides analytics to enhance the learning experience. The Initiative's LMS is designed to improve individual and organizational performance, leading to increased productivity, enhanced job satisfaction, and a more skilled and competent workforce. In addition to the LMS, Breeding Resources also provided in-person workshops, seminars, and training sessions, which were facilitated by industry experts and top universities, with hands-on learning and direct interaction with professionals. To date, 4,400 users were trained either in person or virtually, far exceeding the target of 495 trainees.

Breeders across Centers embraced the services provided by Breeding Resources, fully integrating them into the various breeding pipelines. In total, 26 institutions were using the Initiative's GSS as of 2025, with 50 percent of them being NARES partners. Since the launch of the CGIAR Service Request Portal at the end of 2023, 444 genotyping requests have been submitted. For trialing and nursery support and services, the highest request (49 percent) was for irrigation services, while seed processing, preparation, and postharvesting infrastructure support came in second at 25.5 percent. Without these services, breeders would face considerable challenges in achieving the same level of progress, underscoring their role in modernizing CGIAR breeding efforts. Streamlined access to critical support and services has become an essential part of breeding pipelines, fundamentally changing how they are being operated and what they deliver.

EBS has increasingly been adopted by breeding programs, overcoming initial natural hesitancy among users, and supported by a comprehensive training program fostering adoption across Centers and NARES. With 750 users, Breeding Resources exceeded the expected target of 500 users as EBS has become an indispensable tool in CGIAR's breeding operations. By December 2024, the total number of breeding experiment data points stored in the EBS reached an impressive 33,215, far surpassing the initial target of 8,000. The Rice program, which adopted EBS in 2022, played a pivotal role in this transformation. Its success paved the way for Maize and Wheat programs, which embraced EBS in 2023, to similarly integrate the system into their daily breeding operations. Meanwhile, newer programs, including CIMMYT DCP and IITA Legumes, which began their EBS adoption in late 2024, are still in the early stages of integration. The surpassing of the target demonstrates not only the system's growing value but also the potential for continued expansion as more breeding programs integrate EBS into their workflows. With regular new additions and features, EBS will continue to unlock potential for data management. The tool now seamlessly connects with external solutions and streamlines workflows.

Section 3: **Work Package progress**

WP1: Strategic modernization



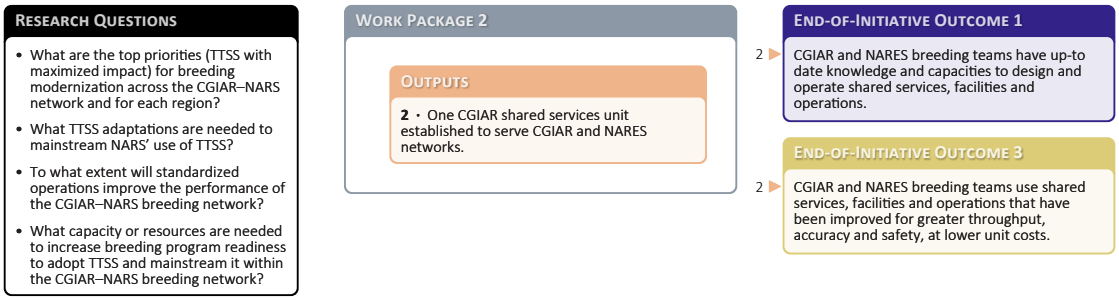
Work Package 1 progress against the theory of change

In 2023, Breeding Resources actively worked to develop a business model for informed decision-making and streamlined business operations. Through this model, Breeding Resources aimed to improve breeding efficiency by better costing services and developing them in alignment with the needs of CGIAR-NARES breeding programs and networks. One example is the costs associated with genotyping and other services: the process for delivering these services was completely overhauled for better definition and standardization. This shift harmonized previously divergent processes, making them more aligned and efficient. As a result of this work, 100 percent of allocated funds are being utilized effectively, whereas resources were previously underutilized. Centralizing expertise, such as agronomic practices, soil management, and irrigation, addressed the challenge of finding specialized skills locally. By leveraging a shared services model, CGIAR Centers avoided the administrative burden and higher costs of independently hiring consultants or companies.

Although establishing a business model holds potential for CGIAR, many constraints need to be overcome for it to be implemented successfully, including determining the true cost of services to facilitate detailed cost analysis. Determining accurate service volume would require detailed planning and forecasting from the breeding programs, a complex process in itself. Instead, Breeding Resources developed a reasonably reliable forecasting system that relies on historical data and improves accuracy through continuous engagement with breeding programs.

Breeding Resources has continued to enhance cost competitiveness and effectiveness by focusing on optimization of operational processes. This includes negotiating favorable contracts with suppliers and third-party service providers, outsourcing non-core activities, and forming strategic partnerships to leverage complementary resources and capabilities. The Initiative's collaboration with Scriptoria, for example, allowed it to rapidly develop a key tool for service delivery (the CGIAR Service Request Portal), making the services accessible to both CGIAR and NARES partners. The partnership with IRRI to centralize genotyping services and support reduced transactional costs, allowing more money to be channeled to genotyping data generation.

WP2: Cost-effective shared services



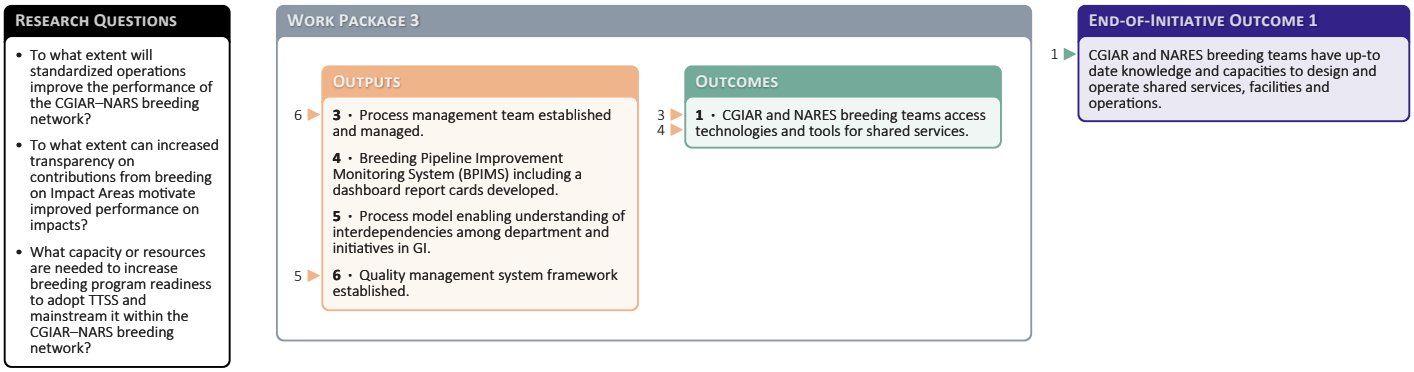
Work Package 2 progress against the theory of change

The Initiative's lab services applied new, faster, and cheaper genotyping and sequencing services to greatly accelerate the rate at which new varieties can be developed. This effort included low- and mid-density genotyping and elite line reference assembly. Breeding Resources also provided access to fast and low-cost genome sequencing technologies (from partners such as Corteva and the Earlham Institute), which were used to develop molecular crop breeding tools. In 2024, related services such as elemental analysis were integrated into the laboratory service framework, including biochemical quality and nutritional testing services (Fe, Zn, AI, Cr, and Ti). This integration provides a more comprehensive approach that reduces redundancies and improves access to critical support functions for breeding programs. This work helps generate cost-effective, high-quality data consistently across the breeding network.

The introduction of the CGIAR Service Request Portal facilitated smooth access to services and reduced administrative complexity for Centers. This system increased transparency and allowed for more efficient project management. Enhanced coordination of capacity development initiatives brought together expertise from various functions, enabling more effective training and knowledge-sharing. For example, collaboration with HarvestPlus evolved to expand services across multiple locations. Additionally, partnerships with Centers such as ICRISAT, IRRI, and AfricaRice were defined to regionalize service delivery, paving the way for further decentralization and local ownership of services. These activities collectively represent a significant step forward in aligning global shared services with breeders' needs, enabling faster development and deployment of improved crop varieties.

Improvements in services deliveries led to a dramatic increase in the adoption of genotyping services, as demonstrated by the CGIAR Service Request Portal dashboard (CGIAR Shared Services). IRRI's rice program has consistently been a major user of the genotyping service, with 147 requests out of 444 requests made by all Centers (33 percent). The increased number of samples processed highlights the expanding reliance on these tools. Without these services, breeders would face considerable challenges in achieving the same level of progress, underscoring their role in modernizing CGIAR breeding efforts.

WP3: Performance management of consistent, connected operations



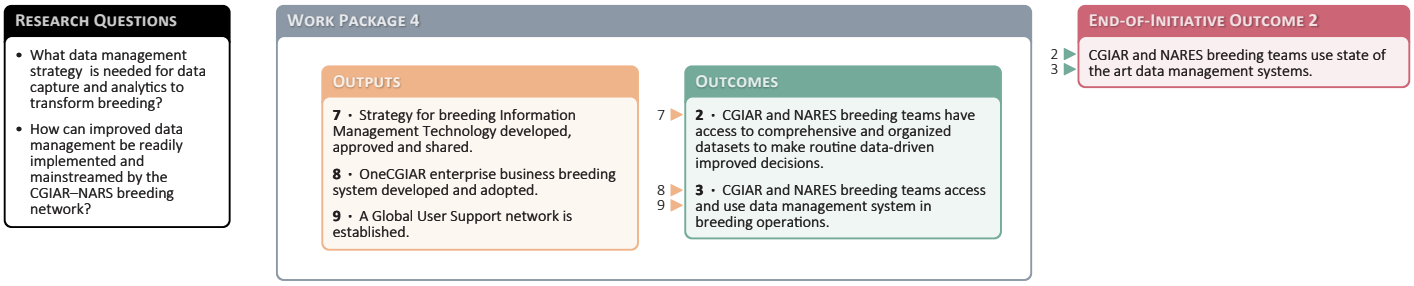
Work Package 3 progress against the theory of change

CGIAR's breeding programs generate and utilize vast amounts of data and germplasm. However, the quality and consistency of these resources remains a continuous challenge. Hence, a robust framework to define and uphold quality standards across CGIAR breeding operations is vital. Recognizing that a crop breeding organization's success relies on the alignment of core assets—high-quality data, robust operational processes, and enhanced know-how—a system to harmonize operational processes and procedures across breeding operations was developed by the process teams established across crops and Centers. Detailed process maps and SOPs for laboratory services, trialing and nursery, and breeding data and analytics were developed and shared. These were designed to integrate performance metrics and key performance indicators (KPIs) to ensure sustained quality and operational excellence. The changes occurring at Centers that implemented these SOPs were mapped with the aim of not only addressing immediate gaps but also creating a foundation for continuous improvement across breeding operations. The SOPs are now accessible through the CGIAR Service Request Portal, providing a centralized repository of research and breeding operations protocols across different crops and pipelines.

Process harmonization through SOPs provides many benefits to breeders and their programs. Implementing standards streamlines crop breeding processes, reducing duplication of efforts, optimizing resource allocation, and ultimately enhancing efficiency in developing new crop varieties. Standards encourage a culture of continuous improvement within research centers and partner organizations. By regularly reviewing and refining operational breeding methodologies in line with these standards, organizations can stay at the forefront of innovation in crop breeding, striving for superior traits and performance. Standards also serve as a reference point for incorporating global best practices into crop breeding programs. Leveraging the collective expertise and experience reflected in these standards can lead to continuous improvements in the effectiveness and impact of crop breeding initiatives.

Capacity building has played a huge role in ensuring the adoption of SOPs across CGIAR Centers. A modern LMS has been introduced that serves as a centralized platform for training delivery. It supports multiple learning formats, tracks progress, and provides analytics to continually enhance the learning experience. Accessible anytime and anywhere, the LMS offers a flexible and engaging experience catered to the diverse needs of learners.

WP4: Smarter use of more date



Work Package 4 progress against the theory of change

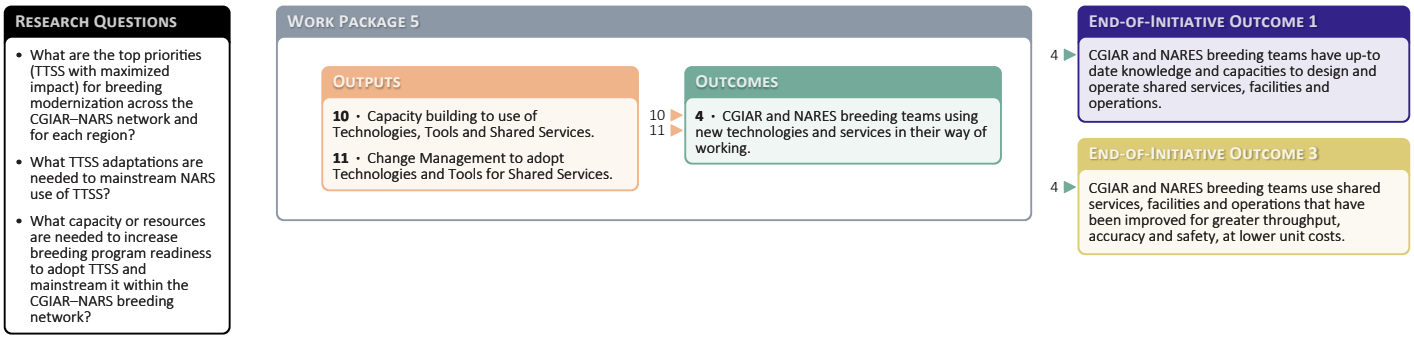
Over the past three years, significant progress has been achieved in the development of the EBS. In 2023, CGIAR endorsed a new data strategy, prioritizing a single breeding data management platform (CGIAR announces new breeding data strategy and endorses single data platform). EBS became CGIAR's preferred breeding data management system due to its robust tools and features, including security and reliability, advantages which are reflected in user support ticket numbers and satisfaction ratings. EBS ensures high-quality, curated data with established protocols to prevent missing or broken information. This level of data integrity is critical for effective breeding workflows. Structured as a "Platform-as-a-Service" (PaaS) system, EBS offers enhanced manageability with lower costs. The system is designed to bolster core breeding activities, including germplasm inventory management, trial design, field operations, phenotyping, sample tracking, genotyping, data analysis, and decision support. EBS adheres to the principles of making data findable, accessible, interoperable, and reusable (FAIR).

To enhance the management of breeding information systems throughout CGIAR, a comprehensive global user support network, known as GUS, was established (EBS Support Desk- Raise a request - Jira Service Management. The primary goal of GUS is to facilitate the adoption and utilization of software tools and devices supported by EBS. Launching GUS is an important step forward in standardizing breeding data management, both within our organization and for partners.

In 2024, Breeding Resources and Accelerated Breeding developed and launched a breeding analytics pipeline called Bioflow to support CGIAR's crop breeding activities. Bioflow is a cutting-edge tool designed to guide decision-making processes in global crop breeding. It extracts crop breeding data from diverse databases and conducts complex analyses for crop breeders, such as estimating genetic gains or employing selection indexes. The launch of Bioflow marked a key moment for CGIAR's crop breeding work, as crop breeding teams across the organization can now access and test the tool, as well as using it and suggesting improvements.

EBS connects seamlessly with Bioflow and other Breeding Resources services. For example, users can order genotyping services through EBS directly and perform complex analysis with their data through Bioflow. This integration maximizes efficiency and holds potential for advanced integrations in the future.

WP5: Innovation development and research exchange (Idare)



Work Package 4 progress against the theory of change

In 2023, all services and support (except EBS and Breeding IT), was managed centrally by GSS. Combining and coordinating the Initiative's resources can enhance the accessibility and efficiency of services and their delivery. GSS has grown steadily over the past three years, broadening its portfolio by introducing and integrating additional services.

To optimize service delivery, a breeding operational assessment first introduced by Excellence in Breeding was further optimized. Through breeding assessments, technological and operations gaps can be identified and specific recommendations can be made on the type of services and support needed. In 2023, the Initiative's breeding operations assessment dashboard was developed to foster efficiency and innovation across CGIAR-NARES breeding stations. The dashboard's primary objective is to offer station users visibility into the capacity of breeding stations, emphasizing both their strengths and weaknesses, while also providing funders, Center directors, and managers with visibility into areas requiring improvement. The dashboard serves as a central hub to provide valuable insights into the harmonization of operational processes by breeding committees. Additionally, the visualization of key investments in critical infrastructure, such as irrigation, field equipment, research equipment, digitization, seed processing, and upgrades to facilities, supports users in understanding stations' capacity.

Working together with Work Package 3, the operational assessments led to the adoption of the SOPs, which then contribute to continuous improvement. Adhering to standards in breeding processes ensures that the quality of novel crop varieties remains consistent. While assessments primarily target results—focusing on outcomes and performance—they can also be used to comprehensively evaluate how work is carried across the entire breeding operational cycle.

As with all services offered by Breeding Resources, the breeding operation services are also available through the CGIAR Service Request Portal. User metrics indicated that 49 percent of all requests were for irrigation-related support, while requests for seed processing and post-harvesting infrastructure development support followed at 25.5 percent. The remaining requests were for facilities and equipment management (14 percent) and agronomic practices support (4.5 percent). The Trialing and Nursery (T&N) Support Services also provide specialized engineering support to Centers and NARES. This support is offered through partner companies and consultants, helping from design to implementation of engineering-related projects. Through fast, easy access (supported by an expert technical team), GSS provides CGIAR and partners with more bargaining power and allows the generation of cost-efficient, high-quality data across breeding networks.

A group of female workers who participated in the training stand in front of a tractor they just learned to drive in Kenya.

Work Package progress rating summary

WORK PACKAGE	PROGRESS RATING & RATIONALE
1	On track Harmonization and development of the cost structure for services and cost recovery model for selected services were completed. Contract negotiation with suppliers and third-party service providers was completed. Outsourcing non-core activities such as the development of CGIAR Service Request Portal was completed.
2	On track A fully integrated suite of laboratory services that include genotyping and elemental analysis was established to provide a more comprehensive approach to shared services, reducing redundancies and improving access to critical support functions for breeding programs. This helps generate cost-effective, high-quality data consistently across the breeding network. The introduction of the CGIAR Service Request Portal facilitates smoother access to services and reduces administrative complexity for Centers. This system has increased transparency and allowed for more efficient project management.
3	On track A system to harmonize operational processes and procedures across breeding operations was established across crops and Centers. Detailed process maps and SOPs for laboratory services, trialing and nursery, and breeding data and analytics were developed and shared. The SOPs are now accessible through the CGIAR Service Request Portal, providing a centralized repository for protocols across different crops and pipelines. A modern LMS was introduced that serves as a centralized platform for training delivery. It supports multiple learning formats, tracks progress, and provides analytics to continually enhance the learning experience. Accessible anytime and anywhere, the LMS offers a flexible and engaging experience catered to the diverse needs of learners.
4	On track EBS' robust features, including security and reliability, have led it to become CGIAR's preferred breeding data management system. EBS ensures high-quality, curated data with established protocols to prevent missing or broken information. This level of data integrity is critical for effective breeding workflows. Structured as a PaaS system, EBS offers enhanced manageability with lower costs. The system is designed to bolster core breeding activities, including germplasm inventory management, trial design, field operations, phenotyping, sample tracking, genotyping, data analysis, and decision support. EBS adheres to the principles of making data FAIR. The system connects seamlessly with other Breeding Resources' services. For example, users can order genotyping services through EBS directly or perform complex analysis with their data through Bioflow, CGIAR's Breeding Analytics Pipeline. This integration maximizes efficiency and holds potential for advanced integrations in the future.

CGIAR breeding expert examines new rice crop varieties at network breeding facility in Uganda.
Credit: Jjumba Martin EiB-CGIAR

WORK PACKAGE	PROGRESS RATING & RATIONALE
5	On track The full suite of breeding operation services can be accessed by both CGIAR and NARES users through the CGIAR Service Request Portal. User metrics indicated that 49 percent of all requests were for irrigation support, while seed processing and postharvesting infrastructure development support followed at 25.5 percent. The remaining requests were for facilities and equipment management (14 percent) and agronomic practices support (4.5 percent). The T&N Support Services also provided specialized engineering support to Centers and NARES. This support was offered through partner companies and consultants, helping from design to implementation of engineering-related projects. Through fast, easy access (supported by an expert technical team) our GSS provided CGIAR and partners with more bargaining power, facilitating the generation of cost-efficient, high-quality data across breeding networks. Through operational assessments, such as breeding evaluations, gaps were identified and recommendations made to facilitate the provision of appropriate services and support. A breeding operations assessment dashboard was developed to foster efficiency and innovation across CGIAR-NARES breeding stations. This dashboard aims to disseminate the findings of CGIAR-NARES breeding stations' evaluations to identify areas for improvement. The primary objective is to provide station users with information on the capacity of breeding stations, emphasizing both their strengths and weaknesses, while also providing funders, Center directors, and managers with visibility into areas requiring improvement. The dashboard serves as a central hub that provides valuable insights into the harmonization of operational processes by breeding committees.

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.

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

This section provides an overview of results reported and contributed to, by the CGIAR Initiative on Breeding Resources from 2022 to 2024. These results align with the CGIAR Results Framework and Breeding Resources'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 6 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

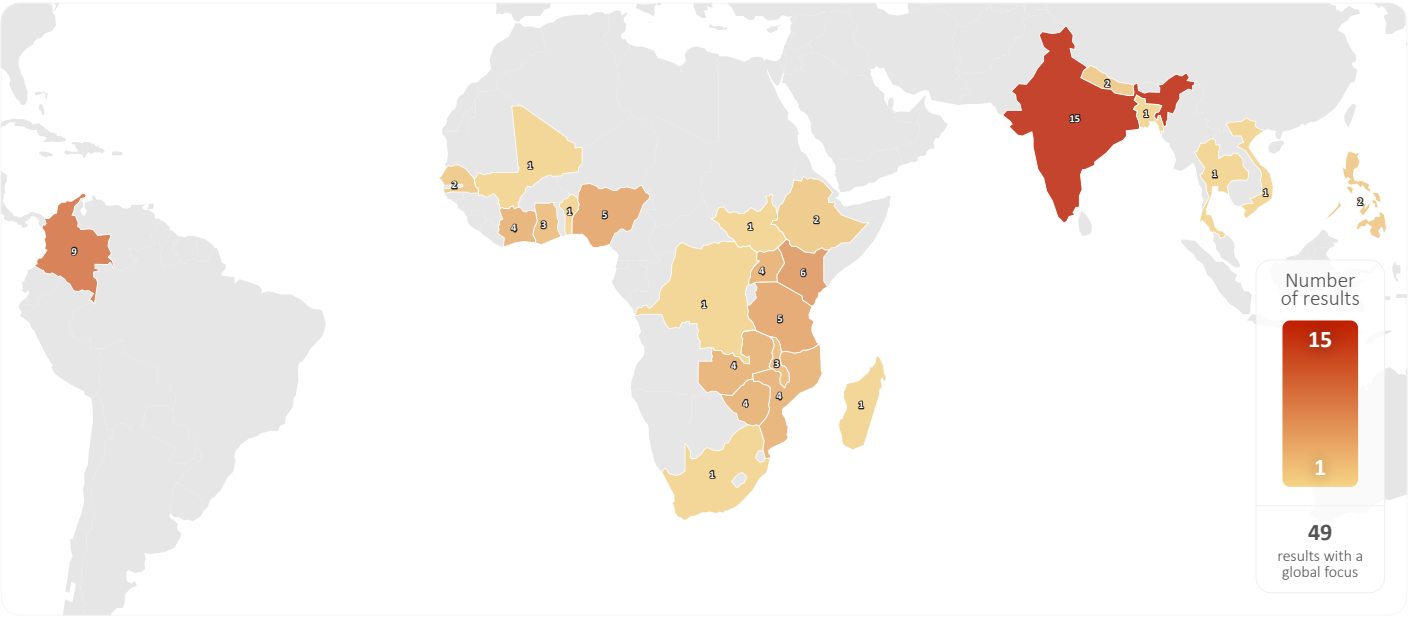
Outputs

- Capacity sharing for development 66
- Other outputs 38
- Innovation development 9
- Knowledge products 3

Outcomes

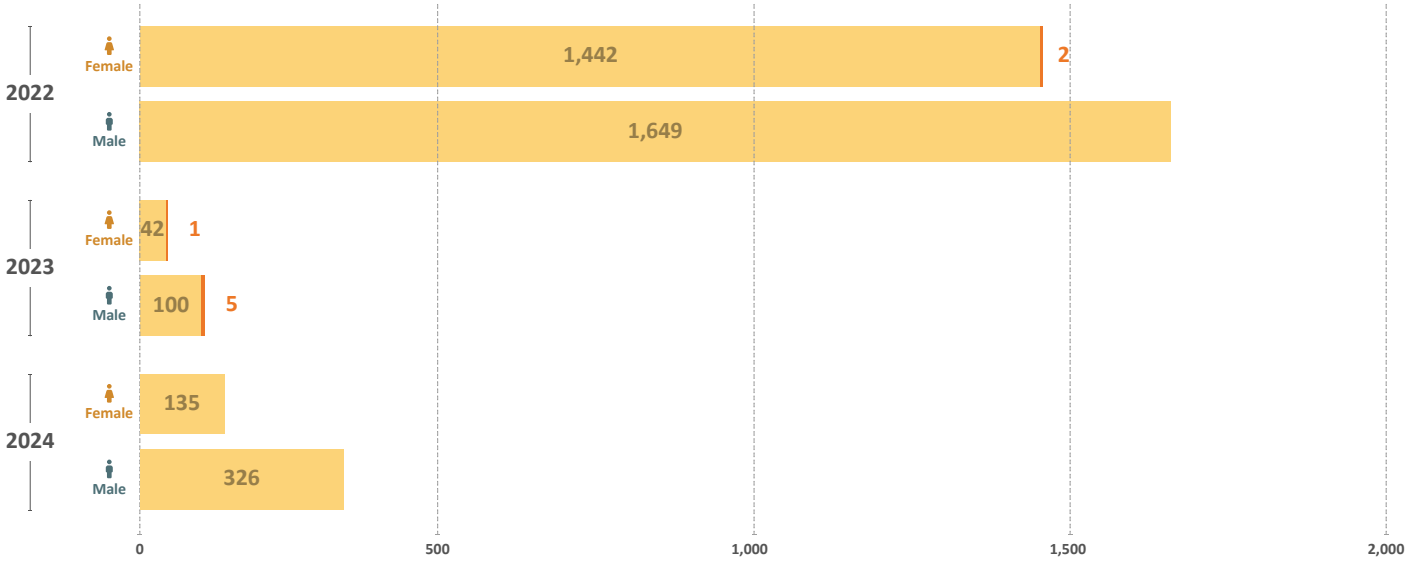
- Innovation use 3
- Capacity change 1

Geographic focus of results



One result can impact multiple countries and can therefore be represented multiple times.

Number of individuals trained by the initiative



Long-term trainees: Long-term training refers to training that goes for three or more months.
Short-term trainees: Short-term training refers to training that goes for less than three months.

CAPACITY BUILDING KEY FIGURES

750
Users registered on EBS LMS

20
Number of countries where BRS organised training sessions

50
CGIAR Centers, NARES and other partners involved

4,400
Single users trained, either in-person or virtually

15,693
Number of participant training hours provided

554
Training sessions registered since launch

GLOBAL SHARED SERVICES KEY FIGURES

444

Genotyping requests submitted since launch

72

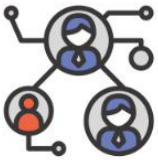
Unique requestors of genotyping services, including CGIAR Centers and partners

26

Institutions using GSS, including 50% of NARES

43

T&N requests addressed since launch



13

Unique requestors of T&N services, including CGIAR Centers and partners

1

T&N support request submitted per month, on average

EBS KEY FIGURES

606

Users with access to EBS

20

Countries supported by EBS Global Users Support (GUS)

8

CGIAR and NARES organizations across 12 crops

4,400

User support tickets processed since launch

15,693

Participant training hours provided

554

Training sessions registered since launch

Stunning scenery of rice terraces in northern Vietnam
Credit: BlueOrange Studio/Shutterstock

Section 5: **Partnerships**

Maize seed qualibration in Kenya.
Credit: Breeding and Research Services

Partnerships and Breeding Resources's impact pathways

Breeding Resources operated through a network of strategic partnerships, as illustrated in the diagram below. Partnerships played a pivotal role in ensuring the effective adoption of the Initiative's services and support. Through these partnerships, Breeding Resources fostered collaboration, knowledge exchange, and resource sharing, which are essential to the development and adoption of services and support. The Initiative also actively sought partnerships with private companies to leverage cutting-edge technologies for the CGIAR-NARES breeding networks to ensure that breeding programs had access to the most effective tools and methods available.

In 2024, through CGIAR's Genetic Innovation (GI) Science Group, Breeding Resources entered into an agreement with IRRI focused on developing, offering, and maintaining global shared breeding services for CGIAR and partner Centers, including genotyping, nutritional analysis, trialing and nursery activities, and digital solutions for breeders. The agreement formalized IRRI's role as a key partner for Breeding Resources. The partnership marked a significant step forward for the Initiative, allowing it to establish connections with influential organizations and receive necessary support for its progress. The agreement represented a formal recognition of the work carried out by Breeding Resources, acknowledged by IRRI, a longstanding partner and advocate for Breeding Resources. This partnership constituted a mutually beneficial collaboration to leverage and expand the scope of the Initiative's work, and it is anticipated to yield benefits for both parties, as emphasized by the signatories. In the same year, a similar agreement was signed with AfricaRice, marking a new partnership for impact that will enhance the effective implementation of the Initiative's services and support in West and Central Africa. Establishing a BRI (Breeding Research Initiative) hub at AfricaRice marked a significant advancement in the Initiative's work in Western and Central Africa and paves the way for future expansion within the continent. This hub will support CGIAR crop breeders and national and regional organizations developing improved crop varieties in the region.

Partnership with users of the Initiative's shared services and support helped to bridge the gap between existing work and new possibilities. It increased the relevance and applicability of shared services and support, making them more likely to be adopted. By involving end users, partnerships helped tailor research outputs to meet their specific requirements. In 2024, Breeding Resources joined forces with IRRI to host a shared services workshop at its headquarters in Los Baños, Laguna, Philippines. The workshop brought together experts, stakeholders, and partners to foster collaboration and enhance understanding of BRS capacities and services. The workshop served as a platform for building stronger networks among NARES, which will ultimately contribute to enhanced breeding efficiency and outcomes in Asia.

Breeding Resources also partnered with private companies to learn and adopt a corporate approach to their work, including

establishing process management, continuous improvement, and a quality management system. These tools and the management system adopted by many private companies proved to be effective in ensuring sustainability in all operations. This partnership led to the development of training programs on LEAN methodologies, which were provided to Centers and NARES partners. Transformative ways of working have resulted in more efficient research outputs and engaged research teams. Partnering with Scriptoria to build the Initiative's LMS yielded a platform aimed at elevating the training experience and its impact across the breeding community in record time. Together with a consultant from Cornell University, the platform was developed based on models from leading agricultural universities and industry partners.

Through change management, partnerships with Breeding Resources facilitated the cultural shifts and institutional reforms required for breeding programs to transform into dynamic multidisciplinary teams of experts. Adoption of modern breeding tools such as genotyping increased the speed of breeding and enabled breeding to meet demands, bringing forward benefits and increasing impacts, as compared to traditional breeding. In Argentina, for example, maize Diversity Array Technology targeted genotyping mid-density genotyping was used to unlock the genetic diversity of more than 500 inbred lines from the National Agricultural Technology Institute's temperate maize (Zea mays L.) breeding program. EMBRAPA, with the support of Breeding Resources, successfully genotyped more than 300 maize elite lines and accessions with the DArTag (Diversity Array Technology) panel aimed at germplasm organization and gene discovery. Using the same panel, breeders from CSIR-Savanna Agricultural Research Institute in Tamale, Ghana, sought knowledge on which maize varieties could tackle the devastating fall armyworm pest in West Africa.

Network of external partners by type

The diagram maps the external partners of Breeding Resources organized by partner type. The numbers in brackets represent the number of results each partner has contributed to, reflecting the scale and diversity of collaborations. To allow for a clearer view, a maximum threshold of eight partners was applied for each typology. The list of partner acronyms is available here.

Section 6: **CGIAR Portfolio linkages**

Participants learning the operation and maintenance of the threshers.
Credit: Breeding Resources

Portfolio linkages and Breeding Resources's impact pathways

Strong linkages between all the Initiatives within CGIAR's GI Science Group are key to achieving the goals of Genetic Innovation. High-performing breeding programs require genetic resources (CGIAR Research Initiative on Genebanks); targeted demand-driven breeding for specific market segments (CGIAR Research Initiative on Market Intelligence); modernized breeding to deliver complex multi-trait varieties (Breeding Resources); partnerships between CGIAR, NARES, and the private sector that link upstream and downstream breeding (Accelerated Breeding); and delivery of genetic gains through seed systems to expand product reach (CGIAR Research Initiative on Seed Equal).

As a provider of shared services and support for breeding programs, Breeding Resources was designed to work seamlessly with Accelerated Breeding. Breeding Resources was fully aligned with the prioritization systems, regions, and crops determined by Accelerated Breeding. Development and provision of shared services and support were tailored to meet the demands of stakeholders, partners, and service clients. Modernized strategies and approaches of both Accelerated Breeding and Breeding Resources generated multiplier effects on the benefits from breeding and seed systems. Improved tools and services enabled breeders to create more complex, multi-trait products that match desired product profiles. Modernizing enabling tools and services increases the speed of breeding, thus shortening research lag and accelerating variety release.

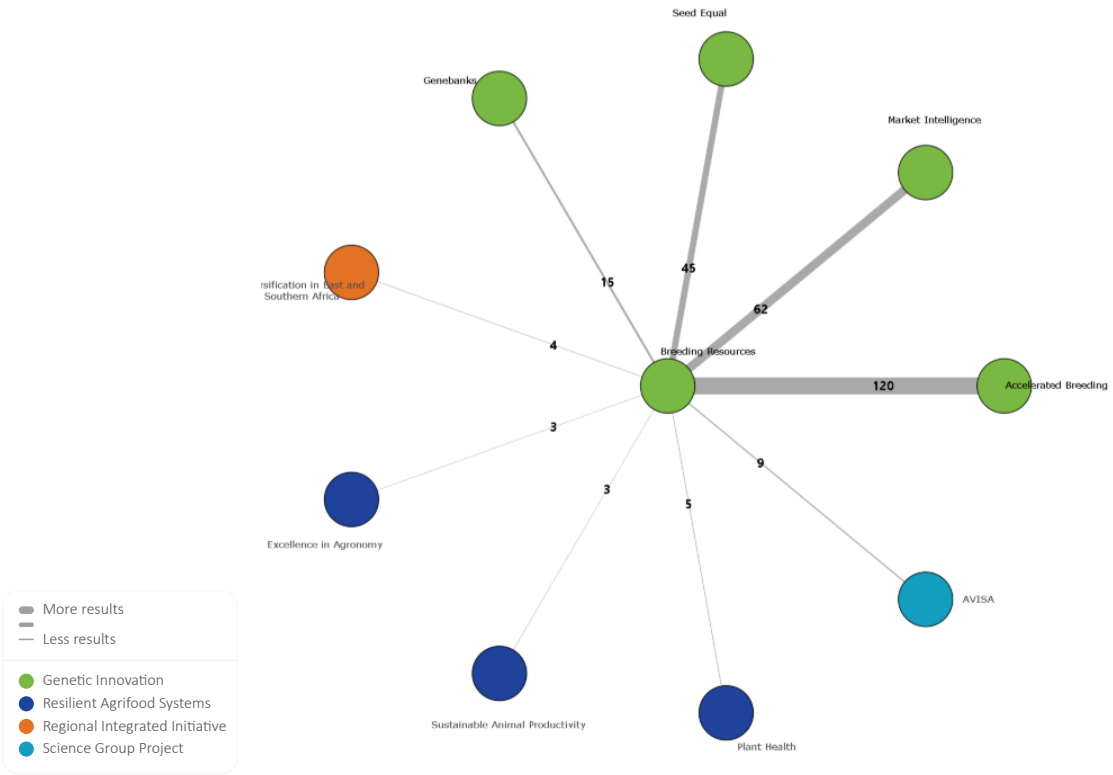
In 2022, a breeding process model was established to link all the GI Initiatives in a way that supports collaboration, deployment, and improvement of GI processes by visualizing the complex relationships between the Initiatives and their work. The breeding process model provided a standard to make all breeding processes transparent, with a structured overview, categorization, and hierarchy. It also detailed the documentation needed as a guiding framework to establish process teams across Centers and crops, thus ensuring that methods, metrics, and collaborative opportunities were harmonized across all Centers. By embracing cross-functional collaboration, sharing knowledge, documenting insights, identifying capacity development needs, and adopting optimal practices, the Initiative created an inclusive and dynamic environment based on learning. Ultimately, this approach saved time, effort, and money. At the end of 2024, Breeding Resources, through its Business Process Management unit, developed 13 SOPs for trialing and nursery operations as part of a multi-year process management effort. These SOPs standardized breeding operation processes across CGIAR Centers, promoting

consistent quality and making it easier to compare data across trials and crops. Standardized SOPs created a foundation for assessing and improving breeding operations. With this framework, Centers can measure progress, identify gaps, and improve resource allocation. SOPs also fostered collaboration among agronomists and enabled CGIAR Centers and national research institutes to work together and adopt the same practices. The SOPs are now freely accessible to CGIAR and national partner staff through the CGIAR Service Request Portal.

Collaboratively produced by Breeding Resources and Accelerated Breeding, Bioflow is another example of how linkages between Initiatives can drive transformative change in CGIAR breeding. Launched in 2024, Bioflow is designed to optimize decision-making in breeding operations. It integrates data from diverse databases and performs advanced analyses, freeing up valuable time and empowering breeders with precise insights. Bioflow features a suite of modular tools, each addressing specific analytical needs critical to crop breeding, while enhancing operational efficiency and reporting accuracy. By streamlining data analysis and fostering collaboration across Centers, the Bioflow pipeline will play a key role in supporting crop breeding and ultimately addressing global food security challenges.

Another example of a successful Initiative portfolio linkage was the development of the Roots, Tubers and Bananas–East Africa Germplasm Exchange Laboratory (RTB-EAGEL), a new facility at the Kenya Plant Health Inspectorate Service (KEPHIS) in Muguga. KEPHIS' tissue culture laboratory focuses on roots, tubers, and bananas (RTB) brought into Kenya, but as demand for its services rose, its screening capacity was limited by an overly small laboratory. Through the Crops to End Hunger (CtEH) program funded by GIZ, the RTB laboratory was rebuilt starting in April 2024. The Breeding Resources team worked with the KEPHIS team and a third-party service provider to help design and build the new facility. Completed in December 2024, the laboratory was equipped with machines and protocols that allowed technicians to clean, certify, and multiply the varieties needed by farmers in East Africa and beyond, much faster than before.

Breeding Resources's internal network of collaborations



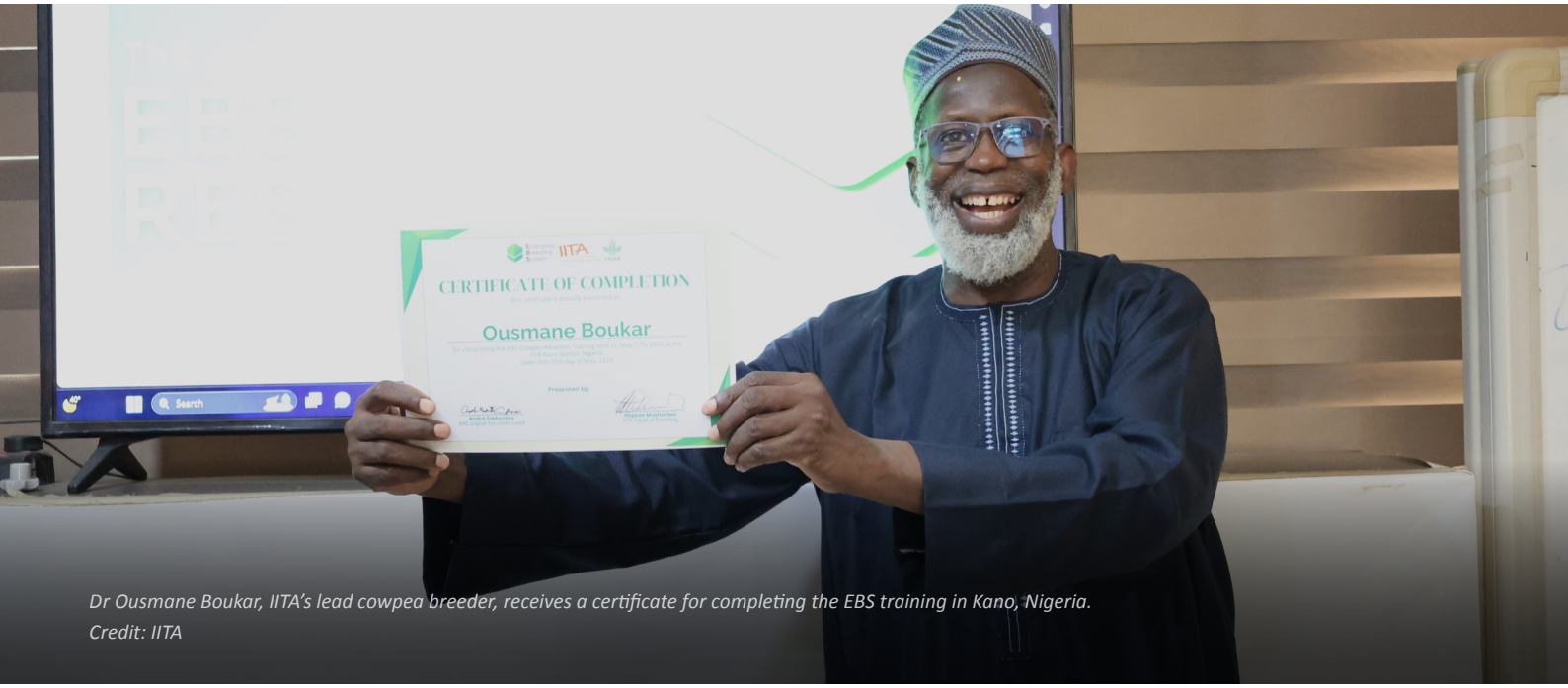
The diagram presents the internal collaborations of Breeding Resources with other CGIAR Initiatives, Impact Area Platforms, and Science Group Projects. Connections are sized according to the number of shared reported results, highlighting the depth of collaboration across the CGIAR Portfolio.

A results threshold filter is applied (set to a minimum of three results) to focus the view on the most significant collaborations. Thicker lines represent stronger collaborative links based on a higher number of shared results.

Section 7: **Key result story**

How EBS advances IITA legume breeding

Enterprise Breeding System (EBS) is a fit-for-purpose tool that enhances IITA cowpea and soybean breeding efficiency and decision-making.



Dr Ousmane Boukar, IITA's lead cowpea breeder, receives a certificate for completing the EBS training in Kano, Nigeria.
Credit: IITA

Primary Impact Area

Other relevant Impact Areas targeted

Contributing Initiative

Breeding Resources Initiative

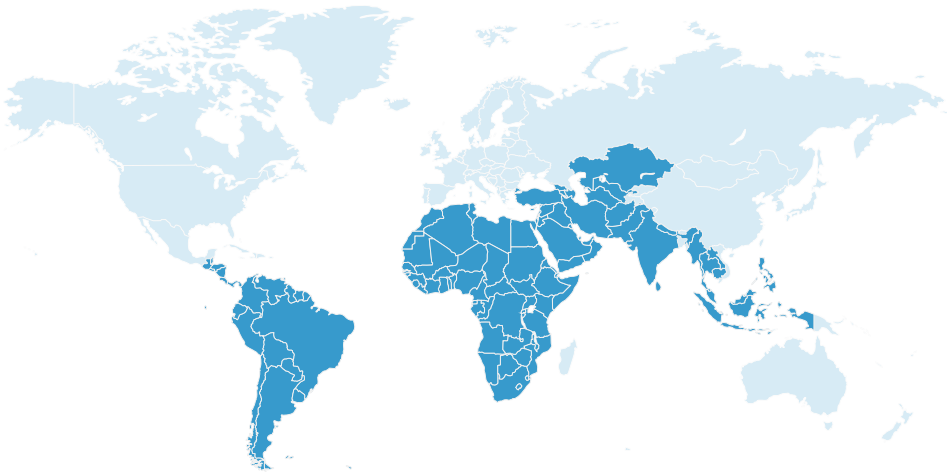
Contributing Centers

IITA, CIMMYT, IRRI

Contributing external partners

Integrated Breeding Platform

Geographic scope



Regions:

Central and West Asia and North Africa · East and Southern Africa · Latin America and the Caribbean · South Asia · Southeast Asia and the Pacific · West and Central Africa

Countries:

Afghanistan · Algeria · Angola · Argentina · Azerbaijan · Bangladesh · Benin · Bolivia (Plurinational State of) · Brazil · Burkina Faso · Burundi · Cambodia · Cameroon · Central African Republic · Chad · Chile · China · Colombia · Congo · Costa Rica · Côte d'Ivoire · Cuba · Dominican Republic · Ecuador · Egypt · El Salvador · Eritrea · Ethiopia · Gambia · Ghana · Guatemala · Guinea · Guinea-Bissau · Guyana · Haiti · Honduras · India · Indonesia · Iran (Islamic Republic of) · Iraq · Jordan · Kazakhstan · Kenya · Kyrgyzstan · Lao People's Democratic Republic · Lebanon · Liberia · Libya · Madagascar · Malawi · Mali · Mauritania · Mexico · Morocco · Mozambique · Myanmar · Nepal · Nicaragua · Niger · Nigeria · Pakistan · Panama · Paraguay · Peru · Philippines · Rwanda · Saudi Arabia · Senegal · Sierra Leone · Somalia · South Africa · South Sudan · State of Palestine · Syrian Arab Republic · Tajikistan · Tanzania, United Republic · Thailand · The Democratic Republic of the Congo · The Republic of the Sudan · The Socialist Republic of Viet Nam · Togo · Tunisia · Türkiye · Uganda · Uruguay · Uzbekistan · Venezuela (Bolivarian Republic of) · Yemen · Zambia · Zimbabwe

The deployment of the Enterprise Breeding System (EBS) at IITA has benefited their maize, cowpea, and soybean breeding programs across Africa. The system includes regular training for breeding teams, ensuring they are equipped with the skills to use advanced breeding data systems, maintaining IITA's leadership in modern breeding and crop improvement, and supporting its mission to improve food security and promote sustainable agriculture in sub-Saharan Africa.

Cowpea and soybean may not be as widely recognized as wheat or maize, but their importance to developing countries is undeniable. For decades, the International Institute of Tropical Agriculture (IITA) has been at the forefront of improving these legume crops. Breeding teams have successfully released high-yielding, climate-resilient (early maturing, pest- and disease-tolerant) varieties of soybean and cowpea across the globe. Now, IITA is taking its breeding programs to the next level by modernizing them, with a particular focus on digitalization and breeding analytics.

As a member of the CGIAR network, IITA implemented the Enterprise Breeding System (EBS), CGIAR's preferred data management platform, across multiple crops. EBS is a breeding data management platform that enhances data accuracy, precision, and analysis capabilities, allowing breeding teams to deliver improved crop varieties more efficiently. IITA deployed EBS for maize in 2022 and is now moving toward cowpea and soybean. The deployment process involved consultations with the breeding teams, development of a new EBS instance dedicated to cowpea and soybean, data migration from various sources and platforms into the new system, and, as a final step, hands-on training. This training covered file preparation for data collection, data capture and uploading, data quality checks, and analysis using tools such as the Data Collection and Phenotypic Data Manager. By systematically capturing and integrating pedigree, phenotypic, genotypic, and trial management data, EBS ensures that all relevant information is accessible to all team members in real time. This leads to better decision-making and more accurate calculations of genetic gains.

Trainees can now effectively navigate and utilize the key features and functionalities of the breeding data management system and configure and customize EBS to suit their specific user and breeding program requirements. They also learned how to create experiments and update experiment management and protocol information, including previewing labels and tags for printouts, managing trial occurrences, and advancing generational nurseries. As part of the training, the EBS team gathered feedback from participants on how to improve the cowpea and soybean data and workflow in production environments, proving that the tool's development is continuous and collaborative. This allowed them, for example, to document crop-specific germplasm nomenclature and printout requirements.

Additionally, EBS integrates with other breeding tools, such as marker databases and the FieldBook app, allowing IITA technicians to collect data in the field and instantly sync it with the system. This improved workflow and automation reduces manual work and minimizes errors, speeds up breeding cycles, and ultimately accelerates the development of improved crop varieties.

EBS not only improves data quality and integrity but also standardizes traits, experiments, crosses, and germplasm nomenclature across breeding programs. This standardization makes it easier to share data and capacity within IITA, across CGIAR breeding programs, and with partners. For example, in West Africa, where IITA has soybean breeding operations in countries such as Benin, Ghana, Nigeria, and Mali, national partners test newly developed varieties.

The EBS package also includes a 24/7 service desk and global user support, allowing IITA teams to submit tickets and receive help whenever they need it. User resources are also available to the entire community, making it a truly comprehensive ecosystem.

Using a unified breeding data management system enables sharing of experimental data and real-time updates, strengthening IITA collective efforts to develop novel soybean and cowpea varieties. This collaborative approach benefits the entire breeding network, improving selection efficiency and ultimately delivering improved varieties to the farmers and processors who need them most.

> EBS is a fit-for-purpose tool that enhances IITA cowpea and soybean breeding efficiency and decision-making, aligning perfectly with our mission to improve food security and promote sustainable agriculture in sub-Saharan Africa.
>
> Hapson Mushoriwa, IITA Head of Breeding, Ibadan, Nigeria

2022 key result story

Maize breeding in Kenya: Helping millions across Sub-Saharan Africa

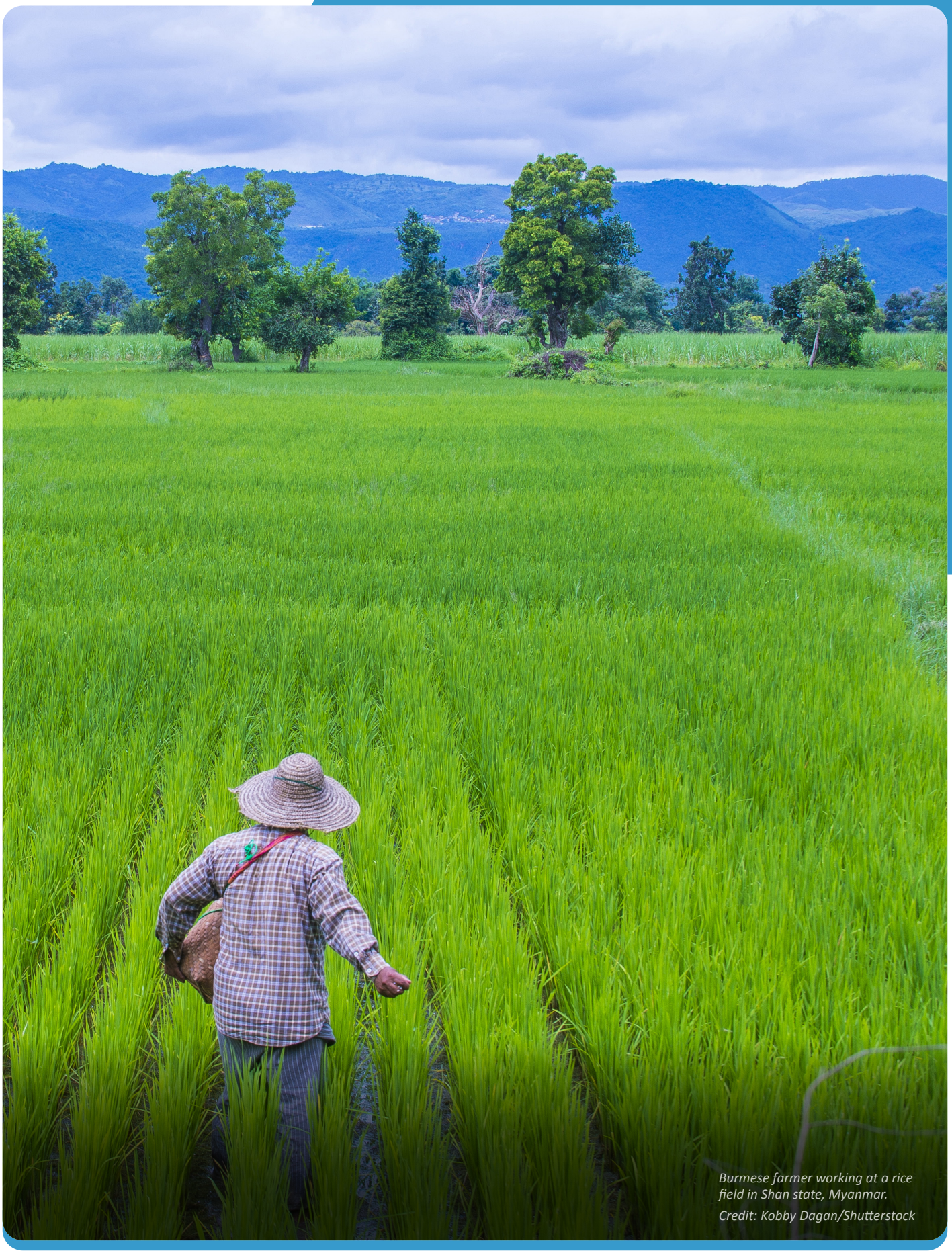
2023 key result story

Three crops in four CGIAR Centers adopt a new breeding data management system to accelerate variety development for smallholder farmers

CGIAR

INITIATIVE ON

Breeding Resources



Burmese farmer working at a rice field in Shan state, Myanmar.

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